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MILITARY HANDBOOK

FIRE PROTECTION FOR FACILITIES ENGINEERING,
DESIGN, AND CONSTRUCTION



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ABSTRACT

This handbook was produced to provide detailed guidance for the incorporation of fire protection engineering measures in the design and construction of Department of Defense (DOD) facilities engineering. Concerns for property, equipment, and personnel were among the comprehensive considerations included in this handbook to ensure safety of human life and continuity of mission, and to minimize injuries and damage to property and equipment.

FOREWORD

This handbook has been developed from an evaluation of facilities at DOD establishments, from surveys of the availability of new material and construction methods, and from selection of the best design practices of the Naval Facilities Engineering Command (NAVFACENGCOC), Army Corps of Engineers, Air Force Office of the Civil Engineer, Deputy Chief of Staff for Installations and Logistics Headquarters Marine Corps, other Government agencies, and the private sector. This handbook was prepared using, to the maximum extent feasible, model building codes, national fire codes, industrial standards, and other recognized standards. Do not deviate from this criteria in the planning, engineering, design, and construction of DOD facilities without prior approval of the respective component office of responsibility--U.S. Army, HQ USACE/CEMP-E; U.S. Navy, NAVFACENGCOC HQ Code 150; U.S. Marine Corps, HQMC Code LFF-1; U.S. Air Force, HQ AFCESA/CES; Defense Logistics Agency (DLA), HQ DLA-D through DLA-MMBI; National Imagery and Mapping Agency (NIMA), Mission Support (Admin Services); all other DOD components, and ADUSD (ES) Conservations and Installations via the DOD Standing Committee on Fire Protection Engineering.

Recommendations for improvement are encouraged. Submit recommendations for approval via the respective component office of responsibility and the DOD Standing Committee on Fire Protection Engineering. Approved recommendations will be forwarded to Commander, Naval Facilities Engineering Command (NAVFACENGCOC) (Code 150), 200 Stovall Street, Alexandria, VA 22332-2300; telephone commercial (703) 325-0036, DSN 221-0036; fax commercial (703) 325-4450, DSN 221-4450.

DO NOT USE THIS HANDBOOK AS A REFERENCE IN A PROCUREMENT DOCUMENT FOR FACILITIES CONSTRUCTION. IT IS TO BE USED IN THE PURCHASE AND PREPARATION OF FACILITIES PLANNING AND ENGINEERING STUDIES AND DESIGN DOCUMENTS USED FOR THE PROCUREMENT OF FACILITIES CONSTRUCTION (SCOPE, BASIS OF DESIGN, TECHNICAL REQUIREMENTS, PLANS, SPECIFICATIONS, COST ESTIMATES, REQUEST FOR PROPOSALS, AND INVITATION FOR BIDS). DO NOT REFERENCE IT IN MILITARY OR FEDERAL SPECIFICATIONS OR OTHER PROCUREMENT DOCUMENTS.

MIL-HDBK-1008C

FIRE PROTECTION CRITERIA MANUALS

<u>Criteria Manual</u>	<u>Title</u>	<u>PA</u>
MIL-HDBK-1008C	Fire Protection for Facilities, Engineering, Design, and Construction	NAVFAC HQ

MIL-HDBK-1008C

FIRE PROTECTION FOR FACILITIES
ENGINEERING, DESIGN, AND CONSTRUCTION

CONTENTS

		<u>Page</u>
Section 1	INTRODUCTION	
1.1	Scope.....	1
1.2	Cancellation.....	1
1.3	Criteria.....	1
1.3.1	Renovation.....	1
1.3.2	Existing Facilities.....	2
1.3.3	Absence of Criteria.....	2
1.3.4	Conflicts in Criteria.....	2
1.3.5	Authority Having Jurisdiction (AHJ).....	2
1.3.6	Waivers.....	2
1.3.7	Guide Specifications.....	3
1.4	Design Analyses.....	3
1.5	Services and Qualifications of Fire Protection Engineers.....	4
1.6	Fire Protection During Construction.....	4
1.7	Definitions.....	4
1.7.1	Combustible Material.....	5
1.7.2	Fire Resistance Rating.....	5
1.7.3	Flame-Spread Rating.....	5
1.7.4	Interior Finish.....	5
1.7.5	Multi-family Housing.....	5
1.7.6	Noncombustible Material.....	5
1.7.7	Smoke-Developed Rating.....	5
1.7.8	Underground Structures.....	5
1.7.9	Windowless Structures.....	5
Section 2	BUILDING CONSTRUCTION	
2.1	Basic Criteria.....	6
2.1.1	Egress and Safety to Life.....	6
2.1.2	Partitions.....	6
2.1.3	Type of Construction.....	6
2.1.4	Separation Between Buildings.....	6
2.2	Fire Areas.....	7
2.2.1	Unsprinklered Attics and Suspended Ceilings.....	7
2.3	Building Height Limitations.....	7
2.4	Special Requirements.....	7
2.5	Limiting Interior Fire Spread.....	7
2.5.1	Vertical Fire Cutoffs.....	8
2.5.2	Protection of Door Openings.....	8
2.6	Means of Egress.....	8

MIL-HDBK-1008C

		<u>Page</u>
2.6.1	Requirements.....	8
2.6.2	Means of Egress Marking.....	9
2.6.2.1	Radioluminous Exit Signs.....	9
2.7	Interior Finish.....	9
2.7.1	New Construction, Alterations, Renovations	9
2.7.2	Existing Construction.....	10
2.7.3	Interior Floor Finish.....	10
2.8	Insulation.....	10
2.8.1	Requirements.....	10
2.8.2	Exceptions to Insulation Criteria.....	11
2.8.2.1	Flame Spread - No Smoke Limitation.....	11
2.8.2.2	No Flame Spread or Smoke Limitation.....	11
2.9	Roof Coverings and Roof Deck Assemblies...	12
2.9.1	Roof Coverings.....	12
2.9.2	Roof Deck Assemblies.....	12
2.10	Roof Access for Manual Firefighting.....	12
2.10.1	Firefighting Access to Roof.....	12
2.11	Fire Department Vehicle Access.....	12
2.11.1	Fire Department Connection.....	13
2.12	Air Handling.....	13
2.12.1	Design Requirements.....	12
2.12.2	Corridors.....	13
2.12.3	Plenums.....	13
2.12.4	Duct Smoke Detectors.....	13
2.12.5	Fire Dampers.....	13
2.12.6	Smoke and Heat Vents.....	14
2.13	Plastic Pipe and Conduit.....	14
2.13.1	Penetrations.....	14
2.13.2	Prohibited Locations.....	14
2.14	Fire Retardant Treated (FRT) Plywood.....	14
2.14.1	New Construction.....	14
2.14.2	Existing Construction.....	14
Section 3	COMMON HAZARDS	
3.1	Heating Equipment.....	15
3.1.1	Requirements.....	15
3.1.2	Gas.....	15
3.1.3	Coal.....	15
3.1.3.1	Storage.....	15
3.1.3.2	Handling.....	16
3.1.3.3	Pulverizing Equipment.....	17
3.2	Power Generating and Utilization Equipment	17
3.2.1	General.....	17
3.2.2	Stationary Combustion Engines, Gas Turbines, and Generators.....	17

	<u>Page</u>
3.2.2.1	Units Under 25,000 Horsepower (18.65 MW).. 17
3.2.2.2	Units 25,000 Horsepower and Larger (18.65 MW)..... 17
3.2.3	Transformers..... 17
3.2.3.1	Requirements..... 17
3.2.3.2	Outdoor Oil-Insulated Transformers..... 17
3.2.3.3	Indoor Oil-Insulated Transformers..... 19
3.2.3.4	Less Flammable, Liquid-Filled Transformers 20
3.2.3.5	Dry Type Transformers..... 21
3.3	Trash Collection and Disposal Facilities.. 21
3.3.1	Central Trash Collection and Dumpsters.... 21
3.3.2	Collection, Baling, and Storage Rooms..... 21
3.3.3	Trash Chutes..... 21
Section 4	SPECIAL OCCUPANCIES AND HAZARDS
4.1	Personnel Housing and Similar Lodging Facilities..... 22
4.1.1	Sleeping Room..... 22
4.1.2	Open Bay Personnel Housing..... 22
4.1.3	Hotel-Style Housing Quarters..... 22
4.1.4	Apartment-Style Personnel Housing Quarters 22
4.1.5	Automatic Sprinkler Protection..... 22
4.1.6	Range Top Cooking Surfaces..... 23
4.1.6.1	Common Areas..... 23
4.1.7	Storage Areas, Shops, and Laundry Areas... 23
4.2	Family Housing..... 23
4.2.1	Family Housing Detection..... 23
4.2.2	Family Housing Sprinkler Protection..... 24
4.2.3	Family Housing Requirements..... 24
4.2.4	Sprinkler Protection in Family Housing Rehabilitation Projects..... 24
4.3	Dining and Food Preparation Facilities.... 24
4.4	Medical Facilities..... 24
4.4.1	Occupancy Use Classification..... 24
4.4.2	Construction Type..... 25
4.4.3	Fire Area Limitations..... 25
4.4.4	Building Height Limitations..... 25
4.4.5	Sprinkler Protection..... 26
4.5	Detention and Correctional Facilities..... 26
4.5.1	Requirements..... 26
4.5.2	Locking Devices..... 26
4.5.3	Hardware..... 27
4.5.4	Interior Finish..... 27
4.6	Libraries..... 27
4.7	Child Development Facilities..... 27

MIL-HDBK-1008C

	<u>Page</u>
4.7.1	Child Development Centers (CDCs)..... 27
4.7.1.1	Locations..... 28
4.7.2	Other Child Development Facilities..... 28
4.7.2.1	School-age Facilities..... 29
4.8	Electronic Equipment Installations..... 29
4.8.1	Requirements..... 29
4.8.1.1	Automatic Sprinkler Protection..... 29
4.8.1.2	Data and Power Cabling..... 30
4.9	Ordnance..... 30
4.9.1	Ordnance Facilities..... 30
4.9.1.1	Sprinkler Protection..... 30
4.9.1.2	Water Demands for Explosives, Pyrotechnics, and Propellant Facilities..... 32
4.9.1.3	Water Demands for Stored Missile Assemblies and Other Ordnance Facilities.. 32
4.9.2	Magazines and Bunkers..... 32
4.10	Warehouses and Storage Facilities..... 32
4.10.1	Sprinkler Protection..... 32
4.10.2	Bin Storage..... 33
4.10.2.1	Requirements..... 33
4.10.3	Column Protection..... 34
4.10.4	Fire Area Limitation and Separation..... 34
4.10.5	Fire Walls..... 34
4.10.5.1	Openings in 4-Hour Rated Fire Walls..... 34
4.10.5.2	Conveyor and Mechanical Handling System Penetrations..... 34
4.11	Storage of Flammable and Hazardous Materials and Hazardous Waste..... 35
4.11.1	Flammable/Hazardous (Flam/Haz) Storage... 35
4.11.1.1	Warehouse Areas for Storage of Flammable Liquids, Solids, and Hazardous Materials.. 35
4.11.2	Flammable and Combustible Liquid Storage Areas..... 35
4.11.2.1	Aqueous Film Forming Foam (AFFF)..... 36
4.11.3	Hazardous Materials Storage Areas..... 36
4.11.4	Hazardous Waste Storage Facilities..... 36
4.11.4.1	Fire Protection for Hazardous Waste Storage Facilities..... 37
4.11.5	Spill Containment..... 37
4.11.6	Prefabricated Structures..... 37
4.11.7	Outdoor Storage Limitations and Separation..... 38
4.11.8	Electric Wiring and Equipment..... 38
4.12	Waterfront Facilities..... 38
4.12.1	Waterfront Facilities Requirements..... 38

	<u>Page</u>
4.13	Petroleum Fuel Facilities..... 39
4.14	Aboveground Vertical Tanks..... 39
4.14.1	Aboveground Tanks for Flammable Liquids... 39
4.14.2	Aboveground Tanks for Combustible Liquids. 39
4.14.3	Fuel Transfer Facilities..... 39
4.14.4	Aircraft Direct Fueling..... 39
4.15	Hydraulic Systems..... 39
4.15.1	Petroleum-Based Hydraulic Fluids..... 39
4.15.2	Hydraulic Test Systems..... 40
4.16	Aircraft Hangars..... 41
4.16.1	Overhead Foam-Water Sprinkler System Requirements..... 41
4.16.1.1	Type of System..... 41
4.16.2	Supplementary Systems..... 41
4.16.2.1	Supplementary Low-Level (Under-Wing) Fixed AFFF System Requirements..... 41
4.16.2.2	Helicopter Hangars..... 42
4.16.3	Activation of Foam-Water Sprinkler Systems and Supplementary Low-Level (Under-Wing) Fixed AFFF Systems..... 42
4.16.3.1	Manual Release Stations..... 42
4.16.3.2	Rate Compensated Heat Detectors..... 42
4.16.3.3	Ultraviolet and Infrared Optical Detectors 42
4.16.4	Water Supplies..... 42
4.16.5	Equipment Locations..... 43
4.16.6	Controls Locations..... 44
4.16.7	Agent Requirements..... 44
4.16.8	Adjacent Areas..... 44
4.17	Aircraft Acoustical Enclosures..... 44
4.17.1	Complete Enclosures (Hush-House)..... 44
4.18	Out-of-Airframe Acoustical Enclosures (Test Cells)..... 44
4.19	Hyperbaric and Hypobaric Chambers..... 45
4.19.1	Hyperbaric Chambers..... 45
4.19.2	Hypobaric Chambers..... 45
4.20	Anechoic Chambers..... 45
4.21	Liquid Oxygen (LOX)..... 45
4.21.1	Fixed Liquid Oxygen Tanks..... 45
4.21.2	Separation Distances for Liquid Oxygen (LOX) Tanks and Carts..... 46
4.21.3	Oxygen Bulk Tanks..... 46
4.21.4	Bulk Tank Vehicle Parking..... 46
4.21.5	Liquid Oxygen Storage for Propellant Applications..... 46
4.22	Department of Defense Dependent Schools... 46

MIL-HDBK-1008C

		<u>Page</u>
4.22.1	Construction.....	46
4.22.2	Requirements.....	47
4.23	Vehicle Parking, Storage, Maintenance, and Repair Facilities.....	47
4.23.1	Vehicle Parking.....	47
4.23.2	Overhaul and Repair Shops.....	47
4.23.2.1	Requirements.....	47
4.23.3	Refueler Vehicle Facilities.....	47
4.24	Pesticide Storage and Handling Facilities.	47
4.25	Windowless Structures.....	48
Section 5	WATER SUPPLY FOR FIRE PROTECTION	
5.1	Water Demands for Sprinklered Facilities..	49
5.1.1	Factors Influencing the Water Demand for Sprinklers.....	49
5.1.2	Water Demand for Sprinklers.....	49
5.1.2.1	Design Densities.....	49
5.1.2.2	Design Area.....	49
5.1.3	Water Demand for Hose Streams.....	49
5.1.4	Total Water Demand for Sprinklered Occupancies.....	49
5.1.5	Water Demand for Sprinklers (Special Facilities).....	49
5.1.5.1	Aircraft Hangars.....	49
5.1.5.2	Warehouses (High Piled or High Rack Storage).....	49
5.1.5.3	Ordnance Facilities.....	50
5.1.5.4	Rubber Tire Storage.....	50
5.1.5.5	Aircraft Acoustical Enclosures.....	50
5.1.5.6	Family Housing.....	50
5.2	Water Demands for Unsprinklered Facilities	51
5.2.1	Hose Stream Demands for Unsprinklered Facilities.....	51
5.2.1.1	Procedure.....	51
5.2.1.2	High Demands.....	51
5.2.2	Water Stream Demand for Unsprinklered Special Facilities.....	51
5.2.2.1	Ship Berthing and Drydock Facilities.....	52
5.2.2.2	Family Housing.....	52
5.2.2.3	POL Areas.....	42
5.2.3	Aircraft Parking and Refueling Facilities.	52
5.2.4	Yard and Outdoor Storage.....	52
5.2.5	Vehicle Parking Areas.....	52
5.3	Water Supply Pressure Requirements.....	52
5.3.1	Pressure Required.....	52

MIL-HDBK-1008C

		<u>Page</u>
5.4	Quantities of Water Required.....	53
5.4.1	Total Storage Capacity.....	55
5.4.2	Reduction in Storage Capacity.....	55
5.4.3	Replenishment of Storage.....	55
5.5	Sources of Water Supply.....	55
5.5.1	Primary Water Supplies.....	55
5.5.2	Secondary Water Supplies.....	55
5.6	Fire Pumps.....	55
5.6.1	Requirements.....	55
5.6.2	Pump Type.....	55
5.6.3	Pump Starting Arrangement.....	56
5.6.4	Pump Drive.....	56
5.6.5	Water Level Controls.....	56
5.6.6	Meters.....	57
5.7	Water Distribution Systems.....	57
5.7.1	Mains.....	57
5.7.2	Valves.....	57
5.7.2.1	Drawings.....	57
5.7.3	Hydrants.....	57
5.7.3.1	Installation Requirements.....	58
5.7.3.2	Spacing Requirements.....	58
5.7.3.3	Hydrant Protection.....	59
5.7.4	Pressure-Regulating Valves (PRVs).....	59
Section 6	FIRE EXTINGUISHING SYSTEMS	
6.1	Automatic Sprinkler Systems.....	60
6.1.1	Characteristics.....	60
6.1.2	Application Requirements.....	60
6.1.3	Fire Administration Authorization Act of 1992.....	61
6.1.4	Design Requirements.....	61
6.1.4.1	Hydraulic Calculations.....	61
6.1.4.2	Sprinkler Coverage.....	62
6.1.4.3	Connections to Exterior Fire Reporting Systems.....	62
6.1.4.4	Strainers.....	62
6.1.5	Sprinkler Shop Drawings.....	62
6.2	Water Spray Systems.....	62
6.2.1	Requirements.....	62
6.3	Foam Systems.....	62
6.3.1	Requirements.....	62
6.4	Standpipe Systems.....	63
6.4.1	Class I Standpipe Systems.....	63
6.4.2	Class II and Class III Standpipes.....	63

MIL-HDBK-1008C

		<u>Page</u>
6.5	Dry Chemical Extinguishing Systems.....	63
6.5.1	Application.....	63
6.5.2	Design Requirement.....	63
6.5.3	Limitations.....	63
6.6	Carbon Dioxide Systems.....	63
6.6.1	Application.....	63
6.6.2	Design Requirements.....	63
6.7	Halon 1301 Systems.....	63
6.7.1	Application.....	64
6.8	Portable Fire Extinguishers.....	64
6.8.1	Extinguisher Cabinets.....	64
6.9	Wet Chemical Extinguishing Systems.....	64
6.9.1	Application.....	64
6.9.2	Design Requirements.....	64
Section 7	FIRE ALARM SYSTEMS	
7.1	Fire Alarm Reporting Systems.....	65
7.1.1	Applications.....	65
7.1.2	Requirements.....	65
7.2	Fire Alarm Evacuation Systems.....	65
7.2.1	Applications.....	65
7.2.2	Requirements.....	66
7.2.2.1	Requirements of the UFAS and ADA.....	66
7.3	Automatic Fire Detection Systems.....	66
7.3.1	Applications.....	66
7.3.2	Requirements.....	66
7.3.3	Detection Systems.....	67
7.3.3.1	Smoke Detection and Destratification Fans.....	67
7.3.4	Addressable Interior Fire Alarm Systems...	67
7.4	Shop Drawings for Fire Alarm Systems.....	67

APPENDICES

APPENDIX A	Uniform Building Code and NFPA 220 Equivalents.....	68
APPENDIX B	Occupancy Hazard Classification for Determining Automatic Sprinkler Densities and Hose Stream Demands.....	69
APPENDIX C	Procedure for Determining Fire Flow Demand for Unsprinklered Facilities.....	73

		<u>Page</u>
TABLES		
Table 1	Fire Protection for Outdoor Oil-Insulated Transformers.....	19
2	Fire Protection for Oil-Insulated Transformers in Fire-Resistive Vaults.....	20
3	Water Demands for Sprinklered Facilities..	50
4	Atmospheric POL Tank Cooling Water.....	54
5	Pressurized POL Tank Cooling Water.....	54
REFERENCES	78
GLOSSARY	88
INDEX	90

Section 1: INTRODUCTION

1.1 Scope. This military handbook, MIL-HDBK-1008C, establishes fire protection engineering policy and criteria for DOD components. The provisions of this handbook are applicable to DOD facilities located on or outside of DOD installations, whether acquired or leased, by appropriated or non-appropriated funds, or third party financed and constructed. Provisions of this handbook also apply to alterations of existing structures and to nonpermanent construction. Facilities covered by this document include all types of buildings and their contents, structures, whether considered temporary or permanent, mobile and stationary equipment, waterfront facilities, outside storage, and shore protection for ships and aircraft. Matters relating to fire department operations, staffing, and equipment are not covered by this handbook.

1.2 Cancellation. This handbook, MIL-HDBK-1008C, dated 10 June 1997, cancels and supersedes MIL-HDBK-1008B, dated 15 January 1994.

