U.S. Fire Administration
Working for a fire-safe America

Safety and Health Considerations for the Design of Fire and Emergency Medical Services Stations

May 2018

FEMA

Safety and Health Considerations for the Design of Fire and Emergency Medical Services Stations

April 2018

Mission Statement

We provide national leadership to foster a solid foundation for our fire and emergency services stakeholders in prevention, preparedness and response.

U.S. Fire Administration

Working for a fire-safe America

Preface

This report was developed through a cooperative research agreement between the U.S. Fire Administration (USFA) and the International Fire Service Training Association (IFSTA) at Oklahoma State University (OSU). The IFSTA has partnered with the OSU Fire Protection Publications — a major publisher of fire service training materials since 1934. Through its association with the OSU College of Engineering, Architecture and Technology, the IFSTA also conducts a variety of funded, technical research on fire service, fire prevention, and life safety issues.

The extensive information provided within this report would not have been possible without the dedication and efforts of the following people assigned to this project:

Project Administrator — Nancy Trench; Assistant Director for Research; OSU Fire Protection Publications

Principle Investigator/Writer — Robert Tutterow; Fire Industry Education Resource Organization (F.I.E.R.O.); Charlotte, North Carolina

Editor — Michael A. Wieder; Executive Director; IFSTA

The USFA extends its gratitude to all the individuals and organizations who provided the photographs and illustrations used in this report.

Table of Contents

Chapter 1: Introduction 1
- Station-related deaths 1
- Station-related injuries 2
- Station-related illnesses 2
- General requirements 3
- Using this manual 8
- Basis for this manual 9

Chapter 2: Needs Assessment-Based Planning Process 11
- The design and construction process 11
- The needs assessment 13
- Risk management plan factors 14
  - Risk identification 15
  - Risk evaluation 15
  - Establishing priorities for action 15
  - Methods of risk control 15
  - Other methods of control 15
  - Risk management monitoring and follow up 16
- The building committee 16
- The design team 18
- Selecting an architect 19

Chapter 3: Site Selection 23
- Response time and service delivery 23
- Standards 24
  - Insurance Services Office Public Protection Classification™ rating 24
  - National Fire Protection Association 1710 25
  - National Fire Protection Association 1720 25
- Demographics 26
- Fundamental criteria 26
  - Size 27
  - Public water or well 27
  - Public sewer or septic system 28
  - Electric power availability (three-phase versus single-phase) 28
  - Communications service lines 28
  - Storm water (regional) 28
  - Clearing/Demolition 28

Natural gas 28
Road access 29
Grading/Topography 29
Wetlands 30
Permitting and approvals 30
Condemned property 30
Beware of free sites 31
Future growth 31
Other cautions about site selection 31
Community acceptance 31
Once a site is secured 33
Chapter 4: Overview of Design Process and Applicable Construction Components 35
Design philosophy for fire and emergency services stations 35
Design factors 36
Impact of Emergency Medical Services on station design 38
Type of department and expected response level 38
Specific functions 39
Local geography 39
Community restrictions 40
Flexibility for future requirements 40
Resources 41
Fire and emergency services building design process 41
Site selection 41
Facility programing and functional analysis 42
Facility design development 43
Construction document phase 44
Construction bids and permits 44
Construction 45
Grand opening 46
Applicable construction components 46
Foundations 46
Apparatus bay floors 46
Drains 46
Coatings 47
Expansion joints 47
Structural systems 47
Framing 47
Walls 48

Control joints 49
Roofs 49
Windows 49
Walk-through doors 50
Apparatus bay doors 50
Station parking, ramps and exterior driveways 52
Other exterior considerations 53
Interior design considerations 54
Walls 54
Ceilings 54
Floor finishes 54
Heating, ventilating and air conditioning systems 55
Lighting and electricity 56
Detection and fire suppression systems 56
Training and the fire station 56
Classroom/Online 57
Mezzanines 58
Training tower 59
Chapter 5: Specific Safety Considerations 61
Electrocution/Shock hazards 61
Extent of problem at the station 62
Relevant regulations and standards 63
Preventive design requirements 63
Station grounds 64
Support areas 64
Slips and falls 65
Extent of problem at the station 65
Relevant regulations and standards 65
Preventive design requirements 66
Station grounds 66
Station interiors 66
Floor finishes for fall prevention 67
Stairways and guardrails 68
Slide poles 68
Elevated surfaces 69
Marine areas 69
Falling objects 70
Relevant regulations and standards 70
Preventive design requirements 70

Explosions 71
Extent of problem at the station 71
Relevant regulations and standards 71
Preventive design requirements 72
Hazardous atmospheres 72
Pressurized cylinders and vessels 72
Vehicle hazards 73
Extent of problem at the station 73
Relevant regulations and standards 73
Site layout 73
Drowning 74
Extent of problem at the station 74
Preventive design requirements 74
Natural disasters 74
Extent of problem at the station 75
Relevant regulations and standards 75
Earthquakes 75
Flooding 77
Fire (all types) 77
Extent of problem at the station 78
Relevant regulations and standards 78
Preventive design requirements 79
Fire-resistive construction 79
Fire detection and suppression systems 79
Means of egress 80
Theft, vandalism and violence 80
Relevant regulations and standards 81
Preventive design requirements 81
Department property 81
Personal property 81
Parking lots 82
Chapter 6: Specific Health Considerations 83
Cancer 83
Extent of problem at the station 83
Preventive design requirements 83
Cancer overview 83
Overall design considerations 85
Red zone 85
Yellow zone 86
Green zone (cold/clean) 86

Decontamination 86
Equipment decontamination room 86
Personal protective equipment cleaning room 87
Personal protective equipment drying 88
Personal protective equipment repairing 89
Personal protective equipment storage 89
Respiratory protection room (self-contained breathing apparatus inspection, testing and repair) 89
Fitness rooms 90
Extent of problem at the station 90
Relevant regulations and standards 90
Exercises and equipment 91
Design criteria 92
Hazardous materials 93
Extent of problem at the station 94
Relevant regulations and standards 94
Preventive design requirements 94
All areas 94
Diesel and vehicle exhaust hazards 95
Extent of problem at the station 96
Relevant regulations and standards 96
Preventive design methods 96
Filtration 96
Source capture (hose connection) 97
Source capture (on-board system) 97
Station alerting system 97
Extent of the problem at the station 98
Preventive design requirements 98
Radon exposure 99
Extent of problem at the station 99
Relevant regulations and standards 100
Preventive design requirements 101
Relevant regulations and standards 101
Water source 102
Methicillin-resistant Staphylococcus aureus 102
Extent of problem at the station 102
Relevant regulations and standards 102
Preventive design requirements 102

Specific facility design and furnishings criteria 103
Specific practices to adopt 103
Bed bugs 103
Extent of problem at the station 103
Relevant regulations and standards 103
Preventive design requirements 104
Recommended practices 104
Food and waterborne infections 104
Extent of problem at the station 104
Relevant regulations and standards 104
Preventive design requirements 105
Kitchen 105
Ice machines 106
Restrooms and showers 106
Emergency medical equipment storage areas 107
Water supply cross-contamination prevention 107
Chapter 7: Key Points — Little Things Mean a Lot 109
Initial versus ongoing costs 109
Initial costs 109
Ongoing costs 109
General 110
Exterior 110
Sight lines 110
Access to roadways 111
Transition angles 111
Bollards 111
Driveways and aprons 112
Parking lots 112
Walks 112
Public entry 112
Yard hydrant 112
Dumpster 113
Rainwater collection 113
Storage building 113
Security 113
Interior 113
Flow 113
Entrance lobby 114

Floor coverings 114
Apparatus bay 114
Apparatus bay doors 116
Diesel exhaust capturing systems 116
Bollards 116
Utility closest/sinks 116
Self-contained breathing apparatus cylinder refill stations 116
Kitchen trash cans 117
Slide poles 117
Locker rooms 117
Hand sanitizers and wipes 117
Personal protective equipment storage 117
Laundry (personal protective equipment) 118
Station alerting systems 118
General storage 118
Fires 118
Facility repair and maintenance 118
Fundamentals for a successful project 119
Chapter 8: Compliance and Funding Issues 121
Determining compliance 121
Funding 121
Achieving a safe and healthy work environment 123
Appendix A: Occupational Safety and Health Administration Regional Offices 125
Appendix B: Occupational Safety and Health Administration Approved State Plans Directory 129
Appendix C: Additional Resources 139
Appendix D: Pertinent Occupational Safety and Health Administration Regulations 145
Appendix E: Organizations With Related Standards 201
Appendix F: Sample Monthly Safety Inspection Checklist 213
Appendix G: Sample Safety and Health Design, Construction and Acceptance Check-Off List 217
Acronyms 235

Chapter 1: Introduction

Station-related deaths

The National Fire Protection Association (NFPA) reports that there were 115 firefighter line-of-duty deaths (LODDs) in fire stations for the 10-year period of 2006 to 2015. The causes of death were as follows:

- Sudden cardiac deaths — 89.
- Internal traumas — 14.
- Strokes — 10.
- Suicides — 2.

Included in these numbers are the following incidents:

- Two members struck their heads and passed away after suffering medical emergencies (one from a heart attack and one from a seizure).
- Seven died from falls.
- Four were struck by apparatus.
- One was trapped under an apparatus.
- One died from an explosion.
- One died from a physical altercation with another member.
- One died from septic shock approximately three months after injuring his elbow in a station training session.

The majority of members (66) were engaged in normal activities when their fatal injuries occurred. Cardiac deaths, strokes, seizures and blood clots accounted for 58 of those 66 deaths. Of the internal trauma deaths, two fell from ladders; one died from a leaking propane tank that ignited and exploded; one fell in the kitchen and struck his head on an appliance; one was crushed between the header of the bay door and the rail of an aerial apparatus while attempting to get a piece of equipment that was stuck overhead; and one lost his balance and fell, striking his head on the ground.

The primary activity being conducted during the LODDs was training (32). Cardiac arrest accounted for 24 of these, and five were the result of stroke. Seven members died while performing maintenance activities. One member was crushed against the wall by a brush unit when it lunged forward during maintenance. Another member was crushed while performing maintenance underneath an apparatus, and the jack used to elevate the apparatus failed.

Four members passed away while performing or preparing for community events at the facility. One passed away after falling from an antique apparatus while it was being loaded onto a trailer. Another one passed away from cardiac arrest while doing construction work on a new station, and one was struck by an aerial boom while assisting an insurance adjuster who was inspecting hurricane damage to the station. No specific information was provided on the fourth fatality.

Additional information about fire and emergency services LODDs can be obtained from the following:

National Fire Protection Association
One-Stop Data Shop
1 Batterymarch Park
Quincy, MA 02169-7471
www.nfpa.org
Email: osds@nfpa.org
Phone: 617-984-7451

Station-related injuries

Firefighter and Emergency Medical Services (EMS) personnel injuries at the station are much more common than recognized by the industry. Unfortunately, firefighter injury statistics, specifically for station injuries, are not collected consistently on a national level. However, this information can be obtained for individual departments when injury information is maintained in computer databases that allow location searches. Any analysis of available data gathered on emergency personnel injuries and deaths that occur at the station clearly show there are plenty of opportunities to make changes in the station design.

Most personal injuries at fire and emergency services stations consisted of strains, sprains and lacerations. While these injuries may not be severe, many cause lost time. Some, such as lower back strains, can result in extensive lost time and can be debilitating. A sprain or strain of moderate severity can cost a career department close to $50,000 in lost time, workers' compensation, medical charges, and overtime hiring.

Station-related illnesses

Station-related illnesses are widespread and result from various chemical, biological and environmental exposures. Cancer has become the leading illness in the fire services. Fire and EMS personnel are constantly exposed to carcinogens at the scene of a fire. They also bring particulates back with them. For example, continued exposure to diesel exhaust may partially explain the high incidence of certain cancers among firefighters. The Occupational Safety and Health Administration (OSHA) and other agencies have clearly stated that diesel exhaust is a confirmed carcinogen, but there are additional carcinogens found in stations as well, including polycyclic aromatic hydrocarbons (PAHs), polybrominated diphenyl ethers, and polychlorinated biphenyls. With the rate of cancer in the fire services rapidly increasing, it is no surprise that more states are passing presumptive laws concerning firefighter cancer. As of the end of 2016, 36 states have enacted some form of cancer-presumptive legislation.

Fire and EMS stations also contribute to infectious disease risks. Due to the nature of their work, fire and EMS personnel are at an increased risk of exposure to bloodborne and airborne pathogens. These pathogens can make their way into fire stations that neglect the proper procedures and areas for decontamination/disposal of medical clothing and equipment. One study (Sexton & Reynolds, 2010) showed high levels of Methicillin-resistant Staphylococcus aureus (MRSA) in station furniture, while another study (Roberts, 2014) found MRSA in both apparatus bays and in living quarters.

Fire and EMS personnel are also at an increased risk of noise-induced hearing loss from alarm tones and engine noises in the station. In relation to station noise, station alerting systems contribute to firefighter heart disease. Studies have shown that heart rates are elevated among firefighters responding to alarms. While at the station, a firefighter's heart rate becomes elevated within 15 to 30 seconds after the alarm. One study found that firefighters' heart rates rise near 80 percent of the predicted heart rate maximum during the first 90 seconds following the alarm. A 2016 study by MacNeal, Cone and Wistrom concluded that small but significant decreases in the amount of tachycardic response to station alerting are associated with simple alterations in alerting methods. Station-specific and ramp-up tones improve perceived working conditions for emergency responders.

Some other major health illnesses that may result from the station include reactions to mold, which can cause respiratory illnesses. Exposure to carbon monoxide and diesel exhaust have been shown to increase risk for cardiovascular disease, which may be contributing to sudden cardiac death in firefighters. Also, cellular towers have become a new concern, as they are being placed on fire stations throughout urban areas. Firefighters working in these stations have reported neurological problems, such as headaches, irritability and sleep disturbance.

The U.S. Fire Administration (USFA) recognizes that many emergency response personnel have needlessly died and have been injured because of accidents at emergency services stations. This recognition is further heightened by the rising number of occupational health exposures to emergency responders.

Federal, state and local regulations have endeavored to curb exposures to diesel emissions, noise abatement, indoor air quality, hazardous materials, waste exposure, toxins, and infectious material. These are all exposures that emergency response personnel are subjected to every day they work. Unfortunately, compliance with these regulations is not consistent throughout the fire and EMS communities.

General requirements

Many emergency response organizations are familiar with NFPA standards. NFPA 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program,* defines a fire department facility as any building or area owned, operated, occupied or used by a fire department on a routine basis, that may include fire and rescue stations, training academies, and communication centers **(see Figure 1.1).** Fire department facilities do not include those facilities not normally under fire department control. Chapter 10 of the standard, Facility Safety, requires an organization's facilities to do the following:

- Comply with all legally applicable health, safety, building and fire code requirements.
- Provide facilities for disinfection, cleaning and storage in accordance with NFPA 1581, *Standard on Fire Department Infection Control Program.* NFPA 1581 provides facility requirements for:
  - Hand washing.
  - Food storage.
  - Kitchens.

Figure 1.1 — NFPA 1500 sets the benchmark for fire service safety issues.

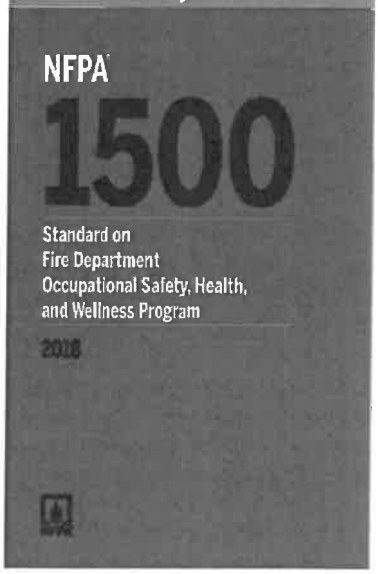

Photo courtesy of Yvonne Smith, NFPA.

- Shelving.
- Bedrooms.
- Bathrooms.
- Equipment storage.
- Personal protective equipment (PPE).
- Contaminated storage.
- Cleaning areas.
- Disinfecting areas.
- Disposal areas.

- Comply with NFPA 101, *Life Safety Code®*, or locally adopted requirements of the building code.
- Provide smoke detectors outside all sleeping areas, in the immediate vicinity of bedrooms, and on every level of the facility, including basements. Also, install smoke detectors in every bedroom, unless the facility has a supervised automatic sprinkler system installed in accordance with NFPA 101. Smoke alarm activation must cause an automatic evacuation signal for the entire facility.
- Be designed with provisions for the ventilation of vehicle exhaust emissions from fire apparatus (and other vehicles) to prevent exposure to firefighters and to prevent contamination of all areas of the facility **(see Figure 1.2).**
- Have carbon monoxide detectors in all sleeping and living areas.
- Have fully-automatic sprinkler system in all new facilities.

Figure 1.2 — A typical apparatus exhaust system connection.

Photo courtesy of Mike Wieder, Stillwater, OK.

- Be a smoke-free facility.
- Prohibit contaminated PPE in any sleeping and/or living area.
- Guards and/or covers for slide pole openings to prevent accidental falls through the opening.
- Be inspected annually to determine compliance with all legally applicable health, safety, building and fire code requirements. These inspections must be documented and recorded.
- Be inspected monthly to identify and document/correct any safety or health hazards.
- Have an established system to maintain facilities and to promptly correct any safety or health hazards, or code violations.

Fire and emergency services organizations are strongly advised to get a copy of NFPA 1500 for complete guidance and explanatory language of the standard's requirements. In addition, the USFA strongly recommends that stations be protected with automatic sprinkler systems.

NFPA 1581, *Standard on Fire Department Infection Control Program,* requires that fire and emergency services facilities comply with all relevant health and infection-control laws and regulations **(see Figure 1.3).** Specifically, the standard requires the following:

- Hand washing:
  - Hand washing facilities anywhere contaminated materials are stored, cleaned, disinfected or laundered.
  - Soap and water are preferred, but if they are not available, you can use waterless cleaners, sanitary wipes or other available skin cleaning products.
  - Hand cleaning should occur prior to members entering living, sleeping and eating areas, if the member has been contaminated with infectious agents.
- Kitchens:
  - All food prep areas and surfaces used for holding/hanging containers and utensils be made of nonporous material.
  - Dish-washing areas equipped with shelving or racks for drip-drying of food containers.
  - Shelving and racks made of nonporous materials.
  - Drainage from shelving and racks designed to drain into the sink or pan that empties into the sanitary sewer or septic system.
  - Kitchens equipped with double-basin sinks or two sinks.
  - A sprayer attachment for the kitchen sink.
  - Sinks, countertops and backsplashes all made of nonporous material.
  - Appliances: range, oven, at least one refrigerator, and a dishwasher.
  - Dishwashers capable of producing to a temperature of 140 F.
  - Food preparation and storage areas meet local health codes.
- Food storage:
  - Perishable food needing cold storage stored at 40 F or lower.
  - Perishable food needing freezer storage stored at 0 F or lower.
  - Foods removed from their original manufactured packaging kept in sealed food containers or wrapped with plastic food wrap.
- Sleeping areas:
  - Minimum of 60 square feet of space per bed.
  - Ventilation, heating and cooling required.
- Bathrooms:
  - Doors, sinks and other fixtures designed to minimize or prevent spread of contaminants.
  - Visible sign reminding members to wash their hands after using bathroom.
  - Meet local health codes.

Figure 1.3 — NFPA 1581 provides direction on infection control programs.

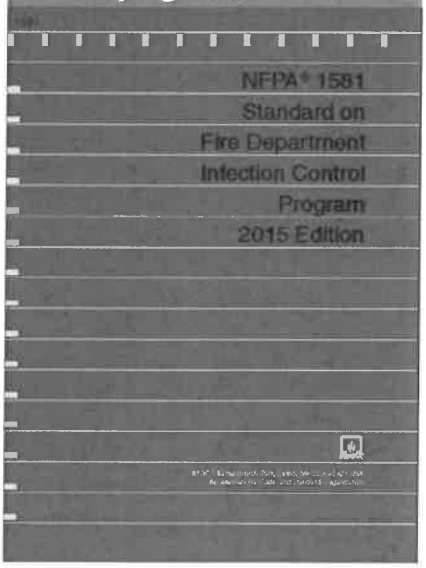

Photo courtesy of Yvonne Smith, NFPA.

- Equipment storage areas:
  - Emergency medical supplies and other equipment should be stored in dedicated and enclosed areas designed to prevent temperature degradation, contamination and other physical damage.
  - Labeled and secured storage area.
  - Open and reusable emergency medical supplies and equipment should not be stored in personal clothing lockers or areas used for the following:
    - Food preparation and cooking.
    - Living.
    - Sleeping.
    - Recreation.
    - Personal hygiene, unless physically separated in locker or room.
- Potentially contaminated PPE:
  - Stored in a dedicated and well-ventilated room.
  - Not allowed in the following areas:
    - Food preparation and cooking.
    - Living.
    - Sleeping.
    - Recreation.
    - Personal hygiene.
- Contaminated storage:
  - Containers or areas for temporary storage of contaminated equipment and EMS supplies isolated from members.
  - Such containers or areas not used for anything else.
- Cleaning areas:
  - Designated cleaning area in each facility for cleaning of PPE, portable equipment, and other clothing **(see Figure 1.4).**
  - Lighted, ventilated and drainage system connected to sanitary sewer system or septic system.
  - Designated cleaning area physically separated from the disinfecting facility and laundry facility.
  - Designated area separated from the following areas:
    - Cleaning of food and utensils.
    - Food preparation.
    - Personal hygiene.
    - Sleeping.
    - Living.

Figure 1.4 — Proper washing equipment for PPE is essential to firefighter health and safety.

Photo courtesy of Jeff Fortney, International Fire Service Training Association (IFSTA)/Fire Protection Publications.

- Disinfecting facilities:
  - If EMS is provided, a dedicated facility should be provided.
  - If in a fire and emergency services facility, the following are required:
    - Lighting.
    - Venting to the outside environment.
    - Drain to sanitary sewer system or septic system.
    - Designed to prevent contamination to other areas of the facility.
  - Disinfecting not allowed in kitchen, living, sleeping or personal hygiene areas.
  - Equipped with racks or shelving to drip-dry equipment.
  - Racks and shelving made of nonporous material.
  - Drainage from racks and shelving flow directly into sanitary sewer system or septic system.
  - If PPE and contaminated uniforms are cleaned in a fire and emergency services facility, a dedicated washer and dryer should be provided in the designated cleaning area.
  - Noncontaminated clothing, bed linens, towels, and other laundry should be cleaned in a separate washer/dryer not located in the designated cleaning area.
- Disposal area:
  - Designated disposal area for regulated waste, including medical waste, not in the kitchen, sleeping, living or personal hygiene areas.
  - Separated from the following areas:
    - Food preparation.
    - Cleaning of food and utensils.
    - Personal hygiene.
    - Sleeping.
    - Living.
  - Separated from the designated cleaning area and disinfecting facility.
  - Locked and secured.
  - Handling, storage and transportation in accordance with all applicable state and local laws and regulations.

Fire and emergency services organizations are strongly advised to get a copy of NFPA 1581 for complete details and explanatory language of the standard's requirements.

Emergency response organizations find it difficult to fully comply with the inspection and maintenance requirements for a number of reasons, including:

- The potentially large number of requirements that can apply to emergency services facilities.
- The lack of organizational knowledge concerning station safety hazards.
- The perception that the station is generally a safer place than the fireground or emergency scene.
- Most importantly, the perceived cost of compliance.

It is imperative that the knowledge base be expanded and that the cost aspect taken into consideration with workers' compensation costs, medical costs, lost time, hire-backs, administrative costs, and insurance costs.

There are a significant number of regulations that apply to fire and emergency services facilities. These regulations may be federal, state, local or insurance-based. Standards, such as those from the NFPA, may not be mandatory — depending on the state or jurisdiction where the facility is located. It is impossible to list all the potentially applicable regulations, and to do so would create an extensively thick and unreadable reference. For this reason, this manual focuses on mandatory, federal regulations (primarily OSHA) which apply to many states within the U.S., and references other standards and regulations as appropriate.

Federal OSHA regulations apply to private sector workers and most federal agencies. Workers at state and local government agencies are not covered by federal OSHA regulations, but have OSHA protections if they work in those states that have an OSHA-approved state program. State OSHA plans are approved programs operated by individual states instead of federal OSHA. OSHA rules also permit states and territories to develop plans that cover only public sector (state and local government) workers.

Using this manual

It is possible to construct a building without identifying what is required by every regulatory agency. Unfortunately, when this happens and problems occur, the structure must be modified after it is occupied and functioning. Not only does this often result in unsafe conditions, but the costs for modifying the station are almost always much greater than if the regulations were considered during the building plans. There have been incidents where new fire stations could not obtain a certificate of occupancy until health and safety issues were addressed. This manual attempts to limit these occurrences by allowing departments to do the following:

- Identify applicable requirements.
- Select appropriate design features.
- Evaluate their compliance for safety and health.

The primary content of this manual is organized into seven more chapters:

- Chapter 2 addresses the planning process. Included in this chapter are roles and responsibilities of the department and its building committee, as well as the design team. This chapter focuses on the needs assessment model to determine department requirements and to identify potential hazards and safety concerns in selecting the site and designing the station.

- Chapter 3 discusses all aspects of site selection and its impact on member safety, as well as safety of the public. There is information on how to work with the community in getting approvals and acceptance for the preferred site. There is also discussion on the potential pitfalls of free sites.

- Chapter 4 provides an overview of general design considerations. Many of the factors described are part of the overall design and construction process; however, specific comments are offered relative to safety and health concerns. Therefore, the principal purpose of this section is to increase safety and health awareness in the selection of specific station designs and features.

- Chapter 5 identifies specific safety concerns at the station. Subsections are provided for each safety concern:
  - Discuss the nature of the hazard.
  - Examine the extent of the hazard and its potential severity at the station.
  - List relevant standards and sources of information.
  - Provide design requirements for preventing or reducing the hazard.
- Chapter 6 identifies specific health concerns at the station, with a special emphasis on cancer risk reduction. As in Chapter 5, subsections are provided for each safety concern:
  - Discuss the nature of the hazard.
  - Examine the extent of the hazard and its potential severity at the station.
  - List relevant standards and sources of information.
  - Provide design requirements for preventing or reducing the hazard.
- Chapter 7 provides a brief description of the small things that can "make or break" the safe and healthy function of a fire and emergency services facility. This section provides a partial overview of some of the key points discussed in additional detail in other chapters.
- Chapter 8 is an overview of compliance of funding issues that confront fire and emergency services organizations.

Basis for this manual

The information presented in this manual was researched through on-site visits to several stations, ranging from rural, to metropolitan, to multipurpose facilities. In addition, materials were gathered through many subject matter experts who routinely give presentations at the annual F.I.E.R.O. Fire Station Design Symposium.

Recommendations included in this publication are specifically directed toward those injury, health and accident concerns associated with activities that occur at fire and emergency services stations. These concerns can be reduced by careful design of new and renovated facilities.

The architect alone cannot design a safe fire station. It takes the involvement and combined effort of the administration and emergency response personnel to design a safe, healthy and functional facility.

Chapter 2: Needs Assessment-Based Planning Process

Adequate planning is the key to a successful station design that addresses all existing and foreseen safety and health hazards. Station planning is an essential step of the design process and should include several individuals who are both inside and outside the department. A fundamental part of this process is conducting a needs and risk assessment. The needs assessment involves identifying specific needs for the construction of the station. When needs are adequately identified, then the group responsible for station planning can research and recommend design solutions that satisfy those needs in terms of economy, and meeting safety and health requirements. This section describes a general station design process, with a specific focus on planning, and provides recommendations for carrying out a general needs assessment.

Organizations should be aware of the five essential elements to the process of planning a new fire and emergency services facility:

1. Property.
2. Architect.
3. Funding.
4. Space allocation.
5. Design issues and considerations.

The design and construction process

The overall design and construction of a fire or emergency services facility involves several steps and can take up to three years to complete. The process will vary from jurisdiction to jurisdiction, but here is an example of how the process might unfold:

- Needs assessment.
- Developing specific spaces and square footage program.
- Issuing a Request for Qualifications (RFQ).
- Short list the design firms that respond to the RFQ.
- Issuing Request for Proposals (RFP) from short-listed firms.
- Interviewing short-listed design firms.
- Selecting the design firm.
- Conducting and discussing additional case studies (optional).
- Revisiting the specific spaces and square footage program.
- Developing design concepts.
- Developing a Schematic Design (SD).
- Design development.
- Construction documents.
- Bidding the project.
- Construction contract administration and construction observation.
- Building acceptance and certificate of occupancy.
- Post-occupancy evaluation.

Figure 2.1 — Modern fire stations feature wide-open apparatus bays with drive-through capabilities.

Photo courtesy of Mike Wieder, Stillwater, OK.

The actual design of a station or facility takes place once the need for a station has been identified and established by the local government and/or fire department leadership **(see Figure 2.1).** The first step in this process is to appoint a building committee. The building committee is generally appointed to determine many of the details required in developing a facility design and to oversee the design/construction process. The actual design process is carried out by the design team that consists of the architect and other experts in building design. The design process begins once an architect is chosen. The components of a design team should include the following:

- Fire and emergency services administration — The administration of the organization or a governing authority decides on the need for a station based on department operations and community expectations. A department official, such as the department chief or a member of his or her staff, appoints a building committee.
- The building committee — conducts all or part of the needs assessment to determine requirements for the station design. The building committee's primary responsibility is to oversee both the design and construction process by interacting with the design team and contractor.
- The design team — prepares the detailed station design based on requirements of the department through interacting with the department administration and/or building committee. The design team translates the department needs and requirements into a specification from which the contractor can build the station.

While the above descriptions represent one possible relationship between the groups involved in designing the station, there are several variations of this process. For example, the degree to which the department defines its needs can be split between the department

administration or the building committee. In some cases, organizations may depend on outside specialists or consultants. Larger departments or departments which are part of the local government may have groups (i.e., standing building committees) already established with these responsibilities.

The specific process for how fire and emergency services organizations, local governments (or other department authorities), architects, and construction engineering firms interact to develop a specific station design varies, especially in the consideration of safety and health regulations, building codes, and other specifications.

In all cases, the design process should start with a needs assessment of the community, the organization, and their expectations. Fire and emergency services administrators should endeavor to provide the best facility with their available budget, in terms of meeting the priorities established in the needs assessment, particularly those related to safety and health. The location of the structure (with consideration of the community's growth) and response time, plus the enhancement of total coverage with existing or neighboring stations, are paramount features in new station design.

Details should be handled by a team of individuals representing various areas of expertise related to the design project. The team should include at least one individual who is knowledgeable in emergency responder safety and health standards and regulations.

The planning phase of fire and emergency services facilities is a complicated task and requires close cooperation among all parties involved, particularly in the early stages when organizational station needs are identified.

The needs assessment

The first consideration of facility planning should be a needs assessment of the community and department to list specific requirements for the station in terms of the following:

- Station capabilities **(see Figures 2.2a and 2.2b).**
- Equipment (e.g., apparatus) accommodation.
- Member safety and health.

Figure 2.2a — Some fire stations that house only a few pieces of equipment and personnel are relatively small structures.

Photo courtesy of Mike Wieder, Stillwater, OK.

Figure 2.2b — Fire stations that serve a variety of purposes, including emergency response, administration, emergency management, and public education, can be expansive structures.

Photo courtesy of Mike Wieder, Stillwater, OK.

The station's needs assessment should begin with community expectations and operational needs, which can be broken down into more specific requirements. For example, a general need might be to accommodate an engine company and an EMS company at the same station. A specific need within this general need is to provide a bay capable of housing two apparatus and an EMS vehicle. As will be explained in later sections, there are several factors to be considered. The building committee or other responsible group must clearly define these needs and, where possible, quantify their requirements.

There are several valuable sources of information that should be consulted during the process of defining specific needs for the design and construction of a station:

- The department's own history with existing stations — a review of existing stations' capabilities, equipment accommodations, and personnel safety and health can point to aspects of the design that work and those that do not.
- Regularly attending educational symposia, such as the F.I.E.R.O. annual Fire Station Design Symposium (www.fierofirestation.com).
- Seeking advice from neighboring departments, as well as departments in the region and across the nation.
- Reading articles in periodicals (both in print and online).
- Hiring a consultant who specializes in fire and emergency services planning and design.

The needs assessment must include a risk assessment that identifies safety and health requirements. Annex D of NFPA 1500 provides excellent guidance on how to conduct a risk assessment, as well as a sample risk management plan. The risk management plan includes the following:

- Risk identification.
- Risk evaluation.
- Establishing priorities for action.
- Methods of risk control.
- Other methods of control.
- Risk management monitoring and follow up.

It is important that health and safety features be a principal part of the design process. Lack of these features will cause member injuries, health issues and deaths. The old adage of "pay me now or pay me later" is appropriate for this situation. Risk factors that NFPA 1500 recommends and should be considered are as follows.

Risk management plan factors

These have been adapted from NFPA 1500 (2018 edition), Annex D, "Risk Management Plan Factors."

Risk identification

List potential problems for every aspect of fire department operations at the station. The following are examples of sources of information that may be useful in the process:

- A list of the risks to which members are or may be exposed.
- Records of previous accidents, illnesses and injuries (both locally and nationally).
- Facility and apparatus surveys, inspections, etc.

Risk evaluation

Using the following two questions, evaluate each item listed in the risk identification process:

1. What is the potential frequency of occurrence?
2. What is the potential severity and expense of its occurrence?

The following sources of information should help set priorities in the risk control plan:

- Safety audits and inspection reports.
- Prior accident, illness and injury statistics.
- Application of national data to the local circumstances.
- Professional judgement in evaluating risks unique to the jurisdiction.

Establishing priorities for action

Knowing the frequency and severity of risk occurrences serves as a tool for establishing priorities. Low frequency/High risk occurrences deserve immediate action. Nonserious incidents with a low likelihood of occurrence are a low priority and are placed near the bottom of the action required list.

Methods of risk control

Once the risks are identified and evaluated, determine which controls should be implemented and documented. The two primary methods of controlling risk, in order of preference, are as follows:

1. Wherever possible, totally eliminate/avoid the risk or the activity that presents the risk. For example, if the risk is falling on ice, then do not allow members to go outside when icy conditions are present, unless it is absolutely necessary.

2. Where it is not possible or practical to avoid or eliminate the risk, take steps to control it. For example, in the above situation, apply sand or absorbent on the ice.

Other methods of control

These include, but are not limited to the following:

- Safety program development, implementation and enforcement.
- Standard operating procedures development, dissemination and enforcement.
- Training.
- Inspections.

Risk management monitoring and follow up

Periodically evaluate the selected controls to determine if they are working satisfactorily. If not, identify and implement new control measures.

Once department needs have been projected and regulatory needs are identified, the assistance of an architectural firm (or design team) can be obtained. The design team will provide the department with preliminary drawings for reviewing department concepts and compliance with regulatory agencies. In many cases, the building committee serves as an interface between department hierarchy and the design team.

The building committee

As the interface between the fire and emergency services organization and the design team, the building committee serves an important function in ensuring that department needs are met. The degree of autonomy provided to the building committee will depend on the individual organization. In addition to supervising the design/construction process, building committee responsibilities can include the following:

- Completing the needs assessment.
- Choosing the architect.
- Monitoring the project's schedule and budget.
- Making recommendations or decisions for approving changes.

The design or redesign of existing facilities can have several different groups or individuals represented on the building committee:

- Administrative staff.
- Organization's health and safety officer.
- Emergency response personnel.
- Labor representatives (if department personnel are represented by a union).
- Local officials involved in planning.
- Local officials involved in budgeting.
- Maintenance personnel.
- Code and regulation personnel.
- The community.
- Special consultants.

Each of these groups and individuals have their own perspective on the design of a facility and will want their own specific needs addressed. The constraint faced by each group is the limitation of funds available for building the station. Therefore, the attainment of each objective is often a function of how these funds are allocated for the facility's construction.

Ideally, the department should choose qualified individuals to serve on the building committee. While some representatives are likely to be selected based on their current positions within the department or part of the community government (for nonvolunteer departments), organizations should assign individuals who have some expertise in construction principles, designs, techniques and budgets, since changes identified early in the process are much easier to correct. In addition, a desire to learn and become educated on the unique facets of a fire and emergency services facility will help provide a better outcome.

Roles of the groups and individuals represented on the building committee:

- Administration staff — The organization's administrative staff should be able to provide a historical overview of what has worked and what hasn't worked for the department. They will also be keenly aware of how the station must function to meet overall department operational needs. They should also be aware of the impact on response times based on the location of the facility.
- Health and Safety Officer (HSO) — The organization's HSO will have data on injuries that occur in the facility and on the facility property, and can identify features to minimize injuries and possible death. This individual also has a focus on design and furnishings that are often over-looked in the design and construction process.
- Emergency response personnel — Members who must live and/or work in these facilities should have an active voice in the design process and will provide the most beneficial information. These individuals know what it takes to make the structure work both functionally and comfortably. Studies have proven that firefighter comfort greatly influences their productivity. Members are often the ones who are quick to identify deficiencies.
- Labor representatives (if the organization has a labor union) — The local union will also speak for the line personnel and try to obtain as many features as possible for increasing their safety and comfort. They have health and safety resources, and they can obtain resources that can bring valuable information to the process.
- Local officials involved in community planning — Community planners will need to be involved on the front-end to make sure the site location is best suited for future planned growth and possible changes in demographics.
- Budget personnel — Budget personnel typically want the most economical structure for meeting their budget. They may not have projected funds to cover features based on requirements from voluntary standards. Arguments should be made to justify these additional requirements by showing improved safety and decreased organizational costs (in a cost-benefit analysis). Failure to comply with existing federal, state or local requirements during the initial planning process will usually add greater costs later when modifications are required. Therefore, part of the cost-benefit analysis should show how higher payouts in future years will occur if certain requirements are overlooked in the initial design process.
- Maintenance personnel — Personnel responsible for the maintenance work will examine station design in terms of longevity and maintenance concerns. They will also make sure that utility service areas are accessible and building components are compatible with other building components within their realm of responsibility.
- Code and regulation personnel — Code officials should be involved during the facility design process. The structure must meet all applicable codes and ordinances, typically those found in the uniform building and fire codes. There must be a clear need demonstrated by the fire and emergency services organization to meet these requirements by performing a cost-benefit analysis and showing the potential liability to the organization if the codes are not followed.

- The community — Community involvement, especially from the very beginning of the process, is crucial. Citizens will want to ensure that the station does not affect the local community in detrimental ways, such as providing pedestrian safety hazards, noise, or an appearance inconsistent with the aesthetics of the neighborhood. Noise and aesthetics are especially important to the neighborhood. Their participation in the building committee is essential. It bears repeating that the interior of the facility belongs to the organization, but the exterior belongs to the community.

- Special consultants — The idea of a hiring a special consultant should not be summarily dismissed. He or she may be hired for any number of reasons: to assist during the design process with some special need, or to provide a general understanding to help fire and emergency services departments who are not familiar with the intricacies of a fire and EMS facility that is safe, healthy and functional. It must be understood that the design and construction of emergency response facilities is a once-in-a-lifetime occurrence for many communities. Larger organizations also have frequent turnover in personnel assignments, and there is little continuity from the design and construction of one facility to the next.

The design team

The design team will consist of the architect and other experts who translate specific emergency response department needs and requirements into a set of plans from which a contractor can build the station. In most cases, the design team will at least include an architect and other design specialists from outside the department, but it is possible that some larger organizations will have an in-house facilities design staff with their own architects and other experts.

Depending on the size of the architectural firm and the resources available to the department, several specialists representing different areas of expertise may be required. In addition to the architect, station design can conceivably require a design team for the following specialties:

- Civil engineering.
- Structural engineering.
- Mechanical engineering.
- Plumbing engineering.
- Electrical engineering.
- Acoustical engineering.
- Lighting.
- Communications/Station alerting.
- Hardware.
- Information technology.
- Space planning.
- Interior design.
- Industrial hygiene.
- Infection control.
- Community relations.

Larger architectural firms will already have specialists in many of these areas. Other architects may be required to hire advisors or other architectural firms representing these areas.

The mechanical, electrical and plumbing engineers (referred to as MEP) are especially critical. In post-occupancy, shortcomings in these systems are often the most problematic. However, spotting these deficiencies during construction can be difficult. It is important that the MEP have excellent references.

Selecting an architect

The choice of an architect is of critical importance. It is imperative that the architect have experience with fire and emergency facilities design, especially in the areas of member health and safety. The role the architect will perform on your project is similar in nature to a battalion chief's role on an emergency scene. The architect will take command of the project; orchestrate the supporting consultants; provide schedules, milestones, deadlines and budgets; and lead the overall design of your project's requirements. The architect should also be a part of the construction oversight team during construction to ensure the organization gets what it requests.

The architect will be the primary contact for the organization, which is referred to as the "client." He or she needs to have a close relationship with the client, as this project (design and subsequent construction) will take years to accomplish. The organization needs to establish a "team" for the architect to interact with. The team will need to provide some basic, yet specific, information for the architect to base their design decisions on. The team will also need to be able to provide plan reviews to ensure the architect is accurately accomplishing the project objectives.

The architect must be a leader; have a background in "commercial" architecture, design and construction (not residential); and have an extensive background in fire and emergency services facilities' design and construction. The architect's "team" must also have experience in design and construction. The architect's team consists of civil, structural, plumbing, mechanical and electrical engineers. Any one of these trades can have detrimental effects on the project if their understanding of emergency services facilities is limited. The organization's relationship is primarily with the architect, but that does not lessen the need for experienced engineers.

If the department has previously used or hired a "designer" who has performed well in the past, then their services could be considered, possibly as a consultant or coordinator acting on behalf of the organization. However, this entity should still be vetted for qualifications as there could be conflicts of interest. Likewise, architects with no experience in fire station design should be avoided, simply because the learning curve is too great.

An interesting analogy is to think of this process like a medical procedure. People want to go to a physician who is qualified (i.e., a specialist) to treat their specific condition. Architects also have "specialized" areas of expertise. For example, an architect who specializes in hospitals, schools or commercial buildings will not understand the complexities of a safe and healthy fire and emergency services station.

Always pay attention to the architect's proposal, including:

- Support staff.
- Consulting engineers.
- Project experience.
- Specific types of project completed.

In addition, contact the general contractors who have built the architect's projects. Their insight into the quality of the drawings, the personality of the architect, and the overall constructability of the project can be a strong tool in the selection of a qualified architect.

Architects with fire and emergency services facilities experience understand how to reconcile an organization's wish list with the realities of the design and physical construction techniques that translate the information into a realistic budget. The architect's job and primary function is to design a building, which meets or exceeds the organization's specific needs, while using their skills to blend the facility into the community.

The architectural firm must be involved as early in the process as possible. They can take on every aspect of the project from property selection and evaluation, to handing over the keys at construction completion. They can be an aid in establishing a realistic budget, timeline, partners (law enforcement, city hall, public works, etc.) and other potential relationships.

Occasionally, local jurisdictions will insist on using a local architectural firm. Most architectural firms have no experience in designing fire and emergency services facilities. If the firm has no experience, it is imperative that the firm "joint venture" with a firm that has experience to ensure that local rules or ordinances are being met while providing the specific project design needs that the organization requires.

