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MILITARY HANDBOOK

FIRE PROTECTION FOR FACILITIES
ENGINEERING, DESIGN, AND CONSTRUCTION



NO DELIVERABLE DATA REQUIRED BY THIS DOCUMENT

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1.0 FIRE PROTECTION POLICY.

1.1 SCOPE. The provisions of this handbook are applicable to Department of Defense (DOD) facilities, whether acquired by appropriated or nonappropriated funds. 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, shore protection for ships and craft, and external protection for aircraft. Matters relating to fire department operations, manning, and equipment are not covered by this handbook.

1.2 CANCELLATION. This handbook supersedes NAVFAC DM-8, Fire Protection Engineering (April 1981), in its entirety and Army TM-5-812-1, Fire Prevention Manual (April 1977).

1.3 CRITERIA. Fire protection criteria shall conform to the requirements of this handbook and of the applicable standards contained in the current National Fire Codes, published by the National Fire Protection Association (NFPA) and the Uniform Building Code (UBC) published by the International Conference of Building Officials except as modified herein or by specific criteria issued by the Military Departments. Specific requirements contained in this handbook are necessary to obtain uniform application of fire protection engineering and to highlight problem areas encountered with Department of Defense (DOD) facilities. Special problems not covered by this handbook nor by the NFPA standards nor by applicable military department criteria shall be referred to the appropriate military department headquarters for guidance.

Deviation from these criteria, where a valid need exists and where an alternate solution involving equivalent concept and sound fire protection engineering is available, may be accepted after approval by the appropriate headquarters. Request for approval must include justification, hazard analysis, cost comparison, criteria used, and other pertinent data. Lack of funds shall not be considered sufficient justification for deviation below established fire protection standards. Approval granted will only apply to the specific request under consideration and not to other cases where circumstances are similar.

1.4 DESIGN ANALYSES. All concept and final design analyses shall address all provisions pertaining to fire protection as required by this handbook. Fire protection provisions shall be summarized and submitted as a separate analysis. Where applicable, the following fire protection provisions must be delineated:

- (1) Type of construction (including interior finish materials).
- (2) Classification of occupancy.
- (3) Building separation or exposure protection.
- (4) Fire protection criteria (this handbook and pertinent standards and codes).

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(5) Location of all fire-rated walls including fire-rated doors and dampers with identification as applicable (fire walls, fire partitions, and smoke partitions, with their fire resistive ratings).

(6) Life safety provisions (exit travel distances, exit unit widths based on the capacity and occupant load, number, type, exit signs, and lighting).

(7) Automatic extinguishing systems (identification of all sprinklered areas and areas protected by other automatic suppression systems).

(8) Water supplies.

(9) Smoke control system. (Smoke compartments and the requirements for smoke dampers, smoke detectors, and smoke partitions shall be provided. The smoke control system shall be delineated by schematic diagram, when applicable, indicating the operations of the normal HVAC mode and the smoke removal mode.)

(10) Fire alarm system (the type of alarm system and location of the fire alarm equipment, and fire zones).

(11) Fire detection system (the type of detection system and location of detectors, and fire zones).

(12) Location of fire extinguisher cabinets and fire hose standpipes.

(13) Interior finish ratings.

1.5 SERVICES OF FIRE PROTECTION ENGINEERS AND THEIR QUALIFICATIONS. All major projects will require the services and review of a fire protection engineering consultant or a registered professional engineer with a fire protection background who has at least 2 years' experience in fire protection design. Qualifications shall be submitted to and approved by the contracting officer.

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2.0 BUILDING CONSTRUCTION.

2.1 TYPES OF CONSTRUCTION.

2.1.1 General. Construction shall conform to the fire resistance requirements and fire area limitations of the International Conference of Building Officials', Uniform Building Code (UBC), except as modified herein. Strategic facilities located in theatres of operation may require special considerations for hardening and survivability which exceed minima set forth in this chapter.

2.1.2 Definitions.

2.1.2.1 Combustible. Combustible materials are those which will ignite, burn, support combustion, or release flammable vapors when subject to heat or fire. The term combustible is not related to any specific ignition temperature or flame spread rating.

2.1.2.2 Fire resistance rating. Fire resistance rating is the time that the construction will withstand the standard fire exposure as determined by the Standard Methods of Fire Tests of Building Construction and Materials, ASTM E-119.

2.1.2.3 Flame spread rating. Flame spread rating is a numerical classification determined by the Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM E-84, which indexes the relative burning behavior of a material by quantifying the spread of flame in a test specimen. (The surface burning characteristic of a material is not a measure of resistance to fire exposure.)

2.1.2.4 Noncombustible. Noncombustible materials are those which will not ignite, burn, support combustion, or release flammable vapors when subjected to heat or fire.

2.1.2.5 Smoke developed rating. Smoke developed rating is a numerical classification determined by the Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM-E-84, which indexes the smoke generation rate of a given material to those of two standard materials, asbestos-cement board and select grade red oak.

2.1.2.6 Windowless structure. Any building or story (including basement) of a building over 1,500 square feet (140 m²) is considered windowless by one of the following definitions:

(1) No exterior wall is provided with more than 20 square feet (2 m²) of opening entirely above ground level in each 50 linear feet (15 m) of wall. Openings shall have a minimum dimension of 30 inches (760 mm), and shall be readily accessible to the fire department for fire fighting and rescue operations.

(2) Openings as described above are located only on one side of a story, and the opposite wall is more than 75 feet (23 m) from the openings.

2.1.2.7 Underground Structures. A structure in which there is no direct access to outdoors or to another fire area other than by upward travel.

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2.1.3 Construction Categories. Buildings shall be placed in one of five major types of construction categories based primarily upon the fire resistance of interior and exterior structural support members, walls, floors and roofs. Fire resistance ratings of buildings shall conform to the Uniform Building Code. The construction categories are Types I, II, III, IV and V as defined by the Uniform Building Code. Table 2-1 provides a summary of required fire resistances for various building components in each of the categories. Fire resistances are expressed in 1-, 2-, 3- or 4-hour ratings.

2.1.4 Classification of Occupancy. Classification of occupancy is in accordance with the Uniform Building Code (See Appendix A). Buildings shall be classified as either Group A, B, E, H, I, M or R depending upon the existing or proposed life and fire hazard. Major classification groups are as follows:

2.1.4.1 Group A occupancies. Places of assembly which include churches, chapels, clubs (Officer, Enlisted Personnel, etc.), drill halls, gymnasiums, schools and stadiums.

2.1.4.2 Group B occupancies. Gasoline service stations, garages, and aircraft hangars where no repair work is done except the exchange of parts and maintenance requiring no open flame, welding or the use of highly flammable liquids; exchanges, commissaries, office buildings, printing plants, factories, and workshops using materials not highly flammable.

2.1.4.3 Group E occupancies. Educational and dependent-care facilities.

2.1.4.4 Group H occupancies. Woodworking shops, aircraft repair hangars, vehicle repair garages and other facilities where hazardous and highly flammable materials are used, stored or dispensed.

2.1.4.5 Group I occupancies. Nurseries, hospitals, medical and dental facilities housing nonambulatory patients; detention and correctional facilities.

2.1.4.6 Group M occupancies. Vehicle parking facilities, sheds, agricultural buildings.

2.1.4.7 Group R occupancies. Barracks, family and bachelor housing.

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TABLE 2-1*
Types of Construction - Fire-Resistive Requirements
(In Hours)

Building Element	Type I	Type II			Type III	Type IV	Type V		
	Noncombustible				Combustible				
	Fire Resistive	Fire- Resistive	1-Hr.	N	1-Hr.	N	H.T.	1-Hr.	N
Exterior Bearing Walls	4	4	1	N	4	4	4	1	N
Interior Bearing Walls	3	2	1	N	1	N	1	1	N
Exterior Nonbearing Walls	4	4	1	N	4	4	4	1	N
Structural Frame ¹	3	2	1	N	1	N	1 or H.T.	1	N
Partitions - Permanent	1	1	1	N	1	N	1 or H.T.	1	N
Shaft Enclosures	2	2	1	1	1	1	1	1	1
Floors	2	2	1	N	1	N	H.T.	1	N
Roofs	2	1	1	N	1	N	H.T.	1	N

N - No general requirements for fire resistance. H.T. - Heavy Timber

¹ Structural frame elements in the exterior wall shall be protected against external fire exposure as required for exterior bearing walls or the structural frame, whichever is greater.