1.3 Criteria. This handbook implements the National Technology Transfer and Advancement Act, Public Law 104-113, March 7, 1996, Section 12 (d), identifying the necessary consensus technical standards required to implement policy objectives and activities within the area of fire protection engineering for the DOD. Compliance with criteria issued in accordance with this handbook does not constitute an exception under Public Law 104-113, March 7, 1996, Section 12 (d) (3). Fire protection criteria shall conform to the requirements of this handbook, the National Fire Codes, published by the National Fire Protection Association (NFPA), except as modified herein, and portions of the Uniform Building Code (UBC), published by the International Conference of Building Officials, as specifically referenced herein. Additional criteria includes portions of the Loss Prevention Data Sheets, published by Factory Mutual Engineering Corporation (FM), as specifically referenced herein. Buildings which are required to be accessible to the disabled or impaired shall meet the provisions of Federal Standard FED-STD-795, Uniform Federal Accessibility Standards (UFAS), and the Americans With Disabilities Act (ADA) of 1990.

1.3.1 Renovation. This handbook also applies to renovation, modernization, alteration, and rehabilitation work. To the extent possible, renovation, modernization, and rehabilitation work shall comply with the requirements for new construction outlined in this handbook. In repair projects, only the new work must meet the requirements for new construction. The fire

protection requirements for repair work shall be coordinated with the authority having jurisdiction as defined in par. 1.3.5 of this handbook.

1.3.2 Existing Facilities. Existing facilities which are acceptable to the authority having jurisdiction, and meet the requirements of NFPA 101, Safety to Life From Fire in Buildings and Structures, for existing occupancies do not have to be modified to comply with the provisions of this handbook. However, if the facilities are renovated, modernized, or rehabilitated, the facilities shall meet the requirements for new construction as specified in this handbook.

1.3.3 Absence of Criteria. When a specific application is not covered by the criteria cited herein, follow national building codes, recognized industry standards, and standard engineering practices. In the absence of such technical information, contact the DOD component authority having jurisdiction (refer to par. 1.3.5).

1.3.4 Conflicts in Criteria. If a conflict exists between this handbook and any other DOD document, referenced code, standard, or publication, this handbook shall take precedence. The individual DOD components may issue technical guidance which shall take precedence. The Army and Air Force issue engineering technical letters (ETLs); the Navy issues planning and design policy letters (PDPs); and the DLA issues technical policies.

1.3.5 Authority Having Jurisdiction (AHJ). The term "AHJ" as used in the codes and standards referenced in this handbook shall mean the component office of responsibility, i.e., U.S. Army, HQ USACE/CEMP-E; U.S. Navy, NAVFACENCOM HQ Code 150; U.S. Marine Corps, HQMC Code LFF-1; U.S. Air Force, HQ AFCESA/CES; DLA, HQ DLA-D through DLA-MMBI; NIMA, Mission Support (Admin Services); and all other DOD components, ADUSD (ES) Conservations and Installations via the DOD Standing Committee on Fire Protection Engineering.

1.3.6 Waivers. Where a valid need exists, waivers for deviation from established criteria may be approved by the AHJ, if an alternate fire protection engineering design providing equivalent fire protection and life safety is approved. Requests for approval shall include justification, hazard analysis, cost comparison, criteria used, and other pertinent data. Lack of funds or cost savings are not considered sufficient justification for deviation from established criteria. Waivers shall apply only to specific requests under consideration and not to cases with similar circumstances.

1.3.7 Guide Specifications. Guide specifications which are issued and approved by the DOD components shall be used in the procurement of new facilities and processes, as well as modernization, renovation, and repair work on existing facilities. The guide specifications include design criteria which is not specifically addressed in this handbook.

1.4 Design Analyses. A fire protection design analysis is required for all designs and shall address the fire protection requirements of the project as required by this handbook. The fire protection design analysis shall be summarized and submitted separate from other disciplines. Where applicable, the following minimum fire protection provisions shall be discussed:

- a) Type of construction,
- b) Height and area limitations,
- c) Classification of occupancy,
- d) Building separation or exposure protection,
- e) Specific compliance with MIL-HDBK-1008C and National Fire Codes,
- f) Requirements for fire-rated walls, fire-rated doors, fire dampers with their fire-resistive ratings,
- g) NFPA 101,
- h) Analysis of automatic suppression systems and protected areas,
- i) Water supplies,
- j) Smoke control systems,
- k) Fire alarm system (the type of alarm system and location of the fire alarm equipment and fire zones),
- l) Fire detection system (the type of detection system and location of detectors and fire zones),
- m) Standpipe systems and fire extinguishers,
- n) Interior finish ratings,

o) Connection to and description of base fire alarm reporting system.

Note: When directed by the cognizant fire protection engineer, projects with little or no fire protection considerations shall not require a fire protection design analysis.

1.5 Services and Qualifications of Fire Protection Engineers. Major projects require the services and review of a qualified fire protection engineer. In addition, projects which involve design or modification of fire detection, fire suppression, or life safety systems shall require the services and review of a qualified fire protection engineer. A qualified fire protection engineer shall be an integral part of the design team, and shall be involved in every aspect of the design as it relates to fire protection. This includes, but is not limited to, building code analysis, life safety code analysis, design of automatic detection and suppression systems, water supply analysis, and a multi-discipline review of the entire project. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:

a) An engineer having a Bachelor of Science or Master of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 5 years' work experience in fire protection engineering.

b) A registered professional engineer (P.E.) who has passed the National Council of Examiners for Engineering and Surveys (NCEE) fire protection engineering written examination.

c) A registered P.E. in a related engineering discipline with a minimum of 5 years' experience dedicated to fire protection engineering.

1.6 Fire Protection During Construction. Contract specifications shall reference the Army Corps of Engineering Manual (EM), EM 385-1-1, Safety and Health Requirements Manual, and NFPA 241, Safeguarding Construction, Alteration, and Demolition Operations, and shall contain the requirement that the activity's fire regulations be followed.

1.7 Definitions

1.7.1 Combustible Material. Combustible material is material which cannot be classified as noncombustible in accordance with that definition.

1.7.2 Fire Resistance Rating. Fire resistance rating is the time that the construction will withstand the standard fire exposure as determined by the American Society for Testing and Materials (ASTM), ASTM E119, Fire Tests of Building Construction and Materials.

1.7.3 Flame-Spread Rating. Flame-spread rating is a numerical classification determined by ASTM E84, Surface Burning Characteristics of Building Materials, which indexes the relative burning behavior of a material by quantifying the spread of flame in a test specimen. The flame-spread rating of the material is not a measure of its fire resistance.

1.7.4 Interior Finish. Interior finish is defined as the exposed material of walls, ceilings, movable partitions, wainscoting, columns, other interior surfaces of a building, and other interior materials applied to these surfaces. Exposed insulating and acoustical materials are considered interior finish.

1.7.5 Multi-family Housing. Multi-family housing is defined as more than two dwelling units under one roof. Town house style units separated by 2-hour fire-rated walls are considered multiple single family dwellings, not multi-family dwellings.

1.7.6 Noncombustible Material. Noncombustible materials are those which will not ignite, burn, support combustion, or release flammable vapors when subject to heat or fire. Building materials that are reported as passing ASTM E136, Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C, shall be considered noncombustible.

1.7.7 Smoke-Developed Rating. Smoke-developed rating is a numerical classification determined by ASTM E84, which indexes the smoke generation rate of a given material to those of two standard materials, asbestos-cement board and select grade red oak.

1.7.8 Underground Structures. Underground structures shall be as defined by NFPA 101.

1.7.9 Windowless Structures. Windowless structures shall be as defined by NFPA 101.

Section 2: BUILDING CONSTRUCTION

2.1 Basic Criteria. Building construction shall conform to fire resistance requirements, allowable floor area, building height limitations, and building separation distance requirements of the UBC. Other requirements of the UBC are not considered criteria but may be used as a guide when established criteria does not address a specific situation.

2.1.1 Egress and Safety to Life. Building construction related to egress and safety to life shall comply with NFPA 101. Conflicts between the UBC and NFPA 101 related to fire resistance rating shall conform to NFPA 101 and applicable criteria contained herein. Appendix A provides a cross reference between the construction types referenced in NFPA 220, Types of Building Construction and the UBC.

2.1.2 Partitions. The UBC fire resistance requirements for permanent partitions shall not apply to non-bearing partitions in Type I and Type II construction. Fire resistance ratings of non-bearing partitions in Type I and Type II construction shall comply with NFPA 101. Occupancy separation walls shall comply with the UBC.

2.1.3 Type of Construction. New buildings shall be limited to noncombustible construction (UBC Type I or Type II), except as listed below and modified herein. For additional construction requirements for medical facilities, refer to par. 4.4.

a) Exception 1: Occupancy Groups B, M, U, and R-3 as defined by the UBC may consist of Types III, IV, or V construction if the total floor area does not exceed 8000 square feet. Allowable area increases are not permitted.

b) Exception 2: Multi-family housing may be of any kind of construction type provided it is within the limits set by the UBC. This includes Navy and Marine Corps bachelor quarters.

c) Exception 3: Navy and Marine Corps child development centers may be of Type III, IV, or V construction if protected by automatic sprinklers.

2.1.4 Separation Between Buildings. Use the UBC to determine required separation distances between buildings. These distances are contingent upon the fire resistance ratings of the exterior walls and the openings in these walls.

2.2 Fire Areas. Fire areas shall conform to the UBC, except as modified herein. Exceptions for specific occupancies are listed in Section 4 of this handbook.

Note: The Air Force permits the allowable area to triple in any building when an approved automatic sprinkler system is installed, regardless of building height or area.

2.2.1 Unsprinklered Attics and Suspended Ceilings. Buildings with an attic(s) separated from all other areas of the building by 2-hour fire rated construction, are not required to adhere to the criteria of this paragraph. Draft stops of gypsum board on wood or metal frame are required in unsprinklered attic spaces of combustible roof construction or in the unsprinklered combustible suspended ceiling spaces to divide the spaces into areas not exceeding 3000 square feet (280 m²). Self closing and latching access doors of similar construction shall be provided in the draft stop where there is no other means of access to the area.

2.3 Building Height Limitations. Building height limitations shall conform to the UBC, except as modified herein.

2.4 Special Requirements. Certain structures shall meet the following special requirements:

a) House trailers shall be separated in accordance with NFPA 501A, Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities.

b) Relocatable or prefabricated structures used for other than family dwellings shall be separated in accordance with the UBC requirements for permanent buildings.

c) Relocatable facilities such as electronic equipment vans shall not be grouped to form areas greater than 6000 square feet (557.4 m²) for unsprinklered facilities and 12,000 square feet (1114.8 m²) for sprinklered facilities. Relocatable facilities having extra hazardous occupancies as defined by NFPA 13, Installation of Sprinkler Systems, shall not be grouped to form areas greater than 4000 square feet (372 m²) for unsprinklered facilities and 8000 square feet (743 m²) for sprinklered facilities. A minimum separation of 50 feet (15 m) shall be provided between groups for extra hazardous and 15 feet (5 m) for all other groups.

2.5 Limiting Interior Fire Spread

2.5.1 Vertical Fire Cutoffs. Enclosures for stairways, elevators, ducts, chases, etc., shall be in accordance with the most current edition of the following criteria:

- a) NFPA 80, Fire Doors and Fire Windows
- b) NFPA 90A, Installation of Air Conditioning and Ventilating Systems
- c) NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems
- d) NFPA 91, Exhaust Systems for Air Conveying of Materials
- e) NFPA 96, Ventilation Control and Fire Protection of Commercial Cooking Operations
- f) NFPA 101
- g) NFPA 211, Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
- h) NFPA 220

Where cables, conduit, telephone wire, ducts, etc., penetrate floors or fire walls, fire stops shall be provided. Fire stops shall be by an assembly tested in accordance with ASTM E814, Fire Tests of Through-Penetration Fire Stops, and shall have a rating equal to the fire resistance rating of the assembly being penetrated.

2.5.2 Protection of Door Openings. Door openings shall be protected in accordance with NFPA 80. Fire door assemblies are required on each side of the door opening in 4-hour fire walls when openings are fitted with 3-hour rolling or sliding fire doors. Fire doors shall be listed by Underwriters Laboratories Inc. (UL), FM, or a nationally recognized testing laboratory (NRTL). Approved fire doors shall not be modified in the field. Local fabrication of fire doors shall not be permitted. The protection of ducts at point of passage through fire walls shall be in accordance with NFPA 90A and/or NFPA 90B.

2.6 Means of Egress

2.6.1 Requirements. Facilities shall comply with the requirements of NFPA 101, except as modified herein.

2.6.2 Means of Egress Marking. The marking of means of egress shall be in accordance with NFPA 101. Signs shall have lettering on a opaque background. Internally illuminated signs shall be light emitting diode (LED) type. Incandescent fixtures are not permitted except existing fixtures, which may remain in use. In overseas locations, additional markings may be required to remain consistent with local national standards.

Exception: In overseas locations, colors may be consistent with local national standards, and bilingual signs are permitted. The appropriate service or agency fire protection engineer shall publish a formal policy to implement this exception.

2.6.2.1 Radioluminous Exit Signs. Use of radioluminous exit signs in DOD facilities is not permitted without the express written approval of the AHJ. Requests for approval must demonstrate that procedures, in accordance with the component radiological health and safety regulations, are in place to track and control inventory, to remove and replace devices at the end of their useful life, to identify, evaluate, and decontaminate leaking or broken devices, and to properly dispose of the devices once they are removed. Use radioluminous signs and markers only in cases where the user has clearly demonstrated the unique requirement for such devices (e.g., electrical power is not available, long distances of wire and conduit make the installation of conventional devices impractical, or where explosive environments exist).

2.7 Interior Finish

2.7.1 New Construction, Alterations, Renovations. Wall and ceiling finishes and movable partitions shall conform to the requirements of NFPA 101, except as follows:

a) Interior finish for exits, exit passageways, hospital patient rooms, sleeping rooms, and correction facilities shall be Class A only. Class B interior finish may be substituted for Class A interior finish throughout health care facilities that are completely protected with automatic sprinklers and that have quick response sprinklers installed throughout smoke compartments containing sleeping rooms.

b) Flame spread (FS) and smoke development (SD) shall be tested in accordance with ASTM E84 (NFPA 255, Test of Surface Burning Characteristics of Building Materials). Tests shall not exceed FS rating of 25 and SD rating of 50 for Class A materials, FS rating of 75 and SD rating of 100 for Class B materials, and

FS rating of 200 and SD rating of 200 for Class C materials. Class C interior finish shall only be permitted in fully sprinklered buildings.

c) Cellular plastics shall not be used as interior wall and ceiling materials. Drop-out ceilings (foam-grid panels) may be used in existing buildings if they are listed by a NRTL for installation under automatic sprinkler systems. Drop-out ceilings shall be installed in strict accordance with testing laboratory instructions; and automatic sprinklers shall be installed above the panels. Where new automatic sprinklers are installed in an existing building, drop-out ceilings shall not be used. Drop-out ceilings shall not be used in new buildings. Drop-out panels shall not be installed above sprinkler systems.

d) For incidental trim, refer to NFPA 101.

e) Carpeting and other textile wall coverings shall only be applied as an interior finish if the material passes the acceptance criteria of the UBC Standard 8-2, Test Method for Textile Wall Coverings, (add this to appropriate organization under references) conducted by a NRTL.

Exception: Carpeting and other textile wall coverings which have passed ASTM E84 may be used as an interior finish in buildings with complete automatic sprinkler protection.

2.7.2 Existing Construction. In the case of combustible interior finishes in existing buildings, certain basic safeguards are essential. The following alternate measures are available to provide the necessary safeguards to protect life and property against fires:

a) Cover combustible surfaces with gypsum board or other materials meeting the requirements of par. 2.7.1; or

b) Protect the building with an automatic sprinkler system; or

c) Remove and replace with an approved material.

2.7.3 Interior Floor Finish. Interior floor finishes shall conform to the requirements of NFPA 101.

2.8 Insulation

2.8.1 Requirements. Thermal and acoustical insulation shall have an FS rating not higher than 75, and a SD rating not higher

than 150 when tested in accordance with ASTM E84 (NFPA 255). Cellular plastic insulation shall be tested in the same densities and thicknesses as the material that will be used in construction applications.

2.8.2 Exceptions to Insulation Criteria. For certain types of insulation installation, the exceptions described in pars. 2.8.2.1 and 2.8.2.2 shall apply.

2.8.2.1 Flame Spread - No Smoke Limitation. Compliance with the SD limitation is not required, and an FS rating up to 100 is permitted for insulation, including insulating sheathing installed within wall assemblies. In such installations, the interior finish materials shall conform to par. 2.7 and shall have a minimum fire-resistance rating of 15 minutes when tested in accordance with ASTM E119.

2.8.2.2 No Flame Spread or Smoke Limitation. Compliance with FS and SD limitations are not required for the following applications:

a) Insulation installed above poured concrete or poured gypsum roof decks, nominal 2-inch (50.8 mm) thick tongue-and-groove wood plank roof decks, or precast roof deck panels or planks that are approved by a NRTL, as noncombustible roof deck construction.

b) Insulation installed above roof decks where the entire roof construction assembly, including the insulation, is UL listed as Fire Classified, or FM approved for Class I roof deck construction or equal listing or classification by a NRTL.

c) Insulation contained entirely within panels where the entire panel assembly used in the construction application meets the cited FS and SD limitations.

d) Insulation isolated from the interior of the building by masonry walls, masonry cavity walls, insulation encased in masonry cores, or concrete floors.

e) Insulation installed over concrete floor slabs and completely covered by wood tongue-and-groove flooring without creating air spaces within the flooring system.

f) Insulation completely enclosed in hollow metal doors.

g) Insulation installed between new exterior siding materials and existing exterior siding or wood board, plywood, fiberboard, or gypsum exterior wall sheathing.

Note: The exception to SD limitations described in this paragraph is not applicable to hospitals and correctional facilities.

2.9 Roof Coverings and Roof Deck Assemblies

2.9.1 Roof Coverings. Roof coverings shall be approved and listed by a NRTL. The UL Building Materials Directory lists three Classes (A, B, and C) of acceptable roof coverings based on compliance with UL 790, Safety Tests for Fire Resistance of Roof Covering Materials and NFPA 256, Fire Tests of Roof Coverings. Class C roof coverings shall be restricted to housing and buildings under 8000 square feet (743.5 m²) and which are not mission essential. In congested areas, the AHJ may want to stipulate Class A roof coverings as defined by UL 790 and NFPA 256.

2.9.2 Roof Deck Assemblies. Roof deck assemblies shall be FM Class I approved, or UL listed as Fire Classified or equal listing or classification by an NRTL.

- a) Fully sprinklered buildings.
- b) Buildings under 8000 square feet (743.5 m²).

2.10 Roof Access for Manual Firefighting

2.10.1 Firefighting Access to Roof. Required interior stair towers which extend to the top floor in any building three or more stories in height shall have, at the highest point of the stair tower, an approved hatch opening to the exterior with an appropriate ladder. The hatch shall be not less than 16 square feet in area, with a minimum dimension of 2 feet (0.61 m). At least one stairway shall terminate at a standard door opening leading onto the roof surface, unless the roof has a slope greater than 4 in 12.

2.11 Fire Department Vehicle Access. Site selection for new facilities shall consider fire department vehicle access. New facilities four stories or more in height and all new warehouses shall be provided with suitable all weather ground access surface for aerial apparatus on a minimum of two sides of the perimeter of the structure. Dimensions for fire lanes and turnarounds shall be in compliance with NFPA 1, Fire Prevention Code.

2.11.1 Fire Department Connection. Facilities with fire department connections for sprinkler or standpipe systems shall be provided with suitable all weather ground access surface for pumper apparatus within 150 feet (45.72 m) of such fire department connections.

2.12 Air Handling

2.12.1 Design Requirements. Air handling, heating, ventilation, and exhaust systems shall meet the design requirements of the following, except as modified herein:

a) NFPA 75, Protection of Electronic Computer/Data Processing Equipment

b) NFPA 90A

c) NFPA 90B

d) NFPA 91,

e) NFPA 96

f) NFPA 101

2.12.2 Corridors. Corridors shall not be used in lieu of duct for air handling supply or return.

2.12.3 Plenums. Plenums may be used as an integral part of an air handling system only if they conform to the requirements of NFPA 90A. Under no circumstances may combustible materials be located within the plenum space. Electrical wiring passing through the space, including telephone and communication wiring, shall be approved for that type of environment or shall be in metal conduit. Rooms or areas which form a plenum space or which are used as a plenum shall not be occupied for any purpose except during repairs or maintenance operations to the air handling equipment.

2.12.4 Duct Smoke Detectors. Provide duct smoke detectors in accordance with NFPA 90A and NFPA 90B.

Exception: Existing facilities without duct detectors.

2.12.5 Fire Dampers. Provide fire dampers in accordance with NFPA 90A and NFPA 90B.

2.12.6 Smoke and Heat Vents. Smoke and heat vents should be provided in buildings where a high rate of heat release is anticipated during a fire. When required in buildings without automatic sprinklers, smoke and heat vents shall be arranged to operate automatically in accordance with NFPA 204M, Smoke and Heat Venting. When required in buildings with automatic sprinkler protection, smoke and heat vents shall be arranged to operate in the manual mode only. In buildings with automatic sprinkler protection, skylights are the preferred method of providing manual smoke and heat vents.