Overall, the organization must support the selected architect and have confidence in their choice. The organization must also be an active participant in the process and must maintain a select group of staff capable of seeing the project through to completion; decision-makers who have the support of the department can proactively work directly with the architect. A quality architectural firm will meet at least the following qualifications:

- Demonstrate successful performance in the design and construction of at least five fire and emergency services facilities.
- Familiarity with government contracts.
- Be versed in commercial projects, preferably public sector projects like fire or police stations, libraries, civic centers and city halls.
- Be registered in the state or jurisdiction where the department resides.
- Be a member of the American Institute of Architects (AIA) (preferred, but not required).
- Be familiar with the NFPA, nationally recognized emergency response standards, Insurance Services Office (ISO) classification, organizational accreditation, and all-hazards response.
- Be familiar with *Leadership in Energy and Environmental Design* (LEED) and the U.S. Green Building Council (USGBC) design standards. Although certifications in these areas are desired, they cost money to achieve. The architect should be able to design a facility that meets or exceeds the certification requirements for LEED and the USGBC, regardless of actual certification credit.
- Have a staff with expertise in the unique aspects of an emergency response facility.
- At least five valid references from other fire departments and the contractors who built their facilities.

Even though the architect will carry the primary responsibility for the station design, there are several other entities, not previously mentioned, that may need to be involved. These typically include other parts of the city or county organizations, such as the finance department, legal department, accounting office, equal employment office, health department, real estate, public works, streets department, and the office of construction and land use. In the case of volunteer fire departments, this may include the board of trustees or community representatives. When each of these groups can cohesively work together, the acceptance of the project is enhanced, the project remains within budget, and the community and department are able to meet their expectations.

It is always wise to involve the community early and often. For example, hold public meetings at a local library or school where the team can be introduced and the project can be proposed. Then, meet again to display and discuss design themes and concepts. And finally, meet again prior to commencing with construction activities. Be transparent, positive and proactive. The architect should be able to lead these discussions and provide all the graphics, presentation boards and any other project-related information. The organization will need to provide the reasons for the project, the budget amounts, and the response time criteria.

Finally, fire and emergency services organizations will need to consider the variety of project delivery methods available to acquire the services necessary for the design and construction of the project. The most common methods:

- Design-bid-build — The architect provides the design, the project is advertised for bids from contractors, then the lowest qualified bidder "builds" the facility.
- CM@R or Construction Manager at Risk — The architect begins the design, and the department advertises for general contractor services based on experience only. Then, as the design progresses, the general contractor is on board and works directly with the architect to provide feasibility input and more accurate cost estimating. As the project nears construction, the general contractor provides Guaranteed Maximum Prices (GMPs). GMPs are the bids from the specific trades that the general contractor will oversee to build the facility. These are shared with the project team. The project team can then select the subcontractors based on their bid, their qualifications, or combinations thereof, to establish the actual construction costs.
- Design-build — A method of project delivery in which one entity, the design-build team, works under a single contract with the fire and emergency services organizations (project owner) to provide design and construction services. This is typically a "joint venture" between the general contractor and the architect, and it is typically a performance-based selection process where the team has collaborated on projects of similar types together. It is common for the contract to be with the general contractor, and the architect is then working for the contractor. In this instance, it is also imperative that the contractor has considerable fire and emergency services project experience.

Chapter 3: Site Selection

It has been said that these are the two most difficult things about fire stations:

1. Trying to put a station in a community.
2. Trying to take a station out of a community.

Site selection can be a challenge to any organization. There are multiple considerations for selecting a site. The two up-front considerations are finding a site location that optimizes the response time and service delivery, and getting community acceptance. Poor site selection can result in poor service delivery and additional costs that could be applied to aiding the organization's most valuable asset — its members, specifically their safety and health.

Response time and service delivery

In almost all cases, service delivery is the fundamental concern of any site selection. Response time is always a concern if a community is experiencing any of the following:

- Expanding or filling in its geographical area.
- Adding an in-fill station to take a workload off existing station(s).
- Relocating an existing station.

Fire and emergency services organizations have two methods for justifying the need for a new station that are based on service delivery and response time. The first method is time and distance. A common response benchmark is for an organization to respond to 90 percent of emergency calls within eight minutes. Using response time data, the department can identify where it is not able to meet this benchmark, and it can therefore justify the need for an additional facility.

There are several software packages available on the market which measure and show response distances on maps. Typically, the software integrates with existing Geographic Information Systems (GISs) to create maps. Response time software varies from being general and relatively cheap to expensive and very specific. While these are very valuable tools for developing qualitative data, there is no substitute for a fire and emergency services leader's knowledge of their jurisdictions.

If software is not an option, the manual method may work quite well. Response time is calculated by multiplying the average speed of fire apparatus by the distance being traveled. For example, traveling 4 miles at 30 miles per hour equals an eight-minute response time. Fire and emergency services organizations can do GIS functions by hand with a large-scale map, a measuring wheel, and a few highlighters. Either way, a map showing response problems is a valuable tool.

The second method for justifying the need for a fire station is to establish a criterion on the number of calls to an area within a given time — say, when there are more than two calls per day in an area, a station will be required. Workload criteria may backfire, however, if a problem arises from a long response into a remote area.

Standards

The ISO Public Protection Classification (PPC™) is an evaluation program that classifies public fire protection on a scale of one to 10. Some areas of the country, and some insurance companies, use past losses in the region to base their fire insurance fees. However, there are over 50,000 protection areas in the U.S. that use the ISO PPC classification rating.

Departments are strongly advised to check the requirements of the two deployment standards from the NFPA. While NFPA standards are not law, and their adoption is up to the authority having jurisdiction, they are considered a standard level of care and can be used for or against fire and emergency services organizations.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, covers career departments, and NFPA 1720, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments,* covers volunteer departments.

Insurance Services Office Public Protection Classification™ rating

An excellent ISO PPC rating, especially a rating of one, not only reduces fire insurance rates for many in the country, but it is also a sign of an organization that provides a high level of protection, and is a source of pride for the community and the organization. Organizations that receive a rating of one almost always proudly display this rating on their facilities, their fleet, and other items, such as letterheads, uniforms, etc.

ISO PPC determines the classification of a fire department through field visits to assess the fire protection infrastructure. They rely heavily on nationally recognized standards, such as:

- The NFPA.
- American Water Works Association (AWWA).
- Association of Public-Safety Communications Officials.

The classification system is based on points, with the maximum number of points being 105.5. The allocation of points is broken down into the following areas:

- Fire department — 50 points:
  - The first-alarm response, such as number of firefighters, number of engines, number of ladders, number of service companies.
  - Use of automatic aid.
  - Equipment carried on apparatus.
  - Pumping capacity.
  - Reserve apparatus.
  - Training.
  - Operational considerations.
- Water supply — 40 points:
  - Community water supply system.
  - Hydrant placement.
  - Hydrant size, type and placement.
  - Hydrant maintenance.

- Emergency communications systems — 10 points:
  - Communications facilities.
  - Support for the system.
- Community risk reduction — 5.5 points:
  - Fire prevention code adoption.
  - Fire prevention code enforcement.
  - Public safety education.
  - Fire investigation.

National Fire Protection Association 1710

NFPA 1710 for career departments has more stringent requirements than does NFPA 1720 for volunteer departments **(see Figure 3.1).**

NFPA 1710 requires the following:

- Turnout time for fire responses — 80 seconds.
- Turnout time for emergency medical responses — 60 seconds.
- For the arrival of the first engine at a fire-suppression incident — 240 seconds or less.
- For a high-rise response — 480 seconds or less for the first full-alarm assignment for a fire-suppression incident.
- For high-rise fire incidents — 610 seconds or less for the first full-alarm assignment.
- For a unit with an automatic external defibrillator (AED) — 240 seconds or less.
- For an advanced life support unit, provided the organization has a responder with an AED or a basic life support on the scene within 240 seconds — 480 seconds or less.

The number of personnel required to mitigate an incident is based on a task analysis as described in the standard. Fire and emergency services organizations are strongly advised to get a copy of NFPA 1710 for complete details and explanatory language of the standard's requirements.

Figure 3.1 — NFPA 1710 sets requirements for career fire departments.

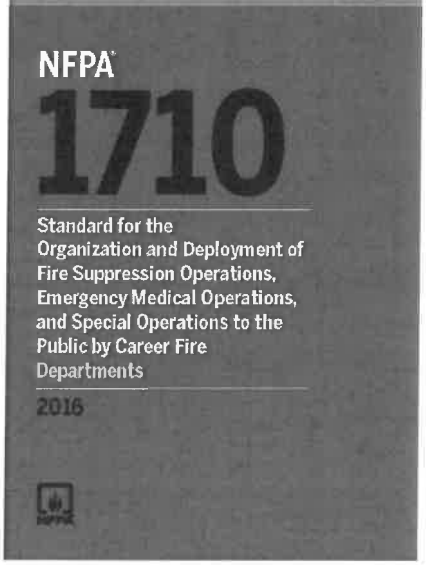

Photo courtesy of Yvonne Smith, NFPA.

National Fire Protection Association 1720

NFPA 1720 contains the following requirements for volunteer departments **(see Figure 3.2):**

- For urban areas, there must be minimum available staff of 15 people to respond, with a response time of nine minutes, which is met 90 percent of the time.
- For suburban areas, there must be a minimum available staffing of 10 people to respond, with a response time of 10 minutes, which is met 80 percent of the time.

Figure 3.2 — NFPA 1720 sets requirements for volunteer fire departments.

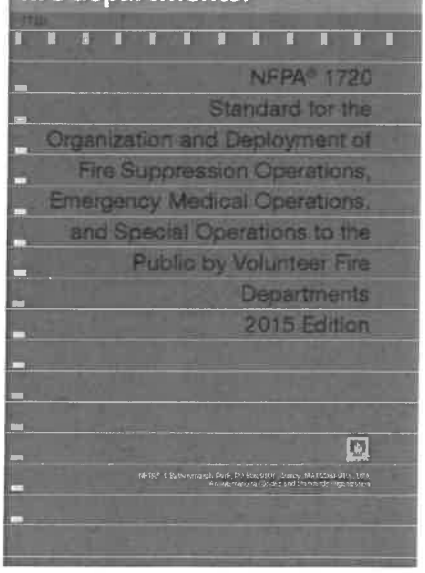

Photo courtesy of Yvonne Smith, NFPA.

- For rural areas, there must be a minimum available staffing of six people to respond, with a response time of 14 minutes, which is met 80 percent of the time.
- For remote areas, there must be a minimum available staffing of four people to respond, with a response time strictly dependent on the travel distance, which is met 90 percent of the time.

The response time requirements of these standards will assist the department in assessing and clarifying its needs. The standard applies to both fire and EMS responses. Fire and emergency services organizations are strongly advised to get a copy of the appropriate standard for their type of department for complete details and explanatory language of the standard's requirements. The standards may also be viewed online, free of charge, at www.nfpa.org.

Demographics

The demographics of a community can play a role in site selection. Population density typically has a direct bearing on the number of responses an organization will have from a designated site. For example, multifamily housing areas will create a higher number of responses than single-family housing areas.

Hospitals, nursing homes, assisted living centers, and other facilities with special life-safety hazards must factor into an organization's site selection. Other factors:

- Heavy-rail and light-rail lines that might disrupt an organization's response.
- Drawbridges that might disrupt an organization's response.
- Rush-hour traffic.
- Interstate highway access.
- Special community events.
- Seasonal population variances.
- One-way streets.
- Bridges with low-weight capacity.

Fundamental criteria

A fire and emergency services station is a major investment. It must function and serve the community for decades **(see Figure 3.3)**. Since a station is a visible and long-term statement of the community's commitment to the safety and well-being of its members, it should be designed to fit into the community and be highly functional.

Figure 3.3 — There are basic fundamental criteria that apply to any new fire station that is being considered.

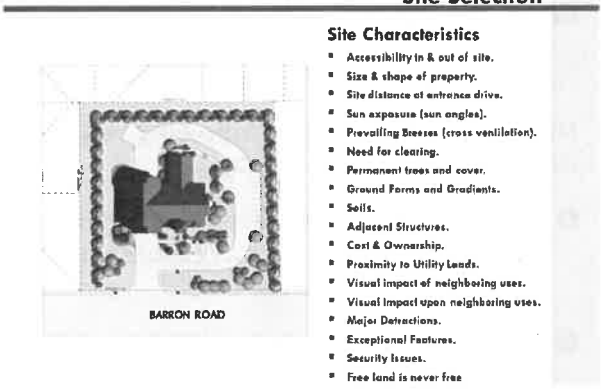

Photo courtesy of Jennifer Bettiol and Ray Holliday, BRW Architects.

The following fundamental criteria will provide guidance in site assessment and selection:

- Size.
- Public water or well.
- Public sewer or septic system.
- Power availability (three-phase versus single-phase).
- Communication service lines.
- Storm water.
- Clearing/Demolition.
- Natural gas.
- Road access.
- Grading/Topography.
- Wetlands.
- Approvals/Permitting.

Size

An acre for every 5,000 square feet of building is a general rule of thumb. This will allow enough room for on-site rainwater retention, parking for employees and visitors, and turning radius for drive-through bays. However, there are many variables to this rule of thumb. Parking is often an overlooked consideration when selecting a site. The following criteria should be used in determining parking spot allocations:

- Additional spaces to accommodate shift change if the station is to be fully staffed 24 hours a day.
- Additional spaces if there is a community room.
- Additional spaces if functions other than response staffing are to be located at the station (such as investigators, public educators, permitting, administrative staff, and other community agencies).
- If off-site parking is required, what is the distance, and what is the long-range commitment of the off-site parking area to the organization?

Additional space might be needed if exterior training evolutions are to be conducted on site. Also, there should be space allocated for additional apparatus to stage for joint meetings and training.

If a dumpster is going to be located on the site, there must be space allocated for it. Space will also be required to allow the waste management vehicle to safely access and empty the dumpster, to turn around, and to safely exit the property. Keep in mind the inside turning radius of a tandem axle apparatus or service truck is 35 feet.

Public water or well

While this might be a given for most available sites, it can be a big issue. Municipal and urban fire and emergency services organizations are often looking for new sites to provide service to an expanding response footprint. This typically comes through annexation. There have been many cases where a department is required to provide emergency response services before public water has been provided. This requires drilling a well that will hopefully provide enough flow and storage to satisfy the facility's needs. If the station is to be staffed 24 hours a day, the water demands are typically much higher than a normal single-family dwelling.

Public sewer or septic system

As with public water or a well, this is likely a given for most sites. Likewise, municipal and urban fire and emergency services organizations are often looking for new sites to provide service to an expanding response footprint. This typically comes through annexation. There have been many cases where a department is required to provide emergency response services before a public sewer system has been installed. If the station is to be staffed 24 hours a day, the sewage output is much higher than a normal single-family dwelling. This will overwhelm a septic system. On occasions where this has occurred, the organization must contract with a septic pumping service company and set up pumping on a weekly basis.

Electric power availability (three-phase versus single-phase)

Most sites have electric power capabilities to one extent or the other. It is important to know if the power source can supply the unique needs of a fire and emergency services organization. Another consideration is whether power can be fed underground to the facility. Underground is preferred to minimize power disruptions due to storms, motor vehicle accidents, and acts of civil unrest.

Communications service lines

Communications service has become increasingly important with the need for communication beyond just a telephone line. Cable lines for internet access are second only to power lines as a basic need for a functional fire station. In addition, there might be a need for television service through a cable line.

Storm water (regional)

Storm water runoff is a major concern that local and regional governments are addressing. When assessing a site, it is important to get the big picture of how storm water might impact the site in the event of sudden, heavy downfalls, as well as prolonged steady rain or snow-melt events. Equally important is the impact of the new facility on storm water for the community and the region. In many jurisdictions, a retention area is required to maintain and control storm water.

Clearing/Demolition

Most potential station sites will require varying degrees of clearing and/or demolition. These are costs that have increased in most areas because of local codes impacting the disposal of cleared vegetation or demolished building materials. In addition to the cost of having to segregate materials for disposal, there can always be disposal fees associated with removal of vegetation.

Natural gas

Access to a natural gas line will lower the operating costs of a fire and emergency services facility. Natural gas burns cleaner than other fossil fuels, producing half the carbon dioxide as coal and about a third less than oil. It also emits fewer amounts of toxic chemicals like nitrogen oxides and sulfur dioxide. In the U.S. market, it is an abundant resource, and it is currently the cheapest source of electrical power. It costs less than coal, hydroelectricity and solar.

Another consideration for assessing natural gas is the growing market for natural gas driven vehicles. Emergency response vehicles are easily suited for this application because the need to refuel is almost always at the same place — the station.

Road access

Road access involves several facets to assess:

- Line of sight — Can the driver/operator of emergency vehicles get a good field of vision to access the road without creating a hazard to motoring public or the emergency response vehicles?
- Returning to the station — If the vehicles are to be backed into the station, can this be done without having to stop traffic on the road?
- Extremely busy roads — Will the site require traffic signals to stop traffic so the responding apparatus can safely/quickly enter the road? Many departments have opted to put facilities on adjacent or side streets to avoid having to access busy roads.
- Responding uphill — If the responding apparatus must start out by climbing a grade, their response time will be negatively impacted. Sites at the bottom of a hill should be avoided, and sites located along an inclined road should receive careful assessment.

Grading/Topography

Grading can be a major expense for a fire and emergency services facility. Foremost, how much soil will need to be brought in, or how much soil will need to be removed? How far will the soil need to be transported if it is brought in or removed? If soil must be brought in, it will need to be compacted. Conversely, existing soil may require additional compaction.

The architect used a creative design to fit this mountain fire station into the sloping lot. The two-story work and living spaces are offset at an angle from the apparatus bay **(see Figure 3.4).**

Figure 3.4 — This station being built on a hilltop is an example of a special construction consideration.

Photo courtesy of Robert Tutterow, F.I.E.R.O.

Grading also entails diverting storm water away from the parking lot and facility. In many cases, it involves the construction of a retention pond. In mountainous areas, grading may require blasting to break through stone to provide space for a facility.

Wetlands

In general, wetlands should be avoided. However, there are cases where it might be unavoidable. Environmental concerns may put fire and emergency services organizations at odds with their members and organizations within the community. These issues get sorted out by the local body of politics. It is imperative that emergency response agencies state their position in a clear and transparent manner.

If a facility must be built in an area subject to possible flooding, consideration should be given to designing a two-story facility, so that the lower floor can be quickly evacuated with minimal property loss.

Permitting and approvals

Permitting and approvals vary from community to community. Fire and emergency services must be aware of all required permits and approvals, and must be sure they can be obtained before purchasing a site. It is also incumbent upon the organization to understand the time allotment needed to obtain approvals and permits. It is not unusual for local citizens (especially neighbors to the site) or community organizations to use permitting and approvals as a tool to keep the organization from constructing a facility on a potential site. As in all situations where there are neighbors and community concerns, it is imperative that the organization state its interests in a factual and transparent way.

Organizations must also be aware of any zoning requirements, as well as homeowner association implications for the proposed site. Some communities have height restrictions. Municipalities and county governments may have art or landscaping ordinances for all public facilities.

Condemned property

Occasionally, a fire and emergency services organization may need to work with their local government to condemn a property to obtain a site. Condemnations are not free. For example, there could be any of the following factors:

- Court costs.
- Legal fees.
- Relocation costs.
- Lost business reimbursement costs.
- Cost of the land.

Many times, organizations may not be allowed to pay more than the assessed valuation of a property without some special effort.

Beware of free sites

In lieu of the above, beware of free sites! It is not uncommon for a citizen or developer to offer a free site to fire and emergency services organizations. However, past experiences have shown that often a free site can be an extremely expensive site. Key questions to ask:

- Is the location too much of a compromise to provide the response service?
- What does the person/company/developer offering the site expect in return?
- Are there site issues that would add significant additional construction expenses for the project?
- Is the site possibly contaminated?

Future growth

It is always a sound decision to find a site that allows for future growth. This can include population growth in the response area, as well as added services provided by the fire and emergency services organization.

No one can predict the future with 100 percent certainty. However, local community leaders, especially planners, can provide valuable insight into the probable changes in the community. This can include land development, road networks, mass transportation, etc.

Other cautions about site selection

There are several issues in site selection that must be considered for fire and emergency services organizations. These include, but are not limited to the following:

- Avoid property adjacent to a hazardous materials area. (The emergency response agency does not need to be the victim.)
- If near an airport, be sure antenna are within Federal Aviation Administration regulations.
- Check all records to make certain the site has not been a burial ground.
- Check all records to make certain the site has not been used for hazardous waste disposal.

Never hesitate to hire an outside expert to conduct a site design feasibility study. It could be the best money you will ever spend.

Community acceptance

Fire departments must be professional in their request and justification for a new station, and in their site selection. It is imperative that they stick to the facts and always be transparent in justifying their needs. Fire departments should keep the station location process practical and out of politics as much as possible. They must also be open to elected officials and the public, and they must keep everyone apprised of what is occurring. "Selling" the need for a new station at a particular location is truly where the rubber meets the road. This is where departments should have their relationships with their stakeholders in good shape, so that they can be successful in their quest.

Gaining community acceptance is a 24/7 process. Successful campaigns in the past have noted that it is easy to be against things (e.g., facilities), but a lot more difficult to be against people (e.g., first responders). Therefore, emergency responders must be in front of the community at every opportunity with a positive look and positive message.

A case study of a northwestern-based fire and emergency services organization revealed that the key to their success was a quarterly newsletter sent to their citizens. The full-color newsletter was loaded with pictures of the organization's members providing service to the community. Not only were there emergency scene photos, but there were photos of smoke detector installations, blood pressure checks, fire extinguisher training, CPR training, home safety training, and other activities showing the members serving their community.

When initiating a campaign for community support, include the following:

- Careful planning.
- Educating the organization.
- Increasing the knowledge base.
- Educating the public.
  - Station tours.
  - Conduct community meetings.
- Continuing information.
- Creating a "tool chest" (who, what, when, where, why, and how much).
- Developing an action plan that includes the following:
  - Defining organization (and community) needs.
  - Knowing the tax burden and benefits.
  - Establishing media contacts.
  - Sharing your financial information in a clear and concise order.
  - Communicating a cohesive message.
  - Dispelling or confirming rumors with facts.

Don't expect everyone to buy in immediately. What is cost effective to one person, might be a waste of money to another person. Don't ever assume the public knows the scope of an organization's service capabilities, or the resources and training to deliver that service.

As was stated at the beginning of this section, it is often said that the following are the two most difficult things about fire and emergency services facilities:

1. Trying to get one in a community.
2. Trying to take one out of a community.

Gaining community requires a 24/7/365 commitment by the organization to be totally transparent with its customers. It must be understood that many people are basically suspicious of the government. So, soliciting funding for a new fire and emergency services facility can be an uphill battle. Sound marketing principles are critical for gaining community support.

Successful marketing by fire and emergency organizations to gain community support for a new or renovated facility includes elements, such as:

- The need must be clearly identified.
- The need must be clearly communicated to the community.
- Be transparent. Transparency equals honesty.

- Be involved in as many community events as possible — always smiling.
- Create an on-going newsletter. This can be monthly or quarterly. With a newsletter, the organization controls the message. Color works better than black and white. Use lots of photos.
- Celebrate your members.
- Create a logo for brand recognition.
- Create a phrase to communicate the organization's service. (Shorter is better.)
- Communicate the organization's value to the community. Quantifiable value is stronger than qualitative value.
- Become active in civic organizations.
- Embrace public speaking, as well as private speaking.
- Offer free services: blood pressure readings, CPR lessons, fire extinguisher training, smoke detector installation, etc.
- Let the public be involved in the exterior appearance of the facility. A good rule of thumb: The interior of the facility belongs to the members; the exterior belongs to the community.
- Opportunities for marketing vary from community to community. It is essential to take advantage of every available opportunity.

Remember, it is easy to vote against things. It is difficult to vote against people. Be sure the community knows that the organization's most valuable asset is its members.

Once a site is secured

Once a site has been approved, fire and emergency services organizations should stake their claim by posting a sign. This will generate questions from citizens about the progress toward building and opening "their" new facility **(Figure 3.5).** Proclaiming the coming facility is a public relations tool to generate goodwill that departments should not miss.

Figure 3.5 — This shows some overall considerations for fire station site selection.

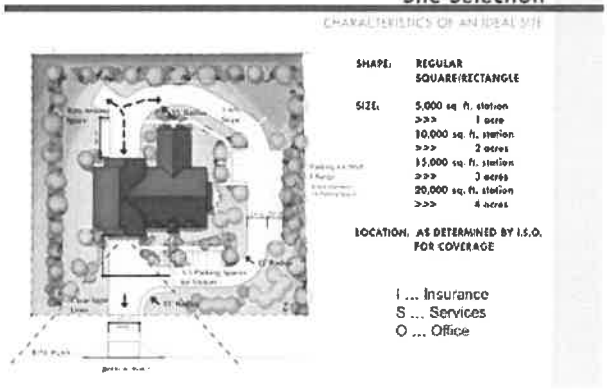

Photo courtesy of Jennifer Bettiol and Ray Holliday, BRW Architects.

Chapter 4: Overview of Design Process and Applicable Construction Components

The design and construction of a fire and emergency services station is a long and complicated process. Many different decisions are required, and different people may be involved in those decisions. The factors governing facility design vary from department to department, and even within the organization itself. For some departments, the construction of a station may be an on-going process as the community or area which it serves is continually growing. These departments may have in-place building committees and well-defined procedures and specifications. In other organizations, building a station may be an infrequent event, requiring new research each time due to changing topography, demographics and industrial developments. In all cases, facilities should be designed to account for all relevant regulations and to promote an appropriate level of safety and health for the occupants.

This section provides an overview of the design process and applicable construction components. While many design choices are based on an organization's specific needs for the new or remodeled facility, there are several design options which are regulated and impact personnel safety and health. The following sections provide insight for considering safety and health issues when making design choices.

Design philosophy for fire and emergency services stations

The old National Board of Fire Underwriters followed by the American Insurance Association originally set the tone for station design. Their concerns covered such factors as quick, efficient and safe response of apparatus to alarms. EMS responses and exposures were not found until departments accepted these responsibilities. With time, organizations began to become more involved with prevention activities and other services rather than exclusively on suppression functions. Stations now include the following:

- Administrative offices for the various functions of the organization, such as fire prevention and fire education.
- Decontamination rooms.
- PPE storage rooms.
- Community meeting rooms.
- Fitness rooms.
- Training props.
- Workshops.

Firefighters and EMS personnel no longer went to the fire house to be trained by their peers, but instead needed specialized training and training facilities.

As the fire and emergency services departments' attention turns to the flexibility of the station, several questions are raised:

- Can the facility be used for other municipal functions?
- Can organizational needs be met with shared facilities?
- Can the facility be incorporated into a private development?

- How long should these facilities last?
- What are the most cost effective ways to build these facilities?
- What should be the land size and space requirements of stations?
- What are the interior space requirements?
- What are the standards and regulations that must be considered in the design and construction process?
- How can the organization maintain its present level of service and be ready to grow in the future?
- How can the organization take on additional services — perhaps unforeseen?

Design factors

Fire and EMS station designs have changed over the past decades. They are being increasingly recognized as specialized facilities with their own specific design approaches. Design and facility features differ among fire stations, EMS stations, and other types of facilities based on a variety of factors, including:

- The role of the station.
- The type of organization and expected response level.
- Specific functions of the facility.
- Integration with joint or shared facilities.
- Community restrictions.
- Future requirements.
- Available resources.

These same factors also can impact the level of safety and health for personnel working and living at these stations.

Differences in station design can occur because of slightly different roles of the specific organization. For example, departments with integrated emergency medical responsibilities have additional station design requirements for accommodating EMS needs.

One way to look at the overall design of a fire and emergency services facility is from a performance perspective. These top 10 performance goals are useful to help formulate goals and keep the design focused on the "big picture":

1. Response.
2. Training.
3. Health and safety.
4. Evaluations (ISO, Accreditation, etc.).
5. Culture (camaraderie).
6. Special functions (may not be applicable for every facility).
7. Technology.
8. Durability.
9. Sustainability.
10. Aesthetics.

The following eight images show a typical chronological order of the design and construction phases for a new fire and emergency services facility. **(See Figures 4.1 through 4.8.)**

Figure 4.1 — The first Schematic Design (SD) Phase.

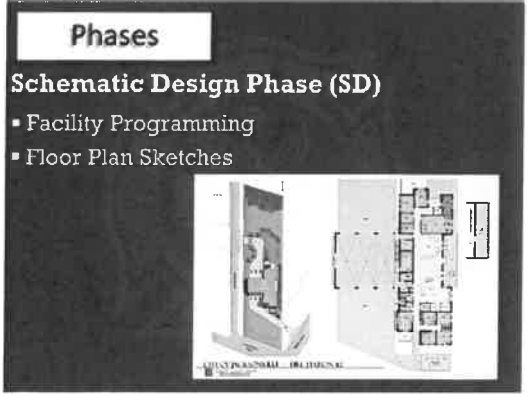

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.2 — The second SD Phase.

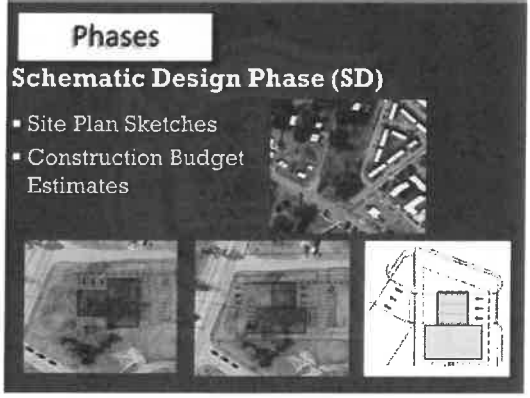

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.3 — The third SD Phase.

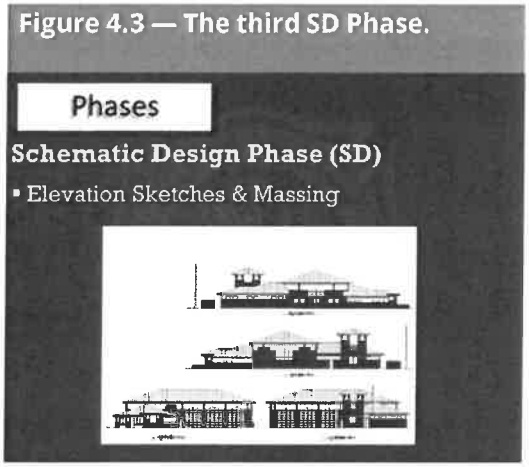

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.4 — The first Design Development (DD) Phase.

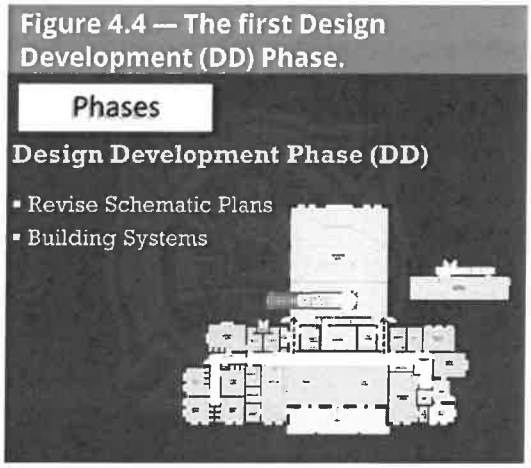

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.5 — The second DD Phase.

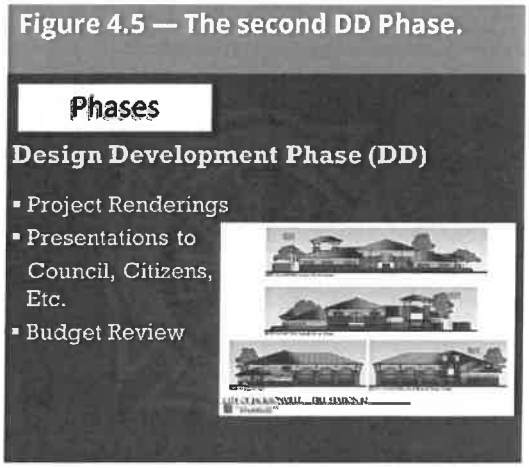

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.6 — The Construction Document (CD) Phase.

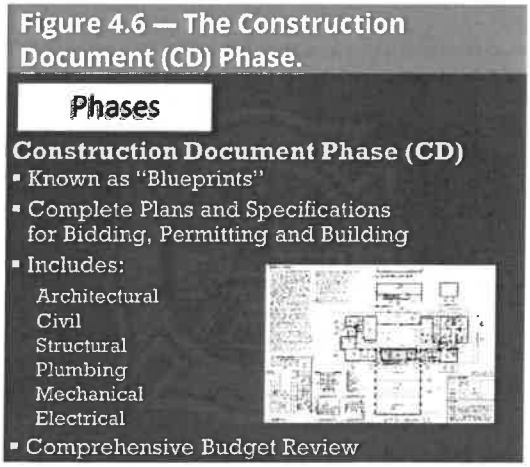

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.7 — The Bid/Negotiation (B/N) Phase.

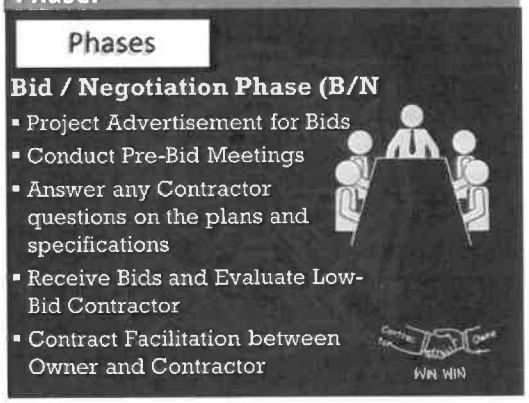

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 4.8 — The Construction Administration (CA) Phase.

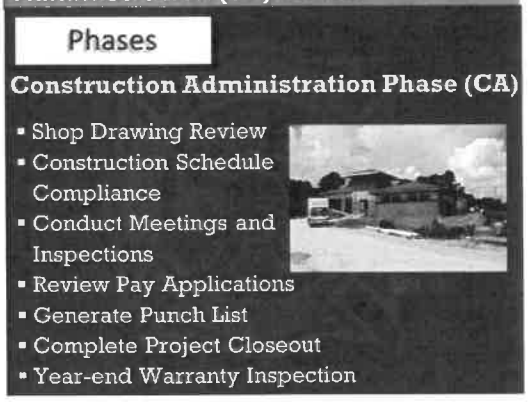

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Impact of Emergency Medical Services on station design

Key safety and health concerns for the following functions are often related to the number of people that the facility must accommodate:

- Special storage requirements (e.g., secure spaces for drugs, refrigerated medical supplies).
- Possible routine handling of medical gases (oxygen).
- Possible segregation of station alerting system (fire versus EMS).
- Possible differences in shift length/separate quarters.
- Differences in vehicle requirements.

Staffing levels and the number of personnel on duty are important. The total number of people that can be in the facility at any one time (due to training, a disaster, or community event) must be considered.

Type of department and expected response level

There are differences in station design — whether the facility is in a metropolitan area, suburban area, or a rural area **(see Figures 4.9a and Figures 4.9b)**. These areas usually impact whether they are career, volunteer or combination organizations. The overall response level also affects aspects of station design. For example, stations that are required to do multiple runs in the immediate local area of the community, compared to other stations, may have infrequent demand but cover relatively larger areas.

Figure 4.9a — A classic fire station in a major city environment.

Photo courtesy of Mike Wieder, Stillwater, OK.

Figure 4.9b — An example of an EMS station in a small, rural community.

Photo courtesy of Mike Wieder, Stillwater, OK.

Examples for the impact of department type and response level on station design:

- Designs for career organizations must be based on the assumption that members will be responding to the apparatus from anywhere in the station. This consideration dictates the layout of the facility in terms of apparatus bay accessibility to all areas. Multiple access points to the apparatus bay area will improve response time. In addition, the fewer turns a responder must take to access the bay will safely improve response time.
- Volunteer organizations are more apt to be less formal and more group oriented. Sleeping quarters may not be needed, but these stations often require ample parking for effective response and building security measures.
- Combination departments require flexible facility designs to accommodate the needs for both volunteer and career responders.

Questions addressing these issues:

- Is it a volunteer station that is to be unmanned for long periods of time; a volunteer station with individuals in and out of it daily; a combination station; or a career station?
- Is the facility located in a rural area, industrial area, commercial district, or residential community? Each of these sites and applications require different design approaches. Furthermore, each of these types of departments may require a different source of funding to complete the task.

Specific functions

Once the type of department is known and the community it serves is defined, the specific functions for the facility must be determined. A rural department with residential and small commercial occupancies would not consider aerial ladder apparatus or similar vehicles in its station design and planning. For EMS service, it may also be important to consult with the local hospital for compatibility between the department and hospitals to enhance the responsiveness of both facilities. If the station is permanently staffed, then station occupant comforts should be addressed. If the station will be used as a community gathering place, consideration must be given to provide a separation between the functional, response part of the station and the civic side of the facility. The organization's administration should decide how long the station is to last, what its growth will be, how to use the facility to meet the community needs, and how to look after its members.

Other functional assignments of the stations will affect facility design. Headquarters buildings may require central offices, dispatch facilities, and training areas. Some facilities may also be a site for apparatus maintenance, a marine unit/fire boat, or other special functions. There are often different safety and health concerns for these special functions.

Local geography

Geography and climate affect several aspects of station design in terms of safety and health. Examples:

- Roof design for local weather conditions (wind/snow loads).
- Choice of substructure and structural elements to withstand seismic activity.
- Terrain for actual facility layout, particularly driveways and aprons.
- Exterior/Interior drainage that prevents ice buildup during winter months.
- Adjacent roadway visibility for apparatus access.
- Overall space for accommodating the entire station layout (some locations accommodate drive-through apparatus bays; others do not).

Most of these aspects will be specific to the area and usually within the common knowledge of the architect, but only if the architect is made aware of the special needs that fire and EMS have compared to regular industrial facilities.

Community restrictions

Community restrictions can take two forms:

1. The community may have its own building codes and regulations to which the station must adhere.
2. The community may have certain expectations that the facility fits with the rest of the architecture in the area, or at least does not interfere negatively with the community.

Many communities have specific laws governing use of utilities, construction materials, and right-of-ways. It is impossible to list the various restrictions that can be imposed. Nevertheless, this aspect of station design is usually handled in the review of building permits where proposed designs and layouts are reviewed against existing local codes, zoning and ordinances. Some communities require that facilities appear to blend with other structures in the community. In these cases, the appearance of the station may be critical from an aesthetic point of view.

Fire department officials should meet with community leaders to discuss the station's design and to solicit their input. The neighborhood should be sought as an ally to work with so as to avoid future problems. While this practice may only affect certain elements of the station's exterior design, some requirements can affect station layout and overall safety. Commonly, facilities are required to shield neighboring structures from noise by using landscaping, and response functions should be tied into local traffic signals. As stated earlier, a guiding principle should be that the interior of the facility belongs to the organization; the exterior belongs to the community.

Flexibility for future requirements

Facility requirements change with time. This can occur as service needs change or as department functions are added or deleted. What is often built to meet the department's current needs requires periodic re-evaluation and possible upgrading or expansion to meet future demands. As the fire and emergency services grow and expand, new facilities are needed to house equipment, training, and possibly personnel. Examples of changes that have occurred in recent years:

- Special training props (such as mezzanines or training towers).
- Decontamination rooms or areas.
- Fitness rooms.
- Accommodations for female emergency responders.
- Dedicated PPE storage rooms.
- Addition of more personnel.
- Additional apparatus (particularly specialized vehicles).
- Consolidation with law enforcement or EMS.
- Emergency management services.

To meet these challenges, some structures must be redesigned accordingly. Separate facilities might be designated to have capabilities for specialized training and activities:

- Decontamination.
- Confined space.
- High-angle rescue.
- Auto-extrication.
- Fire-pump testing.
- Self-contained breathing apparatus (SCBA) maze training.
- Ladder testing.
- SCBA testing and maintenance.
- Apparatus maintenance.

This practice enables departments to evenly spread resources while having qualified individuals in all areas.

In addition, departments must consider how the fire service will change in the long-term future. Just as incorporating EMS represented a major change in fire department responsibilities and impacted station requirements, so should other areas which some fire departments are currently considering. For example, fire prevention has long been a service of fire and emergency services organizations. The future might include new services, such as illness/accident prevention. Facilities may need to include space to administer preventive care. Emergency responders may need small, dedicated vehicles to call upon citizens who are home-bound and require periodic treatment and assessments.

Resources

Every organization would like to build a station which possesses state-of-the-art equipment and uses the best materials. Unfortunately, most organizations are constrained by limited resources and must often make trade-offs between desired features and practical design needs. Nevertheless, these choices should not compromise personnel safety and must obviously be in full compliance with all applicable codes and regulations. Failure to meet these requirements often results in expensive redesigns and renovations. Even though it may be difficult to justify, it is also important for station and other facility designs to anticipate future requirements. These requirements are often in the form of increased functionality or accommodation of new equipment. However, station designs should also forecast new regulations as new safety concerns are identified. For example, the Americans with Disabilities Act (ADA) created the need for stations across the U.S. to be modified.

Fire and emergency services building design process

The following process serves as a model for designing a new facility.

Site selection

There are several basic items to consider when selecting a site:

- Create a four-minute response time map using local GIS data.
- Determine available property in the area where response times are not being met.

- Be skeptical of available property that is "too good to be true," and try to eliminate properties that are odd shaped, have steep-terrain, are in a flood plain, or are otherwise unsuitable for construction.
- Revisit the GIS maps, and model the effectiveness of the potential site candidates to see if there are any hidden conditions — too close to existing emergency services, too far from major arterial streets, etc.
- Property cost: municipalities are only allowed to pay appraised market value. What will the purchase of the property do to the overall cost of the project?
- Thoroughly study the proposed property utilities. The availability will have immediate impact on the budget and should be known before purchasing a proposed property. Are all primary services on site:
  - Water meter.
  - Sewer tap.
  - Electricity.
  - Natural gas or propane.

Have geotechnical studies and/or testing performed to determine suitability of soils for construction. This too should be a condition of purchase. If the site has shallow bedrock; or is a swamp, marsh or watershed zone; consists of sandy loam, clay or other unsuitable material foundation, the costs can be insurmountable.

Note: For more information on site selection, refer to Chapter 3.

Facility programing and functional analysis

Once a site is selected, the basis of the facilities function should be determined. Things to consider:

- What are the intended service needs? What specific apparatus will be housed at this location, and how many? Plan for future growth.
- Will the facility house career or volunteer crews, or both? Is there potential for the future of a volunteer facility to become a career facility?
- Based on the quantity of apparatus, determine the number of staff, and plan on future expansion. For example: four crew per pumper, five per tower, two per ambulance, five per heavy rescue, two per battalion, etc.
- Determine the quantity and arrangement of dormitory space:
  - Unisex open dormitory space.
  - Split men's and women's open dormitory space.
  - Individual bunk rooms.
- Determine common space needs: restrooms, kitchen, dining, day or living space, storage, lockers, cleaning, decontamination, PPE, SCBA, etc.
- Determine the adequate number of showers and the appropriate hot water supply.
- Determine square-foot needs per space.