*Adapted from Uniform Building Code, 1982 Edition, Copyright 1982, with permission of the publisher, the International Conference of Building Officials.

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2.2 FIRE AREAS AND HEIGHT LIMITATIONS.

2.2.1 Fire Areas. Fire areas (the total area bounded by fire walls) shall conform with the Uniform Building Code except as modified herein. Maximum allowable fire areas for given occupancy categories and construction types are summarized in Table 2-2. Exceptions are as follows:

2.2.1.2 General warehouses. General warehouses shall have fire areas not exceeding 40,000 square feet (3700 m²). Fire areas in warehouses should be separated by walls which have 4-hour fire resistance ratings.

2.2.1.3 Depot level warehouses. For depot level warehouses, bay sizes may be increased up to 80,000 square feet (7400 m²) between fire walls upon a finding and determination by the authority having jurisdiction that all the following conditions are met:

- (1) The increased size is required for efficient operation.
- (2) The possible additional loss has been recognized and is acceptable.
- (3) Other fire safety features have been designed to compensate for the additional hazard insofar as such design is practicable.

2.2.1.4 Hazardous materials storage. Warehouses storing hazardous materials shall comply with the applicable NFPA standard and in no case exceed 20,000 square feet (1800 m²).

2.2.1.5 Unsprinklered attics and suspended ceilings. Draft stops of gypsum board on wood or metal frame are required in unsprinklered attic spaces of combustible roof construction or in unsprinklered combustible suspended ceiling spaces to divide the spaces into areas not exceeding 3,000 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 an area.

2.2.2 Building Height Limitations. Building height limitations shall conform to the Uniform Building Code except as modified by specific criteria issued by the Military Departments. Maximum building heights shall not exceed that given for the type of construction and occupancy in Table 2-3. Building heights may be increased when automatic sprinkler protection is provided.

2.3 SEPARATION OF STRUCTURES.

2.3.1 General. Clear space between structures, with the distance dependent on the combustibility of the structures and the contents or nature of the occupancy, is the best protection against exposure fires. Exposure is the hazard of ignition of a structure or its contents from fire in an adjoining building or other exterior source. Ignition of buildings by exposure fires may occur by radiated or convected heat, by direct contact of flames, or by flying brands. The potential danger of ignition by exposure fires depends upon the intensity of the exposure fire, total heat produced, shielding by intervening walls, wind direction and velocity, atmospheric temperature and

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humidity, distance between exposing and exposed buildings, height of exposed building, construction, and protection of exposed and exposing buildings.

2.3.1.1 Exposure classification. The exposure classification, given in Table 2-4, is a function of the occupancy's hazard classification and is used for determining separations. Occupancy hazard classifications are: extra hazard, ordinary hazard (Groups 1, 2 and 3) and light hazard. They are defined and examples provided in Appendix B of this handbook.

2.3.1.2 Separation tables. Separation requirements listed herein are applicable only when combined fire areas exceed the fire area limitations outlined in Section 2.2 of this handbook. The required clearances between structures shall be determined by applying the following rules and Tables 2-4 and 2-5. First, Table 2-4 is used to determine the exposure classification of the exposing building. That classification A, B, C, or D is then used in Table 2-5 to determine a separation distance based upon the exposed wall surface of the exposed building. Separation distances are governed by the building having the greater hazard, not by which building is existing and which is planned. Therefore, in some cases it will be necessary to determine separation distances for both buildings and choose the larger.

2.3.1.3 Rules for the use of Tables 2-4 and 2-5.

(1) Rule 1: Existing building has no automatic sprinklers, new building has automatic sprinklers. Use Table 2-4 for existing building to determine a classification of exposure, and then use Table 2-5 for new building to determine required separation distance.

(2) Rule 2: Existing building has automatic sprinklers, new building has no automatic sprinklers. Use Table 2-4 for the new building to determine a classification of exposure, and then use Table 2-5, also for new building, to determine required separation distances.

(3) Rule 3: Both buildings have automatic sprinklers and at least one building has a 2-hour or greater masonry parapeted fire wall; no separation is required.

(4) Rule 4: Both buildings have automatic sprinklers and neither has a 2-hour or greater masonry parapeted fire wall. Consider each building as the exposing building and determine maximum exposure classification from Table 2-4. Using that exposure, determine separation from Table 2-5 for blank masonry.

TABLE 2-2 - BASIC ALLOWABLE FLOOR AREA FOR BUILDINGS ONE STORY IN HEIGHT*
(In Square Feet)

Occupancy**	Types of Construction								
	I		II		III		IV	V	
	F.R.	F.R.	One-Hour	N	One-Hour	N	H.T.	One-Hour	N
A-1	Unlimited	29,900	Not Permitted						
A)2-2.1	Unlimited	29,900	13,500	Not Permitted	13,500	Not Permitted	13,500	10,500	Not Permitted
A)3-4	Unlimited	29,900	13,500	9,100	13,500	9,100	13,500	10,500	6,000
B)1-2-3	Unlimited	39,900	18,000	12,000	18,000	12,000	18,000	14,000	8,000
B-4	Unlimited	59,900	27,000	18,000	27,000	18,000	27,000	21,000	12,000
E	Unlimited	45,200	20,200	13,500	20,200	13,500	20,200	15,700	9,100
H)1-2 ²	15,000	12,400	5,600	3,700	5,600	3,700	5,600	4,400	2,500
H)3-4-5	Unlimited	24,800	11,200	7,500	11,200	7,500	11,200	8,800	5,100
I)1-2	Unlimited	15,100	6,800	Not Permitted	6,800	Not Permitted	6,800	5,200	Not Permitted
I-3	Unlimited	15,100	Not Permitted						
M	See Chapter 11 of the Uniform Building Code								
R-1	Unlimited	29,900	13,500	9,100	13,500	9,100	13,500	10,500	6,000
R-3	Unlimited								

N - No requirements for fire resistance

F.R. - Fire Resistive

H.T. - Heavy Timber

* Adapted from Table No. 5-C of the Uniform Building Code, 1982 Edition, Copyright 1982, with permission of the publisher, the International Conference of Building Officials.

**See Section 2-1.4 and Appendix A.

TABLE 2-3 - MAXIMUM HEIGHT OF BUILDINGS*

Occupancy**	Types of Construction								
	I		II		III		IV	V	
	F.R.	F.R.	One-Hour	N	One-Hour	N	H.T.	One-Hour	N
	Maximum Height In Feet								
	Unlimited	160	65	55	65	55	65	50	40
A-1 A)2-2.1 A)3-4 B)1-2-3 B-4 E ² H-1 H-2-3-4-5 I-1 I-2 I-3 M R-1 R-3	Maximum Height In Stories								
	Unlimited		4	Not Permitted					
	Unlimited	4	2	Not Permitted	2	Not Permitted	2	2	Not Permitted
	Unlimited	12	2	1	2	1	2	2	1
	Unlimited	12	4	2	4	2	4	3	2
	Unlimited	12	4	2	4	2	4	3	2
	Unlimited	4	2 ¹	1	2 ¹	1	2 ¹	2 ¹	1
	Unlimited	2	1	1	1	1	1	1	1
	Unlimited	5	2	1	2	2	2	2	1
	Unlimited	3	1	Not Permitted	1	Not Permitted	1	1	Not Permitted
	Unlimited	3	2	Not Permitted	2	Not Permitted	2	2	Not Permitted
	Unlimited	2	Not Permitted						
	See Chapter 11 of the Uniform Building Code								
	Unlimited	12	4	2	4	2	4	3	2
	Unlimited	3	3	3	3	3	3	3	3

¹Kindergarten, day care, 1st or 2nd grade occupancies shall not be located above the first story.

N - No requirements for fire resistance

F.R. - Fire Resistive

H.T. - Heavy Timber

* Adapted from Table No. 5-D, Uniform Building Code, 1982 Edition, Copyright 1982, with permission of the publisher, the International Conference of Building Officials.