2.13 Plastic Pipe and Conduit

2.13.1 Penetrations. Penetrations by plastic pipe or conduit through fire-rated walls, partitions, shafts, and floors shall be fire-stopped by an approved or listed method in accordance with ASTM E814 or UL 1479, Safety Fire Tests of Through-Penetration Firestops.

2.13.2 Prohibited Locations. Plastic pipe and conduit shall not be installed in exit stair enclosures, or in air plenum spaces unless specifically listed for that application.

2.14 Fire Retardant Treated (FRT) Plywood

2.14.1 New Construction. Use of FRT plywood is prohibited, except as permitted by the UBC. FRT plywood shall not be used in any part of the roof or roofing system.

2.14.2 Existing Construction. FRT plywood installations should be regularly inspected for structural integrity. Replacement of damaged FRT plywood may require additional fire protection measures if FRT plywood is replaced with more combustible materials.

Section 3: COMMON HAZARDS

3.1 Heating Equipment

3.1.1 Requirements. Designs shall conform to one or more of the following criteria:

- a) NFPA 31, Installation of Oil-Burning Equipment
- b) NFPA 54, National Fuel Gas Code
- c) NFPA 58, Storage and Handling of Liquefied Petroleum Gases
- d) NFPA 85C, Prevention of Furnace Explosions/Implosions in Multiple Burner Boiler-Furnaces
- e) NFPA 211

3.1.2 Gas. Gas service mains shall be installed in accordance with NFPA 54. Gas service mains shall not be permitted within the perimeter of foundation lines. Natural draft cross ventilation shall be provided for building crawl spaces containing gas service piping. Supply connections from the gas service mains shall rise above grade outside the foundation wall and pass through a full swing joint or loop of metallic tubing before entering the building. This will avoid pipe rupture in the event of differential settlement or earthquake. Pressure regulators shall be located outside of buildings or vented to the outside. Standards for heating system components common to all fuel systems are provided in NFPA 211. Related information is also available in the UBC. Heating system devices shall be listed by an NRTL.

3.1.3 Coal

3.1.3.1 Storage. Locate coal storage to comply with the following restrictions:

- a) Do not locate coal storage in an area where contact with an external heat source is possible. Avoid locating storage near piping, flues, boiler walls, and over steam mains, even if buried. Coal shall not be stored over or under fire service mains. Maintain a separation distance of at least 20 feet from any fire service main.
- b) Coal shall not be piled over manhole covers or covered pipe trenches that might allow air to find its way into

the pile. Piles of coal shall not be arranged around or be in contact with timbers, columns, or large pipes, as air may pass along these surfaces and produce a flue effect. Coal piles shall not be vented with pipes or flues.

c) Low-grade coal shall not be piled higher than 10 feet (3 m) and best grade coal not higher than 15 feet (4.5 m), unless they are piled by roll-packing method. Locate yard piles at least 50 feet (7.6 m) from other combustibles and important structures.

d) Coal bins, silos, or bunkers shall be constructed entirely of noncombustible material, preferably concrete. The structure should be roofed over to keep out rain and snow, and the space above the coal sufficiently ventilated to prevent the accumulation of gases given off by the coal. An elevated cone-shaped bin in which the coal is fed at the top and removed at the bottom is recommended. This arrangement prevents fine materials from collecting and remaining in the bin for long periods. The coal at the bottom, which is most likely to be troublesome, is the first to be removed. Coal bins, and when possible, bunkers and silos, should be emptied during the summer shutdowns and other prolonged idle periods. Provide automatic sprinkler protection if the existing storage facility has combustible construction or occupancy other than coal. Provide access openings for manual fire fighting operations.

e) Inactive coal piles, regardless of height are to be compacted to prevent spontaneous heating.

3.1.3.2 Handling. Where combustible conveyor belts are used to transport coal, the following shall be provided:

a) An automatic sprinkler system. It shall be hydraulically designed to operate 10 automatic sprinklers and 2 hand-held hose lines (e.g., two 1-1/2-inch hose lines). Sprinkler spacing should be 100 square feet (9.3 m²) per head. The system should be designed for a flowing pressure of 10 psi (70 Kpa) on the end sprinkler. Water supply should be adequate for at least one-hour duration. Systems should be interlocked with the belt drive to shut down on sprinkler water flow. In a conveyor enclosure less than 15 feet (4.6 m) wide, install a single line of sprinklers.

b) Provide either 1-1/2-inch hose lines or hydrants at suitable intervals such that the entire belt is accessible for fire fighting.

c) Provide each conveyor belt system with tamperproof devices arranged to automatically shut off driving power in the event of greater than 20 percent belt slow down or misalignment of belts. Interlocking devices should also shut off power to contributing conveyors.

3.1.3.3 Pulverizing Equipment. Components of a pulverized fuel system shall be designed and constructed in accordance with requirements of NFPA 8503, Pulverized Fuel Systems.

3.2 Power Generating and Utilization Equipment

3.2.1 General. In general, electrical installations shall conform to NFPA 70, National Electrical Code. Specific details on the hazards of internal combustion engines, gas turbines, generators, and transformers are covered in the NFPA Fire Protection Handbook and the FM Loss Prevention Data Sheets.

3.2.2 Stationary Combustion Engines, Gas Turbines, and Generators. Installation of internal combustion engines, gas turbines, and generators shall follow the requirements of NFPA 37, Installation and Use of Stationary Combustion Engines and Gas Turbines, except as modified herein.

3.2.2.1 Units Under 25,000 Horsepower (18.65 MW). In buildings without automatic sprinkler protection, enclose these units with 2-hour fire resistive construction or protect locally with automatic sprinklers. Automatic sprinklers connected to domestic water supplies are acceptable in accordance with NFPA 13.

3.2.2.2 Units 25,000 Horsepower and Larger (18.65 MW). In buildings without automatic sprinkler protection, enclose with 2-hour fire resistive construction and protect locally with automatic sprinklers. Automatic sprinklers connected to domestic water supplies are acceptable in accordance with NFPA 13.

3.2.3 Transformers

3.2.3.1 Requirements. Transformers shall be installed and located in accordance with NFPA 70, except as modified herein.

3.2.3.2 Outdoor Oil-Insulated Transformers. Table 1 provides fire protection requirements for single-phase or polyphase outdoor oil-insulated transformers.

a) Location of Outdoor Oil-Insulated Transformers. Buildings located 25 feet (8 m) or more from an oil-insulated transformer do not require fire exposure protection. Buildings

within 25 feet (8 m) of a transformer require exposure protection by one of the following methods:

(1) Protect transformers with a permanently piped water spray system.

(2) Where transformers expose only one building of masonry or concrete construction, the following safeguards shall be provided where applicable:

(a) There shall be no window openings in first story walls within a horizontal distance of 10 feet (3 m) from the transformers. Existing window openings shall be closed using brick or concrete block.

(b) Window openings in the first story beyond 10 feet (3 m) and up to 25 feet (7.5 m) horizontally from the transformers shall be protected, using either wired glass in steel sash or glass block.

(c) Window openings in second and third story walls directly above the transformers shall be protected using either wired glass in steel sash or glass block.

(d) Overhanging eaves, where they exist, shall be noncombustible.

(3) Where transformers expose a building having walls other than masonry or concrete, provide a masonry or concrete barrier between the building and transformers, with wing walls at each end of the barrier. The barrier shall extend at least 1 foot (0.3 m) above the top of transformer bushings and pressure-relief vents. Wing walls shall be of the same height and shall extend horizontally 2 to 3 feet (0.6 to 0.9 m) beyond the transformers, including any radiators and tap-changer enclosures. At multistory buildings, provide a fire resistive roof on this three-sided transformer enclosure.

(4) Where transformers expose more than one building, such as transformers located in courts or angles between buildings, or where yard space is limited, they shall be enclosed in a suitable fire resistive vault and protected as given in Table 2.

Table 1
Fire Protection for Outdoor Oil-Insulated Transformers

SIZE (EACH TRANSFORMER)	NUMBER	PROTECTION
Under 9,999 kVA	One or more	Portable Extinguishers
10,000 - 99,999 kVA ¹	One only	Hydrant Protection
10,000 - 99,999 kVA ¹	More than one	a. Provide a 25 ft (8 m) minimum clear space between units, or b. Noncombustible barriers between units, or c. Fixed automatic water spray 100,000 kVA and above. One or more fixed automatic water sprays
100,000 kVA and above	One or more	Fixed automatic water spray
¹ Where there are mission-essential bus structures exposed to possible transformer oil fire, or electric service or production could be interrupted for an extended period, a fixed automatic water spray system shall be provided to minimize the physical damage from fire and reduce the downtime for repairs.		

(5) Where transformers are located on or above noncombustible roofs, suitable curbed and drained concrete mats or welded steel pans shall be underneath units and located so as to not expose roof structures. Oil-filled transformers shall not be installed on combustible roofs.

3.2.3.3 Indoor Oil-Insulated Transformers. Oil-insulated transformers installed indoors shall be located in fire resistive vaults except for indoor transformer installations exempted by NFPA 70. Fire protection shall be provided in accordance with Table 2. Requirements apply to single-phase or polyphase lighting or power transformers.

Table 2
Fire Protection for Oil-Insulated Transformers in
Fire-Resistive Vaults

SIZE (EACH TRANSFORMER)	NUMBER	PROTECTION
50,000 kVA and below	One or more not exceeding 50,000 kVA total	Hydrant Protection
50,000 kVA and below	More than one exceeding 50,000 kVA total	Automatic Sprinkler or water spray systems Automatic sprinkler or water spray systems
Over 50,000 kVA	One or more	

Exception: Existing carbon dioxide systems.

3.2.3.4 Less Flammable, Liquid-Filled Transformers.

Transformers insulated with less flammable liquids (fire point not less than 572 degrees F (300 degrees C)), as defined by ASTM D92, Flash and Fire Points by Cleveland Open Cup, shall be permitted to be installed without a vault in buildings of Type I and Type II construction in areas in which no combustible materials are stored, where there is a liquid confinement area, and where the installation complies with restrictions provided for in the listing of the liquid. Such indoor installations not meeting the requirements of the liquid listing, or installed in other than Type I or Type II buildings, or in areas where combustibles materials are stored shall (1) be provided with an automatic fire suppression system and a liquid containment area, or (2) be installed in an approved vault. Transformers installed indoors and rated over 35,000 volts (V) shall be installed in a vault.

Less flammable liquid-filled transformers installed outdoors whose required spill containment is within 5 feet (1.5 m) of the building shall adhere to the same requirements for ordinary oil-insulated transformers. If they are isolated and present no exposure hazard to important structures, they may be protected with fire hydrants. For additional information, refer to FM Loss Prevention Data Sheets.

3.2.3.5 Dry Type Transformers. Dry type transformers shall be installed and located in accordance with NFPA 70.

3.3 Trash Collection and Disposal Facilities

3.3.1 Central Trash Collection and Dumpsters. Central trash collection units and dumpsters shall be placed 15 feet (4.6 m) or more away from wood frame or metal buildings or from openings in masonry-walled buildings.

3.3.2 Collection, Baling, and Storage Rooms. Collection, baling, and storage rooms shall consist of 2-hour fire resistive construction and shall be protected by automatic sprinklers.

3.3.3 Trash Chutes. Trash chutes in buildings shall be equipped with automatic sprinklers. In non-sprinklered buildings, trash chute sprinkler systems may be connected to the domestic water system.

Section 4: SPECIAL OCCUPANCIES AND HAZARDS

4.1 Personnel Housing and Similar Lodging Facilities. These facilities include barracks, dormitories, lodges, temporary or transit living facilities, and sleeping quarters for over 10 persons.

4.1.1 Sleeping Room. Provide hard-wired smoke detectors in accordance with NFPA 72, National Fire Alarm Code. A hard-wired smoke detector shall be provided for each sleeping room regardless of occupancy or the presence of other detection or protection systems in the building. When activated, the affected detector shall generate an audible signal in the room. Detectors which use a battery as the primary power source are not permitted.

Note: For Air Force projects in unsprinklered facilities, a heat detector shall also be provided in each sleeping room that shall sound a general building alarm and transmit a signal to the fire department or to a constantly monitored central location.

a) Exception 1: Air Force designs shall not have individual secondary power supplies for each hard wired smoke detector.

4.1.2 Open Bay Personnel Housing. Provide a supervised smoke detection system in accordance with NFPA 72. Smoke detectors shall be located in open bay sleeping areas and exit access corridors. When activated, these units shall sound a general building alarm and transmit a signal to the fire department or to a constantly monitored central location. Corridor detectors are not required if the building is protected with complete automatic sprinkler protection.

4.1.3 Hotel-Style Housing Quarters. Provide hard-wired smoke detectors in accordance with NFPA 101.

4.1.4 Apartment-Style Personnel Housing Quarters. Provide hard-wired smoke detectors in accordance with NFPA 101.

4.1.5 Automatic Sprinkler Protection. Complete automatic sprinkler protection shall be provided for buildings which include personnel housing and lodging. NFPA 13 or NFPA 13R, Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height, sprinkler systems are permitted when listed for the specific use.

Note 1: For Army projects, hotel-style buildings without individual cooking facilities which are less than four stories in height and where sleeping rooms and suites have a door that opens directly to the outside at street or ground level or to exterior exit access arranged in accordance with NFPA 101, do not require sprinkler protection.

Note 2: For Air Force projects, hotel-style housing quarters one and two stories in height with sleeping rooms and suites that have a door which opens directly to the outside at street or ground level or to exterior exit access arranged in accordance with NFPA 101, do not require sprinkler protection.

4.1.6 Range Top Cooking Surfaces. Personnel housing and similar lodging facilities with individual range top cooking surfaces shall have automatic sprinkler protection throughout the building.

4.1.6.1 Common Areas. Range top cooking surfaces located only in common areas (i.e., not in individual units) shall be protected with an approved range top extinguishing system. Such systems shall be connected to the building fire alarm system to sound a general building fire alarm. A range top extinguishing system is not required when the building is protected by an approved automatic sprinkler system.

4.1.7 Storage Areas, Shops, and Laundry Areas. Storage areas, shops, laundry areas, and other hazardous areas shall be protected as required by NFPA 101. In many cases, this will require both automatic sprinklers and fire rated construction. Where these areas are required to be sprinklered in buildings without complete automatic sprinkler protection, connection to domestic plumbing shall be permitted in accordance with NFPA 13. Where these areas are not protected by automatic sprinklers, provide automatic heat detectors connected to the building fire alarm system.

4.2 Family Housing. This section includes one-family, two-family, and multi-family dwellings.

4.2.1 Family Housing Detection. Family housing shall conform to NFPA 101. Provide hard-wired smoke detectors in accordance with NFPA 72.

a) Exception: Air Force designs shall not have a secondary power supply for the hard wired smoke detectors.

4.2.2 Family Housing Sprinkler Protection. Residential sprinkler protection shall be provided in new multi-family housing in accordance with the Fire Administration Authorization Act of 1992. NFPA 13, NFPA 13D, Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes, or NFPA 13R sprinkler systems are permitted when listed for the specific use.

4.2.3 Family Housing Requirements. Family housing located outside military installations or bases shall comply with provisions of par. 4.2 as well as local fire and building codes.

4.2.4 Sprinkler Protection in Family Housing Rehabilitation Projects. For multi-family housing rehabilitation projects where the construction cost is 70 percent or more of the replacement value of the housing unit, provide automatic sprinkler protection in accordance with NFPA 13, NFPA 13D, or NFPA 13R.

4.3 Dining and Food Preparation Facilities. Hood and duct systems for commercial cooking equipment which produces smoke or grease-laden vapors shall comply with NFPA 96. Kitchen extinguishing systems shall be limited to wet chemical or automatic sprinklers installed in accordance with NFPA 96. Activation of fire suppression systems shall sound a general building fire alarm and transmit a signal to the fire department or to a constantly monitored location.

4.4 Medical Facilities. This section includes hospitals, composite medical facilities, occupational health clinics, outpatient clinics, dental clinics, flight medicine clinics, and similar facilities. These facilities shall conform to NFPA 101; NFPA 99, Health Care Facilities; MIL-HDBK-1191, Medical and Dental Treatment Facilities Design and Construction Criteria; and the following:

4.4.1 Occupancy Use Classification. Occupancy use classification shall be as follows:

a) Medical facilities, or any part thereof, routinely treating inpatients shall be classified as health care occupancies.

(b) Medical facilities, or any part thereof, used to provide treatment on an outpatient basis for four or more patients, which would render them incapable of taking action for self preservation under emergency conditions without assistance from others, shall be classified as an ambulatory health care

occupancy. Clinic spaces attached to or within a portion of a medical center, hospital complex, or composite medical facility shall be classified as an ambulatory health care occupancy.

(c) Medical facilities normally used by outpatients capable of taking action for self preservation under emergency conditions without assistance from others shall be classified as a business occupancy.

4.4.2 Construction Type. Construction type (as defined in the UBC) shall comply with the following:

a) Medical centers, hospitals, composite medical facilities, and ambulatory health care facilities.

(1) Four or more stories - Type I

(2) Two or three stories - Type II - Fire
Resistive

(3) Single story - Type II One-Hour

b) Detached outpatient and dental clinics

(1) Three stories or more - Type II - Fire
Resistive

(2) One or two stories - Type II - N

Exception: Medical facilities designed and constructed in accordance with the requirements of the Integrated Building System (IBS), with a walk-on platform which provides access to the distribution zone (interstitial space), shall meet the criteria of NFPA 101 and NFPA 220. Refer to MIL-HDBK-1191.

4.4.3 Fire Area Limitations. Fire areas shall be in accordance with the UBC.

Exception: Medical facilities designed and constructed in accordance with the requirements of the IBS.

4.4.4 Building Height Limitations. Building height limitations shall be in accordance with the UBC.

Exception: Medical facilities designed and constructed in accordance with the requirements of the IBS shall meet the height limitations of NFPA 101.

4.4.5 Sprinkler Protection. Medical facilities shall be protected throughout by an approved automatic sprinkler system.

Exception 1: Stand-alone, outpatient and dental clinics less than three stories in height; of Type II One-Hour, Type II Fire Resistive, or Type I construction.

Exception 2: Distribution zone and connection zone (space above suspended ceiling) of facilities designed and constructed in accordance with the requirements of the IBS.

4.5 Detention and Correctional Facilities

4.5.1 Requirements. Comply with NFPA 101 and the following:

a) Individual fire areas shall not exceed 50,000 square feet (4647 m²).

b) Construction type shall not be less than Type II - Fire Resistive, as defined in the UBC.

c) Provide a minimum separation from other structures and public ways of 20 feet (6 m).

d) Provide complete automatic sprinkler protection. Design should utilize correctional (breakaway) type sprinkler heads. Sprinkler piping in inmate areas should be concealed.

e) Provide smoke detection in all areas.

f) Provide an automatic smoke removal system in cell areas. In addition, provide manual system activation controls at a continuously manned position outside of the cell area.

g) Provide for constant visual supervision of cell areas. If this supervision is by direct line of sight, it must be separated by not less than one-hour fire rated construction.

Note: Waterfront brigs shall not exceed one story in height.

4.5.2 Locking Devices. Provide mechanical or closed circuit electrical gang release devices whenever 12 or more locks must be operated to release prisoners confined in cells. Require gang release devices to open doors necessary to evacuate prisoners to an area of refuge. Require heavy, identically keyed, prison-type locks for exit and corridor doors not requiring gang release devices which must be opened for evacuation in the event of fire.

Exception: Dormitory-style confinement facilities.

4.5.3 Hardware. Hardware shall conform to Army Corps of Engineers Guide Specification CEGS-08701, Hardware Prison-Locking Devices.

4.5.4 Interior Finish. Interior finish including padded cells shall be Class A flame spread (i.e., 25 or less) and shall have a SD rating not exceeding 50 when tested in accordance with ASTM E84.

4.6 Libraries. Combustible shelving, stacks, cases, cabinets, fixtures, furniture, and furnishings shall be eliminated to the maximum practical extent. Wall and ceiling finish materials shall be noncombustible.

a) In buildings equipped with automatic sprinklers, libraries shall be protected by automatic sprinklers.

b) In buildings not equipped with sprinkler protection, the following protection features shall be provided for those libraries containing materials which are rare, irreplaceable, or important to the activity mission:

c) Buildings of fire resistive or noncombustible construction shall have smoke detection systems installed throughout the library area and provide a fire cutoff having a fire resistance rating of at least 1 hour to separate the library from other occupancies.

d) Buildings of combustible construction shall have complete automatic sprinkler protection for the library area. The library area shall be separated from the remainder of the building by fire walls having a fire resistance rating of at least 2 hours.