Facility design development

Once the equipment, staff and functional needs have been determined, the architect can begin the design development phase of the project. This is where the floor plan can begin to take shape. This is also where the "look" of the facility begins to be discussed. This phase is one of the most important phases of the project and should be given the most time and effort by the team. This phase is also where the organization will have involvement and will need to make critical decisions affecting the outcome. **This phase is where the architect's knowledge and experience in fire and emergency services will be evident!**

- What are the neighborhood characteristics the facility will serve? These circumstances should contribute to the look of the facility (suburban residential, urban residential, high-occupancy, light industrial, heavy industrial).
- Begin to orient the bubble diagram on the site plan. Experiment with the massing placement; direction of apparatus travel; locations of the nearest intersections; the sun angles (summer and winter); the weather extremes, both in temperature and rainfall. Discuss any other environmental conditions or concerns. These issues will all have an impact on the look of the facility.
- Understand the basic impacts of code compliance. What building codes are applied locally, and are there any amendments to the code by local planning and zoning officials? Determine the occupancy and space separation requirements (this can lead to expensive construction costs if there are too many "barriers" or "fire ratings" required to separate spaces). Apply ADA requirements to the interior and exterior; determine the public, semipublic, semiprivate and private space relationships and their accessibility versus use.

  Note: The application of the ADA is **not** an option. The ADA is a federal law and is administered to all public buildings regardless of occupancy or use.
- The state and local use of either the Uniform Building Code (UBC) or the International Building Code is also law, and compliance is required.
- The use of NFPA and other emergency services documents is not always included in the local code, but should always be included in the design discussion if they are not officially adopted in the local code.
- Discuss finishes, fixtures and equipment:
  - Drywall.
  - Masonry.
  - Concrete.
  - Carpet.
  - Tile.
  - Faucets.
  - Sinks.
  - Appliances.
  - Light fixtures.
  - Air conditioning types.
  - Technology needs.
  - Security.
  - Dispatch.

These issues all have an impact on the functional design and can alter the size of any given space, leading to changes in the exterior elevations of the facility. These issues will also directly affect the budget.

With all this in mind, cost estimating should begin. Any adjustments to scope need to be applied to the budget. The department must be firm and clearly communicate the necessary versus optional aspects of the design to the architect. Mistakes in this phase will lead to costly changes during construction. Any adjustments to the budget need to be implemented now to avoid complications and/or cancellation of the project.

Construction document phase

After a thorough review and budget analysis of the design phase of the project has been completed by the department, the construction document phase can begin. This is the phase that applies the notes, dimensions, specifications, details and overall constructability of the project into the drawings. User groups and planning officials should have input and should hold public meetings to finalize the project's intent. Formal budgets are finalized, and schedules for completion are created to determine timelines to complete the following: begin ancillary planning; order equipment; hire personnel and support staff; deliver or relocate apparatus; and determine the impact the new facility will have on the overall department. These should include payroll, utility costs, traffic flow, and support from other municipal departments, public works, equipment management, and city management.

- Determine the delivery method of construction if not already established. The budget can have a role in this decision, as some methods may lower design fees but increase construction costs, and vice versa.
- This is also a good time to determine some contingency budgets, and possible items or a scope to have on an "Additive Alternate" list. It is generally accepted that adding an item or broadening the scope is more effective than "deducting" it from a scope of work. Some items that are commonly found on "Additive Alternate" lists include:
  - Bay doors — upgrade from overhead sectional to four-fold.
  - Window frames — upgrade from aluminum to vinyl.
  - Flooring — upgrade from ceramic to porcelain tile.
  - Floor plan increases — add additional square footage, an additional apparatus bay, or a dormitory wing.
- The department should hold a final public meeting and acquire written acceptance from any involved user groups, homeowners' associations, governing boards and/or planning commissions.
- **Thoroughly read and edit the specifications!** Understand that when a conflict arises, the specifications always take precedent over a drawing or graphical representation of intent.

Construction bids and permits

Upon completion of the construction documents and specifications, a final review and acceptance of the project are made by the organization. Depending on the delivery method, but regardless of circumstances, all projects must have permits to build. It is common for municipalities to advertise for bids prior to having a permit in place. However, no contracts should be signed, or fees finalized, without a permit in place; the project's plan review process will often require amendments to the drawings and specifications that can have a direct effect on the scope and costs.

Construction

Construction begins upon the acceptance of the bids and the contractor's ability to meet the local bonding and insurance requirements. The contractor becomes the "owner" of the project and the site it is built upon. This means that the contractor is responsible for all activities on the project site, including all safety, traffic flow to and from the site, access, security, theft, vandalism, etc.

The contractor will begin holding weekly or biweekly meetings. Initially, there will be a lot of "submittals" provided that must be reviewed by either the architect, department, or preferably both. The submittals are the product literature that formally state what the subcontractors will be providing in order to build the facility. Submittals cover everything from faucets in the kitchen, to the density of the concrete in the apparatus bay. This is also the opportunity for the department to ensure they are going to get what they want. The acceptance of the submittal becomes the binding document. The department or architect cannot change the outcome after accepting the submittal of a particular product or system.

The contractor will provide meeting minutes, a submittal checklist, schedules and spreadsheets listing Requests for Information (RFIs), and the subsequent Architects Supplemental Instructions. It is also common for the contractor to keep a record of cost adjustments due to changes in submittals, conflict resolution, or unknown circumstances causing delays, such as weather conditions or delays in delivery of critical path construction materials or equipment.

Project completion, closeout and warranty commencement is the final aspect of construction. As the project nears completion, a transition will take place when occupancy of the building is determined.

The first significant completion milestone is establishing "Substantial Completion." This is a date where the organization, architect, user groups, and sometimes the building inspector walk the job and create a "punch list" of items needing correction or containing deficiencies. This list is mutually agreed upon and is attached to the "Substantial Completion" document. The punch list should be a manageable list of correctable basic items, such as, but not limited to the following: scuffs; mars; paint touch-up; drywall patching; heating, ventilating and air conditioning (HVAC) filter replacement; and minor equipment adjustments. Major damage or significant errors or omissions should cause the delay of substantial completion until the list is manageable.

Transition documents to the organization:

- The issuance of a substantial completion letter and attached punch list is when warranties and guarantees go into effect.
- The contractor should also provide all closeout documents, operation and maintenance manuals, as-built drawings, keys to the building, and final payment application.
- This is also a common point for the transition of utilities from the contractor to the owner (either department or municipality).
- A formal Certificate of Occupancy is obtained. All final inspections and "green tags" must be issued before this certificate is given.

Note: In some circumstances, a temporary Certificate of Occupancy can be issued by the building official so the organization can move in and start functioning out of the facility. However, this will be with restrictions that typically have a time constraint applied to them. (If the facility is shared with another agency, a temporary Certificate of Occupancy can be issued so that one agency can begin use while the other waits for an issue to be resolved.)

Grand opening

This event should be held on site by the local government. It is an opportunity for the participants to be recognized and for dedications to be made. Plenty of time should be allotted for this event, and it should be held on a Saturday in the spring or fall to allow for the largest public participation. During the grand opening, the organization should consider facility tours, hold demonstrations, give rides on apparatus, and allow the community to take pride and ownership of their new facility. The contractor can also participate by assisting in the tours, displaying construction techniques used in the project, and providing barbecue meals and/or refreshments.

Applicable construction components

This section reviews various components that go into constructing a new facility.

Foundations

The soils are the starting point for any new design and construction process. Pertinent considerations:

- Footings.
- Foundations to take the heavy load of today's heavier apparatus.
- Ensuring adequate safety factors for the station in either good or bad soil conditions. (With many new structures, casing holes are drilled to solid ground and then filled with concrete. These casing holes are often reinforced with rebar for strength. Similar methods are used for remodeling.)

Apparatus bay floors

Station floors are required to meet the local building codes and should be substantially reinforced in apparatus areas.

Drains

Bay floors should include trench drains that lie directly under where the apparatus are parked. Trench drains are recommended to be 24 feet for each apparatus parking spot. The floor should be sloped to allow water to flow to each of the trench drains. Having a dedicated trench drain for each parking spot minimizes the possibility of water standing in foot passageways. Slips and falls are a common cause of member injury, and everything should be done to minimize the accumulation of slippery liquids on bay floors. Bay floors should never be sloped right-to-left or vice-versa to cause liquids to flow to one central drain. This design will cause problems to the suspension of apparatus. Unlike many heavy-duty trucks, fire apparatus remain loaded all the time. They always park in the same place and remain there for far more hours than other heavy-duty trucks.

Coatings

Apparatus floor slabs should be finished to become slip-resistant. Sealed concrete is very durable and easy to maintain. However, there are concrete floor coatings available now that provide excellent slip resistance and are very attractive. These coatings are available in various colors, and the use of colors to designate apparatus positioning is common with these types of coatings. Floor coating systems, such as methyl methacrylate (MMA) acrylic resinous flooring, offer excellent slip resistance, increase visibility, and improve sanitation. High performance coatings are far superior to paint. They have a strong resistance to moisture, chemicals and high heat, and they are more resistant to abrasive cleanings. Floor markings, such as a different color for where the apparatus is parked, can be used to improve driver/operator safety. The same application can be used to designate foot-traffic pathways. Graphics can be used to enhance the appearance and to show pride to members and the community.

If colored floor coatings are not used to designate vehicle positioning, then safety stripes should be applied on the floor for the positioning of the apparatus. For further safety in stations housing aerial apparatus, a marker should be painted on the apron of the station or in the street denoting where longer apparatus may start a turn when leaving the station.

Expansion joints

All building materials are temperature sensitive, and building walls will shrink and grow as the temperatures fluctuate. Concrete will crack; therefore, control joints are required. Control joints are reliefs in the surface of the wall to control cracking. Organizations should work with the architect to designate the most practical and effective positioning of expansion joints.

Structural systems

Framing

The structural system will usually be either a frame system, where a steel, concrete or wood skeleton supports the building, or a load bearing wall system, where the walls of the building, usually masonry, support the roof and possible second-floor framing. Often, a combination of systems is used. Usually, the choice is primarily based on economics, and secondly on the needs of the building. A partial list of structural methods:

- Load-bearing masonry.
- Conventionally framed steel.
- Pre-engineered steel.
- Conventionally wood-framed.
- Pre-engineered wood.
- Light-gauge framed.
- Reinforced concrete.
- Precast concrete.
- Hybrid methods.

From a responder safety perspective, the frame should be designed to eliminate columns from apparatus bays since columns are both hazards to the apparatus and to members responding to the apparatus. (Columns can be eliminated by increasing the size of the framing members. This increases the cost of the building, but it is a worthwhile investment in terms of safety and future adaptability.)

Walls

Tall, unbraced walls and columns have a natural tendency to deflect and buckle due to structural loads carried from above. Various methods, including horizontal bracing, wall thickening, increased reinforcing, and the insertion of piers, can be used to resist these forces. Excessive deflection in walls will result in cracks in masonry construction. By nature, apparatus bays are high spaces that require tall walls. Stacking living space or other necessary heavy applications above them further complicates the issue.

Walls provide shear resistance from a phenomenon known as racking. Racking is the movement of structural elements out of level or plumb created by forces such as stress, wind, or material shrinkage or expansion. Apparatus bay doors do not provide structural support, and their large openings create a natural weakness in the station's ability to resist natural shear.

A variety of structural engineering methods can address shear. A few examples:

- Diagonal bracing: This often consists of rods, cables, or smaller structural members that create an "X" between columns to ensure vertical elements remain square and parallel. They can present challenges for architects to coordinate window, door and mechanical openings.
- Moment framed: These are connections that are essentially strong, rigid, welded or bolted connections that restrain two or more structural members to a specific design angle.
- Shear walls: These are large areas of walls limited to a few smaller openings. The surface or the wall structure carries and resists the lateral load.

Walls can be either load-bearing or nonload-bearing. Load-bearing walls are usually limited to masonry construction — brick, concrete block, or both. Nonbearing walls can be masonry, precast concrete, metal panels, or any number of proprietary systems. The side and upper surfaces of the parapet wall (roof level) must be protected in areas where ladder drills will be carried out — front, top and rear. Different types of wall construction methods afford different advantages and disadvantages:

- Masonry or precast concrete — Generally, masonry or precast concrete represent the most durable, cost effective, low maintenance wall system, but they must be designed and constructed carefully for proper performance. Both brick and block are available in a large variety of colors and textures. Precast concrete can be fabricated to almost any shape, texture and color. Its cost effectiveness varies from region to region, depending on transportation cost. Natural stone veneers are durable but expensive.
- Metal panels — Metal panels can be inexpensive or very expensive, depending on the design and material selected. The joints tend to leak less, and less expensive systems deteriorate rapidly.
- Exterior Finish and Insulation Systems (EFIS) — These systems represent one of the fastest growing new technologies in construction. They consist of a thin coating of synthetic acrylic or epoxy modified stucco applied to insulation bound over wood/metal studs or a masonry back up. EFIS offer ease of construction combined with good insulation and highly decorative surfaces at very little cost. However, they may not be durable, may be easily damaged, and are combustible. They should be avoided in areas subject to abuse or vandalism.

Control joints

Control joints are reliefs in the surface of the wall to control cracking. Like concrete, masonry also requires control joints at regular intervals. Large buildings or additions may require expansion joints to accommodate movement of several inches. Organizations should work with the architect to carefully plan where control joints will be located.

Roofs

Roofs can be used-flat or pitched, representing differences in economy, performance, weather and seasonal conditions.

Flat roofs are pitched for drainage at about 1/8 to 2 inches per foot. Flat roofs are considered more economical because fewer materials are required in their construction. However, this construction increases the possibility that water will remain on the roof and find a hole or imperfection to penetrate. If appropriate materials are used, and if properly constructed, a flat roof will perform as well as a pitched roof. In geographical areas of the country where rain is prevalent, flat roofs generally do not provide adequate runoff. Flat roofs should be avoided in areas of the country where snow is a major factor because of the weight buildup.

Pitched roofs have slopes with 2 inches of rise for each foot of run — or steeper. These roofs can be covered with asphalt shingles, slate, tile or metal systems. Asphalt shingles are the least expensive and are available in multiple textures and colors. They can be expected to last 25 years or more. Slate and tile are more durable, but more expensive and harder to maintain. Metal systems require careful design and construction; in fact, the less expensive types should be avoided.

Windows

Window construction materials include wood, steel, aluminum or vinyl in custom or standard sizes. Construction cost and insulation performance of these window types vary. Wood-frame windows are considered strong, light-weight, and energy efficient. When the wood is protected by another material (such as metal or a heavy coating), durability is improved. Aluminum and steel windows in the heavy commercial grades are sturdy products intended for hard usage. However, cheaper grades of metal windows offer poor performance. Such windows require special thermal-break construction to obtain the same energy efficiency inherent in wood.

The selected glass work or glazing should be high performance, low-E insulated units with an R factor of 2.5 or better in all but the mildest climates. The slight increase in cost is easily justified in energy savings and personnel comfort. In high vandalism areas, polycarbonate, an impact-resistant plastic, should be considered. Alternatively, window screens or protective shutters can be used. The likelihood of glass breakage should also be factored into window selection. Where fire-rated glazing is required, wire glass is most commonly used. New technology fire-rated glass, gel and ceramic composites that eliminate the visual distraction of the wire are available, but they are much more expensive. Window designs that permit easier cleaning, such as double-hung vertical windows, should be considered to lessen the possibility of falls from cleaning.

NFPA 101 requires sleeping areas to have a minimum window size, usually 90 inches, as measured by vertical length and horizontal length, to accommodate emergency rescue.

Walk-through doors

Two types of doors warrant consideration from a safety and health perspective: exterior doors and apparatus doors. Exterior doors are usually steel "hollow metal" or aluminum and glass. Wood doors can be used, but are not recommended. They are more susceptible to weathering and break-in. Proper weather stripping is important in cold climates. Hardware should be rust resistant, accessible and suitable for heavy usage. Hollow metal doors should be galvanized.

All interior doors leading onto the apparatus floor should swing toward the apparatus. A small window in the door will help prevent the door from striking a person on the other side. Any doors with glass should have safety glass or wire-reinforced glass. Doors leading to the apparatus bay should be metal, since they are susceptible to water exposure during cleaning. Wood doors, except hollow-core, are well-suited for the rest of the interior of the station.

Apparatus bay doors

Apparatus bay doors can be coiling, sectional types or vertically hinged four-fold. Coiling doors are more expensive, generally slower and rarely used anymore. Sectional doors are most common. However, four-fold doors offer many advantages, and they are becoming more common. They are faster when opening and closing, and they are less likely to be struck by an apparatus than roll-up doors **(see Figure 4.10).** Their initial cost is much more expensive, but their robustness causes minimal maintenance. Larger fire departments with multiple stations have found that the reduction in maintenance costs easily justify the higher initial cost of four-fold doors.

Figure 4.10 — The different colored panels on two of these roll-up doors indicate that they have been damaged in collisions.

Photo courtesy of Kevin Roche, FACETS Consulting, LLC.

Care should be taken to avoid large doors that accommodate two pieces of equipment responding out of the bay. These doors are heavy and subject to more failure. Doors should be large enough to accommodate the largest apparatus in the department's fleet. Wood doors are acceptable in milder climates, and are easier and less expensive to repair when damaged. In colder climates, doors must be insulated. However, insulated wooden doors often warp and delaminate. Insulated and weather stripped steel or aluminum doors are best for these situations.

Bay doors can be controlled in several ways, including push buttons adjacent to the door, push buttons near primary access to the bay (such as the watch room), remote control within the apparatus, and remote control from a communications center. Use of special lights, such as miniature traffic signals, are often used to indicate when the door is fully open, so the apparatus can safely leave the station.

The following tables list the pros and cons of different door types.

Table 4.1 — Pros and Cons of Different Doors

Advantages	Disadvantages
Four-fold doors	
Ample natural light	Requires additional floor space
Minimal moving parts	Initial cost
Low maintenance costs	
Fast operating times	
Minimal overhead clearance	
Can be ballistic rated	
Can be manually opened with little difficulty	
Aesthetically pleasing	
Aluminum/Glass sectional doors	
Ample natural light	Heavy
Requires minimal floor space	High maintenance costs
	Overhead clearance: The open position requires careful coordination with other ceiling systems.
	Limited insulation values
Insulated sectional doors	
Minimal natural light	Heavy
Requires minimal floor space	High maintenance costs
	Overhead clearance: The open position requires careful coordination with other ceiling systems.
	Above average insulation values
	Apparatus not visible to community

(See Figures 4.11 through 4.13 for folding bay doors.)

Figure 4.11 — One exterior view of a folding bay door.

Photo courtesy of Kevin Roche, FACETS Consulting, LLC.

Figure 4.12 — Another exterior view of a folding bay door.

Photo courtesy of Robert Tutterow, F.I.E.R.O.

Figure 4.13 — An interior view of a folding bay door.

Photo courtesy of Dave Hartman, Hartman Fire Station Consultants.

Station parking, ramps and exterior driveways

The primary areas directly outside the station must be properly designed to reduce the likelihood of accidents and to provide for efficient operations. The following should be taken into consideration:

- Providing enough spaces for shift changes.
- Designated visitor parking.
- Handicapped parking per code.
- Security fence.
- Security cameras.
- Security lights that are directed to the lot and do not impact adjacent properties.
- Turning radius to accommodate the largest apparatus.
- Bollards to protect bay entrances, fueling stations, gates, etc.
- Ensuring adequate lighting in parking areas and walkways (street and exterior structure lights) at the station for improving security and providing for pedestrian safety at night.

Concrete should always be used for station ramps, instead of asphalt. Asphalt will not withstand the heavy weight of fire apparatus or the sharp spurs of heavy ground ladders. Furthermore, asphalt softens during the hot weather, compounding these deficiencies, and patching asphalt creates uneven surfaces.

Despite attempts at variances, stations must comply with ADA requirements because they are public buildings. Many stations have community rooms and are used as polling places. This will require handicapped parking spaces, as well as ramps or lifts depending on the configuration of the facility.

Other exterior considerations

Several other considerations are important in the design for establishing appropriate levels of safety and health:

- Planning the side yards of stations to be of sufficient width to accommodate long hoselays during drills and hose testing (which will not encumber adjacent sidewalks or create hazards for passing pedestrians).
- Connecting the station alerting system to speakers at both the front and rear of the station to alert members working in those areas. These speakers should be silenced during the evening hours. This can be achieved by flipping an on/off switch located on the watch office console.

  Note: The alerting system should not be confused with the station fire/evacuation alarm, which must remain active at all times.
- Constructing a stand-alone building to house yard maintenance equipment, flammable liquids not carried on the apparatus, and items not requiring climate control.
- Complying with fire and building codes, which require fueling pumps to be located outside station facilities.
- Selecting 1 1/2-inch frost-proof gate valves (hose bibs) on the exterior wall of the drill area, as well as on the front and side of the structure. If the station does not have a hose tower, a dummy standpipe Siamese connection should be installed for drill purposes. Additionally, a hydrant needs to be installed in the drill area to facilitate realistic training.
- Furnishing facilities with the necessary guards and markings that indicate a danger area where drafting pits are located.
- Designing curbing at parking spots, so that vehicle overhang does not extend over sidewalks. This includes the overhang of vehicles that back into a parking space.
- Equipping the stations with a covered public telephone or intercom near the entrance that goes to the communications center in the event the fire station is unoccupied.
- Accessibility of garbage cans or dumpsters for the garbage collection trucks. These are located off the drill court. If garbage trucks access the property, they should drive on concrete rather than asphalt surfaces. The concrete area directly in front of a dumpster should be thicker and reinforced to withstand the weight of a loaded dumpster while it is being lifted.

Interior design considerations

The ADA requires minimum hallway widths, hallways designed free of protruding objects, specific water fountain heights, and special fixtures and dimensions for bathroom facilities. All facilities should provide for adequate evacuation and emergency egress as defined in NFPA 101.

Walls

The principle concern for interior walls is their fire resistance and durability. Masonry-based construction should be used in areas subject to rough use, such as the apparatus bays. Gypsum board on metal studs is common for other spaces. Finishes need to be appropriate for activity in the space.

Areas of rough usage, such as washrooms and the laundry area, should include a spray glaze, high-gloss paint, or ceramic tile. High-performance drywall, especially along the lower half of a wall, is a viable option in hallways and other areas subject to bumps and scrapes. Drywall should never be less than 5/8-inch thick. Flat paint is usually not appropriate, except possibly in office areas.

Ceilings

Basic drywall is common for all living areas. Open ceilings work well in fitness rooms. The use of acoustical ceiling types might be considered to reduce unnecessary noise. Acoustic ceilings come in a wide variety of styles and sizes (e.g., 2-by-2 panels and 2-by-4 panels). Concealed spline ceilings and gypsum board ceilings interfere with maintenance of electrical and mechanical systems. Care must be taken to obtain the proper installation in areas where a fire resistive rating is required. In classrooms or meeting rooms, acoustic (sound) and illumination (lighting) considerations should be a priority.

Floor finishes

Interior floors should be selected to reduce the likelihood of slipping and falling. They should also be easy to clean and durable. Vinyl tile, ceramic tile, or terrazzo are appropriate. Choices of these material should be in heavy-duty grades. High-gloss concrete finishes should be avoided. Apparatus bay floors necessitate rugged yet slip resistant surfaces. Terrazzo (stone chips) is an expensive choice, but it requires minimal maintenance and will last for decades. Seamless floors, usually epoxy with a sand aggregate, are durable, easier to clean, wear resistant and minimize slipping hazards. They are applied in multiple layers to a thickness of about 1/8 inch. If improperly installed, however, they may peel up. Sealed concrete can also be economical. Though found in many stations, carpet is no longer considered a good choice. It is difficult to clean and decontaminate, and it is not especially durable. In areas, such as bedrooms or day rooms, where carpet might be considered necessary, consider smaller replaceable area rugs.

Heating, ventilating and air conditioning systems

HVAC systems make up a sizable portion of the construction, operation and maintenance budget of fire stations. HVAC systems also impact occupant safety and health, and should be selected carefully. Possible systems and relevant factors:

- Heating provided by electricity, fuel oil, natural gas, or propane fuel. The availability of the fuel selected must be dependable. The fire hazards and potential leaks from storing fuel oil or propane must be anticipated. Many codes now require installing costly containment and leak detection systems for fuel storage tanks.
- Heating provided via steam boiler systems. Boiler systems provide a high-quality, comfortable, controllable, efficient and even heat for each type of use within the building, but they are expensive to design and install.
- Heating provided by hot water distribution systems. Hot water systems are economical to install, especially when combined with the air conditioning duct work, but they can be drafty and subject to wide variations in temperature. They usually will not serve the apparatus bays well and must be supplemented.
- Heating provided by direct-fired, hot-air ducts or localized radiant heater systems. Radiant heaters are well suited to high spaces, such as apparatus bays, but inappropriate for the rest of the building. In colder climates, the apparatus bay system must be capable of heating up as quickly as possible for returning cold apparatus and personnel.
- Air conditioning using wall units or central systems. Air conditioning through the wall units is only practical in very small stations. Central systems are generally more efficient and easier to control. In some areas of high electricity rates, gas absorption units (which burn gas to create cooling) are being reintroduced with some success.

In addition, the following concerns exist for general station ventilation:

- Rapid removal of exhaust carcinogens and combustible vapors in apparatus bays, as well as prevention of fumes and vapors from reaching interior living areas or the compressor inlet for filling SCBA. Approaches for achieving this removal include engineering controls on the apparatus, direct ventilation, and source-capture methods **(see Figure 4.14).** There are debates on the most effective system. However, the general consensus among subject matter experts is that source-capture is essential. For the best in maintaining a healthy and safe station environment, both source-capture and direct ventilation should be used.
- Ventilation of commercial grade kitchens via special hoods with grease filters, fire suppression systems, and makeup air systems where called for by energy conservation requirements.
- Appropriate controls to obtain efficiency operation of HVAC systems (which are not overly complex systems and are easily understood and maintained by department personnel). There have been attempts by some local governments to control heating and air conditioning remotely. However, members will always figure a way to override these systems. It is always best to let the occupants control the station temperature.

Figure 4.14 — Exhaust removal systems only work if the hose is hooked to the vehicle's exhaust pipe.

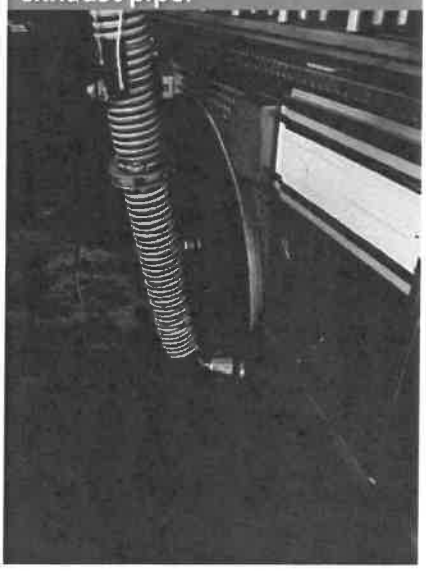

Photo courtesy of Mike Wieder, Stillwater, OK.

Lighting and electricity

Lighting on the apparatus floor is critical to prevent injuries and to complete work in a safe manner. Artificial lighting through designs, such as clerestory windows and skylights, offers effective and very inexpensive day-time lighting. For artificial lighting, instant-on light-emitting diode fixtures are very effective and energy efficient. Lights should be located between the apparatus so that shadows are not cast on walking surfaces. Systems are available to control the amount of light from both natural and artificial lights. The bay area can be zoned as needed for light control. If overhead heaters are used, they should be located far enough away from lighting so there is no chance of combustion. Bay lighting should also be integrated with the station alerting system.

There are general electrical needs which should be considered in the design of the fire and emergency services facilities. For example:

- Electrical outlets should be in ample supply throughout the facility.
- Duplex outlets should be installed with ground fault indicators.
- There should be outlets in all storage areas, locker rooms, and at least two outlets over work bench areas.
- Extra cabling or conduit should be allowed in the construction of stations to accommodate future needs for expanding electrical and cable capabilities.
- Back-up electrical generators should be considered.

Detection and fire suppression systems

Given the role of fire and emergency services organizations, the installation of sprinkler systems in all new and renovated facilities is necessary. Serious consideration should be given to retrofitting automatic sprinkler systems in existing stations. For existing stations, if a total retrofit cannot be funded, then serious thought should be given to adding a system to the apparatus bay. This is typically a very cost-effective retrofit. It must be noted that most station fires begin in apparatus parked in the station. These fires typically go undetected until the fire has spread to the station.

It is sensible that stations must also be equipped with smoke and carbon monoxide detectors. Smoke detectors should be placed in all living spaces, as well as work spaces. Similarly, carbon monoxide detectors should be placed in living and work spaces, as well as near any equipment that is gas fed.

Training and the fire station

Not only do well-trained emergency responders provide superior service, but they are less likely to be injured or killed on the job. For that reason, there is logic in designing a fire station in a manner that encourages classroom, online and hands-on training **(see Figure 4.15).** Often, these features can be added in a very effective, cost-beneficial way. Multiple cases exist where excellent training can be designed into the station for around 2 percent of the overall construction costs.

Figure 4.15 — Rooms designed to hold training or meetings can serve many purposes.

Photo courtesy of Michael Pry and Michael Taylor, DP3 Architects.

Classroom/Online

There are many benefits of having a classroom in a fire station. These rooms should be equipped with the necessary audiovisual equipment. This includes the following items:

- Screen(s).
- Projector(s).
- Recording capabilities.
- Smartboards.
- Easel pads.
- Conference phones.
- Dry-erase boards.
- Adjustable lighting.
- Internet access.
- Tables with electrical outlets and information technology outlets.

Classrooms can be cost-effective by becoming multifunctional rooms. If parking and public access are available, the classroom can be used for the following:

- Emergency Operations Center.
- Polling places.
- Community rooms.
- Social gatherings.
- Family events.
- Rented to outside agencies for training.

Note: Kitchen facilities might be needed if the classroom is used as a multifunctional room.

Figure 4.16 — This ladder training area is protected from the weather.

Photo courtesy of Dennis Ross, Pacheco Ross Architects.

Figure 4.17 — This facility supports elevated rescue training exercises inside the structure.

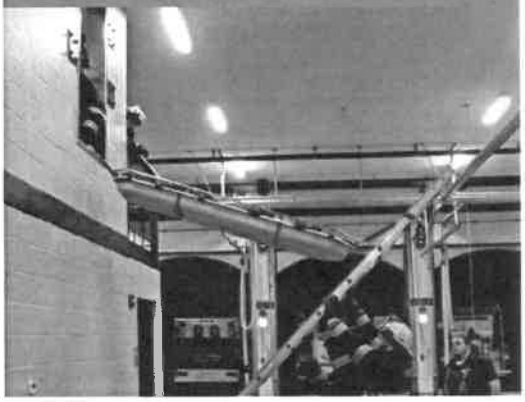

Photo courtesy of Bob Mitchell, Mitchell Associates, Architects.

Mezzanines

Mezzanine areas above single-story fire station living areas and adjacent to the apparatus bay floor are great spaces for integrating training props. Examples of mezzanine uses:

- Ladder evolutions **(see Figure 4.16).**
- Rope rescue.
- Entanglement training.
- Forcible entry.
- Removal of victim from an upper floor **(see Figure 4.17).**
- Confined space/maze training **(see Figure 4.18).**
- Building props.
- Prop storage.

Figure 4.18 — This training maze was constructed in the loft space of a fire station.

Photo courtesy of Bob Mitchell, Mitchell Associates, Architects.

Design considerations when using a mezzanine area for training:

- Removable railings.
- Rope anchors.
- Edge protection.
- Wall reinforcement.
- Overhead clearance.
- Protective blankets for apparatus wall.
- Door opening with easily replaceable and disposable doors for forcible entry training.

Figure 4.19 — Rope rescue training that is protected from the weather may be conducted within a training tower.

Photo courtesy of Bob Mitchell, Mitchell Associates, Architects.

Figure 4.20 — Simulating the removal of a firefighter trapped on an upper level can be accomplished with a drill tower.

Photo courtesy of Bob Mitchell, Mitchell Associates, Architects.

Training tower

A training tower can be a nice architectural feature to a station, as well as a valuable space for on-site training. Examples of training evolutions that can be conducted in a tower:

- Rope rescue **(see Figure 4.19).**
- Rappelling.
- Hose advancement.
- Standpipe evolutions.
- Sprinkler stoppage/change-out.
- Artificial smoke space for SCBA training.
- Rescue of personnel from upper floors **(see Figure 4.20).**

Design considerations when using a tower for training:

- Slip-resistant steps.
- Weather proof materials.
- HVAC.
- Electrical connections.
- Lighting.

If resources allow, incorporating multiple training components into the design of a new fire station will provide maximum flexibility in conducting training exercises **(see Figure 4.21).**

Figure 4.21 — This cutaway drawing shows a fire station that provides multiple training options.

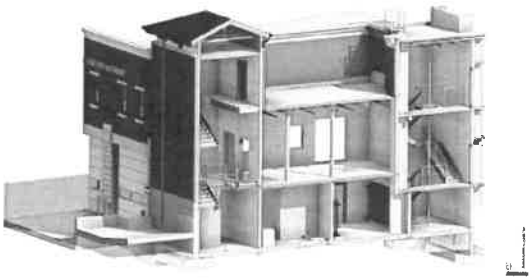

Photo courtesy of Mark Shoemaker, KZF Design, Inc.

Chapter 5: Specific Safety Considerations

It is estimated that over 2,000 emergency responder injuries occur annually at fire and emergency services stations. This includes injuries that occur inside and outside the station. Some activities being performed at the time of injury:

- Training.
- Station maintenance.
- Vehicle maintenance.
- Normal activities.
- Physical fitness.

There are several ways to examine a fire and emergency services facility for safety. The conventional approach considers each space and the specific hazards related to that space. This approach lends itself to a design checklist or inspection system. Each station can be divided into specific areas:

- Station grounds.
  - Driveways.
  - Exterior training areas.
  - Vehicle cleaning and maintenance areas.
- General station interior.
  - Public areas.
  - Office/Meeting/Watch areas.
  - Kitchen.
  - Dormitory/Shower/Locker/Restroom areas.
- Fitness rooms.
- Support areas (storage, mechanical-electrical spaces, shops).
- Apparatus bays.
- Special areas (towers).

A second approach to address station safety is to identify specific safety concerns. As would be expected, certain hazards are common to more than one area of the station. Thus, design solutions for one area may also be applied to other areas of the station. Of course, it is understood that some hazards are specific to certain station areas. One advantage of this approach is that it allows personnel to match applicable regulations and codes to specific hazards. (Many regulations are not area-specific.) In this section, several applicable regulations have been identified that point to specific safety concerns.

Electrocution/Shock hazards

The possibility of electrocution exists wherever an electrical current contacts a person, usually through water, wire or another conductive medium. Pathways for electrical currents may be confined to the limbs that contact the live circuit, or more critically, the current may pass through the body, as in the case of hand-to-hand or hand-to-foot contact. This pathway has the most critical impact on heart function. About 10 percent of the current from a hand-to-foot pathway flows through the heart. Since many processes within the body are mediated and controlled by electrical activity, external voltage can affect individuals in a number of ways.

Figure 5.1 — Faulty electrical equipment is a common cause of fires in fire stations.

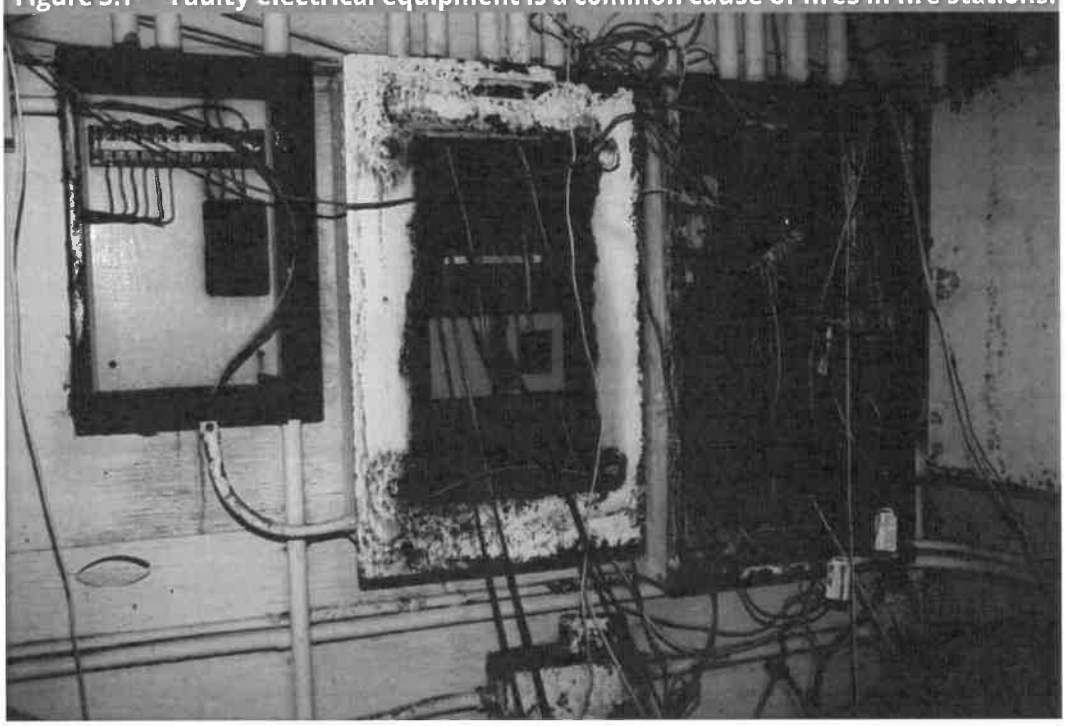

Photo courtesy of Kevin Roche, FACETS Consulting, LLC.

Regrettably, many fire stations have several electrical hazards that go unnoticed **(see Figure 5.1).** Many stations are never inspected to the same degree as other public facilities. There have been occurrences when OSHA has inspected stations, and the results did not reflect positively on fire and emergency services.

Extent of problem at the station

Several possible sources of electrocution arise in fire stations and older buildings:

- Wiring may be exposed when not encased in conduit, when chewed by animals, or when exposed or otherwise frayed through age.
- Waterproof covers may be missing, or outlets not located at a proper height above the ground.
- Electric power tools and outlets may become ungrounded or may be improperly used.
- Power lines in or around the station may be damaged, or may fall to the ground and come into contact with station personnel.
- Water contained in tankers and other apparatus may leak onto the floor when tank seals age. Any electrical device that comes into contact with this water can electrocute/shock a member in and around the apparatus bay.
- Members extending electrical lines without following codes.
- Older fire and emergency services stations may not meet today's increased electrical demands.

After original systems are installed, the most common source of electrical hazards in the fire station is maintenance. Aboveground utility lines constitute electrical hazards when they are close to the station, aerial ladders or towers. A number of members have been seriously injured, and at least one fatality has occurred, as the result of contacting an overhead power line at the station with an aluminum ground ladder.

Relevant regulations and standards

The following are some of the regulations and standards that apply to electrical services in fire stations:

- For OSHA regulations, see **Appendix D.**
- NFPA 70, *National Electrical Code®*.
- NFPA 70E, *Standard for Electrical Safety in the Workplace®*.
- Locally adopted codes.
- Specific organizations:
  - Association of Edison Illuminating Companies.
  - Association of Home Appliances Manufacturers.
  - AIA.
  - American Lighting Association.
  - American Society of Safety Engineers (ASSE).
  - Electrical Generating Systems Association.
  - Institute of Electrical & Electronics Engineers.
  - Lightning Protection Institute.
  - National Electrical Manufacturers Association.
  - International Electrical Testing Association.
  - Underwriters' Laboratories (UL).

Preventive design requirements

Electric shock injuries can be reduced by protecting personnel, selecting and maintaining appropriate equipment, and (most importantly for this section) designing the station or equipment to minimize the possibility of contact with electricity. All electrical work at the station must be done by a licensed electrician, and then inspected by a qualified building/electrical inspector. Specific station design requirements:

- Ground all station electrical outlets, and connect to an electrical panel with circuit breakers sized to handle the load on that circuit. Circuit breakers must be clearly identified on the panel by function or area of coverage with a simple list on the panel door or a numbered facility diagram on the wall next to the panel.
- Keep the main electrical panel area clear and free of storage (allow at least 3 feet of clearance). As with any facility, openings in the panel cover should be properly enclosed to keep live parts from being exposed.
- Ensure that all receptacles and junction boxes are covered with appropriate plates.
- Install ground fault interrupter circuits (GFICs) (designed to interrupt the current during a short to reduce the time a person is in contact with it) in areas that are wet or could be wet, such as bathrooms, apparatus bays, boiler rooms, roofs, outside lighting circuits, and kitchens. Because receptacles can become damaged and wear out, periodically use a circuit tester, including a GFIC tester, to evaluate their condition.

- Extension cords should only be used for temporary applications.
- Protect light bulbs from physical damage when located within 7 feet of the floor. Protection can be in the form of bulb sleeves, covers or plastic lenses.
- When personnel are working on energized circuits or de-energized fixed equipment, follow OSHA's lockout/tagout standard or NFPA 70E.

Station grounds

The following electrical safety considerations should be addressed in relation to the grounds surrounding the fire station:

- Ensure that utility poles are placed at least 10 to 15 feet away from vehicle maneuvering areas to reduce the possibility of collisions and dropping "hot" lines onto the vehicle or building. Extended front bumpers on apparatus may project up to 3 feet beyond the visible end of the vehicle. They can be easily missed when turning and may come into contact with power poles.
- Use bollards to protect ground-mounted transformers from impacts (Uniform Electrical Code) when placed within 10 feet of driveways or parking lots. A one-hour fire-resistive wall must be built to protect buildings or openings in them when occupants could be electrocuted or burned by a damaged or failed transformer.

Support areas

The following electrical safety considerations should be addressed in relation to support areas at the fire station:

- Verify that all electrical powered tools or equipment are insulated to prevent an electrical shock to the user. Most portable or fixed equipment comes with a ground prong (pin) on the male attachment plug to provide a continuous path to ground if hazardous voltage escapes from the machine or equipment. If this prong is missing, the individual operating the tool or equipment may become the path to ground and receive a fatal electric shock. All electrical hand tools must either have a three-prong plug (ground) or must be labelled as "double insulated." Worn or missing plugs must be replaced with UL-listed plugs compatible with the cord and specific equipment.
- Do not use three-prong to two-prong adapters ("cheater" plugs) to operate any equipment (cheater plugs are designed for allowing three-prong plugs to fit into two-prong outlets).

  Note: This requirement is not necessary if all station outlets are properly grounded.
- Design all block heater coaxial cords to feed from an overhead location, with a reinforced flexible connection to a junction box. Floor-mounted cords can cause electrocution or can become a tripping hazard.
- Install an alarm-activated service disconnect on all fixed cooking devices for all new stations containing a kitchen, as well as remodeled station kitchens. These devices shut off appliances when the alarm mobilizes personnel.

Slips and falls

Personnel slips and falls occur when individuals lose balance or traction due to surfaces that are wet, uneven or have poor traction; due to footwear that does not provide adequate slip resistance; or due to above surface standing or walking areas that are unguarded. While most slips and falls result in strains, sprains and broken bones, many can lead to debilitating injuries, such as chronic lower back injury or even death.