**See Section 2-1.4 and Appendix A.

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TABLE 2-4
Classification of Exposure Fire

Construction of exposing building			Hazard due to occupancy ²	Exposure Classification				
Height	Walls	Roof & floor ¹		Fire area ft ² (m ²) per floor				
				1,500- 2,500 (140-230)	2,500- 5,000 (230-460)	5,000 10,000 (460-930)	10,000 20,000 (930-1860)	Over 20,000 (1860)
Multi-story	Load bearing masonry	Comb	Extra	C	B	B	B	A
			Ordinary 2,3	C	C	B	B	B
			Ordinary 1	D	D	C	C	B
			Light	D	D	D	C	B
One story ³	Load bearing masonry	Comb	Extra	C	B	B	B	B
			Ordinary 2,3	C	C	B	B	B
			Ordinary 1	D	D	C	C	B
			Light	D	D	D	D	C
Multi-story	Comb ⁴	NC or Comb	Extra	B	B	A	A	A
			Ordinary 2,3	B	B	B	B	A
			Ordinary 1	B	B	B	B	B
			Light	C	B	B	B	B
One story ³	Comb ⁴	NC or Comb	Extra	B	B	B	B	A
			Ordinary 2,3	C	B	B	B	A
			Ordinary 1	C	B	B	B	B
			Light	D	C	C	B	B
Multi-story	NC panel ⁵ on steel frame	NC or Comb	Extra	C	B	B	B	B
			Ordinary 2,3	C	C	C	B	B
			Ordinary 1	D	D	D	C	C
			Light	D	D	D	D	C
One story ³	NC panel ⁵ on steel frame	NC or Comb	Extra	C	C	B	B	B
			Ordinary 2,3	C	C	B	B	B
			Ordinary 1	D	D	D	D	D
			Light	D	D	D	D	D
Single or multi-story	Load-bearing masonry or concrete	NC	Extra	D	D	C	C	C
			Ordinary 2,3	D	D	C	C	C
			Ordinary 1	D	D	D	D	D
			Light	D	D	D	D	D

Definitions: Comb - Combustible NC - Noncombustible.

Examples of Comb: plank on timber; plank on steel; board on joist.

¹If floors and roof are of different construction, use worst case.

²Based on occupancy classifications as defined in Appendix B.

³One-story buildings 25 ft (8 m) or higher shall be considered as multistory.

⁴Includes old type asphalt coated metal buildings.

⁵NC panel wall may be protected metal, plain or corrugated metal with or without insulation, asbestos-cement, or similar NC materials on steel frame.

Notes: Consider fire walls, if any, when determining fire area.

For explosive ordnance materials, refer to DOD 5154.4S - DOD Ammunition and Explosive Safety Standards.

This table and Table 2-3 were adapted from Factory Mutual Loss Prevention Data Sheets based upon theoretical radiation calculations.

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TABLE 2-5
Separation Distances in Feet (m)

Exposed building (wall surface)	Exposure from Table 2-1			
	A	B	C	D
Wood or Wood Frame				
Asphalt shingle	150 (46)	110 (33)	90 (27)	70 (21)
Painted or unpainted	95 (29)	65 (20)	50 (15)	40 (12)
Steel or aluminum siding	95 (29)	65 (20)	50 (15)	40 (12)
Stucco or asbestos shingle	75 (23)	45 (14)	35 (11)	25 (8)
Veneer of brick or stone	60 (18)	40 (12)	25 (8)	15 (5)
Panel on Steel Frame ¹				
Insulated aluminum, plastic, or fiberglass panel	95 (29)	70 (21)	50 (15)	35 (11)
Asphalt-coated metal	75 (23)	45 (14)	35 (11)	25 (8)
Insulated steel panel	65 (20)	40 (12)	30 (9)	20 (6)
Protected metal, plain metal	55 (17)	35 (11)	25 (8)	15 (5)
Asbestos panel	45 (14)	30 (9)	20 (6)	10 (3)
Masonry or Concrete				
Blank	20 (6)	15 (5)	0	0
Wired glass and window sprinklers	30 (9)	25 (8)	15 (5)	0
Wired glass	40 (12)	35 (11)	20 (6)	10 (3)
Plain glass	60 (18)	40 (12)	25 (8)	15 (5)

¹Wired glass shall be installed in window openings when the separation distance is within 60 feet (18 m) for Class A exposure, 40 feet (12 m) for Class B exposure, 25 feet (8 m) for Class C exposure, and 10 feet (3 m) for Class D exposure.

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(5) Rule 5: Neither building has automatic sprinklers. Determine separation distances twice, considering each building as the exposing building. Use the larger of the determined separation distances as the minimum requirement.

(6) Rule 6: When either building has a 2-hour or greater fire-rated wall but no automatic sprinklers, consider this building to be the exposing building when determining the exposure classification. Determine the classification of exposure from Table 2-4. Next, use Table 2-5 for the other building to determine required separation distance.

(7) Rule 7: When the taller building has a 4-hour or greater masonry free-standing parapeted blank fire-rated wall, no separation is required.

(8) Rule 8: When the taller building has automatic sprinklers and a 2-hour or greater masonry parapeted blank fire-rated wall, no separation is required.

(9) Rule 9: When both buildings have 2-hour or greater masonry parapeted blank fire-rated walls, even though they are not free standing, no separation is required.

2.3.1.4 Parapets. Parapets are not required where roof decks are of heavy noncombustible such as concrete or gypsum. For all other roof decks, parapets shall be 30 inches (760 mm). Where roof decks are Factory Mutual approved, Class I steel deck, a 12-inch (300 mm) parapet is required. The 30-inch (760 mm) or 12-inch (300 mm) dimension is measured from the top surface of the lower roof to the top of the parapet.

2.3.1.5 Roof exposure. When a combustible exposed building roof is below the top of the exposing building, the exposed roof may receive sufficient radiant heat to be set on fire. A burning brand, large enough to cause pilot ignition, may also fall on the roof. For such a case the exposed building roof covering shall be Factory Mutual approved or classified by Underwriters' Laboratories as Class A. Exposed roof covering not meeting these requirements shall be graveled, 3 to 4 lb/ft² (15 to 20 kg/m²), in a flood coat of tar or asphalt. It is necessary to place the gravel within the safe separation distance given in Table 2-5 for asphalt shingle.

2.3.1.6 Special requirements.

(1) Family housing separation requirements shall conform to HUD Minimum Property Standards.

(2) House trailers shall be separated in accordance with Mobile Homes Including Mobile Home Park Requirements, NFPA Standard No. 501A.

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

(4) Relocatable facilities such as electronic equipment vans shall not be grouped to form areas greater than 6,000 square feet for unsprinklered facilities and 12,000 square feet for sprinklered facilities. Relocatable facilities having extra hazardous occupancies (see Paragraph B-1.5, Appendix B) shall not be grouped to form areas greater than 4,000 square feet (372 m²) for unsprinklered facilities and 8,000 square feet (743 m²) for sprinklered facilities. A minimum separation of 50 feet (15 m) shall be provided for extra-hazardous groups and 15 feet (5 m) for all other groups.

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2.4 LIMITING INTERIOR FIRE SPREAD.

2.4.1 Vertical Fire Cutoffs. Enclosures for stairways, elevators, ducts, chases, etc. shall be in accordance with the following:

- (1) NFPA No. 80 Fire Doors and Windows.
- (2) NFPA No. 90A Standard for the Installation of Air Conditioning and Ventilating Systems.
- (3) NFPA No. 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- (4) NFPA No. 91 Standard for the Installation of Blower and Exhaust Systems for Dust, Stack and Vapor Removal or Conveying.
- (5) NFPA No. 96 Vapor Removal for Cooking Equipment.
- (6) NFPA No. 101 Life Safety Code.
- (7) NFPA No. 211 Standard for Chimneys, Fireplaces, and Vents.
- (8) NFPA No. 220 Building Construction, Standard Types.

The proper enclosure of all vertical openings, including stairways, elevator shafts, chases, and ducts, is most important in preventing or retarding the vertical spread of fire. Each floor shall form a barrier to the vertical spread of fire. The protection of vertical openings shall prevent drafts which might accelerate the fires, and retard the spread of heat and gaseous products of combustion to upper floors. Where cables, conduit, telephone wire ducts, etc. penetrate floors or fire cutoffs, fire stops shall be provided. The ratings for fire resistance shall be maintained in selection of the material used for fire stops. Fire stopping of stud walls, partitions, and concealed spaces shall be in accordance with the Uniform Building Code.