4.7 Child Development Facilities

4.7.1 Child Development Centers (CDCs). CDCs shall conform to the requirements of NFPA 101 for day care centers, except as modified herein. Since DOD has adopted staffing levels less than those required by NFPA 101, the following additional requirements shall apply to CDCs:

a) CDCs shall not be located in basements or above the level of exit discharge.

b) An automatic sprinkler system shall be provided regardless of construction type or building height. The entire building shall be provided with complete automatic sprinkler protection in mixed occupancies. New CDCs shall utilize quick response sprinklers.

c) Provide a complete automatic smoke detection system in accordance with NFPA 72. Smoke detectors shall not be provided in areas known to cause false alarms such as kitchens, mechanical rooms, and storage areas. Activation of a single smoke detector, manual pull station, or sprinkler water flow switch shall cause activation of the fire alarm system. Indication of alarm shall be by audiovisual alarm indicating devices and automatic transmission of alarm to the fire department.

d) Dead end corridors shall not be permitted.

e) Provide at least one exit door discharging directly to the outside from each activity room. Provide low profile thresholds and ramps to grade for all elevation changes. Provide hardened surface leading a sufficient distance away from the building. Exit doors and path of travel shall be sufficiently wide enough to permit rolling cribs and wheel chairs to be taken directly to the outside of the building and away from any danger or hazards.

f) Every exterior exit door shall be provided with panic hardware. Pressure actuated panic bars are preferred to minimize the obstruction to the clear egress width. For crib rooms, provide single-action hold-open devices to prevent automatic closing of the door.

g) Interior finish materials in exit corridors and rooms used by children shall not be less than Class A and in other areas shall not be less than Class B rated.

Exception: Army and DLA CDCs shall comply with the Army Corps of Engineers Architectural and Engineering Instructions Design Criteria, Appendix G.

4.7.1.1 Locations. CDCs shall not be located in a mixed occupancy with any B-1, B-3, B-4, H, or M-1 occupancy as defined in the UBC. In any permitted mixed occupancy, CDCs shall be separated from other occupancies by a minimum of 1-hour fire rated construction.

4.7.2 Other Child Development Facilities. Other child development facilities include part-day, preschool, kindergarten,

before and after school programs, etc. These facilities shall comply with the provisions of educational occupancies in NFPA 101, and do not have to comply with the day care center provisions.

4.7.2.1 School-Age Facilities. School-age facilities are those used to supervise out-of-school children during parental working hours. School-age facilities shall meet the requirements of NFPA 101 for day care centers plus the following:

a) Such facilities shall only be located on the level of exit discharge.

b) Each activity room shall have at least one exit that discharges directly to the outside.

c) Air Force designs shall comply with either the above requirements or the requirements of NFPA 101 for educational occupancies.

4.8 Electronic Equipment Installations. These areas include major automatic data processing (ADP) areas, communication centers, command and control systems, and other mission critical systems. Incidental electronic equipment such as word processing stations, printers, and systems; desk top computers; office automation systems; individual data output stations (e.g., printers, etc.); individual computer work stations; telephones; video conference centers; administrative telephone rooms; reproduction equipment; and similar equipment do not require protection under this section.

4.8.1 Requirements. Electronic equipment installations shall be constructed and protected in accordance with NFPA 75, except as modified herein.

4.8.1.1 Automatic Sprinkler Protection. Electronic equipment installations shall be located in buildings protected by wet-pipe automatic sprinklers. Provide complete coverage throughout the building including electronic equipment areas. Electrical equipment installations should be protected by disconnecting the power upon activation of the fire protection system. Where deluge systems are used in electronic equipment installation locations, the use of waterproof thermal heat detectors, light fixtures that are approved for damp locations, and non-ventilated National Electrical Manufacturers Association (NEMA) Type 4 enclosures for all other exposed non-explosion proof equipment is required.

4.8.1.2 Data and Power Cabling. Power cables installed in the ceiling plenum or below the raised floor shall meet the requirements of NFPA 70, except that use of nonmetallic conduit shall not be permitted. Data and other communication cables installed in ceiling spaces and under raised floors shall be plenum rated or installed in conduit in accordance with NFPA 70. If plenum rated cable or conduit is not provided, an extinguishing system shall be provided in the under floor or ceiling area where the volume of the space exceeds 5000 ft³.

4.9 Ordnance

4.9.1 Ordnance Facilities. Ordnance facilities used for manufacturing, maintaining, demilitarizing, handling, processing, servicing, and inspection of ammunition, explosives, propellants and oxidizers or related devices containing these materials shall have complete automatic sprinkler protection and comply with DOD Instruction 6055.9-STD, DOD Ammunition and Explosive Safety Standards. Requirements for UBC Group H occupancies shall be followed in the absence of specific guidance in DOD Instruction 6055.9-STD and the individual service regulations based directly on DOD Instruction 6055.9-STD. The service regulations include:

a) For Navy projects, NAVSEA OP-5, Ammunition and Explosives Ashore Safety Regulations for Handling, Storing, Production, Renovation, and Shipping.

b) For Army projects, Army AR 385-64, U.S Army Explosives Safety Program and the Army Material Command Regulation 385-100, Safety Manual.

c) For Air Force projects, Air Force AFM 127-100, Explosives Safety Standard.

4.9.1.1 Sprinkler Protection. Automatic sprinkler systems in ordnance facilities shall be provided with flexible couplings and sway bracing similar to that provided for buildings in earthquake zones. Complete automatic sprinkler protection is required for ordnance facilities used for manufacturing, maintaining, demilitarizing, handling, processing, servicing, and inspection of ammunition, explosives, pyrotechnics, propellants, and oxidizers or related devices containing these materials, unless such a system will aggravate the hazard. The following guidelines for automatic sprinkler protection shall apply:

a) Where exposed thermally energetic materials are handled that have a high probability of ignition, a large thermal output and a high probability of causing personnel injury,

operations shall be protected using ultra-high speed deluge systems. Ultra-high speed deluge systems have a response time of 100 milliseconds or less. Response time is measured from the time that an energy source is presented to the detector to the time of initial water flow from the critical nozzle, which is normally the nozzle closest to the hazard. Ultra-high speed detectors usually consist of preprimed deluge systems and optical flame detection which views the hazard. Piping is pitched 1/4-inch per 10 feet with air bleeders at the high point. Pipe runs and bends are kept to a minimum. NFPA 15, Water Spray Fixed Systems for Fire Protection, provides additional information on ultra high speed deluge systems.

b) Provide high-speed (operation of 500 milliseconds or less), preprimed deluge systems wherever exposed explosives, pyrotechnics, or propellants are processed or stored in ordnance production facilities. Complete protection of such locations is essential. See Table 1, in Section 5.

c) Provide ordinary deluge systems in other areas or auxiliary sections of buildings in which processing of explosives, pyrotechnics, or propellants takes place.

d) Provide deluge systems, wet-pipe systems, or pre-action systems in other areas or auxiliary sections of buildings in which storage of explosives or propellants takes place.

e) Provide wet-pipe sprinkler systems in other areas or auxiliary sections of buildings if separated by fire partitions.

f) Provide wet-pipe or pre-action sprinkler systems where missile assembly inspection or storage is carried on and where the propellant is confined within the missile, or warheads are present. Similar protection shall be provided for torpedo and air underwater weapons shops.

g) Heat detection equipment of any type is acceptable if equipment meets the operating time limitations and is suitable in other respects, such as complying with explosion-proof requirements. When pneumatic-type detection equipment is used, not more than three detectors, and preferably only one, shall be on a single circuit. The detectors shall be in the same heat influence area.

h) A system providing complete supervision of deluge and pre-action systems shall be provided so that any deficiency

that develops that would affect the speed or reliability of operation will give a distinct alarm separate from the water flow alarm.

i) Water supplies for deluge systems shall be adequate to supply the total demand of the largest fire area at the specific residual pressure required by the system, plus an allowance for hose stream demand, for a period of 45 minutes.

4.9.1.2 Water Demands for Explosives, Pyrotechnics, and Propellant Facilities. Water demands for ordnance facilities that handle exposed powder and propellants shall be 0.50 gpm/square feet, over the entire area for 90-120 minutes.

4.9.1.3 Water Demands for Stored Missile Assemblies and Other Ordnance Facilities. Water demand for stored missile assemblies and all other ordnance facilities requiring sprinkler protection shall meet or exceed the design requirements for ordinary Group 2 occupancies shown in Table 1. For Air Force projects, refer to Air Force manual (AFMAN) 91-201, Explosives Safety Standards.

4.9.2 Magazines and Bunkers. Magazines, storage facilities, and bunkers shall be constructed and located in accordance with DOD Standard 6055.9-STD. Storage facilities, magazines, and bunkers not located under the same roof as facilities used for handling, processing, servicing, and inspection of ammunition, explosives, propellants, and oxidizers shall be constructed and located in accordance with DOD Standard 6055.9-STD. Automatic sprinklers and hydrant protection are not required for magazines, bunkers, and storage facilities similarly constructed and located.

4.10 Warehouses and Storage Facilities. These criteria apply to facilities (except ordnance) used for storage, shipping, receiving, packing, and processing of materials.

4.10.1 Sprinkler Protection. Complete automatic sprinkler protection shall be provided for warehouses and storage facilities 5000 square feet (464.68 m²) or greater. Sprinklers shall be provided for smaller facilities containing materials, equipment and supplies that are mission essential, pose a severe fire hazard, are of high monetary value, pose a safety or environmental health risk, or expose an important structure. Sprinkler protection shall include covered loading docks.

a) Sprinkler protection shall be based on Class IV commodities, as defined by NFPA 231, General Storage and NFPA 231C, Rack Storage of Materials, unless a more severe class of

storage is anticipated, and shall be based on the maximum potential height of storage.

b) Ceiling sprinklers in warehouses shall have a temperature rating of 286 degrees F (141.1 degrees C) for storage under 25 feet (7.62 m), and 165 degrees F (73.89 degrees C) for storage 25 feet (7.62 m) and higher. In-rack sprinklers shall be ordinary temperature rated.

c) In-rack sprinklers shall be supplied from risers which are separate from the ceiling sprinklers, except in existing facilities.

d) Warehouses with rack storage over 12 feet (3.66 m) high shall be protected in accordance with NFPA 231C; general storage over 12 feet (3.66 m) or of group A plastics as defined by NFPA, shall be protected in accordance with NFPA 231. Automatic storage and retrieval systems and bin boxes stacked in rack support structures shall be protected as rack storage.

e) Non-encapsulated rack storage over 22 feet (6.7 m) in height and encapsulated rack storage over 12 feet (3.66 m) in height shall be protected with in-rack sprinklers. Racks with solid shelves over 12 feet (3.66 m) in height shall be protected with in-rack sprinklers at every tier or shelf level. Early suppression fast response (ESFR) sprinklers may be used in lieu of in-rack sprinklers in accordance with NFPA 231C.

4.10.2 Bin Storage. Bin storage consists of five-sided, open from top or side storage containers, stacked in rack structures. They are commonly used in automatic storage and retrieval systems. Bin storage requires unique considerations for fire protection. Bin storage configurations do not limit oxygen supply. Horizontal flame spread can be rapid. The narrower the aisles and the higher the storage, the less ceiling sprinkler water penetration is delivered to control the fire.

4.10.2.1 Requirements. Protection of bin storage stacked in rack configuration shall be in accordance with NFPA 231C. Combustible bins in racks present a greater fire hazard and require a 10 percent increase in ceiling density or one additional level of in-rack sprinklers. Bin storage not stacked in a rack configuration shall be protected in accordance with NFPA 231. Mini-storage and retrieval systems and carousel storage shall be protected in accordance with FM Loss Prevention Data Sheet 8-33S, Protection for Automatic Storage and Retrieval Systems.

4.10.3 Column Protection. Steel columns located within rack storage areas (actually surrounded by racks) over 10,000 square feet (929.36 m²) shall be protected by 2-hour fire rated construction or applied fireproofing or by sidewall sprinklers at 15-foot (4.57 m) elevation intervals pointing directly at the column.

4.10.4 Fire Area Limitation and Separation. Warehouse fire areas shall not exceed 60,000 square feet (5576.2 m²). Warehouse fire areas may be increased to 120,000 square feet (11152.41 m²) with the following provisions:

a) Ceiling sprinkler design area shall be increased by 10 percent.

b) Looped mains with adequate sectional valves shall be provided around the facility.

4.10.5 Fire Walls. Fire walls separating warehouse and storage fire areas shall be of 4-hour fire rated construction. Other occupancies such as offices and shops shall be separated from the warehouse and storage area by a minimum of one-hour fire rated construction.

4.10.5.1 Openings in 4-Hour Rated Fire Walls. Openings in 4-hour rated fire walls shall be protected by Class A fire doors in accordance with NFPA 80, on both sides of the wall. Personnel doors may be protected by a single Class A fire door. Fire doors shall be labeled by an NRTL, refer to par. 2.5.2.

4.10.5.2 Conveyor and Mechanical Handling System Penetrations. When mechanical handling systems such as conveyors are required to penetrate fire walls, and fire doors are not feasible, the opening shall be protected on both sides of the wall by a deluge water spray tunnel system in accordance with FM Loss Prevention Data Sheet 1-23, Protection of Fire (Wall) Partition Openings With Water Spray. The deluge water spray tunnel system shall consist of a separate water spray system for both sides of the opening, and a metal or masonry enclosure around the opening extending a minimum of 5 feet (1.5 m) from both sides of the wall. The spray system shall consist of open spray nozzles that provide a minimum of 2.0 gpm/square feet (0.126 L/s) of opening and shall be activated by heat detectors. Both systems shall be activated simultaneously by any detector. The systems shall be supplied from a separate riser independent of the overhead sprinkler system. Each system shall be equipped with a control valve. Water supply shall be capable of supplying the deluge systems in addition to other required fire protection demands.

Operation of any deluge system or sprinkler system protecting the area of the handling system shall automatically shut down the handling system.

4.11 Storage of Flammable and Hazardous Materials and Hazardous Waste

4.11.1 Flammable/Hazardous (Flam/Haz) Storage. Flam/haz storage includes storage of flammable and combustible liquids as well as storage of materials which are classified as hazardous materials. Provide protection for facilities storing flammable and combustible liquids and other petroleum oil lubricant (POL) products in accordance with NFPA 30, Flammable and Combustible Liquids Code. Class IIIB combustible liquids shall be protected in the same manner as Class IIIA combustible liquids in accordance with NFPA 30. A single building is often used for storage of both flammable and combustible liquids and hazardous materials. Storage of hazardous waste is separate and distinct from storage of hazardous materials.

Note: For Navy facilities used to store hazardous materials, also refer to MIL-HDBK-1032/2, Covered Storage. For Navy and Air Force facilities used to store hazardous waste, also refer to MIL-HDBK-1005/13, Hazardous Waste Storage Facilities.

4.11.1.1 Warehouse Areas for Storage of Flammable Liquids, Solids, and Hazardous Materials. Warehouse areas for storage of flammable liquids, solids, and hazardous materials and chemicals shall not exceed 20,000 square feet (1858.74 m²) between fire walls and travel distance shall not be more than 75 feet (100 feet if sprinklered) to the nearest fire exit. Fire walls shall have a minimum 4-hour rating. Ceiling height shall not exceed 30 feet (9.14 m).

4.11.2 Flammable and Combustible Liquid Storage Areas. Provide automatic sprinkler protection. Sprinklers shall be designed and installed in accordance with NFPA 30. The following minimum criteria shall apply:

a) Provide a minimum longitudinal flue space of 12 inches (30.48 cm) between double row racks and 9 inches (22.86 cm) between single row racks and the wall.

b) Provide ceiling level sprinklers and in-rack sprinklers. The in-rack sprinklers shall protect the longitudinal flue space and shall be located at every level of rack storage.

Exception: Where multiple levels of rack storage are used below the 6 foot (1.83 m) level for hand picking operations, provide one extra row of in-rack sprinklers in the longitudinal flue space at the 3 foot (0.914 m) level. The first level of storage shall not be below the one foot (0.305 m) level to facilitate easier cleanup of spills.

4.11.2.1 Aqueous Film Forming Foam (AFFF). AFFF sprinkler systems are an appropriate means of protecting flammable and combustible liquids. AFFF systems may be used where permitted by NFPA 30.

4.11.3 Hazardous Materials Storage Areas. Provide a minimum of 2-hour fire rated construction between hazardous materials storage areas and those used for storage of flammable and combustible liquids. These areas shall be labeled as "Hazardous Materials Only," and shall also be labeled as to the type of sprinkler protection present in each room. Provide automatic sprinklers at the ceiling level as well as one mandatory level of in-rack sprinklers (i.e., in the flue space between the rack and the wall) located at or slightly above the midpoint with respect to overall storage height. In hazardous material storage areas not containing flammable or combustible liquids, design ceiling sprinkler densities based on the storage of Class IV commodities in NFPA 231 or NFPA 231C. In water reactive areas, provide automatic sprinklers with an OS&Y valve to be locked in the closed position. Provide a metal sign indicating the OS&Y valve is to remain locked in the closed position unless a fire is detected in the storage area. The sign can be attached to a chain and connected to the OS&Y valve or fastened permanently to the wall provided it does not interfere with the operation of the valve. Locate the OS&Y valve outside the water reactive storage area.

4.11.4 Hazardous Waste Storage Facilities. For hazardous waste storage facility requirements, refer to the following:

- a) NFPA 30
- b) NFPA 430, Storage of Liquid and Solid Oxidizers
- c) NFPA 43D, Storage of Pesticides
- d) NFPA 49, Hazardous Chemicals Data
- e) NFPA 490, Storage of Ammonium Nitrate

4.11.4.1 Fire Protection for Hazardous Waste Storage Facilities. The following minimum criteria shall be provided:

a) Exterior fire walls

(1) Exterior walls shall have a 4-hour fire rating when the facility is attached to a structure or it is located within 10 feet (3 m) of another building or property line.

(2) Exterior walls shall have a 2-hour fire rating when the facility is located more than 10 feet (3 m) but less than 50 feet (15 m) from an important building or property line.

(3) Exterior walls shall be of noncombustible construction when the facility is more than 50 feet (15 m) from another building or property line.

b) Interior fire walls

(1) Interior fire walls shall have a 4-hour fire rating if the facility is located within a structure that houses other occupancies.

(2) Interior fire walls shall have a 2-hour fire rating when the area of the room is greater than 300 square feet (28 m²).

(3) Interior fire walls shall have a one-hour rating when the area of the room is 300 square feet (28 m²) or less.

c) Sprinkler protection

(1) Install sprinkler systems suitable for a corrosive environment, in accordance with NFPA 13.

4.11.5 Spill Containment. Provide spill containment for flammable and combustible liquids, hazardous materials, and hazardous waste in accordance with NFPA 30.

4.11.6 Prefabricated Structures. Prefabricated structures (which may be portable) are an acceptable means of storing flammable and hazardous materials and hazardous waste provided they meet the fire protection and spill containment requirements stated herein. Where used, a single prefabricated structure shall not exceed 400 square feet (37 m²). It is preferable to locate these types of structures outside. Where it is

impractical to provide sprinkler supply lines to a prefabricated structure due to distance from an adequate water supply, dry chemical fire extinguishing systems are acceptable.

4.11.7 Outdoor Storage Limitations and Separation. Flammable and combustible liquid outdoor storage includes any storage that is covered by a roof to provide weather protection for containers. The same area may have one or two (but no more than two) walls. Flammable and combustible liquid outdoor storage shall not be more than 400 feet long or wide (121.9 m) and each area shall be separated by 100 feet (30.48 m). No container or portable tank in a pile shall be more than 200 feet (60.96 m) from a 40-foot (12.19 m) wide minimum fire lane to permit approach of fire control apparatus under all weather and ground surface conditions. Fire hydrants shall be located in accordance with the NFPA, but shall not be more than 200 feet (60.96 m) apart.

4.11.8 Electric Wiring and Equipment. Where flammable liquids are dispensed or transferred between containers, electric wiring and equipment shall be suitable for hazardous (classified) locations in accordance with NFPA 70. Where flammable liquids are not dispensed or transferred between containers, ordinary (not classified) locations for electrical equipment shall be provided.

4.12 Waterfront Facilities

4.12.1 Waterfront Facilities Requirements. NFPA 307, Construction and Fire Protection of Marine Terminals, Piers, and Wharves and NFPA 312, Fire Protection of Vessels During Construction, Repair, and Lay-up constitute the minimum requirements for waterfront and harbor facilities. Naval waterfront and harbor facilities shall comply with all of the following:

- a) NFPA 307.
- b) NFPA 312.
- c) MIL-HDBK-1025/1, Piers and Wharves.
- d) MIL-HDBK-1025/2, Dockside Utilities for Ship Service.
- e) MIL-HDBK-1025/6, General Criteria for Waterfront Construction.

f) MIL-HDBK-1029/1, Graving Drydocks.

g) MIL-HDBK-1029/2, Marine Railways.

h) MIL-HDBK-1029/3, Drydocking Facilities Characteristics.

4.13 Petroleum Fuel Facilities. Petroleum fuel facilities shall comply with NAVFAC DM-22, Petroleum Fuel Facilities.

4.14 Aboveground Vertical Tanks. Construction, separation and diking requirements for above ground vertical tanks storing flammable or combustible liquids are contained in NAVFAC DM-22.

4.14.1 Aboveground Vertical Tanks for Flammable Liquids. Aboveground vertical tanks storing Class I flammable liquids shall be equipped with internal honeycomb floating pans constructed of aluminum. Only aluminum pans providing closed cells and full fuel contact will be permitted in new construction. Foam fire extinguishing systems are not required where internal honeycomb floating pans are installed.

4.14.2 Aboveground Vertical Tanks for Combustible Liquids. Aboveground vertical tanks storing Class II mission critical fuels (i.e., JP-5, JP-8, and diesel fuel used for shipboard fueling) shall be equipped with internal honeycomb floating pans constructed of aluminum. Only aluminum pans providing closed cells and full fuel contact will be permitted in new construction. Foam fire extinguishing systems are not required where internal honeycomb floating pans are installed. Tanks containing other Class II liquids do not require internal honeycomb pans or foam extinguishing systems.