Extent of problem at the station

Falls within fire and emergency services facilities, or on station grounds, account for a significant number of reported injuries within the fire service (excluding incident falls). Most occur during a response or during training activities where rapid movements are required. Falls occur when a change of direction is required or where collisions with other personnel are possible, due to poor hallway layout, or where blind spots exist in the response line. Many areas of the station are prone to falling and slipping hazards, due to the following:

- Standing liquid on apparatus bay floors.
- Limited maneuvering space between apparatus.
- Crowded corridors and exits during response.
- High step and improper rail and grab handle design for some apparatus.
- Poor tread design and lack of guardrails for stairways.

Elevated floor areas that have open sides require guardrails when the fall distance is greater than 6 feet (based on OSHA 29 Code of Federal Regulations (CFR) 1926.501). The probability of a fall resulting in traumatic injuries increases as the height increases, and when the area below is a nonflexible surface, such as hard-packed earth, concrete or asphalt. Guardrails form a system designed to prevent accidental falls. Areas commonly in need of guardrails:

- Mezzanines.
- Hose tower platforms.
- Storage areas.
- Stairwell landings.
- Outside areas, such as decks.
- Possibly building roofs, if the area is often used for training (including training towers).

Relevant regulations and standards

The following are some of the regulations and standards that apply to this slip and fall protection:

- Locally adopted building and fire codes.
- For OSHA regulations, see OSHA 1910.501, as well as **Appendix D** under "Interior Areas-Walking-Working Surfaces."
- American National Standards Institute (ANSI)/ASSE 359.1-92, *Safety Requirements for Personal Fall Arrest Systems.*
- Specific organizations listed in **Appendix E** that provide guidance in this area:
  - American Concrete Pavement Association (ACPA).
  - American Concrete Institute (ACI).
  - Asphalt Emulsion Manufacturers Association.

- ANSI.
- ASSE.
- American Wood Protection Association.
- Human Factors and Ergonomics Society.
- National Terrazzo and Mosaic Association, Inc. (NTMA).

Preventive design requirements

Most design solutions for preventing slips and falls involve providing appropriate walking surfaces with good traction, controlling interior station traffic, and providing guardrails and other fall restraint devices. Specific spaces of facility design requirements include the following sections.

Station grounds

In the design of circulation pathways, the requirements should include training areas and vehicle aprons that are level, well-drained, nonslip surfaces. They should be constructed of either asphalt, concrete, corrugated steel plate, or fluid-applied membrane surfaces. **(Note:** Asphalt is not suitable for heavy apparatus, but is suitable for member and public parking areas when restricted to light vehicles.) Good safety design measures:

- Apply a nonslip texture to concrete using a light to heavy broom finish immediately after placement.
- Avoid large areas of painted asphalt surfaces because these surfaces are naturally nonslip, except when painted, stripped, or coated with oil droppings.
- Use a checkered plate or a fluid-applied surface that contains sand or garnet for steel plates that are often used for covering underground vaults, test pits, or transition surfaces, such as ramps.
- Require a coat of fluid-applied deck coating containing sand for decks or other surfaces, including drill towers, which are rendered slippery when wet. Heavy traffic areas may require repeated fluid coatings as part of an ongoing maintenance program.
- Use run-off basins that are equipped with oil-water separators in areas for washing apparatus.

Station interiors

- Maintain access to the apparatus bays in a generally straight line with one or more access points provided **(see Figure 5.2).**
- Avoid access hallways with turns or hallways that connect in a "T" or "X" crossing condition.
- Design access points in the apparatus bays so members can get to the bay with a minimum number of turns.

Figure 5.2 — Any station design should facilitate the expedient travel of personnel to the apparatus bays.

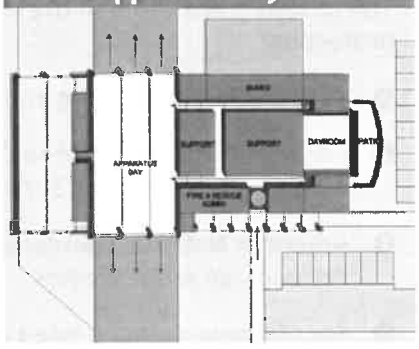

Photo courtesy of Lynn Reda, Hughes Group Architects.

- If possible, locate support and storage areas on the same level as the living and working spaces. The logic of this is often overlooked in both new or older stations. Support or storage areas that require the use of stairs to access should be avoided as falls are more likely to occur when members are carrying items. In addition, vision is restricted on stairways or on ladders while grasping onto storage items.

- A minimum 4-foot clearance shall be maintained (designed) around apparatus parked within the station, if permitted by the structure **(see Figure 5.3).** A minimum 6-foot clearance should be considered if the apparatus doors are four-fold. Aisles need to be established for spacing between apparatus, much like the fire code requires aisle spaces in public assembly buildings, for access to electrical panels, or around high-piled stock.

- Use slip-resistant surfaces on apparatus bay floors where personnel would normally mount or dismount apparatus **(see Figure 5.4).**

Figure 5.3 — A minimum 4-foot clearance shall be maintained (designed) around apparatus parked within the station.

Photo courtesy of Lynn Reda, Hughes Group Architects.

Figure 5.4 — Apparatus bay floor should have slip-resistant surfaces, especially in the primary travel areas.

Photo courtesy of Michael Pry and Michael Taylor, DP3 Architects.

Floor finishes for fall prevention

Fire apparatus bay areas are often finished with a smooth concrete surface and then given a seal coating. Serious consideration should be given to the need for nonslip surfaces, which reduces the potential for slip-trip injuries in those areas that are frequently wet, and where firefighters are moving quickly, mounting and dismounting apparatus **(see Figure 5.4).** Several manufacturers provide floor finishes that allow for safe, sure footing on wet surfaces. Once installed, the finishes remain permanently in place for extended periods and may be warranted for extended periods when properly maintained.

The installation of these floor finishes depends upon the manufacturer. Installation consists of applying a special formulation of nontoxic chemicals which react with surfaces in such a way as to make porous mineral surfaces safe when wet. These treatments can be applied simply and safely to many types of existing floors, both indoors and outdoors. The surface must be porous stone (e.g., granite, ceramic tile, quartz tile, terrazzo, concrete, brick, pool decking, marble, etc.). These floor finish systems will not work on linoleum, vinyl, tile or fiberglass. Some finishes may not be effective in greasy areas. They create a chemical reaction within the pores of the surface, resulting in a higher coefficient of friction when water is present. One manufacturer's system cannot be detected on most surfaces after being applied. Another manufacturer's system uses an epoxy and quartz sand formulation that produces a nonskid or "orange peel" finish.

One of the best floor coating systems is an MMA acrylic resinous coating. It is slip-resistant, easy to clean, and allows for lines, markings and graphics.

Note: Floor coatings that will withstand the extreme heat given off by apparatus tires following a response must be selected.

Stairways and guardrails

- Design guardrails with top rails at 42 inches, mid-rails at 21 inches, support posts at specified distances, and toeboards as needed. Guardrail construction should conform to OSHA and ANSI specifications, which allow latitude in construction materials.

  Note: These recommendations are based on OSHA requirements. Local requirements may be different based upon local building ordinances.

- Use nonslip finishes or treads on stair treads and the nosing (edge of the tread surface). Treads wear out and must be replaced as often as necessary to maintain a slip-resistant surface.

- Use a color or hue on the edge of the stair tread (nonskid material) that contrasts with the rest of the tread.

- Place guardrails on the open sides of stairways (to prevent falls over the side) when there are four or more risers. Stairway rail height should be between 30 and 34 inches when measured vertically from the upper surface of the top rail to the surface of the tread that is in line with the face of the riser at the forward edge of the tread. The number of rails depends on the width of the stairs and the number of open or closed sides. Handrails must be easy to grasp, no more than 2 inches in diameter, and at a height of no less than 34 inches and no more than 38 inches above the tread nose and landings. They must be continuous and extend beyond the last step.

  Note: These recommendations are based on OSHA requirements. The requirements in your area may be different; check your local building ordinance.

- Use contrasting colors for guardrails to make them clearly visible compared to the rest of the stairway.

Slide poles

Slide poles are an iconic part of two-story fire stations **(see Figure 5.5).** There is no doubt they provide expedient access to lower levels. However, they are some of the most dangerous components of a station if not properly guarded and used. Emergency responders have sustained numerous injuries when sliding down poles, particularly to knees and ankles. Station tours often include a demonstration of the slide pole, and far too often, members allow the public to slide down the pole. Children are especially inquisitive about the pole and must be closely watched to make sure they do not attempt a slide. Some departments have installed slides instead of poles. A properly designed slide can be very effective and much safer than a pole.

Figure 5.5 — There should be protective padding at the bottom of a slide pole.

Photo courtesy of Mike Wieder, Stillwater, OK.

To prevent and minimize injuries with a slide pole, remember the following guidelines:

- Where sliding poles are used, guard the pole hole in accordance with the manufacturer's instructions to prevent personnel from walking directly into the hole opening.
- To absorb shock to sliding personnel, use a 3-foot diameter cushioned rubber mat or equivalent device at the bottom of all slide poles.
- Establish rules, and install signage that limit one person on the pole at a time.
- Establish rules, and install signage strictly prohibiting use of the pole except to members who have been trained on the proper technique of sliding down a pole.

Elevated surfaces

Elevated surfaces in a fire station include hose/training towers and mezzanines. General guidelines are as follows:

- Equip floor openings in hose/training tower platforms and mezzanines with a 42-inch guardrail with a mid-rail at 21 inches capable of withstanding a force of 250 pounds applied in any direction at any point on the top rail. Equip each platform with toeboards (barriers at platform level erected along the exposed sides and ends to prevent materials falling off the platform).
- When access ladders extend beyond 20 feet, require offset platforms and cage guards. (Permanent fixed ladders on the outside of drill towers and drill buildings are exempt from the requirements of offset platform landings and ladder cage guards).
- Provide a rung clearance behind the hose/training tower ladders of at least 7 inches.
- Do not have step-across distances that exceed 12 inches.
- Design side rails greater than 16 inches wide.
- Use ladder rung spacing of less than 12 inches.
- Start ladder cages between 7 and 8 feet above a landing.
- Use ladder pitch between 75 and 90 degrees.

Marine areas

Stations that are adjacent to bodies of water often use finger piers or docks to access water rescue craft:

- Construct the dock or pier surface using nonslip materials. Piers of concrete (chambered construction) require either a broom-finish concrete or fluid-applied nonslip coating.
- Locate all tie-off points, hose bibs, or electrical outlets away from walkways, and provide adequate space for access to watercraft.
- In locations where water levels fluctuate, gangways are required to be designed for multiple angles of use. They must also be nonslip, using either raised treads, a nonslip surface, or both. All gangways are required to meet OSHA handrail standards.

Falling objects

Injuries resulting from objects falling and striking personnel at the station are not uncommon in stations with overhead storage, such as lofts, high storage shelving or cabinets, mezzanines, or openings with slide poles. The problem can be classified into two primary areas of concern: objects dropped by others and unsecured objects falling or toppling onto station occupants.

Relevant regulations and standards

Relevant regulations that apply to protection from falling objects include:

- Locally adopted building and fire codes.
- Pertinent OSHA regulations **(Appendix D).**
- Specific organizations, listed in **Appendix E,** which provide standards in this area:
  - American Architectural Manufacturers Association.
  - AIA.
  - National Safety Council (NSC).

Preventive design requirements

Areas most often associated with falling object accidents are the gym, support or storage areas, and the apparatus bays. Items stored in or on file cabinets, storage shelving systems, and wall-mounted or hook-supported systems represent the highest frequency of reported injuries from falling objects.

Considerations for improving safety in storage areas:

- The apparatus bay should not be considered a storage area, except possibly for a fire hose not carried on the apparatus.
- Require all vertical files with three or more drawers to be of an interlock variety that allows only one drawer at a time to be opened. Secure all file cabinets to walls with lag screws and clamps or steel angles.
- For storage shelving or high-rise storage systems, require that all shelving have a 1/2-inch lip on the open edge of each shelf. Install one retaining wire 6 inches above each shelf, and secure each section of a storage system to the floor, or brace back to a wall or ceiling to prevent unit from falling.
- For wall-mounted items, use a 1/2- to 1-inch lip for objects stored on a hook or ledger to prevent the item from being unintentionally dislodged.
- Require installation of walls or guardrails that are a minimum of 42 inches high on all mezzanine storage areas to prevent objects or people from falling to the level below.
- Isolate loft spaces, which are accessed through a hinged door or gate, with three restraining cables, chains or bars to prevent occupants from falling through unprotected openings.
- Include a standard guardrail for a loft or landing platform with a toeboard, which is a vertical barrier, at floor level. Erect guardrails along exposed edges of a floor opening, wall opening, platform, runway or ramp to prevent material from falling.

- In the design phase of station planning, always allow for additional storage space beyond what is currently anticipated. In some cases, due to budget constraints and the cost of a station being assessed on a per square-foot basis, it might be necessary to creatively assign space which can ultimately be used for storage.
- Secure emergency medical drugs and limit access to only authorized personnel.

Explosions

Explosions occur when volatile vapors or gases come into contact with an ignition source, or when pressurized cylinders rupture from overheating or physical breaches. Ignited gases send a burst of flames and pressure into the area where gases have collected. Ruptured cylinders represent physical or projectile-type hazards. Both types of explosions can cause severe personnel injury near the incident. Gas explosions can also ignite combustibles in adjacent areas, creating additional hazards.

Extent of problem at the station

Refueling pumps and battery charging rooms pose a high risk of explosion or fire. Most common ignition sources are ungrounded outlets located less than 18 inches above the floor where vapor or gas accumulation occurs, or where equipment using unsealed switches is used in a room where gases have accumulated.

Other sources of explosions at the station involve pressurized cylinders or other vessels, such as breathing apparatus bottles, fire extinguishers, and steam boilers.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this topic:

- Locally adopted building and fire codes.
- For OSHA regulations, see **Appendix D.**
  - OSHA 1910.94 Ventilation.
  - OSHA 1910.101 Compressed gases (general requirements).
  - OSHA 1910.106 Flammable and combustible liquids.
  - OSHA 1910.110 Storage and handling of liquefied petroleum gases.
  - OSHA 1910.169 Air receivers.
  - NFPA 30, *Flammable and Combustible Liquids Code.*
  - NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages.*
  - NFPA 54, *National Fuel Gas Code.*
  - NFPA 55, *Compressed Gases and Cryogenic Fluids Code.*
  - NFPA 69, *Standard on Explosion Prevention Systems.*
  - NFPA 85, *Boiler and Combustion Systems Hazards Code.*

Specific organizations, listed in **Appendix E,** that provide standards in this area include:

- Associated Air Balance Council (AABC).
- American Boiler Manufacturers Association.
- American Gas Association.
- American Petroleum Institute (API).
- ASSE.
- Battery Council International.

- Compressed Air & Gas Institute.
- Compressed Gas Association (CGA).
- National Propane Gas Association (NPGA).

Preventive design requirements

In occupancy types with atmospheres that are classified as hazardous, NFPA 70 cites specific requirements and locations of electrical equipment in these spaces.

Hazardous atmospheres

- In all spaces where the possibility of an explosion exists, mechanical ventilation of that space should be required in accordance with the Uniform Mechanical Code Sections. The apparatus bays, shop areas, mechanical rooms, vehicle wash equipment, reclaim rooms, and electrical panel rooms present the highest risk of explosions in buildings 10 years or older, where modern safety code requirements were not designed into the building.
- Gas lines, or regulators serving a building, should be carefully researched. Regulators and manifolds should be located at least 20 feet (horizontally and vertically) away from fresh air intakes serving air-handling equipment where burners or electric coils are used.
- Consider the installation of explosive gas monitors or sensors in the design of new or remodeled fire or EMS stations for hazardous classified spaces.
- Do not use Class I or Class II flammable liquids for cleaning purposes to remove grease or dirt from apparatus.
- Install eye wash stations near battery charging areas.
- Install refueling pumps according to the provisions of the locally adopted building codes, or NFPA 30A.
- Dispense Class I liquids as required by the locally adopted building code, or NFPA 30A.
- Post "No Smoking" and "Stop Your Motor" signs in fueling areas.
- Place a refueling pump shut-off switch a minimum of 50 linear feet away from the dispenser, and clearly post a sign, "Fuel Pump Shut-Off." This requirement is based on what is considered a safe distance away from the potential hazard area.

Pressurized cylinders and vessels

- Hydrostatically test pressurized cylinders at regular intervals. The frequency depends on the cylinder construction. Common cylinders requiring hydrostatic testing are stored pressure fire extinguishers, breathing air cylinders, cascade cylinders, oxygen cylinders, and fuel gas (acetylene) cylinders.
- Require inspection and certification by a boiler inspector for pressure vessels, such as boilers, some hot water heaters, and some air tanks.
- Secure the cylinders in storage, or use them to prevent overturning. Use chain or cylinder band clamps for this purpose.

Vehicle hazards

Most fire departments rank vehicular accidents as the leading cause of station personnel injuries. The nature of activities in and around fire and emergency services stations involves rapid vehicle movements, as well as low speed backing or turning actions while responding to or preparing for a response to a call. Accidents that occur because of these vehicle movements often involve nonattentive members or station visitors unfamiliar with these activities. Most emergency response vehicles have large bulk and many blind spots, which further enhance the potential for an accident and injury.

Extent of problem at the station

A significant number of incidents resulting in injuries and death are related to vehicular use around stations. Deaths usually involve the member being crushed between two apparatus or between an apparatus and a wall. There have also been cases of members falling from the apparatus or being pinned against ceiling-mounted equipment.

Several of these accidents can be eliminated by using drive-through bays. However, many drive-through apparatus bays become "back-in" bays because of other vehicles or equipment staged behind primary response vehicles. Most in-station vehicular accidents are the result of apparatus backing up. It is imperative that organizations have a policy that requires spotters when an apparatus is backing up. This policy must be strictly enforced. Another type of accident occurs when the apparatus moves out onto adjacent roadways without proper traffic control. Lastly, apparatus bay doors are struck by apparatus or close on top of the apparatus as it exits the station. In many cases, the potential for injury to personnel is small; however, repair of doors can be difficult.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this topic:

- Locally adopted building and fire codes.
- Pertinent OSHA regulations are provided in **Appendix D** under "Apparatus Area."
- Specific organizations **(Appendix E)** that provide standards in this area include:
  - American Association of State Highway and Transportation Officials.
  - ACPA.

Site layout

Whenever permitted by the site, design the station with "one way" circulation drives (usually one bay deep) that are accessed in a drive-through manner. Avoid driveways that require more than one 90-degree turn to enter a public street. Stations requiring a vehicle to back into the bays will raise the risk of an accident, even when assistance is rendered by other firefighters, such as spotters.

Equip driveways that empty directly onto a public street from the fire station in high-volume traffic areas with traffic control lights. For extremely busy roadways, there should be a series of lights in either direction to get through traffic. Activation of these lights is best controlled through an apparatus on-board activation system. Activation can also be through a switch mounted in the station or through the station alerting system.

Install self-closing doors. These doors should have pressure switches at the bottom, so in the event they start to close when an apparatus is under them, they return to the open position and do not damage the apparatus or the door itself.

Drowning

Drowning is a hazard at marine fire stations or for firefighters operating around piers or waterways. Contributing factors to drowning can include cold water, which causes hypothermia and limits mobility, and wearing heavy protective clothing and equipment.

Extent of problem at the station

Stations in marine settings may have the potential for drowning incidents. Unguarded pier and dock locations, combined with slippery conditions from either wet or cold weather, pose the highest risks for drowning.

Preventive design requirements

The primary means for preventing drowning is to follow the recommendations for slips and falls (see section above), and to require station personnel operating in unguarded areas around docks and piers to wear a U.S. Coast Guard approved Personal Flotation Device.

Natural disasters

Fire and emergency services facilities are often thought of as a place of safety and shelter. When the rest of the community is in a disaster, the structures of fire and emergency services should remain safe and functional. All stations should be designed to exceed all building codes to withstand the forces of nature **(see Figure 5.6).**

Figure 5.6 — As a result of a storm, this station roof buckled under the excessive water weight.

Photo courtesy of Don Collins, Collins Design Service.

If a catastrophic event occurs in urban areas, consideration should be given to one or more stations. This may dictate the need for a special conference room where all local government officials meet and plan the city's survival. This requires extra phone lines, restrooms, chalkboards, break-out rooms, and ample storage for emergency supplies.

The effects of earthquakes on structures are well-known. Current codes divide the U.S. into four seismic zones, ranging from high risk, to nonexistent or low risk. Current codes do not deal with the variables of geology within a seismic zone. Amplifications, caused by locally soft soils, can create much of this variability, which can vary significantly over a short distance. Good geological data is vital in developing designs for new fire stations or evaluating the survivability of an existing one.

Other natural disasters are possible, of course, including the effects of high winds, flooding and lightning associated with severe storms. The likelihood of these events will differ by region, as well as the specific location of the station. High winds pose particular problems for roofs and outside structures. Flooding will primarily affect low-lying areas or communities next to rivers or lakes. Lightning and severe storms can occur anywhere, but areas prone to tornados and hurricanes are especially at risk.

Extent of problem at the station

Most building codes consider fire and emergency services facilities "essential structures"; therefore, their design is vital for the safety of the emergency response personnel and the citizens who depend on them. Essential structures are designed to 125 percent of the earthquake resistance standards required by other residential and public structures. Those basic standards range from Level 1 to Level 4, depending on the seismic zone risk in a particular area. In addition, survivability of the station must be considered for severe weather. For example, appropriate station locations must be considered in areas where flooding is possible.

Relevant regulations and standards

The primary source of regulations for withstanding earthquakes and other natural disasters is the locally adopted building code. Specific organizations, listed in **Appendix E,** that provide standards and guidance in this area include:

- ACI.
- AIA.
- American Institute of Steel Construction (AISC).
- American Institute of Timber Construction (AITC).
- American Society of Civil Engineers (ASCE).
- Concrete Reinforcing Steel Institute.
- Construction Specifications Institute (CSI).
- Precast/Prestressed Concrete Institute (PCI).
- Post-Tensioning Institute (PTI).

In addition, the Federal Emergency Management Agency (FEMA) has established the National Earthquake Hazard Reduction Program (NEHRP), and they have produced several guidelines, including "NEHRP Recommended Seismic Provisions for New Buildings and Other Structures."

Earthquakes

In the design for a building to resist earthquake motions, the designer works within certain constraints, such as the architectural configuration of the building, the foundation conditions, the nature and extent of the hazard should a failure or collapse occur, the possibility of an earthquake, the possible intensity of earthquakes in the region, the cost or available capital for construction, and similar factors. The designer must have some basis for the selection of the strength and the proportions of the building, and for the various support members in it. The required strength depends on factors, such as the intensity of the earthquake motions to be expected, the flexibility of the structure, and the ductility or reserve strength before damage occurs. Because of the interrelations among flexibility and strength of a structure, as well as the forces generated in it by earthquake motions, the dynamic design procedure must take those factors into account. The ideal to be achieved is one involving flexibility and an energy-absorbing capacity that will permit the earthquake's displacements to take place without generating unduly large forces. To achieve this end, control of the construction procedures and appropriate inspection practices are necessary. The attainment of the ductility required to resist earthquake motion must be emphasized.

The UBC has an entire section on earthquake construction requirements for structures by occupancy. These are the latest state-of-the-art concepts based on nationally recognized good practices. Furthermore, building permits will not be issued until earthquake designs

have been considered, and building officials have approved the design or lack of design in writing. For the parts of the country where snow is a major consideration, weight factors also need to be considered when preparing the station design.

The design should consider several factors to avoid adverse impacts and potential harm, and to ensure safe, stable and compatible development appropriate to site conditions. These should include, but not be limited to the following:

- Review of available literature regarding the site and surrounding areas.
- Detailed topographic analysis.
- Subsurface data and exploration logs.
- Ground surface profiles.
- Analysis of relationship of vegetated cover and slope stability.
- Site stability analysis.
- Geotechnical considerations to reduce risk.
- Construction and post-construction monitoring.

Before the 1970s, the structural design of buildings focused primarily on providing sufficient strength to overcome the forces resulting from an earthquake's ground motion. The most glaring deficiency was the need for increased building ductility. Before that time, earthquake building codes required that structures be designed for a prescribed level of static force. An earthquake is a dynamic event, not a static one. Accordingly, structures need strength and the ability to sustain their strength for the duration of the earthquake. Criteria for such a design:

- Provide a design with continuity in the floor plan from a structural perspective.
- Employ structures with continuous earthquake load carrying systems. Stations with wall systems that are discontinuous or interrupted by changes in the floor plan perform poorly.
- Steel-reinforced concrete has performed well in earthquakes.
- Use cross-members, especially along walls with no openings.
- Determine the level of earthquake resistance to be designed into the new station, or the degree to which an older one should be upgraded.
- Base isolation is a design that should be considered. It involves floating a building above its foundation on a system of bearings, springs or padded cylinders. Engineers use a variety of bearing pad designs, but they often choose lead-rubber bearings, which contain a solid lead core wrapped in alternating layers of rubber and steel. The lead core makes the bearing stiff and strong in the vertical direction, while the rubber and steel bands make the bearing flexible in the horizontal direction. Bearings attach to the building and foundation via steel plates and then, when an earthquake hits, allow the foundation to move without moving the structure above it. Thus, the building's horizontal acceleration is reduced, and it suffers far less deformation and damage.
- Use an importance factor of 1.5 in the station design. The importance factor is a ranking of the need for building survivability as applied to structural integrity. It relates to the specification of materials and design techniques that allow building survivability.

Flooding

Generally, the station's location is the first consideration to avoid the potential for flooding, with specific attention given to the area's type of soils, water table, and drainage. The Federal Insurance Administration of FEMA, together with state and local authorities, establish the potential for area flooding by classifying flood risk in every region within the U.S.

If history has demonstrated susceptibility of existing stations to flooding or significantly hindering operations, consider relocating the station to a more desirable location. Justification for moving a station can cite the need to maintain operations when fire and EMS are often most needed, in addition to the costs to the community in terms of relatively slow response times.

Use some of the same factors that apply to earthquake-resistant design when designing structures to avoid potential flood damage. Not only must stations be designed to prevent the inflow of flood waters, they must also take into account forces of running water and pressure created by floodwaters. Particularly important:

- Nearby sewer and runoff capacity.
- Local area flood controls.
- Eliminating basements and crawl spaces from station designs.
- Design of adequate footings and foundations for anchoring structures.
- Allowing appropriate subfloor drainage.
- Waterproofing concrete and masonry walls.
- Foundation elevation above the expected flood level.
- Use of sump pumps and other devices to reduce groundwater accumulation.

Based on the 2012 massive flooding caused by Hurricane Sandy in the northeast, we learned that the following design considerations deserve special attention:

- Electrical service and distribution systems.
- Data systems.
- HVAC systems.
- Emergency power systems.
- Elevators.

FEMA Publication 102, *Floodproofing for Non-Residential Structures,* offers detailed information for building design and construction to reduce damage associated with flooding.

Station design, including specially reinforced walls, reinforced roofs, and structural connections attributes importance in avoiding damage during severe storms, such as those associated with hurricanes. These design features generally add significantly to the cost of construction.

Fire (all types)

An emergency services station is one occupancy that should have no excuse to burn and should be constructed and maintained to make it practically immune to fire. In reality, fire stations are often just as susceptible to fires as other structures. Fires can be caused at stations by vehicle fires within the building, ignition of flammable gases or liquids, or electrical problems. Particularly dangerous are small, undetected fires resulting from improper or damaged wiring that can travel behind walls and in attic spaces. Dangerous fire conditions can also arise from the accumulation of fuel and flammable vapors in areas close to ignition sources.

Extent of problem at the station

On average, 150 fires per year occur in fire stations. (Probably many more small ones go unreported.) The most common hazard is a fire that starts within an apparatus. Another leading cause is kitchen appliances left on during a response. Some of these fires have resulted in substantial damage and sometimes personnel injuries. A review of causes for the majority of these fires appear to relate to the following:

- Faulty installation of apparatus cab electrical components.
- Improper storage of cab equipment.
- Faulty or improper wiring/electrical connections.
- Station equipment/appliances left operating during a response.
- Handling flammable substances within the station.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this topic:

- Locally adopted building and fire codes.
- OSHA regulations are provided in **Appendix D.**
- Specific OSHA regulations include:
  - OSHA 1910.37 Means of Egress, General.
  - OSHA 1910.38 Employee Emergency Plans and Fire Prevention Plans.
  - OSHA 1910.157 Portable Fire Extinguishers.
  - OSHA 1910.158 Standpipe and Hose Systems.
  - OSHA 1910.159 Automatic Sprinkler Systems.
  - OSHA 1910.160 Fixed Extinguishing Systems, General.
  - OSHA 1910.161 Fixed Extinguishing Systems, Dry Chemical.
  - OSHA 1910.162 Fixed Extinguishing Systems, Gaseous Agent.
  - OSHA 1910.163 Fixed Extinguishing Systems, Water Spray and Foam.
  - OSHA 1910.164 Fire Detection Systems.
- Specific NFPA Standards include:
  - NFPA 1, *Fire Code.*
  - NFPA 10, *Standard for Portable Fire Extinguishers.*
  - NFPA 13, *Standard for the Installation of Sprinkler Systems.*
  - NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.*
  - NFPA 70.
  - NFPA 70E.
  - NFPA 101.

Specific organizations, listed in **Appendix E,** that provide additional guidance in this area include:

- AIA.
- AISC.
- AITC.
- ASCE.
- CSI.
- NFPA.
- Volunteer Firemen's Insurance Service, Inc. (VFIS).

Preventive design requirements

Many of the safety concerns related to fire risk have been covered in previous sections, specifically those addressing electrocution/shock hazards, explosions and hazardous materials. Several specific concerns relative to fire protection exist at the fire and emergency services facilities, as in any large industrial or residential structure. These include systems for fire-resistive construction, fire detection, means of extinguishment, and providing adequate egress.

Fire-resistive construction

- Separate apparatus and storage areas from living and sleeping areas, with at least one fire-resistive separation.
- Install wiring, connections and appliance in accordance with NFPA 70 and NFPA 70E. For the latter standard, Chapter 2 (Wiring Design and Protection), Chapter 3 (Wiring Methods, Components, and Equipment for General Use) and Chapter 5 (Hazardous Locations) are particularly relevant.
- Ensure that fire/EMS station design and construction is compliant with NFPA 101. This standard addresses use of compartmentalization construction, smoke barriers, special hazard protection, and interior finishes.

Fire detection and suppression systems

- Require that all stations have both smoke and carbon monoxide detectors installed and directly wired with battery back-up.
- Ensure that fire detectors and fire detection systems are tested and adjusted as often as needed to maintain proper reliability and operating conditions.
- Select the number, spacing and location of fire detectors as based upon design data obtained from field experience, tests, engineering surveys, the manufacturer's recommendations, or a recognized testing laboratory listing as required by local code.
- Provide alarm systems which are recognizable from other alarms systems at the station.
- Provide portable fire extinguishers that are mounted and located in readily visible and accessible locations.
- Use only approved portable fire extinguishers, and be sure they are inspected monthly.
- Ensure that portable fire extinguishers are maintained in a fully charged and operable condition, and kept in their designated places at all times except during use.
- Install automatic sprinkler designs that provide the necessary discharge patterns, densities, and water flow characteristics for complete coverage of designated station areas. Use a Hazard Design of Ordinary Group I in accordance with NFPA 13. The USFA strongly recommends the use of sprinkler systems in the design of fire and EMS stations.
- Sprinkler systems should be installed with consideration to maintenance, adequate water supplies, protection of piping, protection of sprinklers, sprinkler spacing, and appropriate sprinkler alarms.

- There are three main types of fixed extinguishing systems:
  - Dry chemical.
  - Gaseous agent.
  - Water spray and foam.
- These specialized systems may be considered for working spaces where there is a high potential for fire hazards.

Means of egress

- Design exits consistent with expected maximum occupancy, in accordance with the local building code and NFPA 101.
- Mark every exit, and conspicuously indicate the routes for escape from any point. When more than one exit is required from a story or room, arrange at least two of the exits remote from each other to minimize the possibility of both being blocked by fire or another emergency condition.
- Locate and maintain exits and exit access, so that they are always accessible.
- Use side-hinged, swinging type doors from a room to an exit or to an exit access.
- The minimum width of an exit access must not be less than 32 inches clear width and must provide adequate headroom of at least 7 feet, 6 inches.
- Supply each exit with an exit sign illuminated by a reliable light source, giving a value of no less than 5 foot-candles on the illuminated surface.
- Arrange exiting from sleeping and day room areas so that at least one exit route is available without going through the apparatus room.
- Prepare emergency action plans. Post floor plans that clearly show the emergency escape routes, included in the emergency action plan. Color coding will aid employees in determining their route assignments.
- Designate an emergency safe area or rendezvous point in the event of an emergency.
- Practice emergency evacuation.

In each of these areas, the fire and EMS station should serve as the model for the community.

Theft, vandalism and violence

As with any public or private facility, fire and emergency services stations are subject to theft, vandalism and violence. For staffed stations, these acts are most likely to occur when emergency response personnel are on a call. This problem can be more severe for volunteer stations where no rotating occupants stay at the station. Problems can also arise during public functions or outside uses of the station. The specific location of the station within the community can also pose risks to station occupants and contents.

Relevant regulations and standards

Regulations and standards in this area are typically found in local codes. Specific organizations, listed in **Appendix E,** which provide guidance in this area:

- UL.
- VFIS.

Preventive design requirements

Common sense in securing valuable items will help prevent theft, as well as vandalism and violence. It is important that the necessary effort be made to reduce thefts of personal property and station equipment/supplies, as well as to minimize the opportunities for vandalism and violence. Access to the fire and emergency services facilities varies from jurisdiction to jurisdiction. Keys are hard to track, so other systems, such as card entry, are viable options **(see Figure 5.7).**

Figure 5.7 — Card access to fire stations is a viable option.

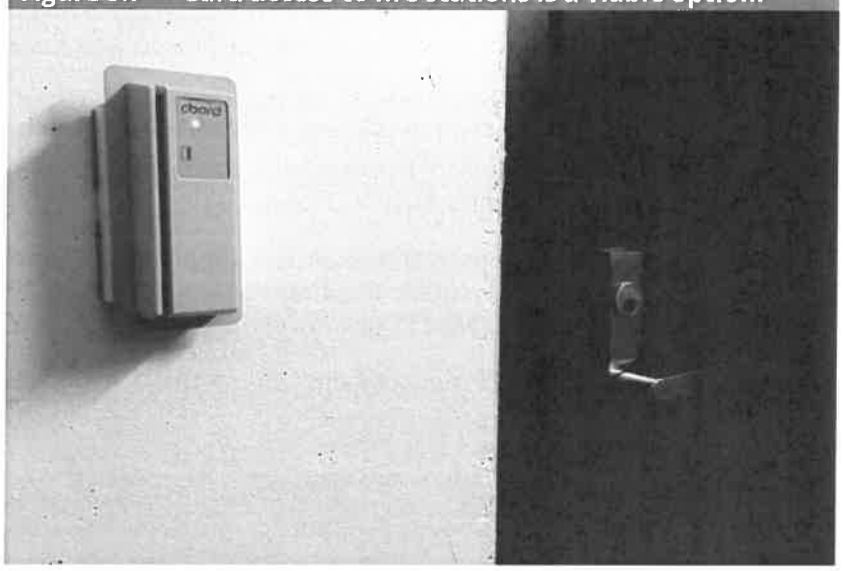

Photo courtesy of Mike Wieder, Stillwater, OK.

Department property

- If practical, place equipment in its storage area at the close of each shift. Silhouette boards for items, such as tools, are a good way to identify items that are missing.
- Inventory equipment frequently and at irregular intervals.
- Install property tags on items. Adhesive labels that hold up very well are available, even on hand tools used in the firefighting environment.
- Install security cameras at every outside door.
- Be sure all utility entry points are located where they are not accessible except by members.
- Drugs used for EMS calls should be secured at all times, with only authorized personnel allowed to access them.

Personal property

- Always use dedicated, single lockers. The best locks are keyed, such as pin-tumbler padlocks with solid brass or steel bodies and hardened shackles at least 3/8 inches in diameter. The shackle should be locked at heel and toe. A high-quality combination padlock meeting the same specifications may also be used.
- Establish natural surveillance points in areas where personnel leave belongings.
- Recommend that personal items be engraved with an identifiable mark.

- Most departments now mark their more valuable equipment in some manner. This is not done, however, for personal property. It is recommended that each fire and emergency services facility develop a system for marking personal property.
- Ballistic protection over windows might be necessary in certain areas to minimize risks resulting from acts of violence.
- Four-fold apparatus bay doors can be specified to meet ballistic standards.

Parking lots

- Personal vehicles are often targeted for breaking and entering. Parking lots designated for members should be fenced, gated and locked.
- Install lighting for the station perimeter, parking lots, walkways, entrances and any sensitive areas that would permit easy vandalism or theft during hours of darkness. In addition, internal lighting should be provided to assist personnel during times when the station is unoccupied.
- Fence appearance is important in many neighborhoods. Be sure the fence has the aesthetic qualities to be accepted by the community. Security cameras should be placed to cover every angle.
- Encourage members not to leave any valuables inside their vehicles.

Chapter 6: Specific Health Considerations

One of the basic tenants of fire station design is ensuring that the station is a healthy place for the firefighters who work and live there, as well as for members of the public who visit. This chapter addresses specific health concerns that fire stations may encounter and how those hazards may be minimized or eliminated.

Cancer

Cancer rates among active and retired firefighters far exceed rates for the general public. Cancer has become an epidemic in the fire service. Several experts are now saying that the fireground is more of a health hazard than a hazardous materials incident, particularly because of the safety precautions that are used to mitigate hazardous materials incidents. The products of combustion, including diesel exhaust, contain carcinogens and other chemicals that are known to be hazardous to human health.

Extent of problem at the station

Fire and emergency services stations are the collection point for contaminated equipment from emergency scenes. In addition to hazards of direct skin contact with the contaminated equipment, there is off-gassing of contaminated equipment into the station environment.

Preventive design requirements

All stations must have decontamination areas and equipment for properly cleaning and disinfecting contaminated equipment.

Cancer overview

The composition of building materials and building furnishings has changed dramatically in recent years. Plastics and synthetic materials are so common that very few products used in construction and furnishings are made of natural materials. There are close to 90,000 chemicals in use today that could be found in the firefighting environment. When these materials combust, the byproducts are far more hazardous to the health of humans than the natural materials used previously in construction and furnishings.

There is a growing body of knowledge that today's house fires are more like hazardous materials incidents than house fires of the previous generations. Residential, commercial and vehicle fires have highly concentrated toxins. Even dumpster fires have unknown contaminants. Many of these toxins enter the body through the skin. It has been shown that the absorption rate for toxins increases 400 percent for every 5-degree increase in skin temperature.

From the Firefighter Cancer Support Network's white paper, "Taking Action Against Cancer in the Fire Service":

> The design of fire stations, whether for new construction or renovation, must include such standard design features as state-of-the-art equipment and systems for adequate air flow, removal and capture of carcinogens and particulates, appropriate location and ventilation of storage rooms for contaminated PPE and other equipment, washer-extractor and gear drying equipment, as well as clear separation of living quarters from the apparatus floor. In short, architects should be working to design cancer out of fire stations. Responsible elected and appointed officials should require this type of expertise when hiring design professionals for fire stations.

Toxic chemicals that may be found in any given firefighting environment:

- Acetaldehyde.
- Acrolein.
- Acrylonite.
- Arsenic.
- Asbestos.
- Benzene.
- Butadiene.
- Coal — tar pitch.
- Carbon monoxide.
- Ethyl benzene.
- Formaldehyde.
- Hydrogen chloride.
- Isocyanates.
- Methyl methacrylate.
- Naphthalene.
- Nickel.
- Polynuclear aromatic hydrocarbons.
- Styrene.
- Toluene.
- Toluene diisocyanate.
- Vinyl chloride.
- Numerous PAHs.

Studies have shown that firefighters are more likely to get the following types of cancer, compared to the general public:

- Testicular — 2.02 times.
- Multiple myeloma — 1.53 times.
- Non-hodgkin's lymphoma — 1.51 times.
- Skin — 1.39 times.
- Brain — 1.32 times.
- Malignant melanoma — 1.31 times.
- Prostate — 1.28 times.
- Colon — 1.21 times.
- Leukemia — 1.14 times.

The recent and ongoing studies about firefighter cancer are even more alarming considering emergency responders are typically physically fit. Furthermore, it is known that many emergency responder cancer cases go unreported to a national data base. This is especially true in the volunteer fire service.

Overall design considerations

The challenge in the design of fire and emergency services facilities to minimize the risks of cancer is to isolate, capture and remove the carcinogens. While these are simple concepts, they require a change that needs to be accepted in the emergency response culture.

There are three major sources of contamination that are typically brought into the station:

1. PPE **(see Figure 6.1).**
2. Fire and rescue equipment.
3. Apparatus (particularly the inside of cabs).

A commonsense approach to address this problem is to decontaminate all of the above before bringing them into the station. For example, many organizations are now bagging their contaminated PPE before leaving the scene. Fire equipment is now being washed more frequently at the scene before it is placed back onto the apparatus.

In cases where this is not feasible, the concept of "zoning" spaces within the fire station must be used **(see Figure 6.2).** For example, the colors of a traffic signal can be used to designate the following three zones:

- Red — spaces exposed to carcinogens (hot zone).
- Yellow — transition area between contaminated area and clean area (warm zone).
- Green — clean area, such as living, kitchen, dormitory, etc., (cold/clean zone).

Figure 6.1 — Signs may be used to remind personnel not to take or wear PPE into the live-in areas of the station.

Photo courtesy of Keith Tyson, Firefighter Cancer Support Network.

Red zone

- Focus on the highest hazards (PPE, hose, etc.).
- Contain the contaminants.
- Separate the members from the contaminants.
- Control or limit crossover to clean areas.
- Isolated HVAC.
- Apparatus bay.
- Decontamination/Cleaning room.
- PPE cleaning room.
- Holding area for equipment and PPE to be cleaned.

Figure 6.2 — This station diagram shows the acceptable areas where potentially contaminated equipment is allowed.

Photo courtesy of Paul Erickson, LeMay Erickson Willcox Architects.

Yellow zone

- Place walk-off mats on floor.
- Dedicated shower(s).
- Dedicated toilet(s).
- Provide area for washing boots.
- Provide access to PPE cleaning room (if PPE is cleaned in-house).
- Sink for hand washing.
- Have separate and designated closet for cleaning and decontamination equipment and supplies.
- Isolated HVAC (air-lock vestibule).
- Hand sanitizer dispensers at all accesses to clean area.

Green zone (cold/clean)

- Kitchen (ideal place for ice machine).
- Dormitory.
- Fitness room.
- Offices.
- Training rooms.
- Restrooms.
- Locker rooms.
- Lobby.
- Study/Library.
- Meeting/Conference rooms.
- Storage areas.
- Isolated HVAC.

Important note: A "saddle-bag" designed station, with the apparatus bay located in the middle of the station, typically requires two yellow or transition zones. For example, many stations will have the sleeping, locker and shower areas on one side of the bay, and the dayroom, kitchen, offices, etc., on the other side of the bay. If this design is selected, it must be understood that the flow from red to yellow to green is more complicated. Also, this design severely limits the organization from adding additional bays.

Decontamination

The ability to safely and effectively decontaminate firefighters and their equipment has come to the forefront of the firefighter health and safety issue. All means must be taken to ensure both new and existing facilities are designed or renovated to allow for proper decontamination procedures to be conducted within them.