2.4.2 Protection of Openings. Although blank, unpierced firewalls are preferable, door openings, when necessary, shall be protected in accordance with NFPA No. 80, Fire Doors and Windows. Fire door assemblies are required on each side of the door opening in 4-hour fire walls. All fire doors shall be listed by Underwriters' Laboratories, Inc., or approved by Factory Mutual's Laboratories. Local fabrication of fire doors shall not be permitted. Protection of conveyor openings through fire walls shall be in accordance with NFPA No. 80. The protection of ducts at point of passage through fire walls shall be in accordance with NFPA No. 90A, Air Conditioning and Ventilating Systems.

2.5 EXITS.

2.5.1 Requirements. All structures shall have exit facilities and means of egress that comply with the requirements of NFPA 101, Life Safety Code, except as modified by this handbook.

2.6 INTERIOR FINISH.

2.6.1 General. Interior finish is defined as the material of walls, ceilings, wainscoting, and other interior surfaces of a building, and other interior surfacing materials applied to the walls, movable partitions, and ceilings. Exposed insulating and acoustical materials are considered in the category of interior finish. Interior finish, along with structural fire

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resistance and contents hazard, is one of the principal elements in determining building fire potential.

2.6.2 Requirements. Specific instances associated with structures are presented in the following paragraphs:

2.6.2.1 New construction, alterations, and rehabilitation. Wall and ceiling finishes and movable partitions shall conform to requirements of Life Safety Code, NFPA No. 101, except as follows:

(1) Interior finish for all exits, hospital patient rooms, and sleeping rooms, shall be Class A only. Interior finish for all other areas shall be either Class A or Class B.

(2) Use of Class C, D, and E materials is not permitted.

(3) Smoke developed ratings by Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM E-84 test shall not exceed 50 for Class A materials and 100 for Class B materials.

(4) Cellular plastics shall not be used as interior finish materials.

2.6.2.2 Existing construction. In the case of combustible interior finishes in existing buildings, certain basic safeguards are essential. Several alternate measures are available to provide the necessary safeguards for the protection of both life and property against fire and are as follows:

(1) Cover combustible surfaces with gypsum board or other materials meeting the requirements of Paragraph 2.6.2.1.

(2) Protect the building with an automatic sprinkler system.

(3) Coat all exposed combustible surfaces with an Underwriters listed fire retardant paint or coating.

2.6.2.3 Carpet systems (Carpeting and underlay combined).

2.6.2.3.1 Basic Flammability Requirements. Federal law requires that all carpet manufactured for sale shall comply with 16 Code of Federal Regulations (CFR) Part 1630 (DOC FF 1-70) Standard for the Surface Flammability of Carpets and Rugs.

2.5.2.3.2 Corridors. Carpet systems for corridors shall meet specific acceptance criteria specified below when tested in accordance with Federal Test Method Standard 372 or Underwriters' Laboratories Chamber Test, UL 992. For this purpose, a corridor is defined as an enclosed space connecting a room or compartment with an exit and may include normal extensions such as lobbies and other enlarged areas.

(1) The flame propagation index of less than 4.0 as determined by UL Chamber Test, UL 992, is acceptable for corridor systems in all facilities.

(2) The minimum acceptance criteria (average critical radiant flux) as determined by Federal Test Method Standard 372 for corridor carpet systems shall be as follows:

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(a) 0.50 watts per square centimeter for bachelor housing, hospitals, temporary lodging facilities, and child care facilities.

(b) 0.25 watts per square centimeter for carpet systems in corridors of all other facilities and in electronic equipment areas.

2.7 INSULATION.

2.7.1 Requirements. Thermal and acoustical insulation shall have flame spread rating not higher than 75, and smoke developed rating not higher than 150 by Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM E-84 test. Cellular plastic insulation shall be tested in the same densities and thicknesses as the material that will be used in construction applications.

2.7.2 Exceptions. For certain special types of installations the following exceptions shall apply:

2.7.2.1 Flame spread 100 - no smoke limitation. Compliance with the smoke developed limitation is not required, and a greater flame spread 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 Section 2.6 of this handbook and shall have a minimum fire retardant rating of 15 minutes by Standard Methods of Fire Tests of Building Construction and Materials, ASTM E-119 Test, when tested as it will be installed in the actual construction application.

2.7.2.2 No flame spread or smoke limitation. Compliance with flame spread and smoke developed limitation is not required for the following applications:

(1) Insulation installed above poured-concrete or poured-gypsum roof decks, nominal 2-inch thick tongue-and-groove wood plank roof decks, or pre-cast roof deck panels or planks that are approved by Factory Mutual as non-combustible roof deck construction.

(2) Insulation installed above roof decks where the entire roof construction assembly, including the insulation, is Underwriters' Laboratories listed as Fire-Classified or Factory Mutual approved for Class I roof deck construction.

(3) Insulation contained entirely within panels where the entire panel assembly, as will be used in the actual construction application, meets the cited flame spread and smoke developed limitations.

(4) Insulation isolated from interior of building by masonry walls, masonry cavity walls, insulation incased in masonry cores, or concrete floors.

(5) Insulation installed over concrete floor slab and completely covered by wood T&G flooring without creating air spaces within the flooring system.

(6) Insulation completely enclosed in hollow metal doors.

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(7) 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 smoke developed limitation in Paragraph 2.7.2.2 is not applicable to hospitals and correctional facilities.

2.8 ROOF COVERINGS AND ROOF DECK ASSEMBLIES.

2.8.1 Roof Coverings. All roof coverings shall be approved and listed by Underwriters' Laboratories, Inc. The UL Building Materials Directory lists three classes (A, B, and C) of acceptable roof coverings based upon Test Methods for Fire Resistance of Roof Covering Materials, UL 790. Class C roof coverings shall be restricted to housing and small, insignificant buildings with light exposure.

2.8.2 Roof Deck Assemblies. Roof deck assemblies are composed of decking with materials (adhesive, vapor barrier insulation, and roof surfacing) added in layers to the deck. They may contribute significantly to the spread of fire beneath the roof deck when exposed to an interior fire. Assemblies acceptable from an interior fire exposure standpoint are listed as Class I in the Factory Mutual Approval Guide and as Fire-Classified in Underwriters' Laboratories Building Materials Directory. Roof deck assemblies shall be of acceptable type when used in buildings that are not fully sprinklered.

2.9 ALTERATIONS, REHABILITATION, AND NEW CONSTRUCTION.

2.9.1 Requirements. Adequate fire protection measures shall be incorporated in all alteration, rehabilitation, repair and new construction projects, and shall be taken consistent with the requirements of this handbook.

2.9.2 Fire Protection During Construction. The contract specifications shall refer to the Army Corps of Engineers Manual, General Safety Requirements, EM 385-1-1, and NFPA No. 241, Building Construction and Demolition Operations, and shall contain the requirement that the activity fire regulations shall be followed.

2.10 ACCESS FOR FIREFIGHTING.

2.10.1 Requirements. A minimum of two stairways or permanently attached noncombustible ladders shall extend to the roof to provide access for firefighting in buildings three (3) stories or higher. Access for firefighting shall be provided in one story, windowless buildings by doors and in two or more story windowless buildings by stair towers at intervals of not over 150 feet (46 m). Underground structures shall also be provided with access for firefighting purposes.

2.11 AIR HANDLING.

2.11.1 General. Air handling systems including ducts involve the potential hazard of spreading fire, smoke, and hot gaseous products of combustion through the building or areas that they serve. This hazard must be minimized

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by providing suitable fire doors or fire dampers where ducts pass through fire walls or fire partitions and by providing protection where ducts pass vertically between floors.

2.11.2 Design Requirements. Air handling, ventilation, and exhaust system shall meet the design requirements of the following, except as modified by this handbook:

- (1) NFPA No. 90A Air Conditioning and Ventilating Systems.
- (2) NFPA No. 90B Warm Air Heating and Air Conditioning Systems.
- (3) NFPA No. 91 Blower and Exhaust Systems.
- (4) NFPA No. 96 Commercial Cooking Equipment, Vapor Removal.
- (5) NFPA No. 101 Life Safety Code.