4.14.3 Fuel Transfer Facilities. Fuel transfer facilities include truck, rail, car and marine transport vessels. Fire protection for these facilities shall be in accordance with NAVFAC DM-22.

4.14.4 Aircraft Direct Fueling. Fire protection for these facilities shall be in accordance with NAVFAC DM-22.

4.15 Hydraulic Systems. Any combustible liquids under pressure shall be treated as a flammable liquid.

4.15.1 Petroleum-Based Hydraulic Fluids. The following requirements shall apply:

a) Provide automatic sprinklers directly over, and at least 20 feet (6.1 m) beyond the hydraulic equipment. Complete sprinkler protection is required if the structure is of combustible construction. Sprinklers may be omitted near a single small system or multiple adjacent small systems not exceeding 100 gallon (378.5 L) aggregate capacity, and if the construction is noncombustible and ignition sources are not normally present, and provisions exist for automatic or manual shutdown of the system(s).

b) An automatic switch, activated by sprinkler water flow alarm, fusible link, or other fire detector, shall be provided to shut down the system if there is 100 gallons (378.5 L) or more of hydraulic fluid.

4.15.2 Hydraulic Test Systems. Hydraulic test systems shall comply with the following:

a) For hydraulic systems that use pressures exceeding 200 psi (1379.5 Kpa), SAE 1,010 dead-soft, cold-drawn, seamless-steel tubing (or equivalent) shall be used. A factor of safety of eight over normal working pressure shall be used. Tubing is preferable to pipe. Tubing can be bent to fit in restricted spaces with a minimum number of fittings, reducing the number of possible leakage points. Solderless, steel fittings of the flareless "locking-sleeve" type or flare type shall be used.

b) Use of threaded pipe should be avoided. Where threaded connections are used, requirements of ANSI B1.20.1 Pipe Thread shall be met. A safety factor of eight over maximum normal pressure shall be used.

c) Tubing runs shall have as few bends as possible, but should have at least one bend to provide for thermal expansion and contraction. The minimum radius of tube bend shall be three tube diameters.

d) Where hose must be used for flexible connections, it shall be steel reinforced, designed for the hydraulic fluid being used, and capable of withstanding five times the actual operating pressure. Hose couplings and fittings and minimum bending radius shall be in accordance with the hose manufacturer's instructions. Hose shall be installed so as not to rub against objects as a result of machine movement, vibration, or pressure surges.

e) Piping and tubing shall be anchored or secured to minimize failure due to vibration. Pipe supports shall not prevent normal thermal expansion.

f) There shall be an accessible, well-marked, emergency shutoff switch for each pump.

g) Provide automatic shutoff switch to deactivate hydraulic pump upon loss of pressure.

4.16 Aircraft Hangars. Requirements listed in this section are applicable to fuel cell maintenance facilities, corrosion control and protective coating, and general purpose maintenance hangars. The following criteria applies to new hangars and the renovation or modernization of existing hangars. All hangars shall comply with NFPA 409, Aircraft Hangars, except as modified herein.

Note: For Air Force projects, refer to Air Force ETLs for additional guidance.

4.16.1 Overhead Foam-Water Sprinkler System Requirements. Provide closed head foam-water sprinkler systems using AFFF in the aircraft servicing area. The minimum foam-water solution application rate shall be a uniform 0.16 gallon (0.61 L) per minute per square foot (0.093 square meter) of floor area (6.5 L/min/m²).

4.16.1.1 Type of System. Provide wet-pipe foam-water sprinkler systems in areas not subject to freezing. In areas subject to freezing, provide pre-action foam-water sprinkler systems. Sprinkler heads shall be of the 175 degrees F, quick response type. The design area for closed-head systems shall be the hydraulically most demanding areas listed in par. 4.16.4.

4.16.2 Supplementary Systems. Supplementary protection includes automatic low-level (under-wing) nozzle systems using AFFF via either fixed or oscillating nozzles. These systems shall be hydraulically designed, and the total flow rate of the maximum number of anticipated operating systems shall be included in determining the total water supply requirements of the hangar. The flow rate of these systems shall also be included when determining the capacity of foam concentrate to be stored.

4.16.2.1 Supplementary Low-Level (Under-Wing) Fixed AFFF System Requirements. Supplementary low-level (under-wing) AFFF nozzles shall deliver a foam solution density of not less than 0.10 gallon per minute per square foot of floor area beneath the

aircraft. These systems shall be designed in accordance with NFPA 409. Supplementary low-level (under-wing) fixed AFFF nozzle systems shall be provided for the following:

a) Hangars which accommodate aircraft whose wing area is greater than 3000 square feet.

b) Hangars which may accommodate multiple small aircraft (of high monetary value) in a close or tight configuration.

4.16.2.2 Helicopter Hangars. Helicopter hangars do not normally require supplementary low-level AFFF systems.

4.16.3 Activation of Foam-Water Sprinkler Systems and Supplementary Low-Level (Under-Wing) Fixed AFFF Systems. Activation of a single overhead thermal rate-compensated heat detector, a single manual release station or a single optical detector shall cause activation of supplementary low-level under-wing systems and pre-action foam-water sprinkler systems. In addition, activation of any foam-water sprinkler system shall activate the supplementary low-level protection systems.

Note: For Army and Air Force projects, optical detection shall not cause the activation of any fire suppression systems.

4.16.3.1 Manual Release Stations. Provide manual release stations for activation of pre-action foam-water sprinkler systems and supplementary low-level under-wing systems. Manual pull stations and manual release stations shall be waterproof and protected from accidental activation. Manual release stations shall be distinctively identified from the manual pull stations associated with the fire alarm evacuation system.

4.16.3.2 Rate Compensated Heat Detectors. Provide "spot-type" rate-compensated heat detectors at the ceiling level where pre-action foam-water sprinkler systems are installed. Rate compensated heat detectors shall be hermetically sealed. Install detectors to provide a maximum coverage of 400 square feet per detector. Detectors shall have a temperature rating not lower than 190 degrees F.

4.16.3.3 Ultraviolet and Infrared Optical Detectors. Provide combination ultraviolet and infrared optical detectors for low-level detection.

4.16.4 Water Supplies

a) The total water supply shall be capable of furnishing water for the largest number of systems that may be expected to operate. This shall include overhead foam-water sprinkler systems and supplementary fixed under-wing protection systems. For overhead foam-water sprinkler systems, calculate the water supply by assuming that a fire at any point will operate all the systems (i.e., every sprinkler head on that system) in every draft-curtained area that is wholly or partially within:

(1) 50 feet (15.2 m) of the point measured horizontally for hangars with ceiling height of 25 feet (7.6 m) or less.

(2) 75 feet (23 m) of the point measured horizontally for hangars with a ceiling height in excess of 25 feet (7.6 m) but not more than 75 feet (23 m).

(3) 100 feet (30.6 m) of the point measured horizontally for hangars with a ceiling height in excess of 75 feet (23 m).

b) Note: For Air Force and Army projects, water supplies to support the overhead foam-water sprinkler systems shall be sufficient to meet the following requirements and supplementary systems. The system shall be designed to supply all sprinkler heads in the hydraulically most demanding areas. The hydraulically most demanding areas shall be as follows:

(1) 6000 square feet (740 m²) area where roof or ceiling height is 25 feet (7.6 m) or less above floor level.

(2) 18,000 square feet (1670 m²) area where roof or ceiling height is over 25 feet (7.6 m) but not more than 75 feet (23 m) above floor level.

(3) 35,000 square feet (3250 m²) area where roof or ceiling height is over 75 feet (23 m) above the floor level.

4.16.5 Equipment Locations. Foam concentrate tanks, proportioning equipment and sprinkler control valves shall be located in a dedicated room separate from the aircraft servicing area by a minimum of 1-hour fire resistive construction. Equipment rooms shall be configured or sized to provide access for inspection, maintenance, and repair of all equipment. Doors providing direct access to the exterior of the structure shall be provided. Equipment shall be located to permit removal of tanks,

bladders, valves, pumps, and motors without the removal of other components. Designers should consider using stainless steel piping and pumps to transport foam concentrate.

4.16.6 Controls Locations. Fire detection and actuation system controls shall be installed in an environmentally controlled area not subject to accidental water leakage.

4.16.7 Agent Requirements. Only AFFF concentrate meeting Military Specification MIL-F-24385F, Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Seawater, shall be permitted.

4.16.8 Adjacent Areas. Automatic wet pipe sprinkler systems shall be provided in areas of the facility outside of the aircraft storage and service areas.

4.17 Aircraft Acoustical Enclosures

4.17.1 Complete Enclosures (Hush-House). Requirements shall be the same as those listed in par. 4.16, with the following additions:

a) Overhead AFFF systems shall be designed for the entire floor area.

b) Low-level (under-wing) systems shall be provided for uniform coverage of the entire floor area.

c) Overhead and low-level (under-wing) systems shall both be automatically actuated by rate compensated heat detectors. Switches for interrupting the automatic features shall be provided in the control room. Clearly visual indication shall be provided when the automatic features have been interrupted.

d) Separate manual controls for actuation of each AFFF system shall be provided in the control room.

Exception: Air Force installations containing approved gaseous fire extinguishing systems.

4.18 Out-of-Airframe Acoustical Enclosures (Test Cells). The requirements for complete acoustical enclosures listed in par. 4.17 shall be provided. In lieu of an overhead AFFF system, the following may be provided:

a) An overhead water deluge system having a density of 0.35 gpm (0.0221 L/s) per square foot (0.0929 m²) over the entire floor area; and

b) A water spray system for the engine having a density of 0.50 gpm (0.0315 L/s) per square foot (0.0929 m²) of engine surface area; and

c) A water spray system for the floor area beneath the engine having a density of 0.50 gpm (0.0315 L/s) per square foot (0.0929 m²) of floor area.

Note 1: For Air Force projects, the required density for the water deluge system is 0.25 gpm (0.01579 L/s) per square foot over the entire floor area, and compliance with item c) is not required.

Note 2: The overhead deluge system need not extend into the area where the water spray systems for the engine and floor are present.

4.19 Hyperbaric and Hypobaric Chambers

4.19.1 Hyperbaric Chambers. Hyperbaric chambers shall conform to NFPA 99, Chapter 19. Criteria contained in the following documents shall be incorporated into the design of hyperbaric chambers.

a) NAVFAC DM-39, Hyperbaric Facilities

b) SS 521-AA-MAN-010, U.S. Navy, Diving and Manned Hyperbaric Systems Safety Certification Manual

4.19.2 Hypobaric Chambers. Hypobaric chambers shall conform to NFPA 99B, Hypobaric Facilities.

4.20 Anechoic Chambers. Anechoic chambers shall be protected in accordance with FM Loss Prevention Data Sheet 1-53, Anechoic Chambers. Regardless of separation distance or type of construction, anechoic chambers of high monetary value with respect to construction or contents shall be protected.

4.21 Liquid Oxygen (LOX)

4.21.1 Fixed Liquid Oxygen Tanks. Fixed tanks having combined capacity of 100 gallons (378.5 L) or less and portable tanks shall conform to NFPA 51, Design and Installation of Oxygen-Fuel

Gas Systems for Welding, Cutting, and Allied Processes, and NFPA 43C for industrial applications, and NFPA 99.

Exception: As modified in par. 4.21.2.

4.21.2 Separation Distances for Liquid Oxygen (LOX) Tanks and Carts. Separation distances for LOX tanks and carts shall be as follows:

a) A minimum of 100 feet from aircraft parking, fueling, or servicing areas.

b) A minimum of 100 feet from any flammable or combustible liquids handling, servicing, processing, or storage area.

c) A minimum of 50 feet from any buildings of Type III, IV, or V construction.

d) A minimum of 25 feet from any buildings of Type I or Type II construction.

4.21.3 Oxygen Bulk Tanks. Fixed bulk tanks having a single or combined capacity of more than 100 gallons (378.5 L) shall conform to NFPA 50, Bulk Oxygen Systems at Consumer Sites.

Exception: As modified in par. 4.21.2.

4.21.4 Bulk Tank Vehicle Parking. Parking for bulk tank vehicles servicing fixed tanks shall meet the separation requirements of NFPA 50, for the fixed bulk tank.

Exception: As modified in par. 4.21.2.

4.21.5 Liquid Oxygen Storage for Propellant Applications. Liquid oxygen storage used for propellant applications shall comply with the DOD Instruction 5154.4, DOD Ammunition and Explosives Safety Standards, OSHA Standard 1910.109, Explosives and Blasting Agents.

Exception: As modified in par. 4.21.2.

4.22 Department of Defense Dependent Schools

4.22.1 Construction. Facilities shall be Type I or II construction in accordance with the UBC.

4.22.2 Requirements. Facilities shall comply with educational occupancies in NFPA 101.

4.23 Vehicle Parking, Storage, Maintenance, and Repair Facilities. Facilities utilized for the parking, storage, maintenance, and repair of general and special purpose motor vehicles shall comply with NFPA 88A, Parking Structures and/or NFPA 88B, Repair Garages.

4.23.1 Vehicle Parking. Enclosed buildings used for vehicle parking and storage of 10 or more vehicles shall be protected by an automatic sprinkler system.

4.23.2 Overhaul and Repair Shops. Facilities falling within this category are those in which major overhaul and repairs are made to various types of equipment or their component parts. Disassembly and testing may also be performed in such facilities, which include aircraft shops, automotive garages and repair shops, and ship repair shops.

4.23.2.1 Requirements. Automotive garages shall conform to NFPA 88B. Ship repair facilities shall conform to NFPA 303, Marinas and Boatyards, and NFPA 312. Major aircraft overhaul and repair shops shall conform to NFPA 409.

4.23.3 Refueler Vehicle Facilities. Facilities used for the parking, storage, maintenance, and repair of aircraft refueler vehicles shall:

- a) Be protected by an automatic sprinkler system or a closed-head foam-water AFFF sprinkler system, and
- b) Utilize Class I Division 2 electrical equipment and wiring as defined by NFPA 70.

4.24 Pesticide Storage and Handling Facilities. Locate facilities or operations involving the storage, mixing, or handling of non-flammable pesticides a minimum of 100 feet (30.48 m) from the nearest building or occupied structure.

- a) Exception 1: Facilities of Type I or Type II - FR construction as defined by the UBC, may be located less than 100 feet (30.48 m) from the nearest building or occupied structure, but not less than 30 feet (9.14 m) in any case.

b) Exception 2: Facilities protected by an automatic sprinkler system may be located less than 100 feet (9.14 m) from the nearest building or occupied structure, but not less than 30 feet (9.14 m) in any case.

c) Exception 3: Existing facilities involving the storage, mixing, or handling of non-flammable pesticides are permitted in a building when all the following are provided:

(1) The building is completely protected, including the pesticide area, by an automatic sprinkler system.

(2) The pesticide area is separated by not less than one-hour fire rated construction from the remainder of the building.

(3) Duct work which penetrates fire rated partitions and wall assemblies is provided with smoke and fire dampers.

4.25 Windowless Structures. Windowless structures are defined in and shall conform to NFPA 101, Chapter 30. Windowless structures three stories or more in height shall also be provided with a manually activated smoke exhaust system.

Section 5: WATER SUPPLY FOR FIRE PROTECTION

5.1 Water Demands for Sprinklered Facilities

5.1.1 Factors Influencing the Water Demand for Sprinklers.

The water demand required for sprinkler protection depends upon occupancy, discharge density, design area, and type of sprinkler system (wet or dry), type of construction, and other building features.

5.1.2 Water Demand for Sprinklers. The water demand required for sprinklers shall be determined from Table 3. Refer to Appendix B for occupancy classifications.

5.1.2.1 Design Densities. Design densities indicated in Table 3 are minimum densities, and each sprinkler in the design area shall discharge at least the flow rate required to produce the stipulated density.

5.1.2.2 Design Area. Design areas shown in Table 3 are the hydraulically most remote areas.

5.1.3 Water Demand for Hose Streams. Hose streams are needed concurrently with sprinkler discharge in order to effect final extinguishment or to wet down adjacent structures. The hose stream demand for sprinklered occupancies shall be determined from Table 1.

5.1.4 Total Water Demand for Sprinklered Occupancies. The total water demand for sprinklered occupancies is equal to the sum of the domestic demand plus the sprinkler system(s) water demand and the hose stream(s) demand. The total demand shall be available at the sprinkler system connection to the underground main, and at the pressure necessary to produce the required sprinkler density over the required hydraulically most remote area of sprinkler operation.

5.1.5 Water Demand for Sprinklers (Special Facilities). Special requirements apply to some facilities, as indicated in pars. 5.1.5.1 through 5.1.5.5.

5.1.5.1 Aircraft Hangars. Water demands for aircraft hangars shall be in accordance with par. 4.16.

5.1.5.2 Warehouses (High Piled or High Rack Storage). Water demands for warehouses containing high rack storage shall conform to NFPA 231C. Water demands for warehouses containing high piled storage shall conform to NFPA 231.

Table 3
Water Demands for Sprinklered Facilities

OCCUPANCY CLASSIFICATION ¹	SPRINKLER		HOSE Gal/Min (L/Min)	DURATION OF SUPPLY Minutes
	DESIGN DENSITY ² (Gal/Min)/FT ² (L/min/m ²)	DESIGN AREA FT ² (m ²)		
Light Hazard	0.10 (4.07)	3000(278.70)	250(946.25)	45
Ordinary-Hazard Group 1	0.15 (6.11)	3000(278.70)	500(1892.50)	60
Ordinary-Hazard Group 2	0.20 (8.15)	3000(278.70)	500(1892.50)	75
Extra-Hazard Group 1	0.30 (12.22)	3000(278.70)	750(2838.75)	120
Extra-Hazard Group 2	0.40 (16.29)	3000(278.70)	750(2838.75)	120

¹Refer to Appendix B for occupancy hazard classification.

²For dry pipe systems, increase design area by 30 percent.

³Design area may be reduced to limits described in NFPA 13, with approval of the EFD/EFA/PWC (Navy/Marine Corps), District (Army), MAJCOM (Air Force), HQDLA (MMBI) fire protection engineer, or the AHJ.

5.1.5.3 Ordnance Facilities. Water demands for ordnance facilities shall conform to par. 4.9.

5.1.5.4 Rubber Tire Storage. Water demands for these facilities shall be in accordance with NFPA 231D, Storage of Rubber Tires.

5.1.5.5 Aircraft Acoustical Enclosures. Water demands for these facilities shall conform to pars. 4.17 and 4.18.

5.1.5.6 Family Housing. Water demands for these facilities shall conform to par. 4.2. Water demand for family housing shall be the sprinkler water demand plus 250 gpm for hose streams.

5.2 Water Demands for Unsprinklered Facilities. Water demands for buildings and facilities that are not fully sprinklered are based on fire department hose stream requirements.

5.2.1 Hose Stream Demands for Unsprinklered Facilities. Hose stream demands and duration requirements for facilities that are not fully sprinklered are outlined in Appendix C. The following factors affect the water demand and duration and shall be considered to determine the specific demand and duration within a given range in accordance with Appendix C:

- a) Occupancy classification,
- b) Response time by fire department,
- c) Type of construction,
- d) Number of stories,
- e) Separation distances,
- f) Building floor area, and
- g) Firefighting access.

5.2.1.1 Procedure. The procedure for determining specific demands within a range is provided in Appendix C. This procedure shall be followed to determine the minimum requirements for facilities that are not fully sprinklered.

5.2.1.2 High Demands. When the required fire flow demand exceeds 2000 gpm (126.16 L/s), a cost and benefit analysis shall be conducted to determine if additional fire protection systems, features, or design changes that provide more favorable factors, such as type of construction or sprinkler protection, are more cost effective than providing the required fire flow. Such changes may reduce the required fire flow to a point that it can be provided more economically.

5.2.2 Water Stream Demand for Unsprinklered Special Facilities. Special requirements may apply to certain facilities. Such facilities include ship berthing and drydock facilities, family housing, POL areas, aircraft parking and refueling areas, and vehicle and yard storage.

5.2.2.1 Ship Berthing and Drydock Facilities. Refer to par. 4.12 for water demand requirements for ship berthing and drydock facilities.

5.2.2.2 Family Housing. The water demand for unsprinklered family housing shall be as follows:

- a) One-story - 500 gpm (1920 L/min) for 90 minutes.
- b) Two-story - 750 gpm (2820 L/min) for 90 minutes.
- c) Three-story and above - 1000 gpm (3780 L/min) for 90 minutes.

5.2.2.3 POL Areas. POL areas shall conform to the following:

a) Aboveground Atmospheric POL Tanks. Table 4 provides fire flow rates for non-pressurized POL tanks.

b) Aboveground Pressurized POL Tanks. Table 5 provides fire flow rates for pressurized POL tanks.

5.2.3 Aircraft Parking and Refueling Facilities. A minimum fire flow rate of 1000 gpm (3780 L/min) for a 2-hour duration is to be provided for all such facilities.

5.2.4 Yard and Outdoor Storage. Yard and outdoor storage shall be protected in accordance with NFPA 80A, Protection of Buildings From Exterior Fire Exposures, NFPA 231, and FM Loss Prevention Data Sheet 1-20, Protection Against Fire Exposure. Aisle widths and separation distances shall be maintained to limit the exposure to nearby buildings and to facilitate manual fire fighting operations.