Equipment decontamination room

Gross decontamination/cleaning should occur at the scene. However, additional cleaning and decontamination is likely necessary at the station. For this reason, a designated room must be allocated for this purpose.

The room should be equipped with specialized equipment for cleaning:

- Isolated HVAC system.
- Hot and cold water.
- Scrubbing tables.

- Soak tank(s).
- Large stainless steel sink(s).
- Floor drain to sanitary sewage.
- Hand-held wands.
- Foot scrubbers.
- Special detergents.
- Scrub brushes.
- Hose cleaning machine.
- Drying racks and hangars.
- Disposable work gloves.
- Hand sanitizer dispensers.

Personal protective equipment cleaning room

PPE is a major investment for any fire and emergency services organization. All elements (coats, pants, helmets, hoods, gloves, boots, SCBA, etc.) are designed and tested to perform under the hazardous conditions faced by emergency responders. The cost of PPE has risen dramatically over recent years, and there is every reason to believe these costs will continue to rise. It is life safety equipment!

Moreover, PPE protects the fire and emergency services most valuable asset — its members!

Fire and emergency services organizations can choose between cleaning their PPE in-house or contracting with an Independent Service Provider (ISP). Occasionally, an organization may decide to use a combination of the two.

NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* sets forth requirements for cleaning PPE **(see Figure 6.3).** The standard includes an entire chapter on cleaning and decontamination. It is the default standard used by fire and emergency services organizations, as well as ISPs.

Figure 6.3 — NFPA 1851 is an excellent source of requirements for health and wellness programs.

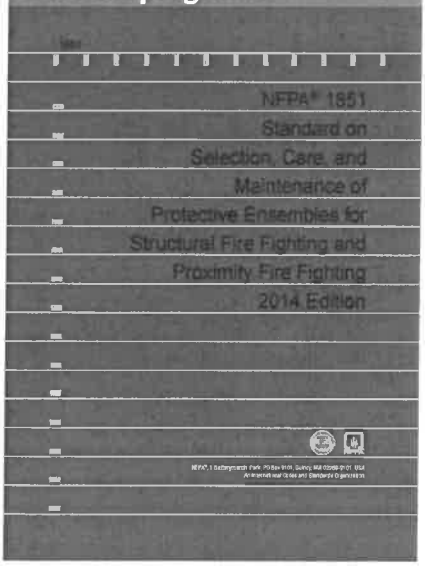

Photo courtesy of Yvonne Smith, NFPA.

The PPE cleaning room should have the following design, equipment and supplies:

- Dedicated large, nonagitator, washer/extractor(s) for garments. (To prevent cross-contamination, this machine must not be used to launder anything but PPE garments. Bed linens, towels, station work uniforms, workout clothing, etc., must be cleaned in equipment that is separate from the PPE cleaning room.)
  - Space allocation per extractor of approximately 6 feet by 6 feet, plus allowance for maintenance access and possible trench drain.
  - Smaller machines bolted to floor because of high revolutions per minute (rpm), and larger machines placed on a reinforced concrete pedestal (placing a washer/ extractor on the second floor of a facility is not recommended because of the weight and forces created).
  - Electrical supply to power washer/extractor(s), three-phase recommended.

- Water temperature not to exceed 105 F.
- Detergents with a pH range of 6.0 to 10.5.
- Rpm not to exceed 100g-force.
- Plumbing to provide water to washer/extractor(s) and discharge of waste water; some machines require an open vent in the drain, while others need an open trench.

- Isolated HVAC system.
- Hot and cold water.
- Dedicated SCBA mask cleaning machine (popular in Europe; these machines are often configured similar to dishwashers).
- Scrubbing tables (for nongarment PPE items, such as helmets, footwear, SCBA, etc.).
- Soak tank(s) (for nongarment items).
- Large double-basin stainless steel sink(s) (for nongarment PPE items).
  - Include a sprayer attachment with hand-held wand.
  - Faucets should not require the user to grasp handle with their hands to turn on or off.
  - All surfaces should be nonporous material with continuous molded counter top and splash panel surfaces.
- Floor drain to sanitary sewage.
- Foot scrubbers.
- Special detergents.
- Scrub brushes.
- Disposable work gloves.
- Hand sanitizer dispenser.
- Computer for documenting cleaning.

Personal protective equipment drying

To minimize the mechanical damage of PPE garments, drying racks or nontumble drying machines are recommended. If a tumble dryer must be used, the drying temperature must not exceed 105 F. Forced air ventilation that allows dry air to transfer through the garment while the garment remains fixed is the preferred method.

To minimize the damage to protective fabrics, the drying area should remain dark, except when occupied by members. Motion sensor lights work well for this area.

Personal protective equipment repairing

NFPA 1851 sets forth requirements for repairing PPE. There is an entire chapter dedicated to repair. Basically, manufacturers' instructions must be followed at all times.

Very few fire and emergency services organizations have been third-party certified to perform repairs on their PPE. For those agencies, there should be a dedicated room with the necessary sewing machines, equipment, and supplies/materials as recommended by the PPE element manufacturer. A computer will be needed to document repairs.

Personal protective equipment storage

NFPA 1851 also sets forth requirements for storing PPE. There is an entire chapter within the standard on the subject. Historically, the most common place to store PPE is the apparatus bay. However, this is one of the worst places for two reasons: contamination from residual diesel exhaust and ultraviolet (UV) degradation.

PPE should be stored in a dedicated room with the following design elements **(see Figure 6.4):**

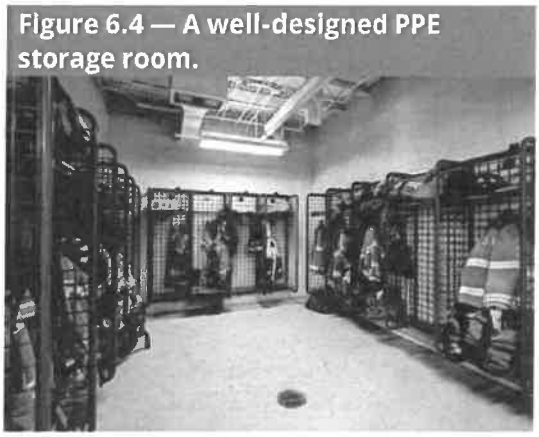

Figure 6.4 — A well-designed PPE storage room.

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

- Isolated HVAC with good air movement to remove the residual contaminants of off-gassing.
  - Air exhausted to the exterior of the building.
  - Humidity levels kept as low as possible to minimize mold and mildew.
- Totally dark room with motion sensor lights to minimize UV degradation.
- Large open mesh storage racks (24-inch width recommended) to allow for plenty of ventilation through the garments and other PPE elements. Select racks that can accommodate more than just coats and trousers. For example:
  - Special hangers for gloves.
  - Special racks for helmets.

Fire and emergency services organizations are strongly advised to get a copy of NFPA 1851 for complete details and explanatory language of the standard's requirements.

Respiratory protection room (self-contained breathing apparatus inspection, testing and repair)

Organizations may choose to do their own SCBA testing and maintenance, or they may choose to use a contract vendor. NFPA 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA),* provides requirements for the inspection, testing and repair of SCBA. If a department chooses to perform their own SCBA inspection, testing and repair, a dedicated room with the following features and equipment will be needed:

- All furnishings and finishes that are easily cleaned and decontaminated.
- Electrical power supply capacity for air compressor.
- Breathing air compressor with containment fill station.
- Large work bench.
- Tool box.

- SCBA flow test machine.
- Abundant storage for parts.
- Computer for data entry.
- Hydrostatic testing equipment (if department does its own hydrostatic testing of SCBA cylinders).

Note: All cleaning of SCBA and masks should occur in the PPE cleaning room before being brought into the respiratory protection room.

Fitness rooms

Emergency responders face very difficult physical challenges. They must be constantly engaged in strength, cardio and flexibility training to provide effective customer service. Many injuries and illnesses can be eliminated or minimized if members are physically fit. Many of the sudden cardiac and stroke deaths occur to members who are not physically fit. It is the responsibility of the organization to provide access to physical fitness equipment.

Extent of problem at the station

The inclusion of a fitness room in fire and emergency services facilities is now standard practice. Physically fit members perform at higher levels. Physically fit members reduce the organization's workers' compensation costs, lost time on the job costs, and insurance costs. However, it must be understood that there are chances of injury and sudden death while performing physical fitness training. These risks are considerably less than the risks of having members who are not physically fit.

Relevant regulations and standards

NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members,* sets the requirements for fire and emergency services organizations to develop and maintain fitness programs **(see Figure 6.5).**

The standard requires that organizations assign a qualified health and fitness coordinator to manage the overall fitness program. The organization is also responsible for conducting an annual physical assessment of each member. A best practice for designing and equipping a fitness room is for the organization to form a committee or task group that understands the objectives of the fitness program. This task group should be charged with the following:

- Understanding why certain pieces of equipment are needed or recommended.
- Working with fitness manufacturers and suppliers to determine the optimal equipment.
- Working with the architect to properly allocate the space and design of the room.

Figure 6.5 – Health-related fitness programs are the focus of NFPA 1583.

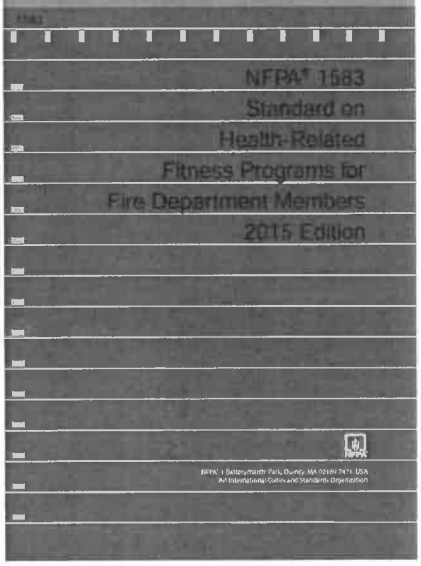

Photo courtesy of Yvonne Smith, NFPA.

Fire and emergency services organizations are strongly advised to get a copy of NFPA 1583 for complete details and explanatory language of the standard's requirements.

Additionally, the International Association of Fire Chiefs/International Association of Fire Fighters "Fire Service Joint Labor Management Wellness-Fitness Initiative" provides information to guide fire departments in developing and implementing a program.

Figure 6.6 — Cardio equipment is one component of a physical fitness room.

Photo courtesy of Joe Mottola and John J. Mayo, H2M Architects + Engineers.

Exercises and equipment

Six of the best exercises, along with the equipment required to help emergency responders perform their job, are as follows:

1. Cardio (helps with endurance).
   - Treadmill (legs and core) **(see Figure 6.6).**
   - Elliptical (legs and core).
   - Stair-climber.
   - Stationary bike (legs, back, core, balance).
   - Rowing machine (full body workout).
2. Deadlifts (helps with picking up heavy objects).
   - Free weights **(see Figure 6.7).**
   - Universal machine **(see Figure 6.8).**
3. Sled drag/push (helps with stretching hoselines, dragging a victim out of a fire).
   - Sled.
   - Tire.
   - Rope.
   - Large, straight area.

Figure 6.7 — Free weights are used for strength training.

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

Figure 6.8 — Universal machines facilitate a variety of strength training options.

Photo courtesy of Ken Newell, Stewart-Cooper-Newell Architects.

4. Upper body (helps with use of hand tools and balance).
   - Bench press (an assisted bench press eliminates the need for a spotter).
   - Pull-ups (pull-up bar).
   - Push-ups (mats).
   - Object carry (kettlebells).
5. Core and back (helps with working in PPE, carrying tools, balance).
6. Legs (helps with balance/stability — preventing falls, working in PPE, routine movement).
   - Step-ups (step box).
   - Squats.
   - Leg-presses (universal machine or leg-press machine).

Design criteria

The following criteria should be used when designing the fitness room for maximum performance and benefit **(see Figure 6.9):**

- Use a glass wall or an abundance of glass, so members in the station can see if a member is down due to injury or health reasons **(see Figure 6.10).**
- Group equipment — cardio on one side of the room and strength training on the other side.
- Incorporate as much natural light as possible. Do not be hesitant to locate the fitness room where it is visible to the public. It is good public relations for the community to see their emergency responders getting in, and remaining in, top physical condition.
- Use floor finishes, such as seamless rubber flooring. Seamless rubber floor covering offers the following advantages:
  - Absorbs sound.
  - Absorbs shock to the feet, legs and spinal column.
  - Less susceptible to damage from heavy weights than other floor coverings, including concrete.
  - Easy to clean and decontaminate from sweating.

  Note: Never select carpet as a floor covering for a fitness room.

Figure 6.9 — A diagram of a well-planned fitness room.

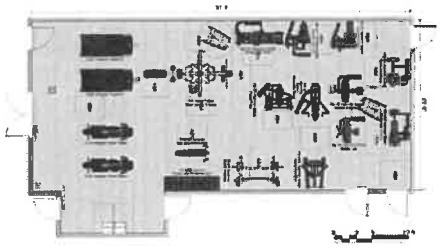

Photo courtesy of Patrick Stone, H2M Architects + Engineers.

Figure 6.10 — It is important that there is a clear path of vision from the outside into the fitness room.

Photo courtesy of Joe Mottola and John J. Mayo, H2M Architects + Engineers.

- Wall finishes should be smooth, hardened and easily scrubbed. Wall padding should be considered near free weights or where lifting objects are used.
- The ceiling height should be high enough (12 feet recommended) to allow for the equipment, as well as exercises such as jump-rope.
- Allow for an abundance of mirrors so members can observe their technique.
- Provide televisions to help pass the time, especially when performing on cardio equipment, such as stationary bikes or treadmills. Also, televised sporting events are an ideal time for many to work out.
- Provide an AED in the room.
- Provide multiple hand sanitizers and sanitary wiping cloths to minimize infections, such as MRSA.
- Consider hydration, such as a water dispenser with disposable cups.
- Be sure the call-alarm notification is audible over the sound of equipment being used, and/or complement with a visible call-alarm, such as a strobe light.
- Install an emergency help/call button for a member to press if he or she is in distress and needs assistance. This should be tied-in to the station alerting system.
- Design the ventilation system so there is a frequent exchange of fresh air.
- Open ceilings tend to work better than drop-in tile ceilings for fitness rooms.
- Install multiple electrical outlets throughout the area for flexibility in powering equipment, especially cardiac strengthening equipment and other electronic equipment.
- For convenience, locate the fitness room near showers and locker rooms.
- Arrange equipment so that there are no obstacles for quick exit to board apparatus for emergency response.

Hazardous materials

Different chemicals present a variety of health, flammability and reactivity hazards. The specific hazards vary with the chemical. While many chemicals may produce severe effects upon exposure at high concentrations, these same chemicals may create chronic health problems (such as cancer) through repeated, low levels of exposure or even one-time, high-concentration exposures.

Fire stations in some cities are used as decontamination sites for city workers who have been exposed to toxic or hazardous material. In this case, it is necessary to have a designated area outside of the structure with hot and cold water, and moderate enclosure along with a drain, so these individuals will not contaminate the entire facility. This concept could also apply in general for many stations.

Extent of problem at the station

A variety of chemicals and solvents may be used around the station for maintenance and other applications. In addition, several fuels and lubricants may be at the station creating the potential for exposure at unacceptable levels.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this concern:

- Locally adopted building and fire codes.
- OSHA 1910.94 Ventilation.
- OSHA 1910.101 Compressed gases (general requirements).
- OSHA 1910.106 Flammable and combustible liquids.
- OSHA 1910.110 Storage and handling of liquefied petroleum gases.
- OSHA 1910.1000 Air contaminants.
- OSHA 1910.1200 Hazard communication.
- NFPA 30.
- NFPA 55.

Pertinent OSHA Regulations are provided in **Appendix D.**

Specific organizations, listed in **Appendix E,** that provide guidance and standards in this area include:

- American Conference of Governmental Industrial Hygienists (ACGIH).
- American Chemical Society (ACS).
- American Institute of Chemical Engineers.
- American Industrial Hygiene Association (AIHA).
- API.
- ASSE.
- American Society for Testing and Materials (ASTM).
- CGA.
- NFPA.
- NPGA.
- NSC.

Preventive design requirements

All areas

- Locate all chemicals in specific, appropriate storage areas. Store flammable chemicals in a flammable chemical storage cabinet. Do not repackage chemicals.

- Ensure that all chemicals are properly labeled and placarded with the appropriate warnings.

- Develop a written hazard communication program for the station, including a list of chemicals used at the station.

Maintain up-to-date Materials Safety Data Sheets (MSDS) on each chemical within the station area. OSHA Hazard Communication Standard 29 CFR 1910.1200: The goal of the Hazard Communication Standard is to reduce the occurrence of workplace illnesses and injuries caused by hazardous chemicals. The standard is designed to achieve this goal by providing information and training for employees who work with hazardous chemicals.

The written program must include the following:

- A description of how the criteria specified in the standard will be met — labels and other forms of warning for MSDS, and for employee information and training.
- A list of hazardous chemicals known to be present. Use the chemical or common name that appears on the appropriate MSDS.
- The methods used to inform employees of the hazards of nonroutine tasks and those hazards associated with chemicals in unlabeled pipes in their work areas.
- A description of the methods used to inform any contractor of hazards in the workplace that they may be exposed to and appropriate protective measures.

In many jurisdictions, oil or fuel spilled within the apparatus area must run through an oil/water separator prior to entering the storm water system via the sewer system. When fuel oil is required to be stored on site, select aboveground storage tanks rather than underground tanks. If possible, both systems require secondary containment which will store any oil that leaks out of the primary tank. The installation of either aboveground or underground tanks should be in accordance with locally adopted building and fire codes, as well as state the Environmental Protection Agency (EPA) regulations.

Diesel and vehicle exhaust hazards

Diesel exhaust has been classified as carcinogenic to humans by the International Agency for Research on Cancer (IARC), a branch of the World Health Organization. Diesel engines, used in fire apparatus, produce a mixture of toxic particulates and gases as the result of the combustion process. The composition of this exhaust product depends on several factors, such as the specific fuel used, temperature of the engine, condition of the engine, cleanliness of the air intake filter, among others. An analysis of general diesel engine exhaust has revealed a variety of extremely toxic substances at significant concentrations:

- Oxides of nitrogen — Any combustion in air will produce various nitrogen oxides. Short-term exposures can cause respiratory tract irritation and infections. Long-term exposures result in lung tissue damage and difficulty breathing.
- Carbon monoxide — This chemical is produced as a by-product of combustion. Exposure to high levels of carbon monoxide causes death by tying up the hemoglobin in blood and preventing oxygen intake by the body. Exposure to carbon monoxide at lower concentrations causes headaches, dizziness, weakness and neurological problems.
- Volatile Organic Compounds (VOCs) — These compounds are a class of carbon-based chemicals, such as benzene, toluene, phenol and chlorinated solvents. Many of these chemicals cause a variety of adverse health effects, such as headaches, nausea, neurological disorders, respiratory irritation, and liver damage. Some VOCs are known or suspected carcinogens.
- Polyaromatic Nuclear Aromatics (PNAs) — PNAs are a class of relatively large, complex chemicals principally formed during the combustion processes. In diesel exhaust, these chemicals often adhere to the soot particles. Most PNAs are documented carcinogens.

Much of the diesel exhaust is invisible, including the smaller soot particles. This means that exposure cannot always be detected. Furthermore, diesel exhaust can penetrate into clothing, furniture and other items with which firefighters have routine contact, where it can be later released after the initial exposure or absorb into members' skin.

Extent of problem at the station

In addition to the IARC, both the National Institute for Occupational Safety and Health (NIOSH) and OSHA have declared human exposure to diesel exhaust as a potential occupational carcinogenic (cancer-causing) hazard through toxicological studies. NIOSH recommends that occupational exposures to diesel exhaust be kept to the lowest feasible concentration.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this topic:

- Locally adopted building and fire codes.
- OSHA 1910.94 Ventilation.
- OSHA 1910.1000 Air contaminants.
- NFPA 1500.
- Other OSHA regulations **(Appendix D).**

Appendix E lists specific organizations that provide guidance in this area:

- AABC.
- ACGIH.
- ACS.
- AIHA.
- Air Conditioning, Heating, and Refrigeration Institute.
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).
- ASSE.
- ASTM.
- Institute of Clean Air Companies (ICAC).
- NFPA.
- NSC.

Preventive design methods

Various methods have been suggested for reducing diesel exhaust emissions at fire stations. These possible solutions take two different forms: filtration and source capture.

Filtration

Filtration uses forced air that filters the air in the station **(see Figure 6.11).** The filtration system units typically hang from the ceiling in the apparatus bay area. They typically have multiple stages of filtration within the units.

Automate the apparatus bay exhaust fan systems to work in conjunction with the opening and closing of the bay doors.

Figure 6.11 — A forced-air filtration system.

Photo courtesy of Sara Scialo, AIRVAC 911.

Source capture (hose connection)

Source capture is the best solution to capture diesel exhaust. This method captures the emissions from the vehicle exhaust system before they are expelled into the apparatus bay **(see Figure 6.12).** The source capture system is designed as follows:

- An automatic disconnect nozzle allowing vehicles to drive into and out of the fire station with the hoses still attached to the exhaust system. (The hose disconnects from the vehicle and retracts into the building allowing automatic doors to close.)
- Automatic activation via an in-line pressure switch when the apparatus engine is started or when apparatus bay doors open (ensuring consistent use).
- Timers to run exhaust fans until all residual gases have been removed from the system (manual operation is also provided).

Figure 6.12 — A typical source capture exhaust filtration system.

Photo courtesy of Kerry Falzone, Plymovent Corporation.

Figure 6.13 — An apparatus-mounted exhaust capture system.

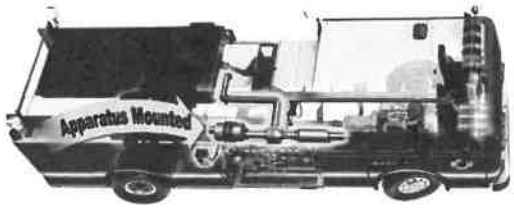

Photo courtesy of Brandon Carlisle, Ward Diesel.

Source capture (on-board system)

The onboard system is mounted underneath the apparatus and is integral with the exhaust system **(see Figure 6.13).** The system is about the size of a 5-gallon bucket. It is an automatic and self-contained system that does not require a hose to be connected to the tail-pipe. It automatically engages when the engine starts and when the apparatus is put in reverse. There is an override to activate the system while idling on the scene. The newer system for apparatus manufactured after 2007 activates immediately at cold start and low idle, both in the station and on scene. The system has a filter that has to be replaced. Busy metropolitan agencies report filter replacement is needed approximately every 12 months. Some volunteer departments report the filter lasting close to 10 years.

Special note: For best results in achieving a healthy air environment for the bay, both a source capture and a filtration system should be used. The ventilation system will capture off-gassing of other contaminated equipment brought into the fire stations, such as fire hose, salvage covers and PPE that cannot be captured by a source capture.

Station alerting system

Fire and emergency services organizations must have a means of being quickly and safely notified of a request for emergency services. Sudden alarm activations, especially during sleep, cause extreme stress on the heart. The repeated exposure to this type of sudden awakening has a cumulative effect that is detrimental to the cardiovascular and nervous system.

Extent of the problem at the station

This is not a problem for most all-volunteer stations. However, for staffed stations, especially those that are staffed during sleeping hours, the stress on the heart and overall mental functions can compromise the health of its members.

Preventive design requirements

Station alerting systems are tied into the organization's dispatch or communications system. The alerting systems notify in-house crews of an alarm, as well as provide many other key features that enable a safe, healthy and quick response from the facility. However, there are ways to make this notification less stressful.

Studies have shown that the human heart rate doubles within 15 seconds after an alarm sounds. Clearly, this is a stress on the body rarely found in any other occupation. There is a big difference between being awakened in a normal manner and being startled awake by loud sounds and bright lights. Alarm tones should ring in, gradually increasing volume rather than at full volume from the onset, to help reduce the impact on the cardiovascular system. In addition, loud tones can also negatively impact hearing over the course of a firefighter's career. The best station alerting systems offer the following features to minimize this impact:

- Ramped-up tones that do not shock the human system. Such systems can be automatically set to activate louder during the day-time and quieter at night.
- Softer voice messaging, such as a pre-announcement of a call.
- Ramped-up lighting to allow the eyes to adjust.
- Lighting that is focused solely on pathways rather than an entire dorm room.
- Use of red lighting to further allow the eyes to adjust while providing good visibility.
- Video messaging to minimize audio messaging.
- Zoned alerting if the station has more than one company housed in the facility. This feature allows only the needed company to be alerted.
- Speakers that can be focused so that only a certain member or bunks will hear the call. This keeps from disrupting the sleep of other members who may not be required to respond. It also minimizes sleep deprivation.
- Automatically shut off cooking appliances when an alarm sounds.
- Automatically open the appropriate apparatus bay door(s).
- Automatically activate street traffic control devices.
- Automatically activate security gates.
- Automatically activate ventilation fans.

Other features of a station alerting system:

- Tied-in to door-bell/Camera to alert members of a visitor.
- Connected to a printer.
- A visible turn-out timer.
- Vehicle present detector.
- Acknowledgement button.
- Ambient noise sensor.
- Notification of off-site staff.

Radon exposure

Radon is a colorless, odorless, radioactive gas produced by the decay of radium-226, an element found in varying concentrations in many soils and bedrock. Because radon is a gas, it can easily move through small spaces, between particles of soil, and enter a building. Radon can enter a building as a component of soil gas and reach levels many times higher than outdoor levels. Radon levels are usually measured in picocuries per liter of air (pCi/L). The lower the radon level, the lower the health risk; therefore, radon levels should be reduced to as close to ambient levels as feasible (0.4 pCi/L). Radon is estimated to cause many thousands of lung cancer deaths each year. In fact, the Surgeon General has warned that radon is the second leading cause of lung cancer in the U.S. today.

Extent of problem at the station

The most common way for radon to enter a building is from soil gas through pressure-driven transport. Radon can also enter a building through diffusion, well-water, and construction materials. The U.S. EPA has collected data on radon to compile a National Radon Potential Map. The map integrated five factors to produce estimates of radon potential:

1. Indoor radon screening measurements.
2. Geology.
3. Soil permeability.
4. Aerial radioactivity.
5. Type of substructure.

The EPA map assigns every county of the U.S. to one of three radon zones **(see Figure 6.14).**

Figure 6.14 — This map shows the various radon zones in the U.S.

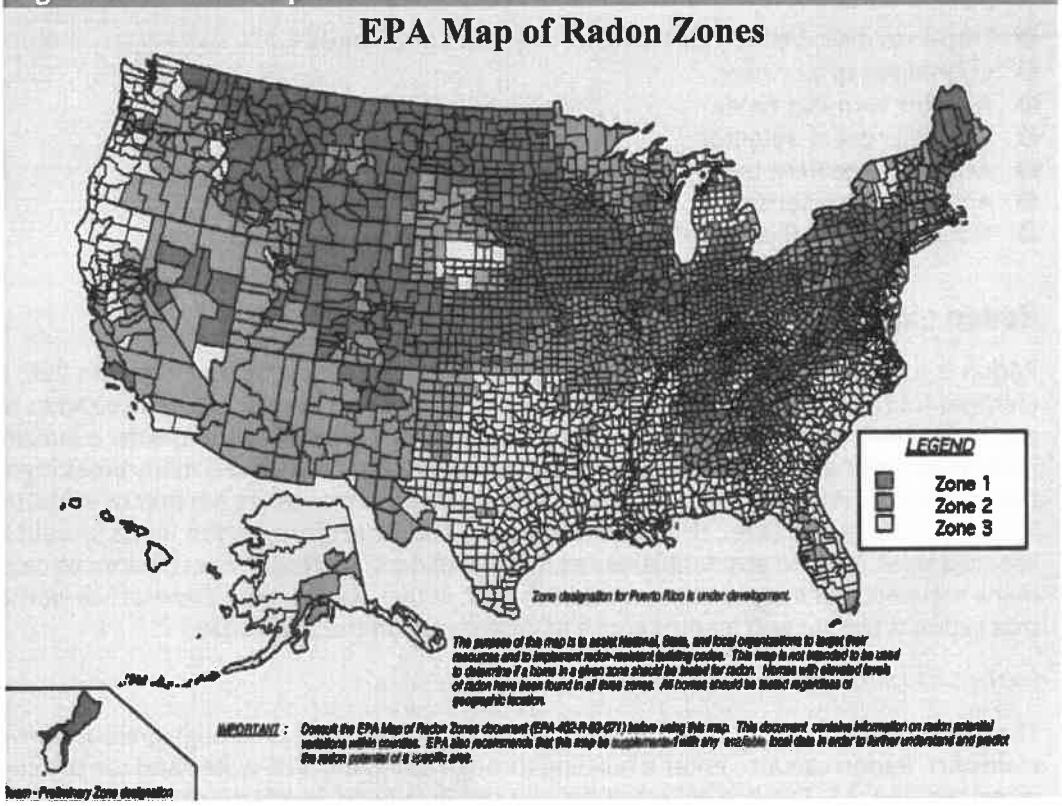

Photo courtesy of the U.S. EPA.

Relevant regulations and standards

The EPA has established "The Indoor Radon Abatement Act of 1998." As stated in the act, the national long-term goal of the U.S., with respect to radon levels in buildings, is that the air within the buildings should be as free of radon as the ambient air outside the building. Additional information on radon can be obtained from a Radiation Program Manager or an EPA Regional Office.

Specific organizations, listed in **Appendix E,** that provide standards and guidance in this area:

- AABC.
- ACGIH.
- AIHA.
- Air Movement and Control Association International, Inc.
- ASHRAE.
- ASSE.
- ASTM.
- Brick Industry Association.
- ICAC.
- NSC.

Preventive design requirements

Like most other indoor air contaminants, radon can best be controlled by keeping it out of the building in the first place. The three primary design/engineering means for achieving this:

1. Soil depressurization — A suction fan is used to produce a low-pressure field under the construction slab. This low-pressure field prevents radon entry by causing air to flow from the building into the soil.
2. Building pressurization — Indoor/Subslab pressure relationships are controlled to prevent radon entry. More outdoor air is supplied than exhausted so that the building is slightly pressurized compared to both the exterior of the building and the subslab area.
3. Sealing radon entry routes — The major routes for radon entry are blocked.

The most effective and frequently used radon reduction technique in existing buildings is active soil depressurization (ASD). An ASD system creates a low-pressure zone below the slab by using a powered fan to create negative pressure beneath the slab and foundation. This low-pressure field prevents soil gas from entering the building because it reverses the normal direction of airflow where the slab and foundation meet. If the low-pressure zone is extended through the entire subslab area, air will flow from the building into the soil, effectively sealing slab and foundation cracks and holes.

Difficulties in providing radon protection in an existing structure can include the following:

- Poor communication below the floor slab (e.g., no aggregate, or aggregate with many fine particles or wide particle size distribution).
- Barriers to subslab communication (internal subslab walls); radon entry points at expansion or control joints.
- Ease of running the radon vent pipe and power source through and/or out onto the building's roof.
- Building depressurization caused by the HVAC system (or other fans) exhausting more air than is supplied.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this issue:

- Locally adopted building and fire codes.
- OSHA 1910.1030 Bloodborne pathogens.
- NFPA 1581.
- OSHA regulations **(Appendix D).**

Specific organizations **(Appendix E)** that provide guidance in this area:

- Association for the Advancement of Medical Instrumentation.
- AIHA.
- American Public Health Association (APHA).
- ASTM.
- NFPA.
- NSC.

Water source

Water that is supplied to the fire station should be tested to assure it meets local standards. Water testing is a broad description for various procedures used to analyze water quality. Water can be provided via a public water system, a well, or through a supply tank.

Specific organizations that provide guidance in this area:

- APHA.
- AWWA.
- EPA.
- National Drinking Water Alliance.
- National Sanitation Foundation (NSF).
- U.S. Geological Survey.
- Water Quality Association (WQA).

Methicillin-resistant Staphylococcus aureus

MRSA is bacterium that cause minor or severe skin infections, blood infections and pneumonia. It is spread by skin-to-skin contact with a person who is infected, or from contaminated items and surfaces. It can live for weeks on items and surfaces if they are not cleaned. Broken skin is the most likely path for MRSA to enter the body.

Extent of problem at the station

Emergency response personnel are most likely to become infected when dealing with infected patients. This contamination is easily spread to items, such as physical fitness equipment; door and sink handles; keyboards; TV remotes; and any fabric, such as upholstery, carpet, bed linens, and towels.

Relevant regulations and standards

The following is a list of links, regulations and standards that pertain to MRSA:

- EPA (List H): www.epa.gov/oppad001/chemregindex.htm.
- Centers for Disease Control and Prevention (CDC): www.cdc.gov/MRSA/.
- OSHA: https://www.osha.gov/SLTC/etools/hospital/hazards/mro/mrsa/mrsa.html.
- OSHA 1910.1030 Bloodborne pathogens.
- NFPA 1851.

Preventive design requirements

Fire and emergency services organizations should develop, adopt and enforce an exposure control plan that embraces universal precautions and other measures specific to the bacterium. Frequent hand washing is one of the best practices to adopt.

Specific facility design and furnishings criteria

- Replace all carpet with hard surface flooring.
- Provide walk-off mats in the apparatus bay at the entrance to every door leading to and from the bay.
- Provide automatic hand-sanitizing dispensers at every entrance door leading to and from the bay.
- Provide touchless paper towel dispensers.
- Provide hands-free faucet controls at every sink.

Specific practices to adopt

- Always disinfect all medical equipment used immediately after the incident.
- Clean and disinfect targeted areas of the station frequently.
- Take special care to clean footwear.
- Keep broken skin dry and bandaged.
- Do not share personal items, such as towels, clothing, soap, etc.
- Vacuum walk-off mats at least daily by using a vacuum cleaner with a HEPA filter.
- Wash bed linens, towels and washcloths frequently in hot water.
- Provide disposable covers for shared items, such as keyboards, TV remotes and portable radios.

Bed bugs

Bed bugs are small, brownish insects that feed on the blood of humans and animals. They prefer human blood. They are about 3/16 of an inch long and are brownish-red in color. They are mainly active at night and tend to hang around near their feeding sites. It takes a bed bug anywhere from three to 10 minutes to penetrate a human's skin to obtain blood. Because of this slow process, the bite is painless. After feeding, they typically return to their hiding place and rarely remain on humans. Symptoms from a bite vary from person to person. Some people (approximately 30 percent) never experience any symptoms, while others will develop a red and itching welt. The welts are often confused with mosquito bites. They are not known to carry any diseases, except possibly helping spread MRSA.

Extent of problem at the station

Bed bugs are easily transmitted from location to location. They are most likely to be transported by PPE or station work uniforms from infested incident scenes. Once introduced into the station, they can easily move from room to room. However, they are most likely found in mattresses, box springs, bedding materials and personal lockers.

Relevant regulations and standards

The following is a list of regulations, links and standards that pertain to bed bugs:

- CDC and EPA — joint statement on bed bug control in the U.S. from the U.S. CDC and the U.S. EPA: www.cdc.gov/nceh/ehs/Publications/Bed_Bugs_CDC-EPA_Statement.htm.
- National Pest Management Association list of state regulations: https://www.pestworld.org/all-things-bed-bugs/.

Preventive design requirements

There are no specific facility design requirements to prevent bed bugs. However, a designated decontamination area that is properly used will minimize their spread.

Recommended practices

- Wash bed linens in hot water (≥ 120 F) after each use.
- Roll linens off the bed rather than pulling them off.
- Use mattress covers.
- Remove clutter from bedrooms.
- Seal crevices and cracks.

If there is a bed bug infestation or suspected infestation, contact a reliable pest control company to assess the situation. There are various treatments available, depending on the extent of the infestation:

- Freezing.
- Steam cleaning.
- Heating the entire room(s) to 120 F to 130 F.
- Fumigation (restricted to certain areas of the country).
- Encasing mattresses and box-springs.

There are companies that offer bedding material designed specifically for first responders. The bedding comprises a total set (fitted sheet, flat sheet, pillow case, comforter) and most importantly, has a built-in barrier material.

Food and waterborne infections

Multiple microorganisms are formed in spoiling food and sewage. If unclean conditions persist, certain microorganisms can grow at rates fast enough to harm humans. Other unwanted microorganisms and contamination can enter the station through cross-contamination of water supplies. Cross connections are links through which it is possible for polluted or contaminated materials to enter a potable water supply. Contamination enters the potable water system when the pressure of the polluted source exceeds the pressure of the potable source.

Extent of problem at the station

Station personnel may be susceptible to food and waterborne-based infections through improper food storage and backflow from sewage systems. At the fire or EMS station, cross contamination may occur in laundry facilities, sewage systems, and outdoor operations involving training.

Relevant regulations and standards

The following are some of the regulations and standards that apply to this area:

- Locally adopted health, building and fire codes.
- OSHA 1910.141 Sanitation.
- NFPA 1581.

OSHA Regulations are provided in **Appendix D.**

Specific organizations, listed in **Appendix E,** that provide guidance and standards in this area include:

- APHA.
- American Public Works Association.
- ASTM.
- AWWA.
- Kitchen Cabinet Manufacturers Association.
- Plumbing and Drainage Institute (PDI).
- WQA.

Preventive design requirements

The kitchen area of a fire or EMS station is often the most neglected. Traditionally, individuals who held the purse strings thought spending money for comfort or health in a fire station was a waste of tax dollars. Often ranges or refrigerators had to be replaced many times, rather than buying what was needed in the first place. Besides being expensive to replace, improper kitchen equipment and design can contribute to unsanitary conditions.

Kitchen

- Food preparation surfaces, as well as surfaces to store or hang food, must be nonporous.

  Note: Stainless steel is antibacterial.

- Select applicable products that are third-party certified by the NSF.
- Use ranges that are commercial grade, self-cleaning, and that include hoods.
- One or more dishwashers might be required, depending on the number of members assigned to the station at any one time.
  - Select stainless steel dishwashers with stainless steel interiors.
  - Select dishwashers capable of providing water temperatures at 140 F.
- Select refrigerator/freezers with solid shelving rather than wire shelving. If the facility is staffed with shift members, each shift should have their own refrigerator/freezer.
  - Refrigerator temperature must be between 33 F and 40 F.
  - Freezer temperature must be 0 F or lower.
- Require double sink basins or two sinks made of stainless steel.
  - Sinks should have heavy-duty grade garbage disposals with matching rated drains.
  - Sinks must be equipped with sprayer wand attachment.
  - Install shelving or racks above sinks for drip-drying. All drainage from the shelving or racks must flow into the sink so it enters the sanitary sewage system.
- Provide separate cabinets for food storage. Allow one storage cabinet for each shift.
- Design the kitchen layout with a center island counter for the preparation of food and for availability to food once it is served. Stainless steel or granite countertops are recommended for durability.
- All local health standards must be met.

Ice machines

Ice machines are common in most fire stations because ice makers in refrigerators do not have enough capacity for a station that is staffed 24 hours a day, or a volunteer station that might have sporadic demand with high peak usage times. In addition, many departments carry coolers for post-incident hydration, and ice machines can supply coolers, whereas refrigeration ice makers lack the capacity. Criteria for ice machines:

- Never install them on the apparatus bay floor because of exposure to residual diesel exhaust and off-gassing of contaminated equipment and PPE **(see Figure 6.15).**
- Install them in an area that is climate controlled. Ice makers lose efficiency if they are stored in a warm or hot space.
- Allow for water supply and drainage.
- Consider the kitchen as the optimal location for an ice machine, as it is near where food and beverages are consumed.

Figure 6.15 — Ice machines should not be placed in areas subject to exhaust or other contamination.

Photo courtesy of Don Collins, Collins Design Service.

Restrooms and showers

Restrooms must be designed with the highest sanitation requirements in mind. For example, they should be equipped with the following:

- A floor drain to allow for ease of cleaning and to capture any overflow from sinks and toilets.
- Hands-free faucets.
- Hands-free toilet valves.
- Hands-free towel dispensers.
- Hands-free soap dispensers.
- Push-to-open doors (no handles or knobs) for exiting — unless designed for single use.
- Disposable toilet seat cover.
- Automatic motion-sensing light activation.
- Single-user restrooms should have internal activated locks for privacy.
- Shower stalls should have at least three walls, and preferably a curtain to ensure privacy.
- A clearly visible sign reminding members to wash their hands after every use.

Each facility must also have a restroom dedicated to public use. All sanitation requirements must meet state and local requirements.

Emergency medical equipment storage areas

All storage areas should be in dedicated and enclosed areas to protect the equipment from temperature degradation, physical damage and contamination. Particular attention must be given to emergency medical supplies. For example:

- All drugs must be kept under lock and key with access limited to only designated personnel.
- EMS supplies must be kept away from the following areas:
  - Sleeping.
  - Food preparation.
  - Living.
  - Personal hygiene.

Medical waste must be kept from the same areas and must be stored in a designated area until disposed. All sharps containers must be compliant with the following:

- ASTM Standard F2132-01, *Standard Specification for Puncture Resistance of Materials Used in Containers for Discarded Medical Needles and Other Sharps.*
- NIOSH Publication No. 97-111, *Selecting, Evaluating, and Using Sharps Disposal Containers.*
- OSHA Bloodborne Pathogens Standard (29 CFR Part 1910.1030).

Local health codes must be followed.

Water supply cross-contamination prevention

A backflow on water outlets directly connected to a hose can cause back pressure or back siphoning. The solution requires the elimination of the cross connection and the installation of an air cap or backflow-prevention assembly. Several methods can be used for the prevention of backflow:

- Air gap.
- Reduced-pressure principle backflow-prevention assembly.
- Double check valve assembly.
- Pressure vacuum breaker.
- Atmospheric vacuum breaker.

An air gap is the unobstructed vertical distance through air between the lowest point of a water supply outlet and the flood level rim of the fixture or assembly into which the outlet discharges.

The reduced-pressure principal backflow-prevention assembly consists of two independently acting, approved check-valves working together with a hydraulically-operating, mechanically-independent pressure differential relief valve located between the check-valves and below the first check-valve.

A double check-valve assembly consists of two internally loaded check-valves, either spring-loaded or internally weighted, installed as a unit between two tightly closing resilient-seated shutoff valves.

A pressure vacuum breaker consists of an independently-operating, internally-loaded check-valve and an independently-operating, loaded air inlet valve located on the discharge side of the check-valve.

An atmospheric vacuum breaker is an assembly that performs similarly to a pressure vacuum breaker. The atmospheric vacuum breaker consists of a float check, a check-seat, and an air inlet port. A shutoff valve immediately upstream may be an integral part of the assembly.

Chapter 7: Key Points — Little Things Mean a Lot

This section will highlight key areas that are often overlooked but are critical to the successful design of a safe and healthy fire and emergency services station **(see Figure 7.1).** Some of the items were discussed in detail in previous sections. When planning the development of a new fire station, or renovating an existing station, the following concepts should be kept in mind:

> The fire station and its status in the community as an environment for both working and living are of concern, in a special way, for no other local service public service agency has a parallel situation. When location and design of facilities are poor, morale is poor, and fire station related injuries increase, as do costs for maintenance, energy consumption and operations. (Bryan, 1979)

Figure 7.1 — One door leads from the kitchen and one from the dayroom; both are hinged on the wrong side. There is also a hazardous step-down to the apparatus bay.