2.11.2.1 Corridors. Corridors shall not be used in lieu of ducts for air handling (either supply or return) in hospitals, dispensaries, bachelor quarters, temporary lodging facilities, schools, places of assembly, and in windowless buildings. Use of corridors for air plenums shall be avoided in other occupancies.

2.11.2.2 Plenums. Ceiling plenums introduce serious smoke and fire spread potential. Plenums may be used as an integral part of an air handling system only if they conform to the requirements of NFPA No. 90A, Air Conditioning and Ventilating Systems. Under no circumstances may combustible materials be located within the air plenum space. All electrical wiring passing through the space, including telephone and communication wiring, shall be in metal conduit unless an automatic extinguishing system is provided.

2.11.2.3 Duct smoke detectors. Duct smoke detectors are not required in air handling units of less than 15,000 cfm capacity, in units serving one fire area or units located in buildings which are fully sprinklered.

Exception: Duct smoke detectors are required in air handling units under 15,000 cfm capacity which are located in hospitals, schools, and detention facilities.

2.11.3 Smoke and Heat Vents. Underwriters' Laboratories listed smoke and heat vents shall be provided in roofs of buildings containing materials having high heat-release potential, such as warehouses, flammable liquid storage and handling facilities, and other extra hazard occupancies. Smoke and Heat Venting Guide, NFPA No. 204, provides guidance.

2.12 PLASTIC PIPE AND CONDUIT.

2.12.1 Requirements. Plastic piping and conduit used in building construction shall adhere to the following requirements:

(1) Plastic piping and conduit shall not penetrate fire walls, fire partitions, or floors.

(2) Vertical distribution in multiple story buildings shall be made with metal piping in fire rated shafts. Metal piping shall extend through shafts for a distance of at least 6 inches (150 mm).

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(3) Piping and conduit which penetrate fire walls, fire partitions, or floors shall be completely metallic on one side and metallic on the other side of the fire wall, fire partition, or floor for a minimum distance of 6 inches (150 mm). In all cases, penetrations shall be sealed to maintain fire resistive integrity as tested per ASTM E-814, Fire Tests of Through-Penetration Fire Stops.

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3.0 COMMON HAZARDS.

3.1 HEATING EQUIPMENT.

3.1.1 Requirements. The appropriate following standard(s) shall be followed:

- (1) NFPA No. 31 Installation of Oil Burning Equipment.
- (2) NFPA No. 54 National Fuel Gas Code.
- (3) NFPA No. 58 Storage and Handling of Liquefied Petroleum Gases.
- (4) NFPA No. 85F Installation and Operation of Pulverized Fuel Systems.
- (5) NFPA No. 85 Oil and Natural Gas-Fired Single Burner Boiler-Furnaces.
- (6) NFPA No. 85B Natural Gas-Fired Multiple Burner Boiler-Furnaces.
- (7) NFPA No. 85D Prevention of Furnace Explosions in Fuel Oil-Fired Multiple Burner Boiler-Furnaces.
- (8) NFPA No. 85E Prevention of Furnace Explosions in Pulverized Coal-Fired Multiple Burner Boiler-Furnaces.
- (9) NFPA No. 89M Clearances for Heat Producing Appliances.
- (10) NFPA No. 211 Chimneys, Fireplaces and Vents.

3.1.2 Gas. Gas feed 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 feed mains shall rise above grade outside the foundation wall and pass through a full swing joint or a 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 outside. Standards for heating system components common to all fuel systems are provided in NFPA No. 211, Chimneys, Fireplaces and Vents. Related information is available also in the Uniform Building Code. Heating system devices shall be approved by a recognized testing laboratory such as Underwriters' Laboratories, Factory Mutual, or American Gas Association.

3.1.3 Coal. Bituminous coal is the most commonly used type of coal for industrial boilers and furnaces. Other coals used are anthracite and lignite. Both are considered to represent less fire hazard than bituminous. Bituminous coal is subject to spontaneous heating and ignition when exposed to air or moisture. Its airborne particles, like most other dusts, can also present an explosion hazard if ignited in an enclosed volume. Safeguards for the storage and handling of bituminous coal are as follows:

3.1.3.1 Storage.

(1) If possible, all coal should be purchased using definite specifications to secure characteristics least likely to support spontaneous heating while providing a satisfactory fuel. Sulfur content should be held to 1 percent and moisture content to 3 percent "as mined," particularly if the coal will not be used for several months.

(2) Do not store coal in contact with any source of external heat, such as piping, flues, boiler walls, and over steam mains, even though buried. Also avoid storage over iron or steel fire service water mains.

(3) 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, because this usually supplies more oxygen and increases the heating.

(4) Low-grade coal shall not be piled higher than 10 feet (3 m) and best-grade not higher than 15 feet (4.5 m), unless it is piled by the roll-packing method. Locate yard piles at least 25 feet (7.6 m) from other combustibles and from important structures.

(5) 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 coal is fed at the top and removed at the bottom is recommended. This arrangement prevents fine material from collecting and remaining in the bin for long periods, and 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 summer shutdowns and other prolonged idle periods. Provide automatic sprinkler protection if the storage facility has combustible construction or occupancy other than coal. Provide access openings for manual firefighting.

3.1.3.2 Handling.

3.1.3.2.1 Conveyor Belts. Where combustible conveyor belts are used to transport coal, the following shall be observed:

(1) An automatic sprinkler system shall be provided. It shall be hydraulically designed to operate ten automatic sprinklers and two small hose streams. 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, which will provide approximately 200 gpm (12.6 L/s) for sprinklers and hose streams. (In a conveyor enclosure less than 15 feet (4.6 m) wide, this can usually be accomplished by installing a single continuous supply line with an unlimited number of sprinklers.) Water supply should be adequate for at least 1 hour duration. System should be interlocked with the belt drive to shut down on sprinkler water flow.

(2) Provide either small hose lines (FM approved 1-1/2 inch) or hydrants at suitable intervals such that the entire belt is accessible for firefighting.

(3) Provide each conveyor belt system with tamperproof devices arranged to automatically shut off driving power in the event of greater than 20 percent

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belt slowdown or misalignment of belts. Interlocking devices should also shut off power to all contributing conveyors.

3.1.3.2.2 Pulverizing Equipment. Considerations for coal pulverizing equipment are as follows:

(1) All equipment which could contain pulverized coal and air mixtures between the inlet of the raw fuel feeder and the point of pulverized fuel delivery to a firebox should be designed to withstand an internal pressure of 50 psi (345 kPa), after allowing for expected corrosion and deterioration. Tensile stresses should not exceed 1/4 of the ultimate strength, or 5/8 of the yield strength of the material.

Note: Exceptions are portions of the system which have adequate explosion venting, areas protected by explosion suppression systems, or areas operating under inert atmospheres.

(2) Electrical equipment in pulverizer areas should be suitable for Class II (NEC designation) hazardous areas. In normally clean areas, electrical equipment should be dust-tight (NEMA Type 5).

3.2. POWER GENERATING AND UTILIZATION EQUIPMENT.

3.2.1 General. In general, all electrical installations shall conform to NFPA No. 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 Factory Mutual Loss Prevention Data Sheets.

3.2.2 Stationary Combustion Engines and Gas Turbines. NFPA No. 37, Stationary Combustion Engines and Gas Turbines, shall be followed for internal combustion engine and gas turbine and generator installations. Unless located in sprinklered areas the following shall apply:

(1) Isolated installations may be protected with a self-contained pressurized sprinkler or water spray system with adequate supply to maintain a density of 0.2 gpm/ft² (8 L/min/m²) for 2,000 square feet (184 m²) for 40 minutes.

(2) Where a turbine is installed as an individual unit in an enclosure, a carbon dioxide system is acceptable as primary protection in accordance with the following criteria for acceptance.

(a) For turbine compartments, the rate of discharge shall be such that a 34 percent concentration of carbon dioxide is attained within 1 minute after actuation and a 30 percent concentration shall be maintained throughout the deceleration period and until all metal surfaces likely to reignite oil are cooled to below the autoignition temperature of the oil (400-500°F (204-260°C)).

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(b) For accessory compartments, to extinguish fires in electrical equipment and oil, a concentration of 50 percent of carbon dioxide shall be obtained within 1 minute after actuation. No less than 30 percent concentration shall be maintained for the following 10 minutes.