5.2.5 Vehicle Parking Areas. Provide a minimum fire flow rate of 500 gpm (1920 L/min) for a 2-hour duration shall be provided for all such facilities.

5.3 Water Supply Pressure Requirements

5.3.1 Pressure Required. Pressure required for sprinklered facilities shall be the pressure required to meet the total demand and shall be determined by hydraulic calculations. The total demand is the required sum of the domestic demand, sprinkler demand, and hose stream demand.

5.4 Quantities of Water Required. Requirements for fire protection water storage are based on the assumption that there will be only one fire at a time. The quantity of water required is equal to the product of the fire protection water demand and the required duration. This quantity represents fire protection requirements only, and shall be available at all times. Water supply for domestic, industrial, and other demands shall be added to these requirements to determine the total amount of water that is necessary at a facility. If the public water system supplying a facility is reliable, provides a minimum of two connections, each providing at least 50 percent of the required capacity, has adequate capacity and pressure to meet water requirements, and continuous reserve storage capacity at least equal to the required fire protection water storage, then no separate water storage facility is required.

Table 4
Atmospheric POL Tank Cooling Water

TANK DIAMETER		FIRE FLOW RATE	
FEET	METERS	GPM	L/MIN
0 - 64	0 - 19	500	1920
65 - 119	20 - 35	750	2820
120 - 154	36 - 46	1000	3780
155 - 199	47 - 61	1250	4740
200 or greater	61 or greater	1500	5700
Minimum duration: 240 minutes.			

Note 1: Allow an additional 500 gpm (1920 L/min) for each exposed tank, pressure vessel or handling facility within 50 ft (15 m) or one tank diameter, whichever is greater, of the largest tank under consideration.

Note 2: For Navy projects, the maximum water supply for storage tanks shall not exceed 2500 gpm.

Table 5
Pressurized POL Tank Cooling Water

TANK GROUP SIZE	FIRE FLOW RATE GPM (L/MIN)
Single tank less than 30,000 gallon capacity. (113,550 L)	250 (960)
Single tank more than 30,000 gallon capacity. (113,550 L)	500 (1920)
2 to 6 tanks, one or more tanks greater than 30,000 gallon capacity. (113,550 L)	500 (1920)
2 to 6 tanks, each greater than 30,000 gallon capacity. (113,550 L)	1000 (3780)
7 or more tanks, each tank less than 30,000 gallon capacity. (113,550 L)	1000 (3780)
7 or more tanks, one or more tanks greater than 30,000 gallon capacity. (113,500 L)	1500 (5700)

Minimum Duration: 240 minutes

5.4.1 Total Storage Capacity. The total stored supply for fire protection purposes shall be sufficient to meet the maximum required fire flow demand for the duration specified.

5.4.2 Reduction in Storage Capacity. In computing the fire protection storage requirement, a reduction in storage capacity is acceptable if an adequate replenishment source is available. Factors that must be evaluated include the reliability of the makeup facility, its sustained flow capacity, its method of operation (automatic or manual), and flow limitations imposed by the capacity of treatment operations.

5.4.3 Replenishment of Storage. The water storage shall be self-replenishing. It shall reach required volume during normal consumption within 48 hours, and with 24 hours curtailing normal consumption.

5.5 Sources of Water Supply

5.5.1 Primary Water Supplies. Primary water supplies shall consist of one or a combination of the following:

a) Two connections to a public water system (one connection is ample for a small activity, such as a Reserve Training Facility).

b) Elevated tanks or reservoirs.

c) Multiple pumps with adequate suction supply.

5.5.2 Secondary Water Supplies. Where public water supply is inadequate or unreliable, a secondary supply is required. Secondary supply shall be by gravity tank, pressure tank, booster pumps taking suction from adequate capacity main(s), or fire pumps taking suction from adequate source(s).

5.6 Fire Pumps

5.6.1 Requirements. Pumps for fire protection shall have adequate capacity with reliable power and water supply. This equipment shall conform to requirements of NFPA 20, Installation of Centrifugal Fire Pumps. Fire pumps, drivers, and other equipment including automatic accessories shall be listed by UL or approved by FM or listed or classified by an NRTL.

5.6.2 Pump Type. A fire pump may be either a horizontal or vertical shaft centrifugal pump or a vertical shaft turbine pump, whichever is most economical and appropriate for the intended

use. A horizontal centrifugal pump in either the horizontal or vertical position shall not be used where suction lift is required. A vertical shaft turbine pump shall be used for suction lift.

5.6.3 Pump Starting Arrangement. Fire pumps shall be arranged to start automatically except that they shall be arranged for manual starting when other available water supply sources are capable of providing demands for automatic sprinkler systems simultaneously with domestic and industrial demands.

5.6.4 Pump Drive. When electric power is economically available from a reliable single power source or from two independent sources in accordance with NFPA 20, pumps shall be electric driven only. A reliable single power source is defined as a power source having an average forced down time, excluding scheduled repairs, which does not exceed 8 consecutive hours for any one incident nor more than 24 hours cumulatively over the last 3 years. When such electrical power supplies are not available, fire pumps shall be diesel driven. Spark ignited internal combustion engines shall not be used to drive fire pumps.

5.6.5 Water Level Controls. Manual controls, double-acting altitude valves, or other automatic devices shall be used to maintain the water level in elevated storage tanks. Altitude valves shall be arranged with bypasses.

5.6.6 Meters. Where meters are installed on water distribution systems, they shall be listed by an NRTL as fire flow meters.

5.7 Water Distribution Systems

5.7.1 Mains. The distribution system shall be sized to accommodate fire flows plus domestic and industrial or flushing demands that cannot be restricted during fires. Distribution shall be looped to provide at least 50 percent of the required fire flow in case of a single break. Dead-end mains shall be avoided. Distribution systems shall be designed in accordance with NFPA 24, Installation of Private Fire Service Mains and Their Appurtenances. For Army and Air Force projects, also refer to TM 5-813-5/AFM 88-10, Water Supply, Water Distribution, Vol. 5. For Navy projects, also refer to MIL-HDBK-1005/7, Water Supply Systems.

5.7.2 Valves. Control valves shall be provided in each source of water supply, such as tanks and pumps. A sufficient number of sectional valves shall be provided so that not more than a combined total of five hydrants and sprinkler systems, or not more than three sprinkler systems shall be out of service due to a single break. Control valves shall be either post-indicating or outside-stem-and-yoke types. Sectional valves may be key-operated type. New valves shall be right-hand valves.

5.7.2.1 Drawings. Drawings shall be provided showing control and sectional valve locations and valve sizes. Existing left-hand valves shall be clearly indicated on drawings.

5.7.3 Hydrants. Fire hydrants shall be UL listed or FM approved or listed or classified by an NRTL and shall have two 2-1/2-inch (64 mm) hose outlets and one 4-inch (102 mm) or 4-1/2-inch (114 mm) suction connection with national standard fire hose threads in accordance with NFPA 24 and NFPA 1963, Fire Hose Connections. Wet-barrel or California-type hydrants are preferable in areas where there is no danger of freezing. Dry barrel or traffic-type hydrants shall be used in areas where there is a danger of freezing. Hydrants shall be aboveground type. If local municipal departments use nonstandard connections, adapters shall be made and supplied to engine companies that respond to DOD installation fires. In DOD installations serviced by only local fire departments, hydrant hose threads shall be meet local requirements.

Note 1: Overseas bases with current below grade hydrants in accordance with local national policy.

Note 2: The one 4-inch (102 mm) suction connection only applies to Navy projects.

5.7.3.1 Installation Requirements. Hydrants shall be installed adjacent to paved areas, not closer than 3 feet (1 m) and not farther than 7 feet (2 m) from the roadway shoulder or curb line, where they will be accessible to fire department apparatus. Hydrants shall be installed with not less than 6-inch (152 mm) connection to the supply main, and valved at the connection. Barrels shall be long enough to permit at least 18-inch (457 mm) clearance between the center of the 4-1/2-inch (114 mm) pumper connection and grade. The ground shall be graded so that any surface drainage is away from the hydrant. Installation shall be in accordance with NFPA 24, except as modified herein. Pumper connection should be perpendicular to the street to allow straight lined connection to the pumper.

5.7.3.2 Spacing Requirements. A sufficient number of hydrants shall be provided so that hose stream demand can be met without taking more than 1250 gpm (4700 L/min) from any single hydrant. Hydrants shall also be spaced in accordance with the following requirements:

a) Parts of the building exterior shall be reached by hose lays of not over 350 feet (110 m) with consideration given to accessibility and obstructions. For new construction, at least one hydrant shall be located within 150 feet (45.72 m) of fire department connections.

b) Hydrants protecting warehouses shall be spaced a maximum of 400 feet (120 m) apart.

c) Hydrants protecting aircraft hangars shall be located at 300 foot (90 m) maximum intervals, and there shall be at least one hydrant at each corner of the hangar.

d) Hydrants protecting POL storage and distribution facilities shall be spaced at 300 foot (91.44 m) maximum intervals.

e) Hydrants protecting aircraft parking and servicing aprons shall be spaced at 300 foot (91.44 m) maximum intervals along one side.

5.7.3.3 Hydrant Protection. Hydrants located adjacent to parking areas or other vehicle traffic areas shall be protected by bollards.

5.7.4 Pressure-Regulating Valves (PRVs). PRVs are restricted in use on fire protection water systems by NFPA 24. Where essential, PRVs shall be installed on individual services rather than on the main piping. Where PRVs are provided in mains supplying systems or portions of systems with fire hydrants, automatic sprinkler systems, or other installed fire protection, the following features shall be provided to safeguard against failures and to facilitate maintenance:

- a) Control valves on each side of the PRVs.
- b) Bypasses around PRVs.

Section 6: FIRE EXTINGUISHING SYSTEMS

6.1 Automatic Sprinkler Systems

6.1.1 Characteristics. Properly engineered and installed automatic sprinkler systems are designed to detect the presence of fire, activate both local and remote (fire department) alarms, and distribute water in sufficient quantity to either control or extinguish the fire. Sprinkler specifications shall include provisions regarding sprinkler contractor qualifications.

6.1.2 Application Requirements. The following requirements are in addition to the sprinkler requirements listed in Section 4, and sprinkler protection required by applicable NFPA codes and standards specifically referenced in this handbook. Sprinkler protection shall be provided in the following facilities:

a) Any new building over 15,000 square feet gross floor area unless permitted by Section 4 of this handbook.

b) Any facility whose operational impairment would reduce the operational readiness and responsiveness of strategic or tactical defensive and offensive capability.

c) Any facility containing direct war fighting assets including combat aircraft, naval vessels, and tactical vehicles.

d) Technical, industrial, and commercial type buildings, including hangars, shops, and laboratories used for production, repair, experimental testing, inspection, electronics overhaul facilities, or processes, services, or equipment involved with mission support.

e) Facilities containing significant amounts of critical equipment or equipment which requires a long lead time to replace. Such equipment or material includes training devices such as simulators for flight, navigation, weapons, radar, or gunnery training.

f) Buildings four stories or more in height, measured from the lowest grade, regardless of occupancy.

g) Facilities and contents of high monetary value (e.g., a combined facility and content replacement value exceeding 2.5 million dollars.)

h) Windowless structures in accordance with NFPA 101.

- i) Underground structures.
- j) Commissaries and exchanges over 8000 square feet (743.49 m²).
- k) New multistory buildings which are accessible to people with severe mobility impairment.
- l) Clubs including officer, non-commissioned officer, and enlisted; bowling centers, craft shops, including auto hobby shops, woodworking shops; and similar facilities.
- m) Facilities of Type III, Type IV, and Type V construction over two stories in height.
- n) Child development centers.
- o) Renovation of existing buildings of Type III, Type IV and Type V construction over 8000 square feet.

6.1.3 Fire Administration Authorization Act of 1992. In addition to the requirements above, automatic sprinklers shall be provided in multi-family housing and federal employee office buildings. For sprinkler requirements in multi-family housing, refer to par. 4.2. For new or renovated Federal employee office buildings under four stories in height, provide sprinklers in hazardous areas as defined by NFPA 101. For new or renovated Federal employee office buildings four or more stories in height, comply with par. 6.1.2, item f). Federal employee office buildings are defined as any building with 25 or more Federal employees.

6.1.4 Design Requirements. Sprinkler systems shall use equipment and devices listed by an NRTL. Sprinkler systems for light, ordinary, and extra hazard occupancies shall follow applicable criteria set forth in NFPA 13 and NFPA 16, Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems. Sprinkler water requirements are stipulated in Section 5 of this handbook.

6.1.4.1 Hydraulic Calculations. New sprinkler systems with areas over 1500 square feet shall be designed using hydraulic calculations. Use of pipe schedule designs is strongly discouraged for any sprinkler system. Required discharge densities and areas of discharge operation are given in Table 1. Calculations shall follow the format of NFPA 13. Pipe friction losses and equivalent lengths of pipe for fittings and valves shall be in accordance with NFPA 13.

Note: Additions to existing pipe schedule systems may be designed using the pipe schedule method.

6.1.4.2 Sprinkler Coverage. In buildings protected by automatic sprinklers, sprinklers shall provide coverage throughout 100 percent of the building. This includes, but is not limited to, telephone rooms, electrical equipment rooms, boiler rooms, switchgear rooms, transformer rooms, and other electrical and mechanical spaces. Coverage per sprinkler shall be in accordance with NFPA 13, except that it shall not exceed 225 square feet for light hazard occupancies or 130 square feet for ordinary hazard.

Exception 1: Facilities that are designed in accordance with NFPA 13R and NFPA 13D.

Exception 2: Sprinklers may be omitted from small rooms which are exempted for specific occupancies in accordance with NFPA 101.

6.1.4.3 Connections to Exterior Fire Reporting Systems. Where sprinklers are located at facilities with station or base fire reporting systems, the sprinkler systems shall be electrically connected to the fire reporting system for transmission of sprinkler water flow alarms.

6.1.4.4 Strainers. Where water conditions warrant, or systems involve high velocity flows, riser strainers shall be installed.

6.1.5 Sprinkler Shop Drawings. Sprinkler shop drawings shall be prepared and submitted by a qualified sprinkler contractor.

6.2 Water Spray Systems

6.2.1 Requirements. Design requirements for water spray systems shall conform to NFPA 15.

6.3 Foam Systems

6.3.1 Requirements. The NFPA Fire Protection Handbook and FM Loss Prevention Data Sheets contain data and information concerning installation and arrangement of foam systems for various types of Class B (flammable liquids) hazards. Foam installations shall be in accordance with NFPA 11, Low-Expansion Foam, NFPA 11A, Medium- and High-Expansion Foam Systems, NFPA 16, and NFPA 16A, Installation of Closed-Head Foam-Water Sprinkler Systems.

6.4 Standpipe Systems. When required, standpipe systems shall be installed in accordance with NFPA 14, Installation of Standpipe and Hose Systems.

Exception: Residual pressure requirements specified in NFPA 14 may be omitted for buildings under 150 feet in height where fire department apparatus are expected to boost pressure in standpipe systems.

6.4.1 Class I Standpipe Systems

a) Class I standpipe systems shall be provided in the stair towers of buildings four stories or more in height. These systems shall not include hoses.

b) Class I standpipe systems shall also be provided in facilities where it is not practical to reach major portions of the building with fire fighting hose lines extended from the exterior of the building, regardless of building height.

6.4.2 Class II and Class III Standpipes. Class II and Class III standpipes shall not be permitted.

6.5 Dry Chemical Extinguishing Systems

6.5.1 Application. Fixed dry chemical systems are approved for protection of certain types of special occupancies, hazards, and facilities such as dip tanks, and other operations involving flammable liquids.

6.5.2 Design Requirement. Dry chemical systems shall conform to NFPA 17, Dry Chemical Extinguishing Systems.

6.5.3 Limitations. Dry chemical agents should not be used to protect sensitive electronics.

6.6 Carbon Dioxide Systems

6.6.1 Application. Carbon dioxide systems are normally effective against flammable liquid (Class B) and electrical (Class C) fires. New systems are not authorized in occupiable areas.

6.6.2 Design Requirements. Carbon dioxide systems shall conform to NFPA 12, Carbon Dioxide Extinguishing Systems.

6.7 Halon 1301 Systems

6.7.1 Application. Installation of new Halon 1301 systems is prohibited except by special approval of the AHJ in the component office listed in par. 1.3.5.

6.8 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with NFPA 10, Portable Fire Extinguishers. Extinguishers should be provided as part of the construction contract.

6.8.1 Extinguisher Cabinets. Recessed or semi-recessed enclosed cabinets shall be provided in all facilities except storage and industrial occupancies.

6.9 Wet Chemical Extinguishing Systems

6.9.1 Application. Fixed wet chemical systems are suitable for protection of certain types of special occupancies, hazards, and facilities, such as cooking surfaces, cooking exhaust systems, and dip tanks.

6.9.2 Design Requirements. Wet chemical systems shall conform to NFPA 17A, Wet Chemical Extinguishing Systems.

Section 7: FIRE ALARM SYSTEMS

7.1 Fire Alarm Reporting Systems

7.1.1 Applications. Fire alarm reporting systems are the base-wide reporting systems which connect the building fire alarm control panel(s) to the base fire department. Install fire alarm reporting systems in occupied areas and buildings as a means for automatically and manually reporting fires to station or base fire departments or to other central alarm locations as required to implement firefighting operations and emergency action. Required systems are to be digital, telephonic, radio, or supervised conductor types. Consider compatibility of extensions of fire reporting systems with existing equipment. Do not provide fire reporting systems at isolated small areas, ammunition and ordnance storage, and similar restricted areas where personnel reporting systems are not generally expected to be present. Do not require reporting systems in family housing areas that are remote from the main built-up area of the activity or station. Street boxes are not required.

7.1.2 Requirements. Alarm reporting systems shall conform to NFPA 72, and shall provide the following where applicable:

- a) Transmission of coded signals to fire department headquarters and other central locations;
- b) Permanent record of alarm signal, time, and date;
- c) Automatic supervision of alarm initiating circuits;
- d) Automatic conditioning for transmission of signals under line fault conditions or signal ground, single open, or both; and
- e) Automatic testing of radio signaling devices.

7.2 Fire Alarm Evacuation Systems

7.2.1 Applications. Fire alarm evacuation systems shall be provided in the following locations:

- a) Buildings required by NFPA 101.
- b) Buildings with an occupant load of 200 or more.
- c) Multistory buildings with an occupant load of 20 persons or more above or below the level of exit discharge.

d) Unaccompanied officer personnel housing (UOPH, BOQ), unaccompanied enlisted personnel housing (UEPH, BEQ), and similar sleeping facilities. Personnel housing and similar lodging facilities.

e) Buildings requiring automatic detection or suppression systems.

7.2.2 Requirements. These systems consist primarily of manual pull stations and fire alarm indicating devices. Automatic alarm initiating devices such as detectors and water flow alarms shall be connected to these systems when provided. Fire alarm systems shall be connected to a central alarm location, fire department, or alarm monitoring location. Building fire alarm evacuation systems shall be installed in accordance with NFPA 72. Fire alarm systems shall be independent, stand-alone systems which are not an integral part of a security, an energy monitoring and control system (EMCS), or other systems. Fire alarm systems may be connected to security systems or an EMCS for monitoring purposes only, but shall in no way rely on any components of those other systems for operation. Wireless interior fire alarms are not permitted.

Exception: Existing fire alarm systems which are controlled by an EMCS.

7.2.2.1 Requirements of the UFAS and ADA. Placement and installation of audiovisual warning devices shall be in accordance with the UFAS and the ADA.

7.3 Automatic Fire Detection Systems

7.3.1 Applications. Fire detection systems shall be provided in areas required by this handbook and should be limited to these applications. Detection systems shall be provided in areas requiring fire detection by NFPA standards and specific criteria contained herein.

7.3.2 Requirements. Fire detection systems shall conform to the applicable provisions of NFPA 72, the UFAS and the ADA. Detection systems shall be arranged to alert building occupants and to transmit a signal to a constantly attended location. Fire detection systems shall be independent, stand-alone systems which are not an integral part of a security system, an EMCS, or other systems. Fire detection systems may be connected to security systems or an EMCS for monitoring purposes only, but shall in no way rely on any components of those other systems for operation.

Exception: Existing fire detection systems which are controlled by an EMCS.

7.3.3 Detection Systems. Detection systems, especially smoke detection systems, require significant maintenance. It is critical that the required detectors are properly installed and maintained. Providing detectors in locations that are not required increases the already high maintenance costs of alarm systems and strains the maintenance program for critical detection systems. If a facility warrants protection and criteria does not require detection, protection should be accomplished by sprinkler protection, preferably wet pipe sprinklers which provide superior protection with little maintenance.

7.3.3.1 Smoke Detection and Destratification Fans. The area of protection for smoke detection devices permitted by NFPA 72 shall be reduced by 50 percent where destratification fans are used.

Exception: This restriction does not apply to thermal or flame detection devices or to residential occupancies.

7.3.4 Addressable Interior Fire Alarm Systems. For large systems, the designer should consider using addressable systems to minimize installation and maintenance costs.