Photo courtesy of Don Collins, Collins Design Service.

Initial versus ongoing costs

Far too often, poor design is the result of not paying attention to the little things. Simple mistakes made in the design of a fire station are likely mistakes that organizations will live with for 70 to 100 years. The following shows the "average" building initial cost as compared to the ongoing lifespan costs.

Initial costs

- Land costs: less than 1 percent.
- Design: 1 percent.
- Construction: 20 percent.
- Original furnishings: 6 percent.

Ongoing costs

The ongoing costs for a fire station are higher than an average building if it is occupied 24/7.

- Replacement furnishings: 4 percent.
- Operations and utilities: 16 percent.
- Maintenance: 29 percent.
- Interest on construction loans: 24 percent.

The point in this analysis is that allocating the funding to get the project right from the beginning has little financial impact on the overall cost of operating and maintaining the facility. With these thoughts in mind, note the following "little things mean a lot."

General

Many communities require that the selected architect be a member of the community. If this is the requirement, and the selected architect has limited or no experience in station design, there is a very high probability there will be many design flaws, unless:

- The organization and community require the architect to hire a subject matter consultant to work with the architect.
- The architect subcontracts with an architect with experience in fire station design.

The following are some general items that should be considered/contemplated when developing:

- Fire and emergency services facilities are very complex with multidisciplined needs that are unique. Health and safety considerations are the most critical of these unique aspects. For example, a fire station can have part of the following elements:
  - Garage.
  - Dormitory.
  - Restaurant.
  - Office building.
  - Fitness facility.
  - Decontamination facility.
  - Repair shop.
  - Warehouse.
  - Educational facility.
  - Training facility.
  - Community functions.
  - Voting place.
  - Museum.
  - Community disaster control center.
- Despite many common beliefs, single-story fire stations are cheaper to build than two-story fire stations. However, due to site size restrictions, a two-story station may be necessary.
- Buyer beware of free sites. Do your homework and do not hesitate to consult an architect for expert advice before accepting a (potentially costly) free site.
- Understand the difficulties often experienced to get a station located in a neighborhood. A good rule of thumb: "The interior belongs to the members; the exterior belongs to the community."

Exterior

The following issues relevant to the exterior portion of the station should be taken into consideration.

Sight lines

Be sure sight lines for entering the highway from the apparatus apron are long and unobstructed. This allows for the safety of the emergency responders, as well as the motoring public.

Access to roadways

Direct access to extremely busy roadways can be difficult for emergency response vehicles. If provided a choice, a better site location is one just off a busy roadway. Traffic signals are a must to access busy roadways.

Transition angles

Fire apparatus have three critical angles to consider when transitioning from one elevation to another: angle of approach, angle of departure, and break-over angle.

- The angle of approach is the amount of clearance the front-most portion of the apparatus needs to make the transition without touching the ground. Extended front bumpers are common on apparatus, and this reduces the angle of approach.
- The angle of departure is the amount of clearance the rear-most portion of the apparatus needs to make the transition without touching the ground. Mid-mounted aerial devices often have a long over-hang behind the rear-most axle, and this decreases the angle of departure.
- Break-over angle is the amount of ground clearance the apparatus has between the front and rear axles. It is not uncommon for apparatus to have storage recessed below the center-line of the axles that reduces the break-over angle.

Bollards

Bollards must be placed anywhere a vehicle is subject to striking the station and other crucial fixed objects **(see Figure 7.2).** This includes both sides of every apparatus bay opening. The bollards must be placed so they are struck before the station is struck. It is recommended that bollards at bay door openings be offset 2 inches to 4 inches to the interior of the opening, so vehicles strike the bollard before striking the door track and station structure **(see Figure 7.3).** Other places include fuel pumps, standby station generators, yard hydrants, security gate openings and gate operators **(see Figures 7.4a and 7.4b).** Bollards should be placed in concrete that has break joints (knockout panels) around the perimeter of the base of the bollard, so there is minimal damage to the concrete apron in the event the bollard is struck. This also makes replacement easier and less expensive.

Figure 7.2 — Bollards may be designed to complement the station exterior.

Photo courtesy of Kevin Roche, FACETS Consulting, LLC.

Figure 7.3 — Exterior bollards properly "inset" to protect the structure of a fire and emergency services facility.

Photo courtesy of Robert Tutterow, F.I.E.R.O.

Figure 7.4a — These bollards protect the station's emergency generator.

Photo courtesy of Robert Tutterow, F.I.E.R.O.

Figure 7.4b — These bollards protect the fuel pump and fuel storage.

Photo courtesy of Kevin Roche, FACETS Consulting, LLC.

Driveways and aprons

Driveways, especially for drive-through bays, must allow for the turning radius of the largest apparatus, remembering that in the future, larger apparatus might be assigned to the facility. If space allows, a good thumb rule is to add 50 feet of apron space to the longest apparatus that will be parked at the station. Concrete must be used for all aprons and any driveways where apparatus might be driven. Asphalt should only be used for drives and parking areas where apparatus will not drive or park.

Parking lots

Parking lots for members should be considered for most station locations. Member vehicles have been the target of break-ins by thieves who often wait to commit their crime when the crew goes on a call. Visitor parking must be clearly marked and located near the public entrance. Parking lots must be well-lit.

Walks

Walks should be well-lit and not butted against parking lot curbs. There should be enough grass or natural area between the parking lot curb and the walk to allow for vehicle overhang. Department members tend to back into parking spaces, and the rear overhang of a vehicle is considerably longer than the front overhang.

Public entry

The public entry must be clearly defined so that it is readily identifiable by the public. The entry should be well-lit at night and have a doorbell that is heard throughout the station. In addition, the entry should have a call-box or phone to notify 911 if the station is not occupied. Public parking should be as close to the public entry as possible.

Yard hydrant

Each station should have a hydrant for refilling booster tanks after training, maintenance or after an emergency response. The hydrant should be located off the roadway, so there is no interference with traffic. For stations with drive-through bays, the yard hydrant should be located at the rear of the station. Some organizations may opt to put a fill station inside the facility to also serve as a wash-down source. This might be a viable option in areas that have frequent freezing temperatures.

Dumpster

If the station is going to have a dumpster, it must be a designated area that is secure from the public. The space must be designed so the refuse truck can easily and safely access the dumpster for dumping. The area where the refuse truck stops to lift the dumpster must have a stronger pad to accommodate the heavy impact load of a refuse truck making the dump.

Rainwater collection

The capture of rainwater can be a huge benefit to a fire station. If the water can be captured in a storage tank and a pump can be installed, the rainwater can be used for the following:

- Refill booster tanks.
- Water the lawn and shrubbery.
- Flush toilets.
- Wash out the bay.
- Wash apparatus.

Storage building

A separate storage building must be available to store yard maintenance equipment and tools. This building could also include other equipment and supplies that do not require conditioned air.

Security

Facility security is an issue for career, volunteer and combination organizations. There are three basic principles in security:

1. Deter.
   - Lighting (entire exterior).
   - Fencing (use attractive fencing commensurate with the neighborhood).
   - Landscaping.
   - Physical barriers.
2. Detect.
   - Security cameras (exterior cameras at each corner of facility, interior cameras in apparatus bay, and class/community/multifunctional rooms).
   - Motion detectors (lighting).
3. Delay.
   - Secure all exterior entrances.
   - Secure station from public vestibule.
   - Secure class/community/multifunctional rooms.

Interior

The following issues relevant to the exterior portion of the station should be taken into consideration.

Flow

Pathway flow for members to access the apparatus bay floor is critical to the design of any station that is staffed. Clear, short and direct are the guiding principles. There should be

a minimum, if any, hard right or left angle turns to minimize slips and falls, as well as to speed up response time. Doors to the apparatus bay should be hinged, so they swing into the apparatus bay. Doors should also have windows of sufficient size to allow members to see if they are opening the door into someone on the other side. Finally, doors should not protrude more than 7 inches into the pathway of responders.

Entrance lobby

The public entrance lobby must be a welcoming space, and a space that indicates to the community the value of the services provided. It is an excellent place to display historical memorabilia, photos, trophies and plaques.

Floor coverings

For ease of maintenance and sanitary reasons, seamless floor coverings work best throughout the living areas. Carpet is not a good choice of floor covering for emergency response stations.

Apparatus bay

The apparatus bay should not be used for storage, except for possibly the storage of fire hoses **(see Figure 7.5).** It is for apparatus only. Never store PPE on the apparatus floor because of UV degradation and residual diesel exhaust carcinogens. Never place an ice machine or breathing air machine on the apparatus floor because of residual diesel exhaust carcinogens **(see Figure 7.6).**

Figure 7.5 — Far too often, the apparatus bay becomes the all-purpose room, including living spaces, due to the lack of determining future needs.

Photo courtesy of Lynn Reda, Hughes Group Architects.

Figure 7.6 — Ice machines should not be on the apparatus bay floor.

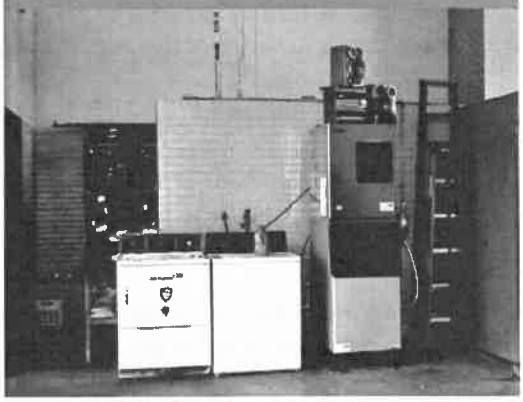

Photo courtesy of Kevin Roche, FACETS Consulting, LLC.

Pathways to the apparatus bay should be as straight and short as possible. If members must make hard 90-degree turns to access the bay, response times will increase. In addition, the possibility of a slip and fall or collision with another member is increased.

The apparatus bay should be recessed below the other parts of the station. However, all the walk-through passageways from the living areas to the bay should have a ramp rather than a step.

Figure 7.7 — Floor markings composed of a slip-resistant floor coating designate passageways and parking alignment.

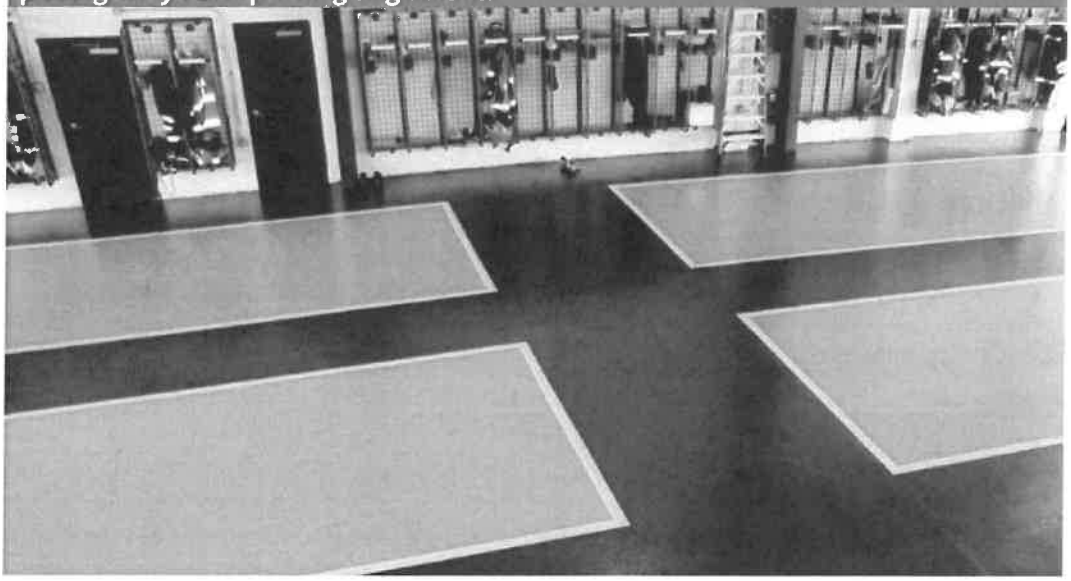

Photo courtesy of Rob Manns, Manns Woodward Studios, Inc.

One of the best floor coating systems for the apparatus bay is an MMA acrylic resinous coating. It is slip resistant, easy to clean, and allows for lines, markings and graphics **(see Figure 7.7).** Floor coatings must be able to withstand the extreme heat given off by apparatus tires following a response. Use painted lines or a floor coloring to help orient drivers for safely moving and parking the apparatus. Adhesive-tape stripes will not hold up.

Hot and cold water faucets for connecting garden hoses for apparatus cleaning might be a consideration, especially in colder climates. If these are installed, use a hose reel for neat and safe storage of the hose. Some organizations may opt for larger booster hose and hose reels for the cleaning. In these cases, the water source should probably come from outside of the station rather than the interior (domestic) water source.

Floor trench drains should be placed directly under where each vehicle parks. There should be a trench drain for each parking position that does not extend beyond the front or rear of the vehicle. This will eliminate wet spots in pathways that cause slips and falls **(see Figure 7.8).**

LED light fixtures should be installed overhead and between where the vehicles are parked to illuminate passageways without creating shadows. These lights should also be tied to the station alerting system (if used). Be sure to assess the color of light wanted in the bay.

Omni-directional loudspeakers are more effective than directional speakers in bay areas.

Low-speed, high-volume large fans, 10 feet or larger in diameter, do a remarkable job of assisting the HVAC system to provide comfort to the bay.

Figure 7.8 — Improper placement of apparatus floor drains create wet spots that will cause slips and falls.

Photo courtesy of Don Collins, Collins Design Service.

Apparatus bay doors

Bay door openings should be at least 14 feet wide and 16 feet high to allow for safe clearance.

Four-fold vertically hinged doors minimize the chances of a vehicle striking a bay door. Over the lifespan of the station, their heavy-duty design more than offsets the maintenance and replacement costs of roll-up bay doors. Some organizations place positioning stops on the apparatus floor to help position the apparatus. However, these become tripping hazards when the apparatus is out of the bay.

Safety light beams are recommended for bay door openings. The light beams automatically cause the door to go into the full-open position when there is an obstruction in the door opening. Signal lights, similar to traffic signals, are effective in letting the driver know the doors are fully open.

Diesel exhaust capturing systems

Source capture diesel exhaust systems are recommended for stations. There are source capture systems that are mounted on the apparatus, as well as systems that are installed in the station and manually connected directly to the exhaust tailpipe. However, they should be supplemented with other exhaust systems to filter the air from off-gassing of contaminated firefighting equipment and PPE. Advanced and cost-effective sensors can detect a wide range of unhealthy gases, including carbon monoxide. When quantities reach unsafe levels, fresh air intake and exhaust fans are automatically activated to exchange the volume of air in the building with fresh air. These systems can also be manually activated to assist with air circulation on hot days.

Bollards

Bollards should be placed on either side of each bay opening for the interior of the bay, just as they should be placed on the exterior. This will help protect against damage to the doors, as well as the structure of the station. As with exterior bollards, it is recommended that bollards at bay door openings be offset 2 inches to 4 inches to the interior of the opening, so vehicles strike the bollard before striking the door track and station structure. Bollards should be placed in concrete that has break joints (knockout panels) around the perimeter of the base of the bollard, so there is minimal damage to the concrete apron in case the bollard is struck. This also makes replacement easier and less expensive. Interior bollards are especially critical to protect four-fold bay doors.

Utility closest/sinks

There should be two utility closets, each with a sink for mops and station maintenance supplies. One of the closets should be located on or adjacent to the apparatus floor and should be used exclusively for the apparatus floor. The other closet should be located somewhere other than the apparatus bay floor and should be used only for the living areas. The use of a closet is preferred over an open area for improved station appearance and isolation from the rest of the station. Often, such closets are overlooked, which causes mops and brooms to be stored outside against a station wall.

Self-contained breathing apparatus cylinder refill stations

SCBA refill stations should not be placed on the apparatus bay floor. To prevent residual diesel exhaust carcinogen contamination, they should be placed in a room.

Kitchen trash cans

Fire station kitchens generate far more trash than an average household. In addition to food preparation for multiple adults, many other activities occur around the kitchen table. As a result, many kitchens require large trash barrels. This creates a sanitation problem because architects rarely think of a designated enclosed space for a large waste barrel, and they are commonly found as afterthoughts somewhere in the kitchen.

In communities with recycling programs, consideration should be given to placing recyclable containers in the kitchen area and other living portions of the station.

Slide poles

Slide poles are an iconic part of multistory fire stations. They offer the quickest and most direct path from the upstairs living areas to the apparatus bay. However, they are among the leading causes of injury and cause higher workers' compensation claims. They can also be a hazard to the public during station tours. If a station has slide poles, be aware, and correct the following potential safety and health hazards:

- Landing pads are often missing or worn-out, and they can be a trip hazard on the bay floor. Effective pads must always be in place.
- The opening between the two floors, if not properly sealed, allows residual carcinogenic diesel exhaust to enter the living space.
- Slide pole openings are often left unguarded, and many station visitors, including children, have been injured while sliding a pole without proper instruction and supervision.

A safer alternative to a slide pole, is a properly designed sliding board. Particular attention must be given to providing a safe landing area.

Locker rooms

In post-occupancy interviews, it is common to hear members say their locker room is too small. For example, they don't have room to sit on the bench with the locker door open. The other big complaint is that their lockers are too small. It is important for organizations and architects to understand what members store in their locker, how they use the locker room, and to design it accordingly. Another recommendation is to design the lockers so they reach the ceiling, or place a 45-degree top on the locker. Otherwise, the top of the lockers will become cluttered storage areas.

Hand sanitizers and wipes

Dispensers for hand sanitizers should be almost as common as light switches in a fire station. They must be in and around the decontamination areas and at every access point off the apparatus bay to the rest of the station. They should be in every restroom. Dispensers or wipes must be readily accessible throughout the fitness room.

Personal protective equipment storage

PPE should be stored in a separate, dedicated room with excellent ventilation. Lighting for this room should be motion-sensor activated. Both natural and artificial light are the "kryptonite" to the flame and heat protective properties of the fibers used in PPE fabric.

With the emphasis on cleaning PPE, more organizations are purchasing a second set of PPE for their members, so they can remain in service while dirty (contaminated) PPE is being cleaned. For this reason, the storage area and lockers should be a sufficient size to accommodate a second set of PPE.

Laundry (personal protective equipment)

If organizations clean their PPE in-house, there must be washer-extractors dedicated to cleaning PPE. Station work uniforms, workout clothing, bed linens, towels, personal clothing, and the like should never be washed in the same machines as PPE. PPE should **never** be taken home or to a public laundry facility for cleaning. Washer/Extractors for PPE require special design considerations.

Station alerting systems

Station alerting systems that offer "ramp-up" lighting and audio call alerts should be selected. Organizations must do a comprehensive analysis of the many features of alerting systems to find the one that provides the best benefits for their need.

General storage

It might be impossible to have too much storage in a fire station. For this reason, more than ample storage should be designed into the station to accommodate future growth and service delivery changes. Pay particular attention to organization. Closet organizer systems should be considered. Storage areas include, but are not limited to, the following:

- Office supplies.
- Janitorial supplies.
- Janitorial equipment.
- Kitchen items (food, pots, pans, utensils, etc.).
- EMS supplies.
- Spare emergency response equipment.
- Firefighting foam.
- Spill absorbent.
- Mass casualty equipment and supplies.
- Training materials and props.
- Public education materials.
- Seasonal use equipment (such as snow chains).

Fires

On average, there are about 150 fires per year reported in fire stations. Most of these originate from vehicle fires that start in the station. Cooking and electrical fires are also common. Fire stations must be the model of fire protection engineering and maintenance, yet many facilities would fail a basic safety inspection. Many fire and emergency services stations are under-insured or not insured. All new fire stations should have a code-compliant fire detection and alarm system, and should be fully sprinklered in accordance with NFPA 13.

Facility repair and maintenance

Fire and emergency services facilities must set the example for community safety by immediately fixing broken things and keeping the facilities in top maintenance condition. This includes exterior and interior appearance, as well as inside basic health, safety and house-keeping diligence. (See the monthly safety inspection checklist in **Appendix F.)**

Fundamentals for a successful project

A wealth of information has been provided to you up until this point in the report. The following section lists some of the keys points to consider, as well as to avoid, when planning your project. Some of the considerations that will help you get off to a successful start include the following:

Attend fire station design conferences, and insist that stakeholders, such as board members, planners and elected officials attend.

- Do a comprehensive needs assessment before starting to plan the project.
- Define the goals.
- Set the priorities.
- Be sure everyone understands what "completion" means.
- Specify the items that will be provided by the organization.
- Set up clear lines of communications.

Because of the unique nature of building fire and emergency services facilities, it can be wise to hire an "owner's representative." This is a person who has experience and expertise in fire station design and construction. This person(s) can serve as the liaison among the organization, the architect, and the construction company.

There are a number of pitfalls that can occur if there is a lack of planning and effective management of the construction process. Hopefully effective management and planning will allow the project to proceed without some of these issues:

- Not enough money was budgeted to complete the desired project.
- Negative reactions from the community regarding the cost, location, need or other aspects of the project.
- Lack of attention reviewing RFI content and not recognizing or understanding substitutions.
- Failure to accurately define the process from the outset.
- Failure to accurately define the deliverables.
- Losing sight of the agreed upon goal of the project.
- Losing focus on the scope of the project.
- Failure of the organization to specify items they will provide during the process.
- Failure to have thoroughly documented meeting minutes.
- Failure of the organizational representatives to stay involved in the process through completion.
- Failure to ask for clarification of something the architect or general contractor is describing.
- Failure to understand all the ramifications of the LEED, if compliance is mandated with the jurisdiction.
- Too many decisions made by the committee rather than more qualified individuals.
- Expecting the architect or construction company to make a change or add something for free.
- Failure to pay attention to security, doors and door hardware until it is too late.

Chapter 8: Compliance and Funding Issues

Up to this point, this report has primarily focused on the aspects of determining the physical needs and functions of a new fire station that is being built. In this final chapter, we will take a brief look at three other aspects of fire station construction or renovation projects that must also be the focus of the group working on the project.

Determining compliance

As this manual has shown, there are numerous safety and health issues that apply to the design or operation of fire and emergency services facilities. While national and state regulations exist for determining compliance with respect to many of these issues, most regulations will be from local sources. Different regions of the country follow different codes. A check with the local authority (city, county or state government) will help to determine which set of codes apply in the area. In addition, there are several organizations that specialize in the development of model codes that have been adopted locally. These organizations, listed below, can provide assistance in identifying appropriate requirements for the specific building area:

- Building Officials & Code Administrators, International.
- International Code Council.
- National Conference of States on Building Codes and Standards.
- Southern Building Code Congress International.

One of the most important steps in the design process, following the needs assessment, is to acquire information about all pertinent regulations and alternatives for meeting the design goals. This manual has been intended to assist in this process. As specific safety and health concerns are identified in the design process, the pertinent sections of the manual should be consulted to identify relevant approaches and sources of additional information.

Another approach for ensuring compliance is to use a Compliance Check-Off List. **Appendix G** provides a representative (generic) check-off list by area of the station. This check-off list is intended to be used in the design process to assist in remodeling, and can be used for a safety and health inspection of existing stations. The form is set up as a simple "check-the-box" format by station area, providing space for noting specific discrepancies in designs or existing stations. As with any system, it cannot account for all safety and health requirements specific to each area.

Note: It is important to use the check-off list throughout the design, construction and acceptance process.

Funding

A major consideration in the design or remodeling process is funding. One consideration is the insurance industry. These companies run smoke detector programs, scholarship programs, arson hot line reward programs, and a multitude of other programs related to the fire service. If a fire or EMS department can show a reduction in fire loss due to aggressive fire prevention, insurance savings could go to enhancing an existing facility or building new ones.

A number of alternative funding sources are available to the fire and EMS stations:

- Fees for special services.
- Benefit assessments.
- Impact development fees.
- Donations (developers, corporate partners, individuals).
- Subscription charges.
- Bond issues.

Major local government funding mechanisms include any combination of the following:

- Taxes.
- Borrowing.
- Leasing.
- Benefit assessment changes.
- Fees.
- Contracts.
- Cost-sharing.
- Subscriptions.
- Impact development fees.

The latter is usually involved for purchase of new fire and EMS stations and their full complement of equipment. In addition to these sources, local governments can also obtain funding from state and federal programs. Federal program funds are often distributed through state programs. Among the various sources are the following:

- Fire insurance surcharges.
- Vehicle-related fees.
- Special state grant programs.
- General state revenues.
- State-provided services.
- Federal grant programs.

Some volunteer fire and emergency services organizations raise most of their funds from the private sector:

- Direct solicitation.
- Fundraising events.
- Corporate donations.
- Private foundations.
- Community service clubs.

Urban and suburban departments might get a station funded by a developer to help get support and approval for the development by the local government and citizens.

A complete description of funding alternatives is offered in the USFA publication FA 331 "Funding Alternatives for Emergency Medical and Fire Services" that was published in 2012 through a cooperative agreement with the IFSTA by Oklahoma State University (OSU). This report provides extensive information on the following topics:

- Writing an effective grant proposal.
- Local revenue and funding alternatives.
- Federal funding for EMS and fire agencies.

- Foundations and corporate grants.
- Example of success stories.

This free report is available online at https://www.usfa.fema.gov/downloads/pdf/publications/fa_331.pdf.

Achieving a safe and healthy work environment

Making department stations safe and healthy requires much more than simply meeting applicable regulations. It requires a commitment from the department at all levels to ensure that the station provides an example to the community in terms of safety and health standards. It requires the attitude that stations are more than a temporary residence for emergency responders. They are an asset for which communities will increasingly become dependent in the future. As with any safety and health-related endeavor, fire and emergency services should focus on the following with regard to station design:

- Attend facility design symposia to learn as much as possible about the process.
- Explicitly determine station needs based on department/community requirements.
- Carefully supervise the design process to ensure that needs are addressed.
- Thoroughly review the safety and health of the station as it is being constructed and periodically after it has been built.
- Use "lessons learned" and experience to establish the basis for future needs.

Given sufficient funding and community support, this process will ensure that stations provide a safe and healthy environment for emergency responders **(see Figure 8.1).**

Figure 8.1 — One way to celebrate the completion of a new fire and emergency services facility is with a special "hose" cutting ceremony, as opposed to the traditional ribbon cutting ceremony.

Photo courtesy of Dennis Ross, Pacheco Ross Architects.

Appendix A: Occupational Safety and Health Administration Regional Offices

There are 28 states with Occupational Safety and Health Administration (OSHA) approved plans. There are 22 state plans (20 states, U.S. Virgin Islands and Puerto Rico) that cover private, state and local government workplaces. Six state plans (Connecticut, Illinois, Maine, New Jersey, New York and the Virgin Islands) cover state and local government workers only.

OSHA is a Division of the U.S. Department of Labor and is headquartered at the following location:

Occupational Safety and Health Administration
200 Constitution Ave., NW
Washington, D.C. 20210
800-321-6742 (OSHA)
www.osha.gov

OSHA also has 10 regional offices as listed below:

Region I: Boston (Connecticut*, Massachusetts, Maine*, New Hampshire, Rhode Island, Vermont*)

*OSHA-approved state plan
JFK Federal Building
25 New Sudbury St., Room E340
Boston, MA 02203
Phone: 617-565-9860
Fax: 617-565-9827

Region II: New York (New Jersey*, New York*, Puerto Rico*, Virgin Islands*)

*OSHA-approved state plan
Federal Building
201 Varick St., Room 670
New York, NY 10014
Phone: 212-337-2378
Fax: 212-337-2371

Region III: Philadelphia (District of Columbia, Delaware, Maryland*, Pennsylvania, Virginia*, West Virginia)

*OSHA-approved state plan
U.S. Department of Labor/OSHA
The Curtis Center, Suite 740 West
170 S. Independence Mall West
Philadelphia, PA 19106
Phone: 215-861-4900
Fax: 215-861-4904

Region IV: Atlanta (Alabama, Florida, Georgia, Kentucky*, Mississippi, North Carolina*, South Carolina*, Tennessee*)

*OSHA-approved state plan
U.S. Department of Labor/OSHA
Sam Nunn Atlanta Federal Center
61 Forsyth St., SW
Room 6T50
Atlanta, GA 30303
Phone: 678-237-0400
Fax: 678-237-0447

Region V: Chicago (Illinois*, Indiana*, Michigan*, Minnesota*, Ohio, Wisconsin)

*OSHA-approved state plan
John C. Kluczynski Federal Building
230 South Dearborn St., Room 3244
Chicago, IL 60604
Phone: 312-353-2220
Fax: 312-353-7774

Region VI: Dallas (Arkansas, Louisiana, New Mexico*, Oklahoma, Texas)

*OSHA-approved state plan
A. Maceo Smith Federal Building
525 Griffin St., Suite 602
Dallas, TX 75202
Phone: 972-850-4145
Fax: 972-850-4149
FSO fax: 972-850-4150

Region VII: Kansas City (Iowa*, Kansas, Missouri, Nebraska)

*OSHA-approved state plan
Two Pershing Square Building
2300 Main St., Suite 1010
Kansas City, MO 64108
Phone: 816-283-8745
Voice: 816-283-0545
Fax: 816-283-0547

Region VIII: Denver (Colorado, Montana, North Dakota, South Dakota, Utah*, Wyoming*)

*OSHA-approved state plan
Cesar Chavez Memorial Building
1244 Speer Blvd., Suite 551
Denver, CO 80204
Phone: 720-264-6550
Fax: 720-264-6585

Region IX: San Francisco (American Samoa, Arizona*, California*, Guam, Hawaii*, Nevada*, Northern Mariana Islands)

*OSHA-approved state plan
San Francisco Federal Building
90 7th St., Suite 18100
San Francisco, CA 94103
Phone: 415-625-2547 (Main Public — 8:00 a.m. to 4:30 p.m. Pacific)
Fax: 415-625-2534

Region X: Seattle (Alaska*, Idaho, Oregon*, Washington*)

*OSHA-approved state plan
Fifth and Yesler Tower
300 Fifth Ave., Suite 1280
Seattle, WA 98104
Phone: 206-757-6700
Fax: 206-757-6705

Appendix B: Occupational Safety and Health Administration Approved State Plans Directory

(Listed alphabetically by state and includes contacts as of Feb 1, 2017.)

Alaska Department of Labor and Workforce Development

P.O. Box 111149
1111 W. 8th St., Room 304
Juneau, AK 99811

Heidi Drygas, Commissioner
Phone: 907-465-2700
Fax: 907-465-2784

Deborah Kelly, Director
Phone: 907-269-4955
Fax: 907-465-6012

Industrial Commission of Arizona

800 W. Washington
Phoenix, AZ 85007

James Ashley, Director
Phone: 602-542-4411
Fax: 602-542-7889

Bill Warren, Program Director
Phone: 602-542-5795
Fax: 602-542-1614

California Department of Industrial Relations

1515 Clay St., 19th Floor
Oakland, CA 94612

Christine Baker, Director
Phone: 510-622-3965
Fax: 510-286-7037

Juliann Sum, Chief, Cal/OSHA
Phone: 510-286-7000
Fax: 510-286-7037

Cora Gherga, Assistant Chief of Enforcement Administration, Cal/OSHA
Phone: 510-286-7000
Fax: 510-286-7037

Connecticut Department of Labor

200 Folly Brook Blvd.
Wethersfield, CT 06109

Sharon Palmer, Commissioner
Phone: 860-263-6505
Fax: 860-263-6529

CONN-OSHA

38 Wolcott Hill Road
Wethersfield, CT 06109

Kenneth Tucker, Director
Phone: 860-263-6900
Fax: 860-263-6940

Hawaii Department of Labor and Industrial Relations (DLIR)

830 Punchbowl St.
Honolulu, HI 96813

Linda Chu Takayama, State Plan Designee and Director, DLIR
Phone: 808-586-8844
Fax: 808-586-9099

Norman Ahu, HIOSH Administrator
Phone: 808-586-9116
Fax: 808-586-9104

Illinois Department of Labor

900 South Spring St.
Springfield, IL 62702

Hugo Chaviano, Director
Phone: 217-782-6206
Fax: 217-782-0596

Ben Noven, Manager
Phone: 217-782-9386

Indiana Department of Labor

State Office Building
402 West Washington St., Room W195
Indianapolis, IN 46204

Rick J. Ruble, Commissioner of Labor
Phone: 317-232-2693
Fax: 317-233-3790

Tim Maley, Deputy Commissioner, IOSHA
Phone: 317-233-3605
Fax: 317-233-3790

Iowa Division of Labor Services

150 Des Moines St.
Des Moines, IA 50309

Michael A. Mauro, Labor Commissioner
Phone: 515-281-3447
Fax: 515-281-5631

Jens Nissen, IOSH Administrator
Phone: 515-281-3122
Fax: 515-281-7995

Kentucky Labor Cabinet

1047 US HWY 127 South, Suite 4
Frankfort, KY 40601

Derrick K. Ramsey, Secretary
Phone: 502-564-0684
Fax: 502-564-5387

Mike Nemes, Deputy Secretary
Phone: 502-564-0979
Fax: 502-564-5387

Ervin Nimeny, Commissioner, Department of Workplace Standards
Phone: 502-564-0977
Fax: 502-564-5387

Chuck Stribling, CSP, OSH Federal-State Coordinator, Department of Workplace Standards
Phone: 502-564-3070
Fax: 502-564-1682

Maine Department of Labor

Workplace Safety and Health Division
45 State House Station
Augusta, ME 04333

Pamela Megathlin, Director, Bureau of Labor Standards
Phone: 207-623-7932
Fax: 207-623-7934

Steve Greeley, Director, MEOSH
Phone: 207-623-7916
Fax: 207-623-7934

Maryland Division of Labor and Industry

Department of Labor, Licensing and Regulation (DLLR)
Division of Labor and Industry
1100 North Eutaw St., Room 606
Baltimore, MD 21201

Matthew Helmeniak, Commissioner
Phone: 410-767-2241
Fax: 410-767-2986

Maryland Occupational Safety and Health (MOSH)
10946 Golden West Drive, Suite 160
Hunt Valley, MD 21031

William Dallas, Assistant Commissioner, MOSH
Phone: 410-527-4499
Fax: 410-527-4481

Michigan Department of Licensing and Regulatory Affairs (LARA)

Michigan Occupational Safety and Health Administration
P.O. Box 30643
Lansing, MI 48909

Shelly Edgerton, Director
Phone: 517-241-7124
Fax: 517-373-2129

Bart Pickelman, Acting Director, MIOSHA
Phone: 517-284-7777
Fax: 517-284-7775

Minnesota Department of Labor and Industry

Minnesota Department of Labor and Industry
443 Lafayette Road
St. Paul, MN 55155

Ken Peterson, Commissioner
Phone: 651-284-5010
Fax: 651-284-5721

James Krueger, Workplace Safety Manager
Phone: 651-284-5602
Fax: 651-284-5724

Cindy Valentine, Compliance Director, MNOSHA Compliance
Phone: 651-284-5110
Fax: 651-284-5741

Nevada Division of Industrial Relations

Department of Business & Industry
400 West King St., Suite 400
Carson City, NV 89703

Joseph Decker, Administrator
Occupational Safety and Health Administration
1301 N. Green Valley Parkway, Suite 200
Henderson, NV 89074
Phone: 702-486-9020

Jess Lankford, Chief Administrative Officer
Phone: 702-486-9020
Fax: 702-990-0358

New Jersey Department of Labor and Workforce Development

New Jersey Public Employees Occupational Safety and Health
1 John Fitch Plaza
P.O. Box 386
Trenton, NJ 08625

Howard Black, Director
Phone: 609-292-0501
Fax: 609-292-4409

Joe Eldridge, Director
Phone: 609-826-4920
Fax: 609-984-2779

New Mexico Environment Department

525 Camino de los Marquez, Suite 3
P.O. Box 5469
Santa Fe, NM 87502

Butch Tangate, Cabinet Secretary
Phone: 505-827-2855
Fax: 505-827-2836

Robert Genoway, Bureau Chief
Phone: 505-476-8700
Fax: 505-476-8734

New York Department of Labor

New York Public Employee Safety and Health (PESH) Bureau
State Office Campus Building 12, Room 158
Albany, NY 12240

Eileen Franko, Director, Division of Safety and Health (DOSH)
Phone: 518-457-3518
Fax: 518-457-5545

Normand Labbe, Program Manager, PESH
Phone: 518-457-1263
Fax: 518-457-5545

North Carolina Department of Labor

1101 Mail Service Center
Raleigh, NC 27699

Cherie Berry, Commissioner
Phone: 919-733-0359
Fax: 919-733-6197

Kevin Beauregard, Deputy Commissioner, OSH Director
Phone: 919-807-2863
Fax: 919-807-2856

Oregon Occupational Safety and Health Division

Department of Consumer and Business Services
350 Winter St. NE, Room 430
P.O. Box 14480
Salem, OR 97309

Michael Wood, Administrator
Phone: 503-378-3272
Fax: 503-947-7461

Julie Love, Deputy Administrator
Phone: 503-378-3272
Fax: 503-947-7461

Puerto Rico Department of Labor and Human Resources

Prudencio Rivera Martinez Building 21st Floor
505 Muñoz Rivera Ave.
Hato Rey, PR 00918

Carlos J. Saavedra Guiterrez, Secretary of Labor
Phone: 787-754-2119
Fax: 787-753-9550

Luis E. Pardo, Assistant Secretary of Labor
Phone: 787-754-2172
Fax: 787-767-6051

South Carolina Department of Labor, Licensing and Regulation (DLLR)

Synergy Business Park, Kingstree Building
110 Centerview Drive
P.O. Box 11329
Columbia, SC 29211

Emily Farr, Director
Phone: 803-896-4300
Fax: 803-896-4393

Dottie Ison, Administrator
Phone: 803-896-7686
Fax: 803-896-7670

Office of Voluntary Programs
Phone: 803-896-7787
Fax: 803-896-7750

Tennessee Department of Labor and Workforce Development

220 French Landing Drive
Nashville, TN 37243

Burns Phillips, Commissioner
Phone: 615-741-2582
Fax: 615-741-5078

Steve Hawkins, TOSHA Administrator
Phone: 615-741-2793
Fax: 615-741-3325

Utah Labor Commission

160 East 300 South, 3rd Floor
P.O. Box 146600
Salt Lake City, UT 84114

Jaceson Maughan, Commissioner
Phone: 801-530-6848
Fax: 801-530-6390

Cameron Ruppe, Division Director, Utah Occupational Safety and Health
Phone: 801-530-6898
Fax: 801-530-7606

Vermont Department of Labor

5 Green Mountain Drive
P.O. Box 488
Montpelier, VT 05601

Lindsay H. Kurrie, Commissioner
Phone: 802-828-4000
Fax: 802-888-4022

Daniel Whipple, VOSHA Program Manager
Phone: 802-828-5084
Fax: 802-828-0408

Virgin Islands Department of Labor (VIDOL)

4401 Sion Farm
Christiansted, St. Croix, VI 00820

Catherine Hendry, Commissioner
Phone: 340-773-1994
Fax: 340-773-1858

Dean Andrews, VIDOSH Director
Phone: 340-773-1994 ext. 2161
Fax: 340-773-0094

Virginia Department of Labor and Industry

Main Street Centre
600 East Main St., Suite 207
Richmond, VA 23219

C. Ray Davenport, Commissioner
Phone: 804-786-2377
Fax: 804-371-6524

William Burge, Assistant Commissioner
Phone: 804-786-2377
Fax: 804-371-6524

Ronald L. Graham, VOSH Health Director
Phone: 804-786-0574
Fax: 804-371-6524

Jennifer Rose, VOSH Safety Director
Phone: 804-786-7776
Fax: 804-371-6524

Jay Withrow, Director, Division of Legal Support
Phone: 804-371-2327
Fax: 804-371-6524

Washington Department of Labor and Industries

General Administration Building
P.O. Box 44001
Olympia, WA 98504

Division of Occupational Safety and Health (DOSH)
7273 Linderson Way SW
Tumwater, WA 98501

Anne Soiza, Assistant Director, Department of Labor and Industries, DOSH
Phone: 360-902-4805
Fax: 360-902-5619

Craig Blackwood, Deputy Assistant Director, DOSH
Phone: 360-902-5828
Fax: 360-902-5619

Wyoming Department of Workforce Services

Workers' Safety and Compensation Division
1510 East Pershing Blvd. — West Wing
Cheyenne, WY 82002

Jason Wolfe, Administrator, Office of Standards & Compliance
Phone: 307-777-7672
Fax: 307-777-5805

Dan Bulkley, Deputy Administrator OSHA
Phone: 307-777-3581
Fax: 307-777-3646

Appendix C: Additional Resources

Avsec, R. (2012, November 15). The choice: 3 systems to remove engine exhaust. *FireRescue1.* Retrieved from https://www.firerescue1.com/fire-products/vehicle-equipment/exhaust-removal-systems/articles/1368873-The-choice-3-systems-to-remove-engine-exhaust/

Avsec, R. (2013, May 22). 3 firefighter PPE storage options. *FireRescue1.* Retrieved from https://www.firerescue1.com/fire-products/Gear-Racks/articles/1450237-3-firefighter-PPE-storage-options/

Avsec, R. (2015, August 13). 5 must-haves for firefighting gear washers. *FireRescue1.* Retrieved from https://www.firerescue1.com/fire-products/fire-station-equipment/articles/3025402-5-must-haves-for-firefighting-gear-washers/

Avsec, R. (2016, August 23). How to buy a fire station security system. *FireRescue1.* Retrieved from https://www.firerescue1.com/fire-products/fire-station-equipment/articles/119050018-How-to-buy-a-fire-station-security-system/

Ballem, E. (2015, July 15). Creating green and red zones in fire stations. *Firehouse.* Retrieved from http://www.firehouse.com/news/12092982/firehouse-magazine-station-design-conference-green-and-red-zones-in-fire-stations-promote-health

Ballem, E. (2015, July 16). Gender neutral fire stations are possible. *Firehouse.* Retrieved from http://www.firehouse.com/news/12092987/firehouse-magazines-fire-station-design-gender-neutral-fire-stations

Cash, J. (2010, September 1). Select the right architect for your new fire station. *FireRescue.* Retrieved from http://www.firerescuemagazine.com/articles/print/volume-5/issue-9/firefighter-safety-health/select-the-right-architect-for-your-new-station.html

CDC. (2016). Oral health conditions. *CDC.* Retrieved from https://www.cdc.gov/oralhealth/conditions/index.html

CDC. (2017). Colorectal (colon) cancer. *CDC.* Retrieved from https://www.cdc.gov/cancer/colorectal/

CDC. (2017). Lung cancer. *CDC.* Retrieved from https://www.cdc.gov/cancer/lung/

CDC. (2017). Mesothelioma and the environment. *CDC.* Retrieved from https://ephtracking.cdc.gov/showCancerMesotheliomaEnv.action

Collins, D. (2015, March 5). Do's and don'ts of fire station design. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-20/issue-3/features/do-s-and-don-ts-of-fire-station-design.html

Crupper, C. (2011, February 11). Tips for combating bedbug infestation. *Fire Engineering.* Retrieved from http://www.fireengineering.com/articles/2011/02/bedbug-infestation.html

Dahm, M. M., Bertke, S., Allee, S., & Daniels, R. D. (2015). Creation of a retrospective job-exposure matrix using surrogate measures of exposure for a cohort of US career firefighters from San Francisco, Chicago and Philadelphia. *CDC.* Retrieved from https://www.cdc.gov/niosh/firefighters/pdf/dahm_et_al_2015.pdf

Daniels, R. D. (2014, December 17). Is there a link between firefighting and cancer? [Blog post]. *CDC.* Retrieved from https://blogs.cdc.gov/niosh-science-blog/2014/12/17/cancer-ff/

Daniels, R. D., Bertke, S., Dahm, M. M., Yiin, J. H., Kubale, T. L., Hales, T. L., . . . Pinkerton, L. E. (2015). Exposure-response relationships for select cancer and non-cancer health outcomes in a cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950-2009). *CDC.* Retrieved from https://www.cdc.gov/niosh/firefighters/pdfs/Daniels-et-al-(2015).pdf

Daniels, R. D., Kubale, T. L., Yiin, James H., Dahm, M., Hales, T., Baris, D., . . . Pinkerton, L. (2013, October 14). Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950-2009). *CDC.* Retrieved from https://www.cdc.gov/niosh/firefighters/pdfs/OEM_FF_Ca_Study_10-2013.pdf

Doyle, K. & Humphreys, J. (2016, August 23). Kitchen design in the modern fire station. *Firehouse.* Retrieved from http://www.firehouse.com/article/12248742/fire-station-kitchen-design-and-features

F.I.E.R.O. (Fire Industry Education Resource Organization) Annual Fire Station Design Symposium. (n.d.). Retrieved from www.fierofirestation.com

Firefighter Cancer Support Network. (n.d.). Retrieved from https://firefightercancersupport.org/

Firefighter Cancer Foundation. (n.d.). Retrieved from http://www.ffcancer.org/index.cfm

Garfield, L. (2016, August 7). This is the fire station of the future – And it costs $32 Million. *Business Insider.* Retrieved from http://www.businessinsider.com/studio-gang-fire-station-new-york-2016-8

Guyer, J. P. (2010). *Introduction to architectural design: Fire stations.* Course #A02-003.