(c) Where it can be established that fire temperatures will be below the decomposition temperature of Halon 1301 (under 900°F (482°C)), Halon 1301 is acceptable as an extinguishing system with provisions that the Halon discharge is sufficient to maintain a minimum design concentration of 5 percent throughout the deceleration period of the turbine.

(3) Large individual units over 25,000 hp (18.65 MW) shall have backup protection of automatic sprinklers.

(4) Emergency generators shall be protected by a local application of carbon dioxide.

3.3 LIQUID-INSULATED TRANSFORMERS.

3.3.1 Oil-Insulated Transformers. Fire protection equipment needed for outdoor transformers depends on their size and importance. Table 3-1 provides fire protection requirements for single-phase or polyphase outdoor transformers.

Buildings located 25 feet (8 m) or more from an oil-cooled 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 (8 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 fireproof.

TABLE 3-1
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 spray

¹Where there are mission essential bus structures exposed to a 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 down time for repairs.

(3) Where transformers must expose a building having walls other than masonry or concrete, the following safeguards shall be taken:

(a) Provide a masonry or concrete barrier between building and transformers, with wing walls at each end of the barrier. The barrier shall extend at least 1 foot (300 mm) above the top of transformer bushings and pressure-relief vents. The wing walls shall be of the same height and shall extend horizontally 2 to 3 feet (600 to 1000 mm) 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 shown in Table 3-2.

(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 not to expose roof structures. Oil-filled transformers shall not be installed on combustible roofs.

(6) Oil-insulated transformers installed indoors shall be located in fire resistive vaults except for indoor transformer installations exempted by NFPA No. 70, National Electrical Code. Fire protection shall be provided in accordance with Table 3-2. Requirements apply to single-phase or polyphase lighting or power transformers.

TABLE 3-2
Protection for Oil-Insulated Transformers in Fire-Resistive Vaults

Size (each transformer)	Number	Fire 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, water-spray, or carbon dioxide system
Over 50,000 kVA	One or more	Automatic sprinkler, water-spray, or carbon dioxide system

3-3.2 High-Fire-Point, Liquid-Insulated Transformers. Transformers filled with cooling/insulating fluids possessing fire points of at least 572°F (300°C)† require different fire protection guidelines than those used for ordinary oil-insulated transformers.

Outdoor transformer installations which are isolated and which present no exposure hazard to important structures may be protected with hydrants.

Factors which affect fire protection requirements for indoor installations, and those outdoor units which present exposure hazards, include (1) the type of construction of the building housing the transformer, (2) the building's occupancy hazard classification, (3) convective and radiative heat release rates of the transformer fluid used, (4) the power rating of the transformer, and (5) the size of the diked containment area surrounding the transformer unit. Variations in (1) the heat release rates of commercially available high-fire-point transformer fluids and (2) containment (diked area) configurations, preclude the issuance of general guidelines for the fire protection of the units. Consult Factory Mutual Data Sheets for additional information.

3-4. TRASH COLLECTION AND DISPOSAL FACILITIES

3-4.1. REQUIREMENTS. Central trash collection units shall be placed 15 feet (5 m) or more away from wood frame or metal buildings or from openings in masonry-walled buildings. Collection, baling and storage room shall have 2-hour fire resistance and be sprinklered.

†Defined by ASTM D-92-72

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4.0 SPECIAL OCCUPANCIES AND HAZARDS.

4.1 PURPOSE. The purpose of this chapter is to address certain specific occupancies and hazards to which attention must be drawn such that appropriate standards may be cited.

4.2 PERSONNEL SUPPORT FACILITIES.

4.2.1 Bachelor Officers and Bachelor Enlisted Quarters (BOQ and BEQ). This occupancy includes barracks, dormitories, sleeping quarters and similar facilities.

4.2.1.1 Requirements. NFPA No. 101, Life Safety Code, provides requirements for life safety features. Installation of fire detection systems shall conform with the requirements of NFPA No. 101 and NFPA No. 72E except as modified in this handbook. Minimum requirements are:

(1) A single station smoke detection unit shall be provided for each sleeping room of personnel housing quarters. Upon activation, a local audible alarm will be generated by the affected unit. Power to smoke detectors shall be hard-wired to the building electrical system. Battery powered detectors are not permitted.

(2) Smoke detectors shall be located in interior corridors, lounges and open ward sleeping areas of hotel-style personnel housing quarters. When activated, these units will sound a general building alarm and transmit a coded signal to a constantly monitored central alarm location.

(3) Smoke detectors shall be located in living room/lounge areas of apartment-style personnel housing quarters. When activated, these units will sound a general building alarm and transmit a coded signal to a constantly monitored central alarm location.

4.2.2 Family Housing. This section includes one-family, two-family, and multiple-family public quarters and rental housing.

4.2.2.1 Requirements. Fire protection criteria shall conform to the standards of the U.S. Department of Housing and Urban Development (HUD) 4900.1 Minimum Property Standards for One and Two Family Dwellings, and 4910.1 Minimum Property Standards for Multi-Family Housing, NFPA No. 101 Life Safety Code and DOD 4270.1-M Construction Criteria Manual. Refer to NFPA No. 74, Household Warning Equipment, for additional guidance on fire detection systems.

4.2.3 Dining/Food Preparation Facilities. Fire protection criteria shall conform to NFPA No. 96, Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, and NFPA No. 101.

4.2.4 Administrative Facilities. Buildings and portions of buildings used primarily for offices are considered in this category. NFPA No. 101 contains requirements for this occupancy with respect to life safety features.

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4.2.5 Hospitals and Dispensaries. These facilities shall comply with the following:

4.2.5.1 Requirements. These facilities shall comply with DOD requirements, the Uniform Building Code, and the following NFPA standards.

- (1) NFPA No. 56A Inhalation Anesthetics.
- (2) NFPA No. 56B Respiratory Therapy.
- (3) NFPA No. 56C Laboratories in Health Related Institutions.
- (4) NFPA No. 56D Hyperbaric Facilities.
- (5) NFPA No. 56E Hypobaric Facilities.
- (6) NFPA No. 56F Nonflammable Medical Gas Systems.
- (7) NFPA No. 70 National Electrical Code.
- (8) NFPA No. 76A Essential Electrical Systems for Health Care Facilities.
- (9) NFPA No. 76C Safe Use of High Frequency Electricity in Health Care Facilities.
- (10) NFPA No. 101 Life Safety Code.

4.2.6 Detention and Correctional Facilities. The following criteria shall be complied with:

4.2.6.1 Gang release devices. Mechanical or closed-circuit electrical gang release devices shall be provided whenever 12 or more locks must be operated to release prisoners confined in cells. This requirement does not apply to the dormitory prisoner population. All doors necessary to evacuate cell inmates shall be opened by the gang release device. Where gang release devices are not required by these criteria, all exit and corridor doors that must be opened for evacuation in case of fire shall be fitted with heavy, identically keyed, prison-type locks.

4.2.6.2 Hardware. Department of the Army, Corps of Engineers, Guide Specification CEGS-08701, Hardware: Prison-Locking Devices shall apply.

4.2.6.3 Interior finish. Interior finish including padded cells shall be Class A as defined by NFPA No. 101, Life Safety Code, with the exception that the smoke developed rating shall not exceed 50, as determined by ASTM E-84, Standard Test Method for Surface Burning Characteristics of Building Materials.

4.2.7 Libraries. Combustible shelving, stacks, cases, cabinets, fixtures, furniture, and furnishings shall be eliminated to the maximum practicable extent. Wall and ceiling finish materials shall be noncombustible. Depending upon various circumstances associated with the library, the following special requirements shall be imposed:

(1) All libraries located in sprinklered buildings shall be protected by sprinklers.

(2) In buildings not equipped with sprinkler protection, the following protection features shall be provided for those libraries containing substantial numbers of items that are rare, irreplaceable, important to activity mission.

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

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

(3) Where sprinkler protection is provided in accordance with paragraphs (1) and (2) preceding, wet-pipe systems with 212°F (100°C) heads shall be used. In special cases where storage arrangements and nature of library materials justify the additional cost, preaction systems may be used. NFPA No. 910, Libraries and Library Collections, and NFPA No. 911, Museums and Museum Collections, shall be applied where appropriate.