Note 1: For Air Force projects, unless automatic suppression systems are required herein or by other guidance, complete automatic fire detection systems and portable fire extinguishers constitute the minimum level of acceptable fire protection for new construction. Smoke detectors in return air plenums do not meet this minimum level.

Note 2: For Air Force projects, when a system is divided into four or more zones, a graphic annunciator constructed of engraved phenolic or metal material shall be installed at a location determined by the host fire department.

7.4 Shop Drawings for Fire Alarm Systems. Fire alarm drawings shall be prepared and submitted by a qualified fire alarm contractor. Shop drawings are required to be submitted for fire alarm reporting systems, fire alarm evacuation systems, and automatic fire detection systems.

MIL-HDBK-1008C

APPENDIX A
UNIFORM BUILDING CODE AND NFPA 220 EQUIVALENTS

UBC	NFPA 220
Type I (FR)	Type I (443) Type I (332)
Type II (FR)	Type II (222)
Type II (One Hour)	Type II (111)
Type II (N)	Type II (000)
Type III (One Hour)	Type III (211)
Type III (N)	Type III (200)
Type IV (HT)	Type IV (2HH)
Type V (One Hour)	Type V (111)
Type V (N)	Type V (000)

APPENDIX B
OCCUPANCY HAZARD CLASSIFICATION FOR DETERMINING AUTOMATIC
SPRINKLER DENSITIES AND HOSE STREAM DEMANDS

1) Classification of Occupancies. The principal occupancy classifications are light hazard, ordinary hazard, and extra hazard. Listed below are the classifications with examples of common occupancies listed under each. The basic hazard classification of an occupancy does not define the fire hazard present in all areas of that occupancy. If more hazardous processes or areas exist within a given occupancy, they shall be protected in accordance with the fire protection requirements pertaining to the hazard classification of that area. The classification for unlisted occupancies shall be determined from the definitions or by comparison with one of the listed occupancies.

a. Light Hazard Occupancies. Occupancies or portions of occupancies where the quantity and combustibility of the contents are low and fires with relatively low rates of heat release are expected. Small, scattered amounts of flammable liquids in closed containers are allowable in quantities not exceeding 5 gallons (20 L). This classification includes but is not limited to the following occupancies:

- (1) Churches and chapels
- (2) Gymnasiums
- (3) Clinics (dental, outpatient, patient areas only)
- (4) Hospitals
- (5) Data processing areas
- (6) Mess areas
- (7) Dispensaries (patient areas only)
- (8) Drill halls (not used for storage or exhibition)
- (9) Disciplinary barracks
- (10) Offices
- (11) Child development centers

APPENDIX B (Continued)

b. Ordinary Hazard Group 1 Occupancies. Occupancies or portions of occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of combustibles do not exceed 8 feet (2.5 m), and fires with moderate rates of heat release are expected. Modest, scattered amounts of flammable liquid, in closed containers are allowable in quantities not to exceed 20 gallons (75 L). This classification includes but is not limited to the following occupancies:

- (1) Armories
- (2) Sheet metal shops
- (3) Bowling alleys
- (4) Ship fitting shops
- (5) Clubs (officer, enlisted personnel, etc.)
- (6) Kitchens and bakery
- (7) Small stores
- (8) Theaters and auditoriums
- (9) Welding shops
- (10) Forge shops
- (11) Laundries
- (12) Automobile parking garage
- (13) Electronics assembly and repair

c. Ordinary Hazard Group 2 Occupancies. Occupancies or portion of occupancies where quantity and combustibility of contents is moderate, stockpiles do not exceed 12 feet (4 m), and fires with moderate rate of heat release are expected. Moderate, scattered amounts of flammable liquids in closed containers are allowable in quantities not to exceed 50 gallons (200 L). Small amounts of flammable liquids may be exposed as required by normal operations. This classification includes but is not limited to the following occupancies:

APPENDIX B (Continued)

- (1) Commissaries
- (2) Exchanges
- (3) Aviation Depots
- (4) Boiler rooms
- (5) Electrical maintenance shops
- (6) Engine and generator rooms
- (7) Laboratories
- (8) Refrigeration and air compressor rooms
- (9) Switchgear rooms
- (10) Machine rooms
- (11) Printing shops (using inks having flash points above 110 degrees F (44 degrees C))
- (12) Libraries
- (13) Piers and wharves
- (14) Vehicle repair garages
- (15) Woodworking shops

d. Special Occupancies. Special occupancies are facilities or areas which cannot be assigned a specific classification because of special protection requirements. This classification includes but is not limited to the following occupancies:

- (1) Flammable and combustible liquids
- (2) Aircraft hangars
- (3) Engine test cells
- (4) Missile assembly
- (5) Ordnance plants

APPENDIX B (Continued)

- (6) Rubber tile storage
- (7) Warehouses (high piled or high rack storage)
- (8) Foam rubber or plastic storage

Note: Refer to Section 5 and the appropriate NFPA codes and standards.

APPENDIX C
 PROCEDURE FOR DETERMINING FIRE FLOW DEMAND
 FOR UNSPRINKLERED FACILITIES

1) The following procedure shall be used to determine the required fire flow demand and duration for buildings that are not fully sprinklered.

a) Step One - Determine the Classification of Occupancy. Appendix C lists the classifications of occupancy hazard as Light, Ordinary Group 1, Ordinary Group 2, and Extra.

b) Step Two - Determine the Water Demand Weighted Factors. The table is divided into three weighted value categories for fire flow and duration in each occupancy classification. These categories are determined from the values established in the six factors discussed below. The final value is determined by adding the values obtained from all six factors. See sample calculations in Appendix C, par. 1-d.

(1) Weighted Factors. The six factors to be assigned weighted values are as follows:

(a) Response Time by Fire Department. Most installations have on-site fire departments which are familiar with hazards of buildings within the facility. The longer the response time for manual firefighting, the greater the water demand and duration. Traffic flow is a factor and traffic congestion is equivalent to a longer response distance. The fire department response weighing factors are as follows:

<u>Type Of Fire Department Response</u>	<u>Value</u>
On-Site (within 1 mile)	1
On-Site (over 1 mile but less than 3 miles)	2
On-Site (3 miles or greater)	3
Off-Site (less than 2 miles)	2
Off-Site (2 miles or greater)	3

(b) Type of Construction. Par. 2.1.4 requires that type of construction comply with the UBC. As structural fire integrity is reduced, water demand and duration will become greater. In addition, the combustibility of construction will add to the water demand for an unsprinklered building. The type of construction weighted values are as follows:

APPENDIX C (Continued)

<u>Type of Construction</u>	<u>Value</u>
Type I	1
Type II	2
Type III	3
Type IV	2
Type V	5

(c) Number of Stories. Firefighting is more difficult for multistory buildings. Furthermore, fire spreads faster vertically than horizontally. Fire in multistory buildings are more difficult to contain and have higher water demands. One-story buildings with high ceiling heights (20 feet or greater) shall be considered multistory. The weighted values for number of stories of a facility are as follows:

<u>Number of Stories</u>	<u>Value</u>
Single Story	1
Two or more stories	2

(plus 1 point for each floor more than two; maximum 6 points)

(d) Separation Distances. The model building codes and NFPA 80A provide that a separation distance of 60 feet or more does not require protection of exterior wall from exposure. The codes indicate that a separation distance of 20 feet or less requires one hour or more fire resistance construction. Water demand for protecting exposed facilities increases as separation distance decrease. In addition, exterior firefighting is hampered as building separation distances are reduced. The weighted values for the building separation distances are as follows:

<u>Separation Distance (feet)</u>	<u>Value</u>
60 or more	1
21 to 59	2
20 or less	4

(e) Building Floor Area. Firefighting water demands are higher for larger unsprinklered buildings. The weighted values for the building floor area factor are as follows:

APPENDIX C (Continued)

<u>Area (square feet)</u>	<u>Value</u>
7500 or less	1
7501 to 15,000	2
15,001 to 25,000	3
25,001 to 40,000	4
Greater than 40,000	5

(f) Firefighting Access. Studies conducted by fire departments have demonstrated that a responding engine company shall be within 180 feet of a fire to effectively control it. This distance is based on the use of a 30-foot stream of water and 150 feet of fire hose. The fire hose distance must be measured as the hose would lay over the terrain from the fire apparatus. Ideally, this distance should be to any part of the first three stories of a building, either by use of ground ladders through windows or by use of windows. The efficiency of the manual approach is reduced as greater hose connections are required. The weighted values for firefighting access based on hose layout distances are as follows:

<u>Maximum Hose Layout (feet)</u> (first three stories)	<u>Value</u>
180 or less	1
181 to 230	2
Greater than 230	4

c) Step Three - Determine Fire Flow and Duration. Using the occupancy classification and summation of weighted values of the six factors, select the required water demand for fire flow and duration from Table C-1.

Table C-1
Water Demands for Unsprinklered Facilities

TOTAL WEIGHTED VALUE						
Occupancy Hazard Classification	Fire Flows (gpm at 20 psi residual pressure)			Duration (minutes)		
	6-10	11-15	16+	6-10	11-15	16+
Light	750	1125	1500	60	90	120
Ordinary Group 1	1000	1500	2000	90	120	150
Ordinary Group 2	1500	2250	3000	90	120	150
Extra	2500	3750	5000	150	195	240

APPENDIX C (Continued)

d) Examples Calculations

(1) Administration Office Building (Light Hazard)

<u>Factors</u>	<u>Values</u>
1. Fire Department response On-site (within 1 mile)	1
2. Type of construction Type II	2
3. Number of Stories Two stories	2
4. Separation Distance 30 feet	2
5. Building Floor Area 22,000 square feet	3
6. Firefighting access 170 feet	2
<u>Total Weighing Value</u>	<u>12</u>

Per Table C-1: 1125 gpm for 90 minutes

(1) Welding Shop (Ordinary Group 1)

<u>Factors</u>	<u>Values</u>
1. Fire Department response Off-site (within 2 miles)	2
2. Type of construction Type II	3
3. Number of Stories Single story	1
4. Separation Distance 20 feet	4
5. Building Floor Area 22,000 square feet	3
6. Firefighting access 250 feet	4
<u>Total Weighing Value</u>	<u>17</u>

Per Table C-1: 2000 gpm for 150 minutes

APPENDIX C (Continued)

(1) Barracks (Light Hazard)

<u>Factors</u>	<u>Values</u>
1. Fire Department response Off-site (more than 3 miles)	3
2. Type of construction Type II	2
3. Number of Stories Three stories	3
4. Separation Distance 40 feet	2
5. Building Floor Area 9000 square feet	32
6. Firefighting access 200 feet	2
<u>Total Weighing Value</u>	<u>14</u>

Per Table C-1: 1125 gpm for 90 minutes

REFERENCES

NOTE: THE FOLLOWING REFERENCED DOCUMENTS FORM A PART OF THIS HANDBOOK TO THE EXTENT SPECIFIED HEREIN. USERS OF THIS HANDBOOK SHOULD REFER TO THE LATEST REVISIONS OF CITED DOCUMENTS UNLESS OTHERWISE DIRECTED.

FEDERAL/MILITARY SPECIFICATIONS, STANDARDS, BULLETINS, HANDBOOKS, DESIGN MANUALS, AND NAVFAC GUIDE SPECIFICATIONS:

Unless otherwise indicated, copies are available from the Defense Printing Service, Standardization Document Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

DESIGN MANUALS

DM-22	Petroleum Fuel Facilities.
DM-25 Series	Waterfront Operational Activities.
DM-29 Series	Dry Docking Facilities.
DM-35	Family Housing
DM-39	Hyperbaric Facilities.

HANDBOOKS

MIL-HDBK-1005/7	Water Supply Systems.
MIL-HDBK-1005/13	Hazardous Waste Storage Facilities.
MIL-HDBK-1025/1	Piers and Wharves.
MIL-HDBK-1025/2	Dockside Utilities for Ship Service.
MIL-HDBK-1025/6	General Criteria for Waterfront Construction.
MIL-HDBK-1029/1	Graving Dry Docks.
MIL-HDBK-1029/2	Marine Railways.
MIL-HDBK 1029/3	Drydocking Facilities Characteristics.
MIL-HDBK-1032/2	Covered Storage.
MIL-HDBK-1190	Facility Planning and Design Guide.

MIL-HDBK-1008C

MIL-HDBK-1191 Medical and Dental Treatment Facilities
Design and Construction Criteria.
SPECIFICATIONS

MIL-F-24385F Fire Extinguishing Agent, Aqueous Film-
Forming Foam (AFFF) Liquid Concentrate,
for Fresh and Seawater.

STANDARDS

FED-STD-795 Uniform Federal Accessibility Standards
(UFAS).

OTHER GOVERNMENT DOCUMENTS AND PUBLICATIONS:

DOD 5154.4 DOD Ammunition and Explosives Safety
Standards.

DOD 6055.9 DOD Ammunition and Explosive Safety
Standards.

NAVFAC 11012.114 Bachelor Enlisted Quarters Design
Guidance, New Construction Program.

NAVSEA OP 5 Ammunition and Explosives Ashore Safety
Regulations for Handling, Storing,
Production, Renovation, and Shipping.

SS 521-AA-MAN-010 U.S. Navy Diving and Manned Hyperbaric
Systems Safety Certification Manual.

Army Corps of Engineers, Department of the Army, Office Chief
Engineer DAEN-ASP, Forestall Building, Washington, DC 20314.

AR 385-64 U.S. Army Explosives Safety Program.

Reg 385-100 Safety Manual.

EM385-1-1 General Safety Requirements.

Army Corps of Engineers, Department of the Army, Publications
Depot, Alexandria, VA 22304.

TM5-813-5/
AFM88-10 Water Supply, Water Distribution.

CEGS-08701 Hardware Prison-Locking Devices.

Armed Services Explosives Safety Board, Government Printing Office, Washington, DC 20402.

Explosives Safety Manual.

Safety Manual for Siting, Constructing and Equipping Pier and Wharf.

Facilities for Handling Explosives.

Structures to Resist the Effects of Accidental Explosions.

Department of Labor, Occupational Safety and Health Administration, Code of Federal Regulations (CFR).

CFR 40 Series Protection of Environment

CFR 40-264 Regulations for Owners and Operators of Hazardous Waste Facilities.

CFR 40-265 Interim Station Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.

CFR 40-270 EPA Administered Permit Program: The Hazardous Waste Permit Program.

CFR 1910.109 Explosives and Blasting Agents

Federal Test Method Standards, U.S. Government Printing Office, Washington, DC 20402.

No. 372 Test for Critical Radiant Flux of Carpet Flooring Systems (Flooring Radiant Panel Test).

U.S. Department of Commerce, U.S. Government Printing Office, Washington, DC 20402.

DOC FF1-7 Standard for the Surface Flammability of Carpet and Rugs.

FPCA RP-1 Standard Practice for the Fire Protection of Essential Electronic Equipment Operations.

HUD 4900.1 Minimum Property Standards, Single Family.

MIL-HDBK-1008C

HUD 4910.1 Minimum Property Standards, Multi-Family.

NON-GOVERNMENT PUBLICATIONS:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A17.1B Safety Code for Elevators, Dumbwaiters,
Escalators, and Moving Walks.

ANSI C2 National Electrical Safety Code.

(Unless otherwise indicated, copies are available from the American National Standards Institute (ANSI), 11 West 42nd Street, New York, NY 10036.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D92 Flash and Fire Points by Cleveland Open Cup.

ASTM E84 Surface Burning Characteristics of Building Materials.

ASTM E136 Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C.

ASTM E119 Fire Tests of Building Construction and Materials.

ASTM E648 Critical Radiant Flux of Floor Covering Systems Using a Radiant Flux Heat Source.

ASTM E814 Fire Tests of Through-Penetration Fire Stops.

(Unless otherwise indicated, copies are available from the American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME Boiler and Pressure Vessel Code.

(Unless otherwise indicated, copies are available from the American Society of Mechanical Engineers (ASME), 345 East 47th Street, New York, NY 10017.)

FACTORY MUTUAL (FM)

Approval Guide.

Loss Prevention Data Sheets.

(Unless otherwise indicated, copies are available from Factory Mutual (FM), Norwood, MA 02062.)

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

Uniform Building Code (UBC).

(Unless otherwise indicated, copies are available from the International Conference of Building Officials (ICBO), Whittier, CA 90601.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 1	Fire Prevention Code
NFPA 10	Portable Fire Extinguishers.
NFPA 11	Low-Expansion Foam.
NFPA 11A	Medium- and High-Expansion Foam Systems.
NFPA 11B	Synthetic Foam and Combined Agent Systems.
NFPA 12	Carbon Dioxide Extinguishing Systems.
NFPA 12A	Halogenated Fire Extinguishing Agent Systems, Halon 1301.
NFPA 13	Installation of Sprinkler Systems.
NFPA 13D	Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes.
NFPA 13R	Sprinkler Systems in Residential Occupancies Up To and Including Four Stories in Height.
NFPA 14	Installation of Standpipe and Hose Systems.
NFPA 15	Water Spray Fixed Systems for Fire Protection.
NFPA 16	Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems.
NFPA 16A	Installation of Closed-Head Foam-Water Sprinkler Systems.

MIL-HDBK-1008C

NFPA 17	Dry Chemical Extinguishing Systems.
NFPA 17A	Wet Chemical Extinguishing Systems.
NFPA 20	Installation of Centrifugal Fire Pumps.
NFPA 24	Installation of Private Fire Service Mains and Their Appurtenances.
NFPA 30	Flammable and Combustible Liquids Code.
NFPA 31	Installation of Oil-Burning Equipment.
NFPA 33	Spray Application Using Flammable and Combustible Materials.
NFPA 34	Dipping and Coating Processes Using Flammable or Combustible Liquids.
NFPA 37	Installation and Use of Stationary Combustion Engines and Gas Turbines.
NFPA 43A	Storage of Liquid and Solid Oxidizing Materials.
NFPA 43D	Storage of Pesticides.
NFPA 46	Storage of Forest Products.
NFPA 48	Storage, Handling, and Processing of Magnesium.
NFPA 49	Hazardous Chemicals Data.
NFPA 50	Bulk Oxygen Systems at Consumer Sites.
NFPA 50A	Gaseous Hydrogen Systems at Consumer Sites.
NFPA 50B	Liquefied Hydrogen Systems at Consumer Sites.
NFPA 51	Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes.
NFPA 54	National Fuel Gas Code.
NFPA 56A	Inhalation Anesthetics.

MIL-HDBK-1008C

NFPA 56B	Respiratory Therapy.
NFPA 56C	Laboratories in Health Related Institutions.
NFPA 56D	Hyperbaric Facilities.
NFPA 56E	Hypobaric Facilities.
NFPA 56F	Nonflammable Medical Gas Systems.
NFPA 58	Storage and Handling of Liquefied Petroleum Gases.
NFPA 59A	Liquefied Natural Gas.
NFPA 70	National Electrical Code.
NFPA 72	National Fire Alarm Code.
NFPA 72D	Proprietary Protection Signaling Systems.
NFPA 72E	Automatic Fire Detectors.
NFPA 74	Household Warning Equipment.
NFPA 75	Protection of Electronic Computer/Data Processing Equipment.
NFPA 76A	Essential Electrical Systems for Health Care Facilities.
NFPA 76C	Safe Use of High Frequency Electricity in Health.
NFPA 80	Fire Doors and Fire Windows.
NFPA 80A	Protection of Buildings From Exterior Fire Exposures.
NFPA 85	Oil and Natural Gas-Fired Single Burner Boiler-Furnaces.
NFPA 85B	Natural Gas-Fired Multiple Burner Boiler-Furnaces.
NFPA 85C	Prevention of Furnace Explosions/Implosions in Multiple Burner Boiler-Furnaces.

MIL-HDBK-1008C

NFPA 85D	Prevention of Furnace Explosions in Fuel Oil-Fired Multiple Burner Boiler-Furnaces.
NFPA 85E	Prevention of Furnace Explosions in Pulverized Coal-Fire Multiple Burner Boiler-Furnaces.
NFPA 85F	Installation and Operation of Pulverized Fuel Systems.
NFPA 86A	Ovens and Furnaces.
NFPA 86B	Industrial Furnaces.
NFPA 86C	Industrial Furnaces Special Processing.
NFPA 87	Piers and Wharves.
NFPA 88A	Parking Structures.
NFPA 88B	Repair Garages.
NFPA 89M	Clearance for Heat Producing Appliances.
NFPA 90A	Installation of Air Conditioning and Ventilating Systems.
NFPA 90B	Installation of Warm Air Heating and Air Conditioning Systems.
NFPA 91	Installation of Blower and Exhaust Systems for Dust, Stack and Vapor Removal or Conveying.
NFPA 96	Ventilation Control and Fire Protection of Commercial Cooking Operations.
NFPA 99	Health Care Facilities.
NFPA 99B	Hypobaric Facilities.
NFPA 101	Safety to Life From Fire in Buildings and Structures.
NFPA 204M	Smoke and Heat Venting.
NFPA 211	Chimneys, Fireplaces, and Vents, and Solid Fuel-Burning Appliances.