Hartman, D. & Hartman, M. (2015, August 1). 15 questions to ask your architect/engineer candidates. *Firehouse.* Retrieved from http://www.firehouse.com/article/12086976/fire-station-design-supplement-15-questions

Hartman, D. (2004, November 4). Keys to building the perfect fire station for your department. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-19/issue-11/features/keys-to-building-the-perfect-fire-station-for-your-fire-department.html

Hoffman, J. (2014, May 1). Top 5 cardio equipment for firefighters. *Fire Engineering.* Retrieved from http://www.fireengineering.com/articles/2014/05/top-5-cardio-equipment-for-firefighters.html

IAFF. (n.d.). *Wellness-fitness initiative resource.* Retrieved from http://www.iaff.org/hs/wfiresource/default.html

ISO Mitigation. (2018). Retrieved from https://www.isomitigation.com

Kowalczyk, L. & Porter, R. (2016, October 25). Station furnishings: Creating your home away from home. *Firehouse.* Retrieved from http://www.firehouse.com/article/12272705/choosing-fire-station-furniture-fire-station

LeMasters, G. K., Genaidy, A. M., Succop, P., Deddens, J., Sobeih, T., Barriera-Viruet, H., . . . Lockey, J. (2006, November). Cancer risk among firefighters: A review and meta-analysis of 32 studies. *JOccup Environ Med, 48*(11), 1189–202.

MacNeal, J., Cone, D., & Wistrom, C. (2016). Effect of station-specific alerting and ramp-up tones on firefighters' alarm time heart rates. *Journal of Occup Environ Hyg., 13*(11), 866-870. doi: 10.1080/15459624.2016.1183018

McLure, J. (2016, February 23). The dirt on installing laundry equipment in a fire station. *Firehouse.* Retrieved from http://www.firehouse.com/article/12167643/fire-station-design-laundry-room-design-tips

Mion, E. G. (2009, June). *Fire station. Whole building design guide.*

Newell, K. (2012, August 1). Fire station design: The single story vs. the multi-story firehouse. *Carolina Fire Rescue EMS Journal.* Retrieved from http://www.carolinafirejournal.com/Articles/Article-Detail/ArticleId/2285/Fire-Station-Design-the-single-story-vs-multi-story-firehouse

Newell, K. (2014, October 10). A "shelf-help" guide to station storage needs. *Carolina Fire Rescue EMS Journal.* Retrieved from http://www.carolinafirejournal.com/Articles/Article-Detail/ArticleId/4332/A-8216-Shelf-Help-8217-guide-to-station-storage-needs

Newell, K. (2014, October 10). From Dalmatians to decontamination: 40 years of station evolution. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-19/issue-10/features/from-dalmatians-to-decontamination-40-years-of-station-evolution.html

NFPA. (2013). *NFPA 1500, Standard on fire department occupational safety, health, and wellness program.* Quincy, MA: Author.

NFPA. (2015). *NFPA 1581, Standard on fire department infection control program.* Quincy, MA: Author.

NFPA. (2015). *NFPA 1583, Standard on health-related fitness programs for fire department members.* Quincy, MA: Author.

NFPA. (2016). *NFPA 1710, Standard for the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments.* Quincy, MA: Author.

NFPA. (2014). *NFPA 1720, Standard for the organization and deployment of fire suppression operations, emergency medical operations and special operations to the public by volunteer fire departments.* Quincy, MA: Author.

NFPA. (2014). *NFPA 1851, Standard on selection, care and maintenance of protective ensembles for structural fire fighting and proximity fire fighting.* Quincy, MA: Author.

NFPA. (2016, November). *Fourth needs assessment of the U.S. fire service.* Retrieved from https://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/the-fire-service/administration/needs-assessment

NIOSH. (2013, November). Frequently asked questions: NIOSH fire fighter cancer study. *CDC.* Retrieved from https://www.cdc.gov/niosh/firefighters/pdfs/FAQ-NIOSHFFCancerStudy.pdf

NIOSH. (2013, October 17). NIOSH study of firefighters finds increased rates of cancer [Press release]. *CDC.* Retrieved from https://www.cdc.gov/niosh/updates/upd-10-17-13.html

NIOSH. (2016, July). Findings from a study on cancer among U.S. fire fighters. *CDC.* Retrieved from https://blogs.cdc.gov/niosh-science-blog/2017/05/10/ff-cancer-facts/

Oberklaid, S. (2015, August 25). Inside the most sustainable fire station in the USA: Fire station 20. *The Urbanist.* Retrieved from https://www.theurbanist.org/2015/08/25/inside-the-most-sustainable-fire-station-in-the-usa-fire-station-20/

Petrillo, A. M. (2015, January 8). Fire station exhaust systems. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-21/issue-1/features/fire-station-exhaust-systems.html

Petrillo, A. M. (2015, July 9). More to alerting systems than alerting. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-20/issue-7/features/more-to-alerting-systems-than-alerting.html

Petrillo, A. M. (2015, June 3). More to apparatus floor finishes than on the surface. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-20/issue-6/features/more-to-apparatus-floor-finishes-than-on-the-surface.html

Petrillo, A. M. (2015, May 4). Fire station bay door options. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-20/issue-5/features/fire-station-bay-door-options.html

Petrillo, A. M. (2016, August 1). Kitchens: Designed to be "heart" of the fire station. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-21/issue-8/features/kitchens-designed-to-be-heart-of-the-fire-station.html

Petrillo, A. M. (2016, February 11). Turnout gear cleaning and decon done both in station and by outside service providers. *Fire Apparatus & Emergency Equipment.* Retrieved from http://www.fireapparatusmagazine.com/articles/print/volume-21/issue-2/features/turnout-gear-cleaning-and-decon-done-both-in-station-and-by-outside-service-providers.html

Predmore, A. (2015, August 1). Building community support for a fire station. *Firehouse.* Retrieved from http://www.firehouse.com/article/12086450/fire-station-design-supplement-building-community-support

Sexton, J. & Reynolds, K. (2010). Exposure of emergency medical responders to methicillin-resistant staphylococcus aureus. *Am J Infect Control, 38*(5), 368-373. doi: 10.1016/j.ajic.2010.01.004

Steinitz, D. (2016, July 21). Selecting lighting for your next fire station project. *Firehouse.* Retrieved from http://www.firehouse.com/article/12235187/selecting-lighting-for-your-next-fire-station-project

U.S. DOT & FHWA. *Manual on uniform traffic control devices.* Retrieved from https://mutcd.fhwa.dot.gov/

University of Washington. (n.d.). *Prevent MRSA – Maintain a "clean zone" in the fire station.* Retrieved from http://deohs.washington.edu/sites/default/files/brochures/preventMRSA.pdf

Wong, C. (2010, November). Privacy in the modern firehouse. *FireWork.* Retrieved from https://www.i-women.org/wp-content/uploads/2014/04/Privacy-in-the-Modern-Firehouse-Part-1.pdf

Appendix D: Pertinent Occupational Safety and Health Administration Regulations

Section 6(a) of the Williams-Steiger Occupational Safety and Health Act (OSHA) of 1970 (84 Stat. 1593) provides that "without regard to chapter 5 of Title 5, United States Code, or to the other subsections of this section, the Secretary shall, as soon as practicable during the period beginning with the effective date of this Act and ending 2 years after such date, by rule promulgate as an occupational safety or health standard any national consensus standard, and any established Federal standard, unless he determines that the promulgation of such a standard would not result in improved safety or health for specifically designated employees." The legislative purpose of this provision is to establish, as rápidly as possible and without regard to the rule-making provisions of the Administrative Procedure Act, standards with which industries are generally familiar, and on whose adoption interested and affected persons have already had an opportunity to express their views. Such standards are either (1) national consensus standards on whose adoption affected persons have reached substantial agreement, or (2) Federal standards already established by Federal statutes or regulations.

The following requirements are OSHA regulations that could influence the construction/remodel and maintenance of fire and emergency medical services stations from Part 1910 - General Occupational Safety and Health Standards. Specific regulations are organized by area of the station and by types of hazards. **This list may not contain all applicable OSHA regulations that apply to station design for safety and health. The following regulations are current through December 31, 2016.**

General areas of highlighted OSHA regulations

- **Fire Protection**
- **Means Of Egress**
- **All Areas — Electrical**
- **Living Spaces — General**
- **Specific Interior Areas**
- **Interior Areas — Walking-Working Surfaces**
- **Equipment, Tools and Maintenance**
- **Apparatus Area**
- **Exterior Areas**

Fire Protection

1910.38 *Employee Emergency Plans and Fire Prevention Plans.*

1910.38(a) *Application.* An employer must have an emergency action plan whenever an OSHA standard in this part requires one. The requirements in this section apply to each such emergency action plan.

1910.38(b) *Written and oral emergency action plans.* An emergency action plan must be in writing, kept in the workplace, and available to employees for review. However, an employer with 10 or fewer employees may communicate the plan orally to employees.

1910.38(c) *Minimum elements of an emergency action plan.* An emergency action plan must include at a minimum:

1910.38(c)(1) Procedures for reporting a fire or other emergency;

1910.38(c)(2) Procedures for emergency evacuation, including type of evacuation and exit route assignments;

1910.38(c)(3) Procedures to be followed by employees who remain to operate critical plant operations before they evacuate;

1910.38(c)(4) Procedures to account for all employees after evacuation;

1910.38(c)(5) Procedures to be followed by employees performing rescue or medical duties; and

1910.38(c)(6) The name or job title of every employee who may be contacted by employees who need more information about the plan or an explanation of their duties under the plan.

1910.38(d) *Employee alarm system.* An employer must have and maintain an employee alarm system. The employee alarm system must use a distinctive signal for each purpose and comply with the requirements in § 1910.165.

1910.38(e) *Training.* An employer must designate and train employees to assist in a safe and orderly evacuation of other employees.

1910.38(f) *Review of emergency action plan.* An employer must review the emergency action plan with each employee covered by the plan:

1910.38(f)(1) When the plan is developed or the employee is assigned initially to a job;

1910.38(f)(2) When the employee's responsibilities under the plan change; and

1910.38(f)(3) When the plan is changed.

1910.157 *Portable Fire Extinguishers.*

1910.157(a) *Scope and application.* The requirements of this section apply to the placement, use, maintenance, and testing of portable fire extinguishers provided for the use of employees. Paragraph (d) of this section does not apply to extinguishers provided for employee use on the outside of workplace buildings or structures. Where extinguishers are provided but are not intended for employee use and the employer has an emergency action plan and a fire prevention plan that meet the requirements of 29 CFR 1910.38 and 29 CFR 1910.39 respectively, then only the requirements of paragraphs (e) and (f) of this section apply.

1910.157(b) *Exemptions.*

1910.157(b)(1) Where the employer has established and implemented a written fire safety policy which requires the immediate and total evacuation of employees from the workplace upon the sounding of a fire alarm signal and which includes an emergency action plan and a fire prevention plan which meet the requirements of 29 CFR 1910.38 and 29 CFR 1910.39 respectively, and when extinguishers are not available in the workplace, the employer is exempt from all requirements of this section unless a specific standard in part 1910 requires that a portable fire extinguisher be provided.

1910.157(b)(2) Where the employer has an emergency action plan meeting the requirements of 1910.38 which designates certain employees to be the only employees authorized to use the available portable fire extinguishers, and which requires all other employees in the fire area to immediately evacuate the affected work area upon the sounding of the fire alarm, the employer is exempt from the distribution requirements in paragraph (d) of this section.

1910.157(c) *General requirements.*

1910.157(c)(1) The employer shall provide portable fire extinguishers and shall mount, locate and identify them so that they are readily accessible to employees without subjecting the employees to possible injury.

1910.157(c)(2) Only approved portable fire extinguishers shall be used to meet the requirements of this section.

1910.157(c)(3) The employer shall not provide or make available in the workplace portable fire extinguishers using carbon tetrachloride or chlorobromomethane extinguishing agents.

1910.157(c)(4) The employer shall assure that portable fire extinguishers are maintained in a fully charged and operable condition and kept in their designated places at all times except during use.

1910.157(c)(5) The employer shall remove from service all soldered or riveted shell self-generating soda acid or self-generating foam or gas cartridge water type portable fire extinguishers which are operated by inverting the extinguisher to rupture the cartridge or to initiate an uncontrollable pressure generating chemical reaction to expel the agent.

1910.157(d) *Selection and distribution.*

1910.157(d)(1) Portable fire extinguishers shall be provided for employee use and selected and distributed based on the classes of anticipated workplace fires and on the size and degree of hazard which would affect their use.

1910.157(d)(2) The employer shall distribute portable fire extinguishers for use by employees on Class A fires so that the travel distance for employees to any extinguisher is 75 feet (22.9 m) or less.

1910.157(d)(3) The employer may use uniformly spaced standpipe systems or hose stations connected to a sprinkler system installed for emergency use by employees instead of Class A portable fire extinguishers, provided that such systems meet the respective requirements of 1910.158 or 1910.159, that they provide total coverage of the area to be protected, and that employees are trained at least annually in their use.

1910.157(d)(4) The employer shall distribute portable fire extinguishers for use by employees on Class B fires so that the travel distance from the Class B hazard area to any extinguisher is 50 feet (15.2 m) or less.

1910.157(d)(5) The employer shall distribute portable fire extinguishers used for Class C hazards on the basis of the appropriate pattern for the existing Class A or Class B hazards.

1910.157(d)(6) The employer shall distribute portable fire extinguishers or other containers of Class D extinguishing agent for use by employees so that the travel distance from the combustible metal working area to any extinguishing agent is 75 feet (22.9 m) or less. Portable fire extinguishers for Class D hazards are required in those combustible metal working areas where combustible metal powders, flakes, shavings, or similarly sized products are generated at least once every two weeks.

1910.157(e) *Inspection, maintenance and testing.*

1910.157(e)(1) The employer shall be responsible for the inspection, maintenance and testing of all portable fire extinguishers in the workplace.

1910.157(e)(2) Portable extinguishers or hose used in lieu thereof under paragraph (d)(3) of this section shall be visually inspected monthly.

1910.157(e)(3) The employer shall assure that portable fire extinguishers are subjected to an annual maintenance check. Stored pressure extinguishers do not require an internal examination. The employer shall record the annual maintenance date and retain this record for one year after the last entry or the life of the shell, whichever is less. The record shall be available to the Assistant Secretary upon request.

1910.157(e)(4) The employer shall assure that stored pressure dry chemical extinguishers that require a 12-year hydrostatic test are emptied and subjected to applicable maintenance procedures every 6 years. Dry chemical extinguishers having non-refillable disposable containers are exempt from this requirement. When recharging or hydrostatic testing is performed, the 6-year requirement begins from that date.

1910.157(e)(5) The employer shall assure that alternate equivalent protection is provided when portable fire extinguishers are removed from service for maintenance and recharging.

1910.157(f) *Hydrostatic testing.*

1910.157(f)(1) The employer shall assure that hydrostatic testing is performed by trained persons with suitable testing equipment and facilities.

1910.157(f)(2) The employer shall assure that portable extinguishers are hydrostatically tested at the intervals listed in Table L-1 of this section, except under any of the following conditions:

1910.157(f)(2)(i) When the unit has been repaired by soldering, welding, brazing, or use of patching compounds;

1910.157(f)(2)(ii) When the cylinder or shell threads are damaged;

1910.157(f)(2)(iii) When there is corrosion that has caused pitting, including corrosion under removable name plate assemblies;

1910.157(f)(2)(iv) When the extinguisher has been burned in a fire; or

1910.157(f)(2)(v) When a calcium chloride extinguishing agent has been used in a stainless steel shell.

1910.157(f)(3) In addition to an external visual examination, the employer shall assure that an internal examination of cylinders and shells to be tested is made prior to the hydrostatic tests.

Table L-1

Type of extinguishers	Test interval (years)
Soda acid (soldered brass shells) (until 1/1/82)	(1)
Soda acid (stainless steel shell)	5
Cartridge operated water and/or antifreeze	5
Stored pressure water and/or antifreeze	5
Wetting agent	5
Foam (soldered brass shells) (until 1/1/82)	(1)
Foam (stainless steel shell)	5
Aqueous Film Forming foam (AFFF)	5
Loaded stream	5
Dry chemical with stainless steel	5
Carbon Dioxide	5
Dry chemical, stored pressure, with mild steel, brazed brass or aluminum shells	12
Dry chemical, cartridge or cylinder operated, with mild steel shells	12
Halon 1211	12
Halon 1301	12
Dry powder, cartridge or cylinder operated with mild steel shells	12

[1]Extinguishers having shells constructed of copper or brass joined by soft solder or rivets shall not be hydrostatically tested and shall be removed from service by January 1, 1982. (Not permitted)

1910.157(f)(4) The employer shall assure that portable fire extinguishers are hydrostatically tested whenever they show new evidence of corrosion or mechanical injury, except under the conditions listed in paragraphs (f)(2)(i)-(v) of this section.

1910.157(f)(5) The employer shall assure that hydrostatic tests are performed on extinguisher hose assemblies which are equipped with a shut-off nozzle at the discharge end of the hose. The test interval shall be the same as specified for the extinguisher on which the hose is installed.

1910.157(f)(6) The employer shall assure that carbon dioxide hose assemblies with a shut-off nozzle are hydrostatically tested at 1,250 psi (8,620 kPa).

1910.157(f)(7) The employer shall assure that dry chemical and dry powder hose assemblies with a shut-off nozzle are hydrostatically tested at 300 psi (2,070 kPa).

1910.157(f)(8) Hose assemblies passing a hydrostatic test do not require any type of recording or stamping.

1910.157(f)(9) The employer shall assure that hose assemblies for carbon dioxide extinguishers that require a hydrostatic test are tested within a protective cage device.

1910.157(f)(10) The employer shall assure that carbon dioxide extinguishers and nitrogen or carbon dioxide cylinders used with wheeled extinguishers are tested every 5 years at 5/3 of the service pressure as stamped into the cylinder. Nitrogen cylinders which comply with 49 CFR 173.34(e)(15) may be hydrostatically tested every 10 years.

1910.157(f)(11) The employer shall assure that all stored pressure and Halon 1211 types of extinguishers are hydrostatically tested at the factory test pressure not to exceed two times the service pressure.

1910.157(f)(12) The employer shall assure that acceptable self-generating type soda acid and foam extinguishers are tested at 350 psi (2,410 kPa).

1910.157(f)(13) Air or gas pressure may not be used for hydrostatic testing.

1910.157(f)(14) Extinguisher shells, cylinders, or cartridges which fail a hydrostatic pressure test, or which are not fit for testing shall be removed from service and from the workplace.

1910.157(f)(15)(i) The equipment for testing compressed gas type cylinders shall be of the water jacket type. The equipment shall be provided with an expansion indicator which operates with an accuracy within one percent of the total expansion or .1cc (.1mL) of liquid.

1910.157(f)(15)(ii) The equipment for testing non-compressed gas type cylinders shall consist of the following:

1910.157(f)(15)(ii)(A) A hydrostatic test pump, hand or power operated, capable of producing not less than 150 percent of the test pressure, which shall include appropriate check valves and fittings;

1910.157(f)(15)(ii)(B) A flexible connection for attachment to fittings to test through the extinguisher nozzle, test bonnet, or hose outlet, as is applicable; and

1910.157(f)(15)(ii)(C) A protective cage or barrier for personal protection of the tester, designed to provide visual observation of the extinguisher under test.

1910.157(f)(16) The employer shall maintain and provide upon request to the Assistant Secretary evidence that the required hydrostatic testing of fire extinguishers has been performed at the time intervals shown in Table L-1. Such evidence shall be in the form of a certification record which includes the date of the test, the signature of the person who performed the test and the serial number, or other identifier, of the fire extinguisher that was tested. Such records shall be kept until the extinguisher is hydrostatically retested at the time interval specified in Table L-1 or until the extinguisher is taken out of service, whichever comes first.

1910.157(g) *Training and education.*

1910.157(g)(1) Where the employer has provided portable fire extinguishers for employee use in the workplace, the employer shall also provide an educational program to familiarize employees with the general principles of fire extinguisher use and the hazards involved with incipient stage fire fighting.

1910.157(g)(2) The employer shall provide the education required in paragraph (g)(1) of this section upon initial employment and at least annually thereafter.

1910.157(g)(3) The employer shall provide employees who have been designated to use fire fighting equipment as part of an emergency action plan with training in the use of the appropriate equipment.

1910.157(g)(4) The employer shall provide the training required in paragraph (g)(3) of this section upon initial assignment to the designated group of employees and at least annually thereafter.

1910.158 *Standpipe and Hose Systems.*

1910.158(a) *Scope and application.*

1910.158(a)(1) Scope. This section applies to all small hose, Class II, and Class III standpipe systems installed to meet the requirements of a particular OSHA standard.

1910.158(a)(2) Exception. This section does not apply to Class I standpipe systems.

1910.158(b) Protection of standpipes. The employer shall assure that standpipes are located or otherwise protected against mechanical damage. Damaged standpipes shall be repaired promptly.

1910.158(c) *Equipment.*

1910.158(c)(1) Reels and cabinets. Where reels or cabinets are provided to contain fire hose, the employer shall assure that they are designed to facilitate prompt use of the hose valves, the hose, and other equipment at the time of a fire or other emergency. The employer shall assure that the reels and cabinets are conspicuously identified and used only for fire equipment.

1910.158(c)(2) *Hose outlets and connections.*

1910.158(c)(2)(i) The employer shall assure that hose outlets and connections are located high enough above the floor to avoid being obstructed and to be accessible to employees.

1910.158(c)(2)(ii) The employer shall standardize screw threads or provide appropriate adapters throughout the system and assure that the hose connections are compatible with those used on the supporting fire equipment.

1910.158(c)(3) *Hose.*

1910.158(c)(3)(i) The employer shall assure that every 1 1/2 inch (3.8 cm) or smaller hose outlet used to meet this standard is equipped with hose connected and ready for use. In extremely cold climates where such installation may result in damaged equipment, the hose may be stored in another location provided it is readily available and can be connected when needed.

1910.158(c)(3)(ii) Standpipe systems installed after January 1, 1981, for use by employees, shall be equipped with lined hose. Unlined hose may remain in use on existing systems. However, after the effective date of this standard, unlined hose which becomes unserviceable shall be replaced with lined hose.

1910.158(c)(3)(iii) The employer shall provide hose of such length that friction loss resulting from water flowing through the hose will not decrease the pressure at the nozzle below 30 psi (210 kPa). The dynamic pressure at the nozzle shall be within the range of 30 psi (210 kPa) to 125 psi (860 kPa).

1910.158(c)(4) Nozzles. The employer shall assure that standpipe hose is equipped with shut-off type nozzles.

1910.158(d) Water supply. The minimum water supply for standpipe and hose systems, which are provided for the use of employees, shall be sufficient to provide 100 gallons per minute (6.3 l/s) for a period of at least thirty minutes.

1910.158(e) *Tests and maintenance.*

1910.158(e)(1) *Acceptance tests.*

1910.158(e)(1)(i) The employer shall assure that the piping of Class II and Class III systems installed after January 1, 1981, including yard piping, is hydrostatically tested for a period of at least 2 hours at not less than 200 psi (1380 kPa), or at least 50 psi (340 kPa) in excess of normal pressure when such pressure is greater than 150 psi (1030 kPa).

1910.158(e)(1)(ii) The employer shall assure that hose on all standpipe systems installed after January 1, 1981, is hydrostatically tested with couplings in place, at a pressure of not less than 200 psi (1380 kPa), before it is placed in service. This pressure shall be maintained for at least 15 seconds and not more than one minute during which time the hose shall not leak nor shall any jacket thread break during the test.

1910.158(e)(2) *Maintenance.*

1910.158(e)(2)(i) The employer shall assure that water supply tanks are kept filled to the proper level except during repairs. When pressure tanks are used, the employer shall assure that proper pressure is maintained at all times except during repairs.

1910.158(e)(2)(ii) The employer shall assure that valves in the main piping connections to the automatic sources of water supply are kept fully open at all times except during repair.

1910.158(e)(2)(iii) The employer shall assure that hose systems are inspected at least annually and after each use to assure that all of the equipment and hose are in place, available for use, and in serviceable condition.

1910.158(e)(2)(iv) When the system or any portion thereof is found not to be serviceable, the employer shall remove it from service immediately and replace it with equivalent protection such as extinguishers and fire watches.

1910.158(e)(2)(v) The employer shall assure that hemp or linen hose on existing systems is unracked, physically inspected for deterioration, and reracked using a different fold pattern at least annually. The employer shall assure that defective hose is replaced in accordance with paragraph (c)(3)(ii).

1910.158(e)(2)(vi) The employer shall designate trained persons to conduct all inspections required under this section.

1910.159 *Automatic Sprinkler Systems.*

1910.159(a) *Scope and application.*

1910.159(a)(1) The requirements of this section apply to all automatic sprinkler systems installed to meet a particular OSHA standard.

1910.159(a)(2) For automatic sprinkler systems used to meet OSHA requirements and installed prior to the effective date of this standard, compliance with the National Fire Protection Association (NFPA) or the National Board of Fire Underwriters (NBFU) standard in effect at the time of the system's installation will be acceptable as compliance with this section.

1910.159(b) Exemptions. Automatic sprinkler systems installed in workplaces, but not required by OSHA, are exempt from the requirements of this section.

1910.159(c) *General requirements.*

1910.159(c)(1) *Design.*

1910.159(c)(1)(i) All automatic sprinkler designs used to comply with this standard shall provide the necessary discharge patterns, densities, and water flow characteristics for complete coverage in a particular workplace or zoned subdivision of the workplace.

1910.159(c)(1)(ii) The employer shall assure that only approved equipment and devices are used in the design and installation of automatic sprinkler systems used to comply with this standard.

1910.159(c)(2) *Maintenance.* The employer shall properly maintain an automatic sprinkler system installed to comply with this section. The employer shall assure that a main drain flow test is performed on each system annually. The inspector's test valve shall be opened at least every two years to assure that the sprinkler system operates properly.

1910.159(c)(3) *Acceptance tests.* The employer shall conduct proper acceptance tests on sprinkler systems installed for employee protection after January 1, 1981, and record the dates of such tests. Proper acceptance tests include the following:

1910.159(c)(3)(i) Flushing of underground connections;

1910.159(c)(3)(ii) Hydrostatic tests of piping in system;

1910.159(c)(3)(iii) Air tests in dry-pipe systems;

1910.159(c)(3)(iv) Dry-pipe valve operation; and

1910.159(c)(3)(v) Test of drainage facilities.

1910.159(c)(4) *Water supplies.* The employer shall assure that every automatic sprinkler system is provided with at least one automatic water supply capable of providing design water flow for at least 30 minutes. An auxiliary water supply or equivalent protection shall be provided when the automatic water supply is out of service, except for systems of 20 or fewer sprinklers.

1910.159(c)(5) *Hose connections for fire fighting use.* The employer may attach hose connections for fire fighting use to wet pipe sprinkler systems provided that the water supply satisfies the combined design demand for sprinklers and standpipes.

1910.159(c)(6) *Protection of piping.* The employer shall assure that automatic sprinkler system piping is protected against freezing and exterior surface corrosion.

1910.159(c)(7) *Drainage.* The employer shall assure that all dry sprinkler pipes and fittings are installed so that the system may be totally drained.

1910.159(c)(8) *Sprinklers.*

1910.159(c)(8)(i) The employer shall assure that only approved sprinklers are used on systems.

1910.159(c)(8)(ii) The employer may not use older style sprinklers to replace standard sprinklers without a complete engineering review of the altered part of the system.

1910.159(c)(8)(iii) The employer shall assure that sprinklers are protected from mechanical damage.

1910.159(c)(9) *Sprinkler alarms.* On all sprinkler systems having more than twenty (20) sprinklers, the employer shall assure that a local waterflow alarm is provided which sounds an audible signal on the premises upon water flow through the system equal to the flow from a single sprinkler.

1910.159(c)(10) *Sprinkler spacing.* The employer shall assure that sprinklers are spaced to provide a maximum protection area per sprinkler, a minimum of interference to the discharge pattern by building or structural members or building contents and suitable sensitivity to possible fire hazards. The minimum vertical clearance between sprinklers and material below shall be 18 inches (45.7 cm).

1910.159(c)(11) *Hydraulically designed systems.* The employer shall assure that hydraulically designed automatic sprinkler systems or portions thereof are identified and that the location, number of sprinklers in the hydraulically designed section, and the basis of the design is indicated. Central records may be used in lieu of signs at sprinkler valves provided the records are available for inspection and copying by the Assistant Secretary.

1910.160 *Fixed Extinguishing Systems, General.*

1910.160(a) *Scope and application.*

1910.160(a)(1) This section applies to all fixed extinguishing systems installed to meet a particular OSHA standard except for automatic sprinkler systems which are covered by 1910.159.

1910.160(a)(2) This section also applies to fixed systems not installed to meet a particular OSHA standard, but which, by means of their operation, may expose employees to possible injury, death, or adverse health consequences caused by the extinguishing agent. Such systems are only subject to the requirements of paragraphs (b)(4) through (b)(7) and (c) of this section.

1910.160(a)(3) Systems otherwise covered in paragraph (a)(2) of this section which are installed in areas with no employee exposure are exempted from the requirements of this section.

1910.160(b) *General requirements.*

1910.160(b)(1) Fixed extinguishing system components and agents shall be designed and approved for use on the specific fire hazards they are expected to control or extinguish.

1910.160(b)(2) If for any reason a fixed extinguishing system becomes inoperable, the employer shall notify employees and take the necessary temporary precautions to assure their safety until the system is restored to operating order. Any defects or impairments shall be properly corrected by trained personnel.

1910.160(b)(3) The employer shall provide a distinctive alarm or signaling system which complies with 1910.165 and is capable of being perceived above ambient noise or light levels, on all extinguishing systems in those portions of the workplace covered by the extinguishing system to indicate when the extinguishing system is discharging. Discharge alarms are not required on systems where discharge is immediately recognizable.

1910.160(b)(4) The employer shall provide effective safeguards to warn employees against entry into discharge areas where the atmosphere remains hazardous to employee safety or health.

1910.160(b)(5) The employer shall post hazard warning or caution signs at the entrance to, and inside of, areas protected by fixed extinguishing systems which use agents in concentrations known to be hazardous to employee safety and health.

1910.160(b)(6) The employer shall assure that fixed systems are inspected annually by a person knowledgeable in the design and function of the system to assure that the system is maintained in good operating condition.

1910.160(b)(7) The employer shall assure that the weight and pressure of refillable containers is checked at least semi-annually. If the container shows a loss in net content or weight of more than 5 percent, or a loss in pressure of more than 10 percent, it shall be subjected to maintenance.

1910.160(b)(8) The employer shall assure that factory charged nonrefillable containers which have no means of pressure indication are weighed at least semi-annually. If a container shows a loss in net weight or more than 5 percent it shall be replaced.

1910.160(b)(9) The employer shall assure that inspection and maintenance dates are recorded on the container, on a tag attached to the container, or in a central location. A record of the last semi-annual check shall be maintained until the container is checked again or for the life of the container, whichever is less.

1910.160(b)(10) The employer shall train employees designated to inspect, maintain, operate, or repair fixed extinguishing systems and annually review their training to keep them up-to-date in the functions they are to perform.

1910.160(b)(11) The employer shall not use chlorobromomethane or carbon tetrachloride as an extinguishing agent where employees may be exposed.

1910.160(b)(12) The employer shall assure that systems installed in the presence of corrosive atmospheres are constructed of non-corrosive material or otherwise protected against corrosion.

1910.160(b)(13) Automatic detection equipment shall be approved, installed and maintained in accordance with 1910.164.

1910.160(b)(14) The employer shall assure that all systems designed for and installed in areas with climatic extremes shall operate effectively at the expected extreme temperatures.

1910.160(b)(15) The employer shall assure that at least one manual station is provided for discharge activation of each fixed extinguishing system.

1910.160(b)(16) The employer shall assure that manual operating devices are identified as to the hazard against which they will provide protection.

1910.160(b)(17) The employer shall provide and assure the use of the personal protective equipment needed for immediate rescue of employees trapped in hazardous atmospheres created by an agent discharge.

1910.160(c) Total flooding systems with potential health and safety hazards to employees.

1910.160(c)(1) The employer shall provide an emergency action plan in accordance with 1910.38 for each area within a workplace that is protected by a total flooding system which provides agent concentrations exceeding the maximum safe levels set forth in paragraphs (b)(5) and (b)(6) of 1910.162.

1910.160(c)(2) Systems installed in areas where employees cannot enter during or after the system's operation are exempt from the requirements of paragraph (c) of this section.

1910.160(c)(3) On all total flooding systems the employer shall provide a pre-discharge employee alarm which complies with 1910.165, and is capable of being perceived above ambient light or noise levels before the system discharges, which will give employees time to safely exit from the discharge area prior to system discharge.

1910.160(c)(4) The employer shall provide automatic actuation of total flooding systems by means of an approved fire detection device installed and interconnected with a pre-discharge employee alarm system to give employees time to safely exit from the discharge area prior to system discharge.

1910.161 *Fixed Extinguishing Systems, Dry Chemical.*

1910.161(a) Scope and application. This section applies to all fixed extinguishing systems, using dry chemical as the extinguishing agent, installed to meet a particular OSHA standard. These systems shall also comply with 1910.160.

1910.161(b) Specific requirements.

1910.161(b)(1) The employer shall assure that dry chemical agents are compatible with any foams or wetting agents with which they are used.

1910.161(b)(2) The employer may not mix together dry chemical extinguishing agents of different compositions. The employer shall assure that dry chemical systems are refilled with the chemical stated on the approval nameplate or an equivalent compatible material.

1910.161(b)(3) When dry chemical discharge may obscure vision, the employer shall provide a pre-discharge employee alarm which complies with 1910.165 and which will give employees time to safely exit from the discharge area prior to system discharge.

1910.161(b)(4) The employer shall sample the dry chemical supply of all but stored pressure systems at least annually to assure that the dry chemical supply is free of moisture which may cause the supply to cake or form lumps.

1910.161(b)(5) The employer shall assure that the rate of application of dry chemicals is such that the designed concentration of the system will be reached within 30 seconds of initial discharge.

1910.162 *Fixed Extinguishing Systems, Gaseous Agent.*

1910.162(a) *Scope and application.*

1910.162(a)(1) Scope. This section applies to all fixed extinguishing systems, using a gas as the extinguishing agent, installed to meet a particular OSHA standard. These systems shall also comply with 1910.160. In some cases, the gas may be in a liquid state during storage.

1910.162(a)(2) Application. The requirements of paragraphs (b)(2) and (b)(4) through (b)(6) shall apply only to total flooding systems.

1910.162(b) *Specific requirements.*

1910.162(b)(1) Agents used for initial supply and replenishment shall be of the type approved for the system's application. Carbon dioxide obtained by dry ice conversion to liquid is not acceptable unless it is processed to remove excess water and oil.

1910.162(b)(2) Except during overhaul, the employer shall assure that the designed concentration of gaseous agents is maintained until the fire has been extinguished or is under control.

1910.162(b)(3) The employer shall assure that employees are not exposed to toxic levels of gaseous agent or its decomposition products.

1910.162(b)(4) The employer shall assure that the designed extinguishing concentration is reached within 30 seconds of initial discharge except for Halon systems which must achieve design concentration within 10 seconds.

1910.162(b)(5) The employer shall provide a distinctive pre-discharge employee alarm capable of being perceived above ambient light or noise levels when agent design concentrations exceed the maximum safe level for employee exposure. A pre-discharge employee alarm for alerting employees before system discharge shall be provided on Halon 1211 and carbon dioxide systems with a design concentration of 4 percent or greater and for Halon 1301 systems with a design concentration of 10 percent or greater. The pre-discharge employee alarm shall provide employees time to safely exit the discharge area prior to system discharge.

1910.162(b)(6)(i) Where egress from an area cannot be accomplished within one minute, the employer shall not use Halon 1301 in concentrations greater than 7 percent.

1910.162(b)(6)(ii) Where egress takes greater than 30 seconds but less than one minute, the employer shall not use Halon 1301 in a concentration greater than 10 percent.

1910.162(b)(6)(iii) Halon 1301 concentrations greater than 10 percent are only permitted in areas not normally occupied by employees provided that any employee in the area can escape within 30 seconds. The employer shall assure that no unprotected employees enter the area during agent discharge.

1910.163 *Fixed Extinguishing Systems, Water Spray and Foam.*

1910.163(a) Scope and application. This section applies to all fixed extinguishing systems, using water or foam solution as the extinguishing agent, installed to meet a particular OSHA standard. These systems shall also comply with 1910.160. This section does not apply to automatic sprinkler systems which are covered under 1910.159.

1910.163(b) *Specific requirements.*

1910.163(b)(1) The employer shall assure that foam and water spray systems are designed to be effective in at least controlling fire in the protected area or on protected equipment.

1910.163(b)(2) The employer shall assure that drainage of water spray systems is directed away from areas where employees are working and that no emergency egress is permitted through the drainage path.

1910.164 *Fire Detection Systems.*

1910.164(a) Scope and application. This section applies to all automatic fire detection systems installed to meet the requirements of a particular OSHA standard.

1910.164(b) *Installation and restoration.*

1910.164(b)(1) The employer shall assure that all devices and equipment constructed and installed to comply with this standard are approved for the purpose for which they are intended.

1910.164(b)(2) The employer shall restore all fire detection systems and components to normal operating condition as promptly as possible after each test or alarm. Spare detection devices and components which are normally destroyed in the process of detecting fires shall be available on the premises or from a local supplier in sufficient quantities and locations for prompt restoration of the system.

1910.164(c)(1) The employer shall maintain all systems in an operable condition except during repairs or maintenance.

1910.164(c)(2) The employer shall assure that fire detectors and fire detection systems are tested and adjusted as often as needed to maintain proper reliability and operating condition except that factory calibrated detectors need not be adjusted after installation.

1910.164(c)(4) The employer shall assure that the servicing, maintenance and testing of fire detection systems, including cleaning and necessary sensitivity adjustments are performed by a trained person knowledgeable in the operations and functions of the system.

1910.164(c)(5) The employer shall also assure that fire detectors that need to be cleaned of dirt, dust, or other particulates in order to be fully operational are cleaned at regular periodic intervals.

1910.164(d)(3) The employer shall assure that detectors are supported independently of their attachment to wires or tubing.

1910.164(f) Number, location and spacing of detecting devices. The employer shall assure that the number, spacing and location of fire detectors is based upon design data obtained from field experience, or tests, engineering surveys, the manufacturer's recommendations, or a recognized testing laboratory listing.

Means of Egress

1910.36(a)(1) *An exit route must be permanent.* Each exit route must be a permanent part of the workplace.

1910.36(a)(2) *An exit must be separated by fire resistant materials.* Construction materials used to separate an exit from other parts of the workplace must have a one-hour fire resistance-rating if the exit connects three or fewer stories and a two-hour fire resistance-rating if the exit connects four or more stories.

1910.36(a)(3) *Openings into an exit must be limited.* An exit is permitted to have only those openings necessary to allow access to the exit from occupied areas of the workplace, or to the exit discharge. An opening into an exit must be protected by a self-closing fire door that remains closed or automatically closes in an emergency upon the sounding of a fire alarm or employee alarm system. Each fire door, including its frame and hardware, must be listed or approved by a nationally recognized testing laboratory.

1910.36(b) *The number of exit routes must be adequate.*

1910.36(b)(1) *Two exit routes.* At least two exit routes must be available in a workplace to permit prompt evacuation of employees and other building occupants during an emergency, except as allowed in paragraph (b)(3) of this section. The exit routes must be located as far away as practical from each other so that if one exit route is blocked by fire or smoke, employees can evacuate using the second exit route.

1910.36(b)(2) *More than two exit routes.* More than two exit routes must be available in a workplace if the number of employees, the size of the building, its occupancy, or the arrangement of the workplace is such that all employees would not be able to evacuate safely during an emergency.

1910.36(b)(3) *A single exit route.* A single exit route is permitted where the number of employees, the size of the building, its occupancy, or the arrangement of the workplace is such that all employees would be able to evacuate safely during an emergency.

Exit discharge

1910.36(c)(1) Each exit discharge must lead directly outside or to a street, walkway, refuge area, public way, or open space with access to the outside.

1910.36(c)(2) The street, walkway, refuge area, public way, or open space to which an exit discharge leads must be large enough to accommodate the building occupants likely to use the exit route.

1910.36(c)(3) Exit stairs that continue beyond the level on which the exit discharge is located must be interrupted at that level by doors, partitions, or other effective means that clearly indicate the direction of travel leading to the exit discharge.

1910.36(d)(1) Employees must be able to open an exit route door from the inside at all times without keys, tools, or special knowledge. A device such as a panic bar that locks only from the outside is permitted on exit discharge doors.

1910.36(d)(2) Exit route doors must be free of any device or alarm that could restrict emergency use of the exit route if the device or alarm fails.

1910.36(e)(1) A side-hinged door must be used to connect any room to an exit route.

1910.36(e)(2) The door that connects any room to an exit route must swing out in the direction of exit travel if the room is designed to be occupied by more than 50 people or if the room is a high hazard area (*i.e.*, contains contents that are likely to burn with extreme rapidity or explode).

1910.36(f)(1) Exit routes must support the maximum permitted occupant load for each floor served.

1910.36(f)(2) The capacity of an exit route may not decrease in the direction of exit route travel to the exit discharge.

1910.36(g)(1) The ceiling of an exit route must be at least seven feet six inches (2.3 m) high. Any projection from the ceiling must not reach a point less than six feet eight inches (2.0 m) from the floor.