4.3 ELECTRONIC EQUIPMENT INSTALLATIONS.

4.3.1 Scope. The following minimum requirements are applicable to all electronic equipment installations of high monetary value essential to operations, weapons and communication systems, whether Government-owned or leased, including EDP, computers, avionics, communications, flight simulators, major electronic training devices, etc.

4.3.2 Construction. New facilities to house electronic equipment installations shall be fire-resistive or noncombustible construction and separated from other occupancies by minimum 1-hour fire-rated walls or partitions.

4.3.2.1 Existing combustible construction shall be replaced with noncombustible construction and separated from other occupancies by fire-rated walls or partitions wherever practical.

4.3.2.2 Additional guidance for construction and for protection is found in NFPA No. 75, Computer/Data Processing Equipment.

4.3.3 Sprinkler Systems. Standard wet-pipe or preaction automatic sprinkler systems shall be provided in the following areas:

(1) Electronic equipment areas where combustible materials of construction are present or where combustible materials, including cards, paper, and plastics, are processed or stored (excluding cards, paper, disks, and tapes within machines).

(2) Areas containing flight simulators or major electronic training devices where combustible materials are present in the basic structure or as part of the simulator trainer.

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(3) Record storage rooms unless records are contained in closed metal files or cabinets.

(4) Areas adjacent to electronic equipment spaces in building of non-combustible or fire-resistive construction where the occupancy in such areas presents serious fire exposures to the electronic equipment spaces.

4.3.4 Gaseous Extinguishing Systems.

4.3.4.1 Halon 1301 total flooding systems may be provided in electronic equipment or areas where mission-essential functions are conducted and continued operation of equipment is essential to ongoing operations. However, Halon 1301 systems shall not be considered a substitute for required sprinkler protection.

4.3.4.2 Halon 1301 or carbon dioxide flooding systems or automatic sprinkler protection shall be provided for underfloor spaces containing nonmetallic sheathed exposed cables. For underfloor areas having less than 5,000 cubic feet (57 m³) volume, fixed extinguishing systems may be omitted unless the electronic equipment is considered mission essential.

4.3.4.3 Halon 1301 shall be provided to protect against hydraulic fluid fires in flight simulators or other high cost electronic training devices when Class A combustibles are not present and automatic sprinkler protection is not required.

4.3.5 Automatic Fire Detection Systems.

4.3.5.1 Smoke detection systems shall be provided in electronic equipment areas and in record storage rooms. Detectors shall transmit a signal to the fire department or central alarm location.

4.3.5.2 Smoke detection systems shall be provided in underfloor spaces containing exposed nonmetallic sheathed cables. Fixed-temperature rate-compensated or fixed temperature rate-of-rise heat detectors may be provided in underfloor spaces under circumstances when smoke detectors are not effective. Systems shall transmit signal to fire department or central alarm location and shall activate underfloor Halon 1301 or carbon dioxide systems.

4.3.6 Emergency Power Shutoff Switches. Where required, such switches shall be located at the principal exits.

4.4 INDUSTRIAL FACILITIES.

4.4.1 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, ship repair shops, and ordnance shops.

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4.4.1.1 Requirements. Automotive garages shall conform to NFPA No. 88B, Repair Garages. The requirements for ship repair facilities in NFPA No. 303, Marinas and Boatyards, and NFPA No. 312, Fire Protection of Vessels During Construction, Repair, and Lay-up, shall be followed. Major aircraft overhaul and repair shops shall conform to NFPA No. 409, Aircraft Hangars and to Sections 4.4.6. and 4.4.7. of this handbook.

4.4.1.1 Other standards. Because repair shops may contain multiple occupancies, each including a specific hazard, the following additional standards shall be complied with where appropriate:

- (1) NFPA No. 33 Spray Application Using Flammable and Combustible Materials.
- (2) NFPA No. 51 Oxygen-Fuel Gas Systems For Welding and Cutting.
- (3) NFPA No. 70 National Electrical Code.

For other common and special hazards refer to the appropriate section of this chapter.

4.4.2 Ordinance Facilities. Automatic sprinkler systems in ordnance facilities shall be provided with flexible couplings and sway bracing similar to that provided for buildings in earthquake zones. Specific automatic sprinkler protection requirements for areas within these structures are as follows:

- (1) High-speed (operation of 0.5 second), preprimed, deluge systems wherever exposed powder, explosives, or propellants are processed or stored. Complete protection of such locations is essential (see Table 5-1, Water Demands for Sprinklered Facilities).
- (2) Ordinary deluge systems in other areas or auxiliary sections of buildings in which processing or storage of explosives or propellants takes place.
- (3) Wet-pipe sprinkler systems in other areas or auxiliary sections of buildings if separated by fire partitions.
- (4) Wet-pipe or preaction 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. If electronic equipment is present in assembly and inspection areas, preaction sprinkler systems shall be provided.
- (5) Sprinkler System Detectors. Any type of heat detection equipment is acceptable if it meets the operating time limitations and is suitable in other respects, such as complying with explosionproof requirements. When pneumatic-type detection equipment is used, not more than three detectors, and preferably only one, shall be on a single circuit. They must be in the same heat influence area. Photoelectric detectors may be used for spot or for local protection applications, but shall not substitute for area or room heat detectors.

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(6) **Supervision.** All deluge and preaction systems shall be completely supervised so that any deficiency that develops that would affect the speed or reliability of operation will give a distinctive alarm separate from the water flow alarm.

(7) 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.

4.4.3 **Storage.** Consideration must be given to proper storage of materials to prevent the undue hazard and concentration of large quantities in a single location subject to a single catastrophe.

4.4.3.1 **Outside storage.** Material stored outside shall comply with the following NFPA standards:

- (1) NFPA No. 30 Flammable and Combustible Liquids Code.
- (2) NFPA No. 46 Storage of Forest Products.

Water supply requirements shall be in accordance with Section 5.2.2.5 of this handbook.

4.4.3.2 **Inside storage.** Inside storage arrangements and facilities shall comply with the following NFPA standards:

- (1) NFPA No. 30 Flammable and Combustible Liquids Code.
- (2) NFPA No. 231 Indoor General Storage.
- (3) NFPA No. 231C Rack Storage of Materials.
- (4) NFPA No. 231D Storage of Rubber Tires.
- (5) NFPA No. 232 Protection of Records.

4.4.4 **Waterfront Facilities.** Waterfront and harbor facilities shall comply with the following:

- (1) NAVFAC DM-25 Series.
- (2) NAVFAC DM-29 Series.
- (3) NFPA No. 87 Piers and Wharves.
- (4) NFPA No. 312 Fire Protection of Vessels During Construction, Repair and Lay-up.

4.4.5 **Petroleum Oils and Lubricants (POL) Facilities.** Requirements for POL facilities are contained in NFPA No. 30, Flammable and Combustible Liquids Code, and NFPA No. 385, Tank Vehicles for Flammable and Combustible Liquids, and applicable service criteria. The standards of the American Petroleum Institute (API) provide additional guidance. See 5.0 of this handbook for water supply requirements. For Navy see DM-22, Petroleum Fuel Facilities, for additional criteria.

4.4.6 **Aircraft Hangars.** Requirements listed in this section are applicable to fuel cell maintenance facilities, corrosion control and protective coating, and general purpose maintenance hangars. All hangars shall comply with NFPA No. 409, Aircraft Hangars, except where modified as follows:

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(1) Aqueous film-forming foam (AFFF) deluge sprinkler systems or preaction AFFF sprinkler systems using standard water sprinkler heads shall be provided in main hangar areas. The discharge rate shall be a minimum of 0.16 gallons of air-foam solution per minute per square foot (6 L/min/m^2) floor area.

(2) Where preaction AFFF sprinkler systems are used, water supply in addition to hose streams and monitor nozzles shall be sufficient to satisfy the volume of water required by the number of sprinkler heads opened in accordance with one of the following:

(a) Within an 8,000 square foot (740 m^2) area where roof or ceiling height is 25 feet (8 m) or less above the floor level.

(b) Within an 18,000 square foot (1670 m^2) area where roof or ceiling height is over 25 feet (8 m) but not more than 75 feet (23 m) above the floor level.

(c) Within a 35,000 square foot (3250 m^2) area where roof or ceiling height is over 75 feet (23 m) above the floor level.

(3) Supplementary low level fixed AFFF nozzle systems shall be provided in main hangar areas. Oscillating nozzles may be provided instead of fixed nozzles if the use of fixed nozzles is not feasible. These systems shall be designed at a minimum application rate of 0.10 gallons per minute per square foot (4 L/min/m^2). These systems shall be activated by the overhead detection system. Strategically located manual controls shall also be provided.

(4) Foam concentrate tanks, proportioning equipment, and deluge valves shall be separated from main hangar areas by construction having a minimum of 1-hour fire resistance rating.

(5) Automatic, wet-pipe sprinkler systems shall be provided in all areas of the hangar facility not requiring overhead AFFF sprinkler protection.

4.4.7 Aircraft Acoustical Enclosures.

4.4.7.1 Complete enclosures (HUSH HOUSE). Requirements shall be the same as those listed for Aircraft Hangars, Section 4.4.6, in addition to the following:

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

(2) Low-level systems shall provide uniform coverage for the entire floor area.

(3) The overhead and the low level systems shall both be automatically actuated by fixed temperature-rate compensation detectors. Switches for interrupting the automatic features shall be provided in the control room. Clearly visual indication shall be provided when the automatic feature has been interrupted.

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(4) Separate manual controls for actuation of each aqueous film-forming foam system shall be provided in the control room.

4.4.7.2 Out-of-airframe acoustical enclosures (test cells). The requirements for complete acoustical enclosures listed in Section 4.4.7.1 Complete Enclosures, shall be provided except for the following:

(1) In lieu of the overhead aqueous film-forming foam system required in Section 4-4.7.1, overhead water deluge protection having a discharge density of 0.35 gallons per minute per square foot (14 L/min/m^2) of the entire floor area may be used where adequate water supply is available and where this type of extinguishing system is effective in controlling fuel that may be encountered.

(2) In lieu of the supplementary low level aqueous film-forming foam system described in Section 4.4.6, a supplementary local application system for engine protection shall be provided. Engines shall be protected by local application of water spray with a density of 0.50 gallons per minute per square foot (20 L/min/m^2) of engine surface area.

(3) The fuel room shall be protected by deluge or wet-pipe sprinkler system.

4.4.8 Hyperbaric and Hypobaric Chambers. Hyperbaric chambers shall conform to NFPA No. 56D, Hyperbaric Facilities. Hypobaric chambers shall conform to NFPA No. 56E, Hypobaric Facilities.

4.4.9 Anechoic Chambers. Anechoic chambers shall be protected with automatic sprinkler systems in accordance with Table 4-1. When chamber construction materials used to eliminate echoes and reverberations have passed the Factory Mutual Research Corporation Corner Test, sprinklers are not required.

4.5 HIGH RISE BUILDINGS.

Buildings having floors that are beyond the reach of fire department ladders (normally more than four stories in height) present serious life loss potentials from fire and severe difficulties in firefighting operations. Such buildings require the following:

(1) Automatic sprinkler protection in accordance with Chapter 8 of NFPA No. 13, Installation of Sprinkler Systems.

(2) Smoke control system that permits the development of positive pressures in stair and elevator shafts and in floor areas not involved in fire and development of negative pressures in areas involved in fire.

(3) Means for placing control of elevators under emergency forces complying with the requirements of ANSI A17.1B, Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks.

(4) Building control center with two-way communications to all floors, elevators, and stair towers.

TABLE 4-1

Fire Protection for Anechoic Chambers*

PROTECTION	Smooth surfaces		Geometric shapes (Pyramids)		
	Up to 10 in thick (250 mm)	Over 10 in thick (250 mm)	Up to 6 in deep (150 mm)	6 to 12 in deep (300 mm)	Over 12 in deep (300 mm)
Automatic sprinklers (100 sq ft coverage, 10-ft max spacing, 212° 1/2 in. extra hazard piping, 0.30 gal/min/ft ² (12 L/min/m ² average density ¹)	X		X		
Automatic sprinklers (50 sq ft coverage, 8-ft max spacing, 212° 1/2 in. extra hazard piping, 0.60 gal/min/ft ² (25 L/min/m ² average density)		X		X ²	
Automatic sprinklers (40 sq ft coverage, 7-ft max spacing, 212° 1/2 in. extra hazard piping, 0.60 gal/min/ft ² (25 L/min/m ² average density)					X ²
Side wall automatic sprinklers (not over 7-ft spacing)	X ³	X ³	X ^{2,4}		
Side wall automatic sprinklers (not over 5-ft spacing)				X ^{2,4}	X ^{2,4}

¹Average Density - At chambers under 2,000 ft² (186 m²) of floor area, the average density shall be for all heads. At chambers over 2,000 ft², average density shall be for 3/4 of the sprinklers.

²Sprinklers shall be located 1/3 the length of the pyramid from the base of the pyramid.

³Required for walls over 15 ft high and installed at approximately 15 ft (5 m) vertical intervals.

⁴Intermediate row required for walls over 15 ft (5 m) high.

*Adapted from Factory Mutual Loss Prevention Data Sheets.

4.6 FLAMMABLE AND COMBUSTIBLE LIQUIDS.

4.6.1 Specific Safeguards. The following standards and guides are applicable to the storage, handling and use of flammable and combustible liquids and shall be applied:

- (1) NFPA No. 30 Flammable and Combustible Liquids Code.
- (2) NFPA No. 33 Spray Application Using Flammable and Combustible Materials.
- (3) NFPA No. 34 Dipping and Coating Processes Using Flammable or Combustible Liquids.
- (4) NFPA No. 68 Explosion Venting Guide.
- (5) NFPA No. 407 Aircraft Fuel Servicing.
- (6) NFPA No. 415 Aircraft Fueling Ramp Drainage.

4.7 FLAMMABLE GASES.

4.7.1 Specific Safeguards. The following standards and guides are applicable to the storage, handling, and use of hazardous gases and shall be applied:

- (1) NFPA No. 50 Bulk Oxygen Systems at Consumer Sites.
- (2) NFPA No. 50A Gaseous Hydrogen Systems at Consumer Sites.
- (3) NFPA No. 50B Liquefied Hydrogen Systems at Consumer Sites.
- (4) NFPA No. 51 Oxygen-Fuel Gas Systems for Welding and Cutting.
- (5) NFPA No. 54 National Fuel Gas Code.
- (6) NFPA No. 56A Inhalation Anesthetics.
- (7) NFPA No. 56B Respiratory Therapy.
- (8) NFPA No. 56D Hyperbaric Facilities.
- (9) NFPA No. 56E Hypobaric Facilities.
- (10) NFPA No. 56F Nonflammable Medical Gas Systems.
- (11) NFPA No. 58 Liquefied Petroleum Gases.
- (12) NFPA No. 59A Liquefied Natural Gas.

4.8 HAZARDOUS CHEMICALS.

4.8.1 Specific Safeguards. The following standards are applicable to the storage, handling, or use of specific hazardous chemicals and shall be applied:

- (1) NFPA No. 43A Storage of Liquid and Solid Oxidizing Materials.
- (2) NFPA No. 48 Storage, Handling and Processing of Magnesium.
- (3) NFPA No. 481 Production, Processing, Handling and Storage of Titanium.
- (4) NFPA No. 482M Production, Processing, Handling and Storage of Zirconium.
- (5) NFPA No. 490 Storage of Ammonium Nitrate.
- (6) NFPA No. 492 Separation Distances of Ammonium Nitrate and Blasting Agents.
- (7) NFPA Hazardous Materials Handbook.

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Many hazardous chemicals are not covered by specific standards, but NFPA No. 49, Hazardous Chemical Data, includes suggestions and remarks pertinent to firefighting and storage for each of the chemicals listed. Whenever a specific standard is lacking, the recommendations contained in NFPA No. 49 shall be followed.

4.9 EXPLOSIVES AND BLASTING AGENTS.

4.9.1 Safeguards. Safeguards for the storage, handling and use of explosives and blasting agents other than military explosives shall be provided as required by NFPA No. 495, Explosive Materials.

4.10 COMBUSTIBLE DUSTS.

4.10.1 Specific Safeguards. The following standards and guides are applicable to the storage, handling, use, or production of combustible dusts and shall be applied:

- (1) NFPA No. 65 Aluminum, Processing and Finishing.
- (2) NFPA No. 68