MIL-HDBK-1008C

NFPA 220	Types of Building Construction.
NFPA 231	General Storage.
NFPA 231A	Recommended Safe Practices for Outdoor General Storage.
NFPA 231C	Rack Storage.
NFPA 231D	Storage of Rubber Tires.
NFPA 232	Protection of Records.
NFPA 241	Safeguarding Construction, Alteration, and Demolition Operations.
NFPA 255	Test of Surface Burning Characteristics of Building Materials.
NFPA 256	Fire Tests of Roof Coverings.
NFPA 303	Marinas and Boatyards.
NFPA 307	Construction and Fire Protection of Marine Terminals, Piers, and Wharves.
NFPA 312	Fire Protection of Vessels During Construction, Repair, and Lay-up.
NFPA 385	Tank Vehicles for Flammable and Combustible Liquids.
NFPA 407	Aircraft Fuel Servicing.
NFPA 409	Aircraft Hangars.
NFPA 415	Aircraft Fueling Ramp Drainage.
NFPA 430	Storage of Liquid and Solid Oxidizers.
NFPA 481	Production, Processing, Handling and Storage of Titanium.
NFPA 482M	Production, Processing, Handling and Storage of Zirconium.
NFPA 490	Storage of Ammonium Nitrate.

MIL-HDBK-1008C

- NFPA 492 Separation Distances of Ammonium Nitrate and Blasting Agents.
- NFPA 495 Explosives Materials.
- NFPA 501A Fire and Safety Criteria for Manufactured Home Installations, Sites, and Communities.
- NFPA 651 Manufacture of Aluminum or Magnesium Powder.
- NFPA 654 Prevention of Dust Explosion in Plastics Industry.
- NFPA 664 Prevention of Dust Explosions in Woodworking and Wood Floor Manufacturing Plants.
- NFPA 910 Libraries and Library Collections.
- NFPA 911 Museums and Museum Collections.
- NFPA 1963 Fire Hose Connections.
- NFPA 1221 Public Fire Service Communications.
- NFPA 8503 Pulverized Fuel Systems.

Fire Protection Handbook.

National Fire Codes, Volumes 1-16 inclusive.

(Unless otherwise indicated, copies are available from the National Fire Protection Association (NFPA), One Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.)

UNDERWRITERS LABORATORIES INC. (UL)

- UL Building Materials Directory.
- UL Fire Resistance Directory.
- UL 790 Safety Tests for Fire Resistance of Roof Covering Materials.
- UL 992 Ul Chamber Test.
- UL 1479 Safety Fire Tests of Through-Penetration Firestops.

GLOSSARY

- ADA. Americans With Disabilities Act.
- ADP. Automated data processing.
- AFFF. Aqueous film-forming foam.
- AHJ. Authority having jurisdiction.
- ANSI. American National Standards Institute.
- ASTM. American Society for Testing and Materials.
- CDC. Child development center.
- DLA. Defense Logistics Agency.
- DOD. Department of Defense.
- DPL. Design policy letter.
- EM. Engineering manual.
- ETL. Engineering technical letter.
- EMCS. Energy monitoring and control system.
- FM. Factory Mutual Engineering Corporation.
- FRT. Fire retardant treated.
- FS. Flame spread.
- IBS. Integrated Building System.
- LED. Light emitting diode.
- LOX. Liquid oxygen.
- NAVFACENGCOM. Naval Facilities Engineering Command.
- NCEE. National Council of Examiners for Engineering and Surveys.
- NEMA. National Electrical Manufacturers Association.
- NFPA. National Fire Protection Association.

MIL-HDBK-1008C

NIMA. National Imagery and Mapping Agency.
NRTL. Nationally recognized testing laboratory.
POL. Petroleum oil lubricant.
PRV. Pressure-regulating valve.
SD. Smoke development.
UBC. Uniform Building Code.
UEPH. Unaccompanied enlisted personnel housing.
UFAS. Uniform Federal Accessibility Standards.
UL. Underwriter Laboratories Inc.
UOPH. Unaccompanied officer personnel housing.

INDEX

- ADA, 1, 62
- Air Handling
 - Corridors, 13
 - Plenums, 13
- Aircraft Acoustical Enclosures
 - Complete Enclosure (Hush-House), 42
 - Out-of-Airframe Acoustical Enclosures (Test Cells), 42
- Aircraft Direct Fueling, 37
- Aircraft Hangars
 - Activation of Suppression Systems, 40
 - Adjacent Areas, 41
 - Agent Requirements, 41
 - Calculation of Ceiling System Water Supply, 40
 - Controls Locations, 41
 - Equipment Locations, 41
 - Helicopter Hangars, 39
 - Overhead Foam-Water Sprinkler System, 39
 - Supplementary Systems, 39
 - Types of Overhead Foam-Water Sprinkler System, 39
 - Water Supplies, 40
- Alterations, 9
- Ambulatory Health Care
 - Occupancy Definition, 23
- Anechoic Chambers, 43
- Attics, 7
- Authority Having Jurisdiction (AHJ), 2
- Automatic Smoke Removal Systems
 - Correctional Facilities, 24
- Automatic Sprinkler Systems
 - Ordnance Facilities, 29
 - Medical Facilities, 24
- Bin Storage, 31
- Building Height, 7
- Bulk Tank Vehicle Parking, 44
- Bunkers, 30
- Burning behavior, 4
- Cable
 - Electronic Equipment Installations, 27
- Carbon Dioxide Systems
 - Application, 59
 - Design Requirements, 59
- Ceiling
 - Combustible Suspended, 7
 - Finished, 10
- Child Development Centers
 - Definition, 26
 - Locations, 27
 - Type of Construction, 26
- Child Development Facilities
 - Other, 27
- Coal
 - Bins, 15
 - Bunkers, 15
 - Conveyor Belts, 16
 - Handling, 16
 - Inactive Piles, 16
 - Low-grade, 15
 - Silos, 16
 - Storage, 15
- Combustible Liquids
 - Floating Pan, 37
 - Hydraulic Test Facilities, 38
 - Indoor Storage Areas, 34
 - Internal Floating Roof Tanks, 37
 - Outdoor Storage Limitations, 36
 - Prefabricated Structures, 35
 - Protection of Storage Tanks, 37
 - Pump Houses, 38
 - Separation, 36
 - Spill Containment, 35
 - Storage Areas, 33
 - Under Pressure, 38
- Combustible Material, 4
- Combustible Roof, 11
- Conduit
 - Penetrations, 13

- Prohibited Locations, 13
- Conflicts in Criteria, 2
- Construction Type
 - Bunkers, 30
 - Correctional Facilities, 24
 - Department of Defense
 - Dependent Schools, 27
 - Libraries, 25
 - Magazines, 30
 - Pesticide Handling Facilities, 45
 - Pesticide Storage Facilities, 45
- Conveyor belt
 - Coal, 15
 - Warehouse Facilities, 32
- Cooking Equipment, 23
- Cooking Facilities, 23
- Correctional Facilities
 - Construction Type, 24
 - Hardware, 25
 - Interior Finish, 25
 - Locking Devices, 25
 - Requirements, 24
- Definitions, 4
- Deluge Systems
 - Ordnance Facilities, 29
- Department of Defense
- Dependent Schools, 27
- Design Analyses, 3
- Design Policy Letters (DPLs)
 - Cancellation, 1
 - Conflicts in Criteria, 2
- Destratification Fans, 63
- Detention Facilities, 24
 - See Correctional Facilities, 24
- Dispensing
 - Flammable Liquids, 37
- Door Openings
 - Fire Door, 8
 - Protection of, 8
- Draft stops, 7
- Dry Chemical Extinguishing Systems
 - Application, 59
 - Design Requirement, 59
 - Limitations, 59
- Duct
 - Penetrations, 13
 - Smoke Detector, 13
 - Systems in Food Preparation, 23
- Dumpsters
 - Location, 20
- Dwelling Units, 5
- Egress, 8
- Egress Marking, 8
- Electric Power Fire Pump Drive, 52
- Electrical
 - Power Generating Equipment, 17
 - Utilization Equipment, 17
- Electronic Equipment
 - Installations
 - Automatic Sprinkler Protection, 28
 - Data and Power Cabling, 28
 - Requirements, 28
- Energy Monitoring and Control System (EMCS), 62
- Engineering Technical Letters (ETLs), 2
- Existing Facilities
 - Compliance, 2
 - Duct Smoke Detectors, 13
 - Guide Specifications, 2
 - Pesticide Storage and Handling, 45
 - Warehouse and Storage, 31
- Existing Structures, see Existing Facilities
- Exit Signs
 - Fluorescent, 9
 - Incandescent, 9
 - LED, 9
 - Neon, 9
 - Overseas, 9
 - Radioluminous, 9
- Family Housing
 - Off Base, 22
 - Rehabilitation, 23
 - Smoke Detection, 22
- Fire Alarm Systems

- Automatic Fire Detection Systems, 63
- Fire Alarm Evacuation Systems, 61
- Fire Alarm Reporting Systems, 61
- Shop Drawings for Fire Alarm Systems, 63
- Fire Areas, 7
 - Correctional Facilities, 25
- Fire Dampers, 13
- Fire Department
 - Sprinkler Connection, 12
 - Standpipe System, 12
 - Vehicle Access, 12
- Fire Flow Demand
 - Unsprinklered Facilities, 47
- Fire Protection During Construction, 4
- Fire Pumps
 - Meters, 53
 - Pump Drive, 52
 - Pump Starting Arrangement, 52
 - Pump Type, 52
 - Requirements, 52
 - Water Level Controls, 52
- Fire Retardant Treated Plywood, 14
- Flame-Spread Rating, 4
- Flammable Liquids
 - Electric Equipment, 36
 - Electric Wiring, 36
- Floating Pan Roofs, 37
 - Indoor Storage Areas, 33
 - Internal Floating Roof Tanks, 37
 - Outdoor Storage Limitations, 36
 - Prefabricated Structures, 35
 - Protection of Storage Tanks, 37
 - Separation, 36
 - Spill Containment, 35
 - Flammable/Hazardous (Flam/Haz) Storage, 33
- Foam Systems, 58
- Fuel Transfer Facilities, 37
- Gas
 - Heating System Components, 15
 - Natural Draft Cross Ventilation, 15
 - Pressure Regulators, 15
 - Service Mains, 15
 - Service Pipe, 15
 - Supply Connections, 15
- Halon 1301 Systems, 59
- Hangars
 - Aircraft, 39
 - Helicopter, 39
- Hazardous Materials
 - Prefabricated Structures, 35
 - Spill Containment, 35
 - Storage Area, 34
- Hazardous Waste
 - Prefabricated Structures, 35
 - Spill Containment, 35
- Hazardous Waste Storage Facilities
 - Fire Protection, 35
- Health Care Occupancy Definition, 23
- Heat Vents, 13
- Heating Equipment
 - Coal, 15
 - Gas, 15
- Heating System Components, 15
- Helicopter Hangars, 39
- Hood Systems in Food Preparation Facilities, 23
- Horizontal Shaft Centrifugal Pump, 52
- Hose Streams
 - Demands, 46, 47
 - Family Housing, 48
 - POL Areas, 49
 - Ship Berthing and Drydock Facilities, 48
 - Total Water Demand for Sprinklered Occupancies, 46
- House Trailers, 7
- Hush-House, 42
- Hydrants
 - California-type, 53
 - Dry barrel, 53

- Installation
 - Requirements, 54
 - Left-hand Valves, 53
 - Protection, 54
 - Spacing Requirements, 54
 - Traffic-type, 53
 - Wet-barrel, 53
- Hydraulic Systems, 37
- Hydraulic Test Facilities, 38
- Hydraulic Test Systems, 38
- Hyperbaric Chambers, 43
- Hypobaric Chambers, 43
- Insulation
 - Acoustical, 10
 - Cellular Plastic, 10
 - Correctional Facilities, 11
 - Exceptions to Insulation Criteria, 10
 - Exterior Materials, 11
 - Flame Spread, 11
 - Floors, 11
 - Hollow Metal Doors, 11
 - Hospitals, 11
 - Masonry Walls, 11
 - Panels, 11
 - Roof Decks, 12
 - Smoke Development, 11
 - Thermal, 11
- Integrated Building System, 24
- Interior Finish
 - Alterations, 9
 - Carpeting, 10
 - Cellular Plastics, 9
 - Child Development Centers, 26
 - Class A, 9
 - Class B, 9
 - Class C, 9
 - Definition, 4
 - Detention and Correction Facilities, 24
 - Drop-out Ceiling, 9
 - Existing Construction, 9
 - Fire Protection Provisions, 4
 - Flame Spread, 9
 - Floor Finish, 10
 - New Construction, 9
 - Renovations, 9
 - Smoke Development, 9
 - Textile Wall Coverings, 10
 - Trim, 10
- Interior Fire Spread, 7
- Laundry Areas
 - Personnel Housing Facilities, 22
- Libraries
 - Combustible Construction, 25
 - Noncombustible Construction, 25
- Life Safety, 6
- Liquid Oxygen (LOX)
 - Fixed Tanks, 43
 - Separation Distances for Tanks and Carts, 43
 - Storage for Propellant Applications, 44
- Magazines, 30
- Medical Facilities
 - Building Height Limitations, 24
 - Construction Type, 23
 - Definition, 24
 - Fire Area Limitations, 24
 - Integrated Building System, 24
 - Occupancy, 23
 - Sprinkler Protection, 24
- Missile
 - Assembly - Occupancy, 67
 - Sprinkler Protection, 29
 - Water Demands, 46
- Movable Partitions, 5, 9
- Multi-family Housing
 - Definition, 5
- New Buildings, 6
- New Construction, 9
- Non-encapsulated Rack
 - Storage, 31
- Nonpermanent Construction, 1
- Occupancies
 - Hazard Classification, 65
 - Light Hazard, 65

- Ordinary Hazard Group 1, 65
- Ordinary Hazard Group 2, 66
 - Special, 67
 - Type of Construction, 6
 - Off Base Housing, 22
- Ordnance
 - Bunkers, 30
 - Magazines, 30
 - Production, 28
 - Storage, 30
- Ordnance Facilities
 - Definition, 28
- Oxygen Bulk Tanks, 43
- Partitions, 6
- Personnel Housing
 - Facilities, 21
 - Apartment-Style, 21
 - Automatic Sprinkler Protection, 21
 - Hotel-Style, 21
 - Laundry Areas, 22
 - Open Bay, 21
 - Range Top Cooking Surfaces, 22
 - Shops, 22
 - Sleeping Room, 21
 - Smoke Detection, 21
 - Sprinkler Protection, 21
 - Storage, 22
- Pesticide Handling
 - Facilities, 45
- Pesticide Storage
 - Facilities, 45
- Petroleum Fuel Facilities, 37
- Petroleum-Based Hydraulic Fluids, 37
- Plastic Pipe
 - Penetrations, 12
 - Prohibited Locations, 12
- Portable Fire Extinguishers
 - Cabinets, 60
- Power Generating Equipment
 - Gas Turbines, 17
 - Generators, 17
 - Stationary Combustion Engines, 17
 - Units 25,000 Horsepower and Larger, 14
 - Units Under 25,000 Horsepower, 17
- Prefabricated Structures, 7
- Primary Water Supplies, 51
- Professional Engineer (P.E.), 4
- Pulverizing Equipment, 17
- Qualifications of Fire Protection Engineers, 4
- Range Top Cooking Surfaces
 - Personnel Housing, 22
- References, 73
- Reliable Water Source, 51
- Relocatable Facilities
 - Electronic Equipment Vans, 7
 - Extra Hazardous Occupancies, 7
 - Sprinklered, 7
 - Unsprinklered, 7
- Relocatable Structures, 7
- Renovations, 9
- Roof Access, 12
- Roof Coverings, 11
- Roof Deck Assemblies, 12
- Secondary Water Supplies, 52
- Security System
 - Fire Detection Systems, 62
- Separation, 6
 - Correctional Facilities, 25
- Services of Fire Protection Engineers, 4
- Shops
 - Personnel Housing Facilities, 21
 - Smoke Detection
 - Apartment-Style Personnel Housing Quarters, 21
 - Battery-powered, 62
 - Child Development Centers, 26
 - Correctional Facilities, 24
 - Duct, 13
 - Family Housing, 22
 - Hotel-Style Housing Quarters, 21
 - Libraries, 25

- Maintenance, 63
- Open Bay Personnel Housing, 21
- Sleeping Room, 21
- Smoke Vents, 13
- Smoke-Developed Rating, 5
- Special Structures
 - Requirements, 7
- Sprinkler Systems
 - Aircraft Hangars, 39
 - Application Requirements, 56
 - Characteristics, 56
 - Child Development Centers, 26
 - Combustible Liquids, 34
 - Correctional Facilities, 24
 - Densities, 65
 - Design Requirements, 57
 - Electronic Equipment Installations, 27
 - Family Housing Rehabilitation Projects, 23
 - Fire Administration Authorization Act of 1992, 57
 - Flammable Liquids, 33
 - Hazardous Waste Storage Facilities, 34
 - Hydraulic Equipment, 37
 - Libraries, 25
 - Medical Facilities, 23
 - Ordnance Facilities, 28
 - Personnel Housing, 21
 - Shop Drawings, 58
 - Storage Facilities, 31
 - Warehouse Facilities, 31
- Sprinkler Type
 - Early Suppression Fast Response (ESFR), 31
 - In-rack, 31, 33
- Standpipe Systems
 - Class I Standpipe Systems, 59
 - Class II and Class III Standpipes, 59
- Storage
 - Flammable Liquids, 33
 - Hazardous Materials, 33
 - Hazardous Waste, 33
 - Ordnance, 28
 - Personnel Housing Facilities, 21
 - Pesticide Facilities, 45
 - Trash Rooms, 20
 - Vehicle, 44
- Storage Facilities
 - See Warehouse Facilities, 31
- Suspended Ceilings, 7
- Technical Policies, 2
- Test Cells, 42
- Transferring
 - Flammable Liquids, 37
- Transformers
 - Dry Type, 20
 - Indoor Oil-Insulated, 19
 - Less Flammable, Liquid-Filled, 20
 - Less Flammable, Liquid-Filled Outdoor Spill Containment, 20
 - Less Flammable, Liquid-Filled Vault, 20
 - Outdoor Oil-Insulated, 17
 - Outdoor Oil-Insulated Barriers, 17
 - Outdoor Oil-Insulated Exposures, 19
 - Outdoor Oil-Insulated Location, 17
- Trash
 - Baling, 20
 - Chutes, 20
 - Collection, 20
 - Dumpsters, 20
 - Storage Rooms, 20
- Type of Construction, 6
 - NFPA 220, 64
 - Uniform Building Code, 64
- UFAS, 1
 - Placement and Installation of Audiovisual Devices, 62
- Unsprinklered Attics, 7
- Utilization Equipment
 - See Power Generating Equipment, 17

- Valves
 - Outside-stem-and-yoke
 - Type, 53
 - Post-indicating Type, 53
 - Pressure-Regulating, 53
- Vehicle
 - Maintenance, 44
 - Parking, 44
 - Refueler, 44
 - Repair, 44
 - Storage, 44
- Vertical Fire Cutoffs
 - Fire Stops, 7
 - Penetrations, 8
- Vertical Shaft Centrifugal Pump, 52
- Vertical Shaft Turbine Pump, 52

- Wainscoting, 5
- Waivers, 2
- Wall Finishes, 9
- Warehouse Facilities
 - Bin Storage, 31
 - Column Protection, 32
 - Fire Area Limitation, 32
 - Fire Walls, 32
 - Flammable Liquids, 33
 - Flammable Solids, 33
 - Hazardous Materials, 34
 - Separation, 32
 - Sprinkler Protection, 31
 - Storage Height, 31
- Waste
 - Disposal Facilities, 20
 - Trash Collection, 20
- Water Demand for Special Facilities, 46
- Water Demand for Special Facilities With Sprinklers
 - Aircraft Acoustical Enclosures, 47
 - Aircraft Hangars, 46
 - Family Housing, 47
 - Ordnance Facilities, 46
 - Rubber Tire Storage, 47
 - Warehouses (High Piled or High Rack Storage), 46
- Water Demand for Sprinklered Facilities
 - Total Water Demand for Sprinklered Occupancies, 46
- Water Demand for Hose Streams, 46
- Water Demand for Sprinklers (Special Facilities), 46
- Water Demand for Sprinklers
 - Design Area, 46
 - Design Densities, 46
- Water Demand for Unsprinklered Facilities
 - Aircraft Parking and Refueling Facilities, 49
 - Hose Stream Demands, 47
 - Vehicle Parking Areas, 49
- Water Stream Demand for Unsprinklered Special Facilities, 48
 - Yard and Outdoor Storage, 49
- Water Distribution System
 - Hydrants, 53
 - Mains, 53
 - Pressure-Regulating Valves (PRVs), 55
 - Valves, 53
- Water Spray Systems
 - Requirements, 58
- Water Storage Capacity, 51
- Water Supply
 - Primary, 51
 - Secondary, 52
- Water Supply for Fire Protection
 - Fire Pumps, 52
 - Quantities of Water Required, 49
 - Sources of Water Supply, 51
- Water Demands for Sprinklered Facilities, 46
 - Water Demands for Unsprinklered Facilities, 47
- Water Distribution Systems, 53
 - Water Supply Pressure Requirements, 49
- Water Supply Reduction, 51
- Water Supply Replenishment, 51

Waterfront Facilities, 36
Wet Chemical Extinguishing
Systems

Application, 60
Design Requirements, 60

CUSTODIANS

ARMY - CE
NAVY - YD2
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