1910.36(g)(2) An exit access must be at least 28 inches (71.1 cm) wide at all points. Where there is only one exit access leading to an exit or exit discharge, the width of the exit and exit discharge must be at least equal to the width of the exit access.

1910.36(g)(3) The width of an exit route must be sufficient to accommodate the maximum permitted occupant load of each floor served by the exit route.

1910.36(g)(4) Objects that project into the exit route must not reduce the width of the exit route to less than the minimum width requirements for exit routes.

1910.36(h)(1) The outdoor exit route must have guardrails to protect unenclosed sides if a fall hazard exists.

1910.36(h)(2) The outdoor exit route must be covered if snow or ice is likely to accumulate along the route, unless the employer can demonstrate that any snow or ice accumulation will be removed before it presents a slipping hazard;

1910.36(h)(3) The outdoor exit route must be reasonably straight and have smooth, solid, substantially level walkways; and

1910.36(h)(4) The outdoor exit route must not have a dead-end that is longer than 20 feet (6.2 m).

1910.37 *Means of Egress, General.*

1910.37(a) *The danger to employees must be minimized.*

1910.37(a)(1) Exit routes must be kept free of explosive or highly flammable furnishings or other decorations.

1910.37(a)(2) Exit routes must be arranged so that employees will not have to travel toward a high hazard area, unless the path of travel is effectively shielded from the high hazard area by suitable partitions or other physical barriers.

1910.37(a)(3) Exit routes must be free and unobstructed. No materials or equipment may be placed, either permanently or temporarily, within the exit route. The exit access must not go through a room that can be locked, such as a bathroom, to reach an exit or exit discharge, nor may it lead into a dead-end corridor. Stairs or a ramp must be provided where the exit route is not substantially level.

1910.37(a)(4) Safeguards designed to protect employees during an emergency (e.g., sprinkler systems, alarm systems, fire doors, exit lighting) must be in proper working order at all times.

1910.37(b) *Lighting and marking must be adequate and appropriate.*

1910.37(b)(1) Each exit route must be adequately lighted so that an employee with normal vision can see along the exit route.

1910.37(b)(2) Each exit must be clearly visible and marked by a sign reading "Exit."

1910.37(b)(3) Each exit route door must be free of decorations or signs that obscure the visibility of the exit route door.

1910.37(b)(4) If the direction of travel to the exit or exit discharge is not immediately apparent, signs must be posted along the exit access indicating the direction of travel to the nearest exit and exit discharge. Additionally, the line-of-sight to an exit sign must clearly be visible at all times.

1910.37(b)(5) Each doorway or passage along an exit access that could be mistaken for an exit must be marked "Not an Exit" or similar designation, or be identified by a sign indicating its actual use (e.g., closet).

1910.37(b)(6) Each exit sign must be illuminated to a surface value of at least five foot-candles (54 lux) by a reliable light source and be distinctive in color. Self-luminous or electroluminescent signs that have a minimum luminance surface value of at least .06 footlamberts (0.21 cd/m2) are permitted.

1910.37(b)(7) Each exit sign must have the word "Exit" in plainly legible letters not less than six inches (15.2 cm) high, with the principal strokes of the letters in the word "Exit" not less than three-fourths of an inch (1.9 cm) wide.

1910.37(c) *The fire retardant properties of paints or solutions must be maintained.*
Fire retardant paints or solutions must be renewed as often as necessary to maintain their fire retardant properties.

1910.37(d) *Exit routes must be maintained during construction, repairs, or alterations.*

1910.37(d)(1) During new construction, employees must not occupy a workplace until the exit routes required by this subpart are completed and ready for employee use for the portion of the workplace they occupy.

1910.37(d)(2) During repairs or alterations, employees must not occupy a workplace unless the exit routes required by this subpart are available and existing fire protections are maintained, or until alternate fire protection is furnished that provides an equivalent level of safety.

1910.37(d)(3) Employees must not be exposed to hazards of flammable or explosive substances or equipment used during construction, repairs, or alterations, that are beyond the normal permissible conditions in the workplace, or that would impede exiting the workplace.

1910.37(e) *An employee alarm system must be operable.*
Employers must install and maintain an operable employee alarm system that has a distinctive signal to warn employees of fire or other emergencies, unless employees can promptly see or smell a fire or other hazard in time to provide adequate warning to them. The employee alarm system must comply with § 1910.165.

All Areas — Electrical

General

1910.303(b)(2) *Installation and use.* Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.

1910.303(b)(3) *Insulation integrity.* Completed wiring installations shall be free from short circuits and from grounds other than those required or permitted by this subpart.

1910.303(b)(4) *Interrupting rating.* Equipment intended to interrupt current at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

1910.303(b)(5) *Circuit impedance and other characteristics.* The overcurrent protective devices, the total impedance, the component short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without the occurrence of extensive damage to the electrical components of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors, or between any circuit conductor and the grounding conductor or enclosing metal raceway.

1910.303(b)(6) *Deteriorating agents.* Unless identified for use in the operating environment, no conductors or equipment shall be located in damp or wet locations; where exposed to gases, fumes, vapors, liquids, or other agents that have a deteriorating effect on the conductors or equipment; or where exposed to excessive temperatures.

1910.303(b)(7) *Mechanical execution of work.* Electric equipment shall be installed in a neat and workmanlike manner.

1910.303(b)(7)(i) Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases, or housings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.

1910.303(b)(7)(ii) Conductors shall be racked to provide ready and safe access in underground and subsurface enclosures that persons enter for installation and maintenance.

1910.303(b)(7)(iii) Internal parts of electrical equipment, including busbars, wiring terminals, insulators, and other surfaces, may not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives, or corrosive residues.

1910.303(b)(7)(iv) There shall be no damaged parts that may adversely affect safe operation or mechanical strength of the equipment, such as parts that are broken, bent, cut, or deteriorated by corrosion, chemical action, or overheating.

1910.303(b)(8)(i) Electric equipment shall be firmly secured to the surface on which it is mounted.

1910.303(b)(8)(ii) Electric equipment that depends on the natural circulation of air and convection principles for cooling of exposed surfaces shall be installed so that room airflow over such surfaces is not prevented by walls or by adjacent installed equipment. For equipment designed for floor mounting, clearance between top surfaces and adjacent surfaces shall be provided to dissipate rising warm air.

1910.303(b)(8)(iii) Electric equipment provided with ventilating openings shall be installed so that walls or other obstructions do not prevent the free circulation of air through the equipment.

1910.303(c) *Electrical connections.*

1910.303(c)(1) *General.* Because of different characteristics of dissimilar metals:

1910.303(c)(1)(i) Devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and shall be properly installed and used;

1910.303(c)(1)(ii) Conductors of dissimilar metals may not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum) unless the device is identified for the purpose and conditions of use; and

1910.303(c)(1)(iii) Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type that will not adversely affect the conductors, installation, or equipment.

1910.303(c)(2) *Terminals.*

1910.303(c)(2)(i) Connection of conductors to terminal parts shall ensure a good connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. However, No. 10 or smaller conductors may be connected by means of wire binding screws or studs and nuts having upturned lugs or equivalent.

1910.303(c)(2)(ii) Terminals for more than one conductor and terminals used to connect aluminum shall be so identified.

1910.303(c)(3) *Splices.*

1910.303(c)(3)(i) Conductors shall be spliced or joined with splicing devices identified for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be spliced or joined to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device identified for the purpose.

1910.303(c)(3)(ii) Wire connectors or splicing means installed on conductors for direct burial shall be listed for such use.

1910.303(d) *Arcing parts.* Parts of electric equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

1910.303(e) *Marking.*

1910.303(e)(1) *Identification of manufacturer and ratings.* Electric equipment may not be used unless the following markings have been placed on the equipment:

1910.303(e)(1)(i) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified; and

1910.303(e)(1)(ii) Other markings giving voltage, current, wattage, or other ratings as necessary.

1910.303(e)(2) *Durability.* The marking shall be of sufficient durability to withstand the environment involved.

1910.303(f) *Disconnecting means and circuits.*

1910.303(f)(1) *Motors and appliances.* Each disconnecting means required by this subpart for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

1910.303(f)(2) *Services, feeders, and branch circuits.* Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

1910.303(f)(3) *Durability of markings.* The markings required by paragraphs (f)(1) and (f)(2) of this section shall be of sufficient durability to withstand the environment involved.

1910.303(f)(4) *Capable of accepting a lock.* Disconnecting means required by this subpart shall be capable of being locked in the open position.

1910.303(f)(5) *Marking for series combination ratings.*

1910.303(f)(5)(i) Where circuit breakers or fuses are applied in compliance with the series combination ratings marked on the equipment by the manufacturer, the equipment enclosures shall be legibly marked in the field to indicate that the equipment has been applied with a series combination rating.

1910.303(f)(5)(ii) The marking required by paragraph (f)(5)(i) of this section shall be readily visible and shall state "Caution -- Series Combination System Rated_____Amperes. Identified Replacement Component Required."

1910.1000 *Air contaminants.*

Living Spaces — General

Sanitation

1910.141(a) *General.*

1910.141(a)(1) *Scope.* This section applies to permanent places of employment.

1910.141(a)(2) *Definitions applicable to this section.*

Non-water carriage toilet facility means a toilet facility not connected to a sewer.

Number of employees means unless otherwise specified, the maximum number of employees present at any one time on a regular shift.

Personal service room means a room used for activities not directly connected with the production or service function performed by the establishment. Such activities include, but are not limited to, first-aid, medical services, dressing, showering, toilet use, washing, and eating.

Potable water means water that meets the standards for drinking purposes of the State or local AHJ, or water that meets the quality standards prescribed by the U.S. Environmental Protection Agency's National Primary Drinking Water Regulations (40 CFR 141).

Toilet facility means a fixture maintained within a toilet room for the purpose of defecation or urination, or both.

Toilet room means a room maintained within or on the premises of any place of employment, containing toilet facilities for use by employees.

Toxic material means a material in concentration or amount which exceeds the applicable limit established by a standard, such as 1910.1000 and 1910.1001 or, in the absence of an applicable standard, which is of such toxicity so as to constitute a recognized hazard that is causing or is likely to cause death or serious physical harm.

Urinal means a toilet facility maintained within a toilet room for the sole purpose of urination.

Water closet means a toilet facility maintained within a toilet room for the purpose of both defecation and urination and which is flushed with water.

Wet process means any process or operation in a workroom which normally results in surfaces upon which employees may walk or stand becoming wet.

1910.141(a)(3) *Housekeeping.*

1910.141(a)(3)(i) All places of employment shall be kept clean to the extent that the nature of the work allows.

1910.141(a)(3)(ii) The floor of every workroom shall be maintained, so far as practicable, in a dry condition. Where wet processes are used, drainage shall be maintained and false floors, platforms, mats, or other dry standing places shall be provided, where practicable, or appropriate waterproof footgear shall be provided.

1910.141(a)(3)(iii) To facilitate cleaning, every floor, working place, and passageway shall be kept free from protruding nails, splinters, loose boards, and unnecessary holes and openings.

1910.141(a)(4) *Waste disposal.*

1910.141(a)(4)(i) Any receptacle used for putrescible solid or liquid waste or refuse shall be so constructed that it does not leak and may be thoroughly cleaned and maintained in a sanitary condition. Such a receptacle shall be equipped with a solid tight-fitting cover, unless it can be maintained in a sanitary condition without a cover. This requirement does not prohibit the use of receptacles which are designed to permit the maintenance of a sanitary condition without regard to the aforementioned requirements.

1910.141(a)(4)(ii) All sweepings, solid or liquid wastes, refuse, and garbage shall be removed in such a manner as to avoid creating a menace to health and as often as necessary or appropriate to maintain the place of employment in a sanitary condition.

1910.141(a)(5) *Vermin control.* Every enclosed workplace shall be so constructed, equipped, and maintained, so far as reasonably practicable, as to prevent the entrance or harborage of rodents, insects, and other vermin. A continuing and effective extermination program shall be instituted where their presence is detected.

1910.141(b) *Water supply.*

1910.141(b)(1) *Potable water.*

1910.141(b)(1)(i) Potable water shall be provided in all places of employment, for drinking, washing of the person, cooking, washing of foods, washing of cooking or eating utensils, washing of food preparation or processing premises, and personal service rooms.

1910.141(b)(1)(iii) Portable drinking water dispensers shall be designed, constructed, and serviced so that sanitary conditions are maintained, shall be capable of being closed, and shall be equipped with a tap.

1910.141(b)(1)(vi) A common drinking cup and other common utensils are prohibited.

1910.141(b)(2) *Non-potable water.*

1910.141(b)(2)(i) Outlets for non-potable water, such as water for industrial or firefighting purposes, shall be posted or otherwise marked in a manner that will indicate clearly that the water is unsafe and is not to be used for drinking, washing of the person, cooking, washing of food, washing of cooking or eating utensils, washing of food preparation or processing premises, or personal service rooms, or for washing clothes.

1910.141(b)(2)(ii) Construction of non-potable water systems or systems carrying any other non-potable substance shall be such as to prevent backflow or back siphonage into a potable water system.

1910.141(b)(2)(iii) Non-potable water shall not be used for washing any portion of the person, cooking or eating utensils, or clothing. Non-potable water may be used for cleaning work premises, other than food processing and preparation premises and personal service rooms: Provided, that this non-potable water does not contain concentrations of chemicals, fecal coliform, or other substances which could create unsanitary conditions or be harmful to employees.

1910.141(c) *Toilet facilities.*

1910.141(c)(1) *General.*

1910.141(c)(1)(i) Except as otherwise indicated in this paragraph (c)(1)(i), toilet facilities, in toilet rooms separate for each sex, shall be provided in all places of employment in accordance with table J-1 of this section. The number of facilities to be provided for each sex shall be based on the number of employees of that sex for whom the facilities are furnished. Where toilet rooms will be occupied by no more than one person at a time, can be locked from the inside, and contain at least one water closet, separate toilet rooms for each sex need not be provided. Where such single-occupancy rooms have more than one toilet facility, only one such facility in each toilet room shall be counted for the purpose of Table J-1.

Table J-1

Number of employees	Minimum number of water closets[1]
1 to 15	1
16 to 35	2
36 to 55	3
56 to 80	4
81 to 110	5
111 to 150	6
Over 150	([2])

[1]Where toilet facilities will not be used by women, urinals may be provided instead of water closets, except that the number of water closets in such cases shall not be reduced to less than 2/3 of the minimum specified.
[2]1 additional fixture for each additional 40 employees.

1910.141(c)(1)(iii) The sewage disposal method shall not endanger the health of employees.

1910.141(c)(2) *Construction of toilet rooms.*

1910.141(c)(2)(i) Each water closet shall occupy a separate compartment with a door and walls or partitions between fixtures sufficiently high to assure privacy.

1910.141(d) *Washing facilities.*

1910.141(d)(1) *General.* Washing facilities shall be maintained in a sanitary condition.

1910.141(d)(2) *Lavatories.*

1910.141(d)(2)(i) Lavatories shall be made available in all places of employment. The requirements of this subdivision do not apply to mobile crews or to normally unattended work locations if employees working at these locations have transportation readily available to nearby washing facilities which meet the other requirements of this paragraph.

1910.141(d)(2)(ii) Each lavatory shall be provided with hot and cold running water, or tepid running water.

1910.141(d)(2)(iii) Hand soap or similar cleansing agents shall be provided.

1910.141(d)(2)(iv) Individual hand towels or sections thereof, of cloth or paper, air blowers or clean individual sections of continuous cloth toweling, convenient to the lavatories, shall be provided.

1910.141(d)(3) *Showers.*

1910.141(d)(3)(i) Whenever showers are required by a particular standard, the showers shall be provided in accordance with paragraphs (d)(3)(ii) through (v) of this section.

1910.141(d)(3)(ii) One shower shall be provided for each 10 employees of each sex, or numerical fraction thereof, who are required to shower during the same shift.

1910.141(d)(3)(iii) Body soap or other appropriate cleansing agents convenient to the showers shall be provided as specified in paragraph (d)(2)(iii) of this section.

1910.141(d)(3)(iv) Showers shall be provided with hot and cold water feeding a common discharge line.

1910.141(d)(3)(v) Employees who use showers shall be provided with individual clean towels.

1910.141(e) *Change rooms.* Whenever employees are required by a particular standard to wear protective clothing because of the possibility of contamination with toxic materials, change rooms equipped with storage facilities for street clothes and separate storage facilities for the protective clothing shall be provided.

1910.141(f) *Clothes drying facilities.* Where working clothes are provided by the employer and become wet or are washed between shifts, provision shall be made to insure that such clothing is dry before reuse.

Illumination

1910.305(a)(2)(ix) All lamps for general illumination shall be protected from accidental contact or breakage by a suitable fixture or lampholder with a guard. Brass shell, paper-lined sockets, or other metal-cased sockets may not be used unless the shell is grounded.

1910.305(j)(1) *Lighting fixtures, lampholders, lamps, and receptacles.*

1910.305(j)(1)(i) Fixtures, lampholders, lamps, rosettes, and receptacles may have no live parts normally exposed to employee contact. However, rosettes and cleat-type lampholders and receptacles located at least 2.44 m (8.0 ft) above the floor may have exposed terminals.

1910.305(j)(1)(ii) Handlamps of the portable type supplied through flexible cords shall be equipped with a handle of molded composition or other material identified for the purpose, and a substantial guard shall be attached to the lampholder or the handle. Metal shell, paper-lined lampholders may not be used.

1910.305(j)(1)(iii) Lampholders of the screw-shell type shall be installed for use as lampholders only. Where supplied by a circuit having a grounded conductor, the grounded conductor shall be connected to the screw shell. Lampholders installed in wet or damp locations shall be of the weatherproof type.

1910.305(j)(1)(iv) Fixtures installed in wet or damp locations shall be identified for the purpose and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders, or other electrical parts.

1926.56(a) *General.* Construction areas, ramps, runways, corridors, offices, shops, and storage areas shall be lighted to not less than the minimum illumination intensities listed in Table D-3 while any work is in progress:

Table D-3 — Minimum illumination intensities in foot-candles

Foot-candles	Area of operation
5	General construction area lighting.
3	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	Indoors: warehouses, corridors, hallways, and exitways.
30	First aid stations, infirmaries, and offices.

Source: https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10630

1926.56(b) *Other areas.* For areas or operations not covered above, refer to the American National Standard A11.1-1965, R1970, Practice for Industrial Lighting, for recommended values of illumination.

Noise

1910.95(a) Protection against the effects of noise exposure shall be provided when the sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response.

1910.95(b)(1) When employees are subjected to sound exceeding those listed in Table A-X, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table G-16, personal protective equipment shall be provided and used to reduce sound levels within the levels of the table.

1910.95(b)(2) If the variations in noise level involve maxima at intervals of 1 second or less, it is to be considered continuous.

Table G-16 — Permissible noise exposures

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Specific Interior Areas

Medical-related areas

1910.151(b) In the absence of an infirmary, clinic, or hospital in near proximity to the workplace which is used for the treatment of all injured employees, a person or persons shall be adequately trained to render first aid. First aid supplies approved by the consulting physician shall be readily available.

1910.1000 *Air contaminants.*

1910.1030 *Bloodborne pathogens.*

1910.1030(a) *Scope and Application.* This section applies to all occupational exposure to blood or other potentially infectious materials as defined by paragraph (b) of this section.

1910.1030(b) *Definitions.* For purposes of this section, the following shall apply:

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, or designated representative.

Blood means human blood, human blood components, and products made from human blood.

Bloodborne Pathogens means pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).

Clinical Laboratory means a workplace where diagnostic or other screening procedures are performed on blood or other potentially infectious materials.

Contaminated means the presence or the reasonably anticipated presence of blood or other potentially infectious materials on an item or surface.

Contaminated Laundry means laundry which has been soiled with blood or other potentially infectious materials or may contain sharps.

Contaminated Sharps means any contaminated object that can penetrate the skin including, but not limited to, needles, scalpels, broken glass, broken capillary tubes, and exposed ends of dental wires.

Decontamination means the use of physical or chemical means to remove, inactivate, or destroy bloodborne pathogens on a surface or item to the point where they are no longer capable of transmitting infectious particles and the surface or item is rendered safe for handling, use, or disposal.

Director means the Director of the National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designated representative.

Engineering Controls means controls (e.g., sharps disposal containers, self-sheathing needles, safer medical devices, such as sharps with engineered sharps injury protections and needleless systems) that isolate or remove the bloodborne pathogens hazard from the workplace.

Exposure Incident means a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.

Handwashing Facilities means a facility providing an adequate supply of running potable water, soap, and single-use towels or air-drying machines.

HBV means hepatitis B virus.

HIV means human immunodeficiency virus.

Licensed Healthcare Professional is a person whose legally permitted scope of practice allows him or her to independently perform the activities required by paragraph (f) Hepatitis B Vaccination and Post-exposure Evaluation and Follow-up.

Needleless systems means a device that does not use needles for:

(1) The collection of bodily fluids or withdrawal of body fluids after initial venous or arterial access is established;

(2) The administration of medication or fluids; or

(3) Any other procedure involving the potential for occupational exposure to bloodborne pathogens due to percutaneous injuries from contaminated sharps.

Occupational Exposure means reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

Other Potentially Infectious Materials means

(1) The following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids;

(2) Any unfixed tissue or organ (other than intact skin) from a human (living or dead); and

(3) HIV-containing cell or tissue cultures, organ cultures, and HIV- or HBV-containing culture medium or other solutions; and blood, organs, or other tissues from experimental animals infected with HIV or HBV.

Parenteral means piercing mucous membranes or the skin barrier through such events as needlesticks, human bites, cuts, and abrasions.

Personal Protective Equipment is specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes (e.g., uniforms, pants, shirts or blouses) not intended to function as protection against a hazard are not considered to be personal protective equipment.

Production Facility means a facility engaged in industrial-scale, large-volume or high concentration production of HIV or HBV.

Regulated Waste means liquid or semi-liquid blood or other potentially infectious materials; contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed; items that are caked with dried blood or other potentially infectious materials and are capable of releasing these materials during handling; contaminated sharps; and pathological and microbiological wastes containing blood or other potentially infectious materials.

Research Laboratory means a laboratory producing or using research-laboratory-scale amounts of HIV or HBV. Research laboratories may produce high concentrations of HIV or HBV but not in the volume found in production facilities.

Sharps with engineered sharps injury protections means a nonneedle sharp or a needle device used for withdrawing body fluids, accessing a vein or artery, or administering medications or other fluids, with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident.

Source Individual means any individual, living or dead, whose blood or other potentially infectious materials may be a source of occupational exposure to the employee. Examples include, but are not limited to, hospital and clinic patients; clients in institutions for the developmentally disabled; trauma victims; clients of drug and alcohol treatment facilities; residents of hospices and nursing homes; human remains; and individuals who donate or sell blood or blood components.

Sterilize means the use of a physical or chemical procedure to destroy all microbial life including highly resistant bacterial endospores.

Universal Precautions is an approach to infection control. According to the concept of Universal Precautions, all human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

Work Practice Controls means controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique).

1910.1030(c) *Exposure Control.*

1910.1030(c)(1) *Exposure Control Plan.*

1910.1030(c)(1)(i) Each employer having an employee(s) with occupational exposure as defined by paragraph (b) of this section shall establish a written Exposure Control Plan designed to eliminate or minimize employee exposure.

1910.1030(c)(1)(ii) The Exposure Control Plan shall contain at least the following elements:

1910.1030(c)(1)(ii)(A) The exposure determination required by paragraph (c)(2),

1910.1030(c)(1)(ii)(B) The schedule and method of implementation for paragraphs (d) Methods of Compliance, (e) HIV and HBV Research Laboratories and Production Facilities, (f) Hepatitis B Vaccination and Post-Exposure Evaluation and Follow-up, (g) Communication of Hazards to Employees, and (h) Recordkeeping, of this standard, and

1910.1030(c)(1)(ii)(C) The procedure for the evaluation of circumstances surrounding exposure incidents as required by paragraph (f)(3)(i) of this standard.

1910.1030(c)(1)(iii) Each employer shall ensure that a copy of the Exposure Control Plan is accessible to employees in accordance with 29 CFR 1910.20(e).

1910.1030(c)(1)(iv) The Exposure Control Plan shall be reviewed and updated at least annually and whenever necessary to reflect new or modified tasks and procedures which affect occupational exposure and to reflect new or revised employee positions with occupational exposure. The review and update of such plans shall also:

1910.1030(c)(1)(iv)(A) Reflect changes in technology that eliminate or reduce exposure to bloodborne pathogens; and

1910.1030(c)(1)(iv)(B) Document annually consideration and implementation of appropriate commercially available and effective safer medical devices designed to eliminate or minimize occupational exposure.

1910.1030(c)(1)(v) An employer, who is required to establish an Exposure Control Plan shall solicit input from non-managerial employees responsible for direct patient care who are potentially exposed to injuries from contaminated sharps in the identification, evaluation, and selection of effective engineering and work practice controls and shall document the solicitation in the Exposure Control Plan.

1910.1030(c)(1)(vi) The Exposure Control Plan shall be made available to the Assistant Secretary and the Director upon request for examination and copying.

1910.1030(d)(1) *General.* Universal precautions shall be observed to prevent contact with blood or other potentially infectious materials. Under circumstances in which differentiation between body fluid types is difficult or impossible, all body fluids shall be considered potentially infectious materials.

1910.1030(d)(2) *Engineering and Work Practice Controls.*

1910.1030(d)(2)(i) Engineering and work practice controls shall be used to eliminate or minimize employee exposure. Where occupational exposure remains after institution of these controls, personal protective equipment shall also be used.

1910.1030(d)(2)(ii) Engineering controls shall be examined and maintained or replaced on a regular schedule to ensure their effectiveness.

1910.1030(d)(2)(iii) Employers shall provide handwashing facilities which are readily accessible to employees.

1910.1030(d)(2)(iv) When provision of handwashing facilities is not feasible, the employer shall provide either an appropriate antiseptic hand cleanser in conjunction with clean cloth/ paper towels or antiseptic towelettes. When antiseptic hand cleansers or towelettes are used, hands shall be washed with soap and running water as soon as feasible.

1910.1030(d)(2)(viii) Immediately or as soon as possible after use, contaminated reusable sharps shall be placed in appropriate containers until properly reprocessed. These containers shall be:

1910.1030(d)(2)(viii)(A) Puncture resistant;

1910.1030(d)(2)(viii)(B) Labeled or color-coded in accordance with this standard;

1910.1030(d)(2)(viii)(C) Leakproof on the sides and bottom; and

1910.1030(d)(2)(viii)(D) In accordance with the requirements set forth in paragraph (d)(4)(ii)(E) for reusable sharps.

1910.1030(d)(2)(xiii) Specimens of blood or other potentially infectious materials shall be placed in a container which prevents leakage during collection, handling, processing, storage, transport, or shipping.

1910.1030(d)(2)(xiii)(A) The container for storage, transport, or shipping shall be labeled or color-coded according to paragraph (g)(1)(i) and closed prior to being stored, transported, or shipped. When a facility utilizes Universal Precautions in the handling of all specimens, the labeling/color-coding of specimens is not necessary provided containers are recognizable as containing specimens. This exemption only applies while such specimens/containers remain within the facility. Labeling or color-coding in accordance with paragraph (g)(1)(i) is required when such specimens/containers leave the facility.

1910.1030(d)(2)(xiii)(B) If outside contamination of the primary container occurs, the primary container shall be placed within a second container which prevents leakage during handling, processing, storage, transport, or shipping and is labeled or color-coded according to the requirements of this standard.

1910.1030(d)(2)(xiii)(C) If the specimen could puncture the primary container, the primary container shall be placed within a secondary container which is puncture-resistant in addition to the above characteristics.

1910.1030(d)(2)(xiv) Equipment which may become contaminated with blood or other potentially infectious materials shall be examined prior to servicing or shipping and shall be decontaminated as necessary, unless the employer can demonstrate that decontamination of such equipment or portions of such equipment is not feasible.

1910.1030(d)(2)(xiv)(A) A readily observable label in accordance with paragraph (g)(1)(i)(H) shall be attached to the equipment stating which portions remain contaminated.

1910.1030(d)(2)(xiv)(B) The employer shall ensure that this information is conveyed to all affected employees, the servicing representative, and/or the manufacturer, as appropriate, prior to handling, servicing, or shipping so that appropriate precautions will be taken.

1910.1030(d)(4)(iii) *Regulated Waste.*

1910.1030(d)(4)(iii)(A) *Contaminated Sharps Discarding and Containment.*

1910.1030(d)(4)(iii)(A)*(1)* Contaminated sharps shall be discarded immediately or as soon as feasible in containers that are:

1910.1030(d)(4)(iii)(A)*(1)(i)* Closable;

1910.1030(d)(4)(iii)(A)*(1)(ii)* Puncture resistant;

1910.1030(d)(4)(iii)(A)*(1)(iii)* Leakproof on sides and bottom; and

1910.1030(d)(4)(iii)(A)*(1)(iv)* Labeled or color-coded in accordance with paragraph (g)(1)(i) of this standard.

1910.1030(d)(4)(iii)(A)*(2)* During use, containers for contaminated sharps shall be:

1910.1030(d)(4)(iii)(A)*(2)(i)* Easily accessible to personnel and located as close as is feasible to the immediate area where sharps are used or can be reasonably anticipated to be found (e.g., laundries);

1910.1030(d)(4)(iii)(A)*(2)(ii)* Maintained upright throughout use; and

1910.1030(d)(4)(iii)(A)*(2)(iii)* Replaced routinely and not be allowed to overfill.

1910.1030(d)(4)(iii)(A)*(3)* When moving containers of contaminated sharps from the area of use, the containers shall be:

1910.1030(d)(4)(iii)(A)*(3)(i)* Closed immediately prior to removal or replacement to prevent spillage or protrusion of contents during handling, storage, transport, or shipping;

1910.1030(d)(4)(iii)(A)*(3)(ii)* Placed in a secondary container if leakage is possible. The second container shall be:

1910.1030(d)(4)(iii)(A)*(3)(ii)(A)* Closable;

1910.1030(d)(4)(iii)(A)*(3)(ii)(B)* Constructed to contain all contents and prevent leakage during handling, storage, transport, or shipping; and

1910.1030(d)(4)(iii)(A)*(3)(ii)(C)* Labeled or color-coded according to paragraph (g)(1)(i) of this standard.

1910.1030(d)(4)(iii)(A)*(4)* Reusable containers shall not be opened, emptied, or cleaned manually or in any other manner which would expose employees to the risk of percutaneous injury.

1910.1030(d)(4)(iii)(B) *Other Regulated Waste Containment.*

1910.1030(d)(4)(iii)(B)*(1)* Regulated waste shall be placed in containers which are:

1910.1030(d)(4)(iii)(B)*(1)(i)* Closable;

1910.1030(d)(4)(iii)(B)*(1)(ii)* Constructed to contain all contents and prevent leakage of fluids during handling, storage, transport or shipping;

1910.1030(d)(4)(iii)(B)*(1)(iii)* Labeled or color-coded in accordance with paragraph (g)(1)(i) this standard; and

1910.1030(d)(4)(iii)(B)*(1)(iv)* Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.

1910.1030(d)(4)(iii)(B)*(2)* If outside contamination of the regulated waste container occurs, it shall be placed in a second container. The second container shall be:

1910.1030(d)(4)(iii)(B)*(2)(i)* Closable;

1910.1030(d)(4)(iii)(B)*(2)(ii)* Constructed to contain all contents and prevent leakage of fluids during handling, storage, transport or shipping;

1910.1030(d)(4)(iii)(B)*(2)(iii)* Labeled or color-coded in accordance with paragraph (g)(1)(i) of this standard; and

1910.1030(d)(4)(iii)(B)*(2)(iv)* Closed prior to removal to prevent spillage or protrusion of contents during handling, storage, transport, or shipping.

1910.1030(d)(4)(iii)(C) Disposal of all regulated waste shall be in accordance with applicable regulations of the United States, States and Territories, and political subdivisions of States and Territories.

1910.1030(d)(4)(iv) *Laundry.*

1910.1030(d)(4)(iv)(A) Contaminated laundry shall be handled as little as possible with a minimum of agitation.

1910.1030(d)(4)(iv)(A)*(1)* Contaminated laundry shall be bagged or containerized at the location where it was used and shall not be sorted or rinsed in the location of use.

1910.1030(d)(4)(iv)(A)*(2)* Contaminated laundry shall be placed and transported in bags or containers labeled or color-coded in accordance with paragraph (g)(1)(i) of this standard. When a facility utilizes Universal Precautions in the handling of all soiled laundry, alternative labeling or color-coding is sufficient if it permits all employees to recognize the containers as requiring compliance with Universal Precautions.

1910.1030(d)(4)(iv)(A)*(3)* Whenever contaminated laundry is wet and presents a reasonable likelihood of soak-through of or leakage from the bag or container, the laundry shall be placed and transported in bags or containers which prevent soak-through and/or leakage of fluids to the exterior.

1910.1030(d)(4)(iv)(B) The employer shall ensure that employees who have contact with contaminated laundry wear protective gloves and other appropriate personal protective equipment.

1910.1030(d)(4)(iv)(C) When a facility ships contaminated laundry off-site to a second facility which does not utilize Universal Precautions in the handling of all laundry, the facility generating the contaminated laundry must place such laundry in bags or containers which are labeled or color-coded in accordance with paragraph (g)(1)(i).

1910.1030(g) *Communication of Hazards to Employees.*

1910.1030(g)(1) *Labels and Signs.*

1910.1030(g)(1)(i) *Labels.*

1910.1030(g)(1)(i)(A) Warning labels shall be affixed to containers of regulated waste, refrigerators and freezers containing blood or other potentially infectious material; and other containers used to store, transport or ship blood or other potentially infectious materials, except as provided in paragraph (g)(1)(i)(E), (F) and (G).

1910.1030(g)(1)(i)(B) Labels required by this section shall include the following legend:

BIOHAZARD

1910.1030(g)(1)(i)(C) These labels shall be fluorescent orange or orange-red or predominantly so, with lettering and symbols in a contrasting color.

1910.1030(g)(1)(i)(D) Labels shall be affixed as close as feasible to the container by string, wire, adhesive, or other method that prevents their loss or unintentional removal.

1910.1030(g)(1)(i)(E) Red bags or red containers may be substituted for labels.

1910.1030(g)(1)(i)(F) Containers of blood, blood components, or blood products that are labeled as to their contents and have been released for transfusion or other clinical use are exempted from the labeling requirements of paragraph (g).

1910.1030(g)(1)(i)(G) Individual containers of blood or other potentially infectious materials that are placed in a labeled container during storage, transport, shipment or disposal are exempted from the labeling requirement.

1910.1030(g)(1)(i)(H) Labels required for contaminated equipment shall be in accordance with this paragraph and shall also state which portions of the equipment remain contaminated.

1910.1030(g)(1)(i)(I) Regulated waste that has been decontaminated need not be labeled or color-coded.

1910.1030(g)(1)(ii) *Signs.*

1910.1030(g)(1)(ii)(A) The employer shall post signs at the entrance to work areas specified in paragraph (e), HIV and HBV Research Laboratory and Production Facilities, which shall bear the following legend:

BIOHAZARD

(Name of the Infectious Agent)
(Special requirements for entering the area)
(Name, telephone number of the laboratory director or other responsible person.)

1910.1030(g)(1)(ii)(B) These signs shall be fluorescent orange-red or predominantly so, with lettering and symbols in a contrasting color.

Interior Areas — Walking-Working Surfaces

General

1910.22(a)(1) All places of employment, passageways, storerooms, and service rooms shall be kept clean and orderly and in a sanitary condition.

1910.22(a)(2) The floor of every workroom shall be maintained in a clean and, so far as possible, a dry condition. Where wet processes are used, drainage shall be maintained, and false floors, platforms, mats, or other dry standing places should be provided where practicable.

1910.22(b)(1) Where mechanical handling equipment is used, sufficient safe clearances shall be allowed for aisles, at loading docks, through doorways and wherever turns or passage must be made. Aisles and passageways shall be kept clear and in good repairs, with no obstruction across or in aisles that could create a hazard.

1910.22(b)(2) Permanent aisles and passageways shall be appropriately marked.

1910.22(c) *Covers and guardrails.* Covers and/or guardrails shall be provided to protect personnel from the hazards of open pits, tanks, vats, ditches, etc.

1910.22(d)(1) In every building or other structure, or part thereof, used for mercantile, business, industrial, or storage purposes, the loads approved by the building official shall be marked on plates of approved design which shall be supplied and securely affixed by the owner of the building, or his duly authorized agent, in a conspicuous place in each space to which they relate. Such plates shall not be removed or defaced but, if lost, removed, or defaced, shall be replaced by the owner or his agent.

1910.23(a) *Protection for floor openings.*

1910.23(a)(1) Every stairway floor opening shall be guarded by a standard railing constructed in accordance with paragraph (e) of this section. The railing shall be provided on all exposed sides (except at entrance to stairway). For infrequently used stairways where traffic across the opening prevents the use of fixed standard railing (as when located in aisle spaces, etc.), the guard shall consist of a hinged floor opening cover of standard strength and construction and removable standard railings on all exposed sides (except at entrance to stairway).

1910.23(a)(2) Every ladderway floor opening or platform shall be guarded by a standard railing with standard toeboard on all exposed sides (except at entrance to opening), with the passage through the railing either provided with a swinging gate or so offset that a person cannot walk directly into the opening.

1910.23(a)(3) Every hatchway and chute floor opening shall be guarded by one of the following:

1910.23(a)(3)(i) Hinged floor opening cover of standard strength and construction equipped with standard railings or permanently attached thereto so as to leave only one exposed side. When the opening is not in use, the cover shall be closed or the exposed side shall be guarded at both top and intermediate positions by removable standard railings.

1910.23(a)(3)(ii) A removable railing with toeboard on not more than two sides of the opening and fixed standard railings with toeboards on all other exposed sides. The removable railings shall be kept in place when the opening is not in use. Where operating conditions necessitate the feeding of material into any hatchway or chute opening, protection shall be provided to prevent a person from falling through the opening.

1910.23(a)(4) Every skylight floor opening and hole shall be guarded by a standard skylight screen or a fixed standard railing on all exposed sides.

1910.23(a)(5) Every pit and trapdoor floor opening, infrequently used, shall be guarded by a floor opening cover of standard strength and construction. While the cover is not in place, the pit or trap opening, shall be constantly attended by someone or shall be protected on all exposed sides by removable standard railings.

1910.23(a)(6) Every manhole floor opening shall be guarded by a standard manhole cover which need not be hinged in place. While the cover is not in place, the manhole opening shall be constantly attended by someone or shall be protected by removable standard railings.

1910.23(a)(7) Every temporary floor opening shall have standard railings, or shall be constantly attended by someone.

1910.23(a)(8) Every floor hole into which persons can accidentally walk shall be guarded by either:

1910.23(a)(8)(i) A standard railing with standard toeboard on all exposed sides, or

1910.23(a)(8)(ii) A floor hole cover of standard strength and construction. While the cover is not in place, the floor hole shall be constantly attended by someone, or shall be protected by a removable standard railing.

1910.23(a)(9) Every floor hole into which persons cannot accidentally walk (on account of fixed machinery, equipment, or walls) shall be protected by a cover that leaves no openings more than 1 inch wide. The cover shall be securely held in place to prevent tools or materials from falling through.

1910.23(a)(10) Where doors or gates open directly on a stairway, a platform shall be provided, and the swing of the door shall not reduce the effective width to less than 20 inches.

1910.23(b) *Protection for wall openings and holes.*

1910.23(b)(1) Every wall opening from which there is a drop of more than 4 feet shall be guarded by one of the following:

1910.23(b)(1)(i) Rail, roller, picket fence, half door, or equivalent barrier. Where there is exposure below to falling materials, a removable toe board or the equivalent shall also be provided. When the opening is not in use for handling materials, the guard shall be kept in position regardless of a door on the opening. In addition, a grab handle shall be provided on each side of the opening with its center approximately 4 feet above floor level and of standard strength and mounting.

1910.23(b)(1)(ii) Extension platform onto which materials can be hoisted for handling, and which shall have side rails or equivalent guards of standard specifications.

1910.23(b)(2) Every chute wall opening from which there is a drop of more than 4 feet shall be guarded by one or more of the barriers specified in paragraph (b)(1) of this section or as required by the conditions.

1910.23(b)(3) Every window wall opening at a stairway landing, floor, platform, or balcony, from which there is a drop of more than 4 feet, and where the bottom of the opening is less than 3 feet above the platform or landing, shall be guarded by standard slats, standard grill work (as specified in paragraph (e)(11) of this section), or standard railing. Where the window opening is below the landing, or platform, a standard toeboard shall be provided.

1910.23(b)(4) Every temporary wall opening shall have adequate guards but these need not be of standard construction.

1910.23(b)(5) Where there is a hazard of materials falling through a wall hole, and the lower edge of the near side of the hole is less than 4 inches above the floor, and the far side of the hole more than 5 feet above the next lower level, the hole shall be protected by a standard toeboard, or an enclosing screen either of solid construction, or as specified in paragraph (e)(11) of this section.

1910.23(c) *Protection of open-sided floors, platforms, and runways.*

1910.23(c)(1) Every open-sided floor or platform 4 feet or more above adjacent floor or ground level shall be guarded by a standard railing (or the equivalent as specified in paragraph (e)(3) of this section) on all open sides except where there is entrance to a ramp, stairway, or fixed ladder. The railing shall be provided with a toeboard wherever, beneath the open sides,

1910.23(c)(1)(i) Persons can pass,

1910.23(c)(1)(ii) There is moving machinery, or

1910.23(c)(1)(iii) There is equipment with which falling materials could create a hazard.

1910.23(c)(2) Every runway shall be guarded by a standard railing (or the equivalent as specified in paragraph (e)(3) of this section) on all open sides 4 feet or more above floor or ground level. Wherever tools, machine parts, or materials are likely to be used on the runway, a toeboard shall also be provided on each exposed side. Runways used exclusively for special purposes (such as oiling, shafting, or filling tank cars) may have the railing on one side omitted where operating conditions necessitate such omission, providing the falling hazard is minimized by using a runway of not less than 18 inches wide. Where persons entering upon runways become thereby exposed to machinery, electrical equipment, or other danger not a falling hazard, additional guarding than is here specified may be essential for protection.

1910.23(c)(3) Regardless of height, open-sided floors, walkways, platforms, or runways above or adjacent to dangerous equipment, pickling or galvanizing tanks, degreasing units, and similar hazards shall be guarded with a standard railing and toeboard.

1910.23(d) *Stairway railings and guards.*

1910.23(d)(1) Every flight of stairs having four or more risers shall be equipped with standard stair railings or standard handrails as specified in paragraphs (d)(1)(i) through (v) of this section, the width of the stair to be measured clear of all obstructions except handrails:

1910.23(d)(1)(i) On stairways less than 44 inches wide having both sides enclosed, at least one handrail, preferably on the right side descending.

1910.23(d)(1)(ii) On stairways less than 44 inches wide having one side open, at least one stair railing on open side.

1910.23(d)(1)(iii) On stairways less than 44 inches wide having both sides open, one stair railing on each side.

1910.23(d)(1)(iv) On stairways more than 44 inches wide but less than 88 inches wide, one handrail on each enclosed side and one stair railing on each open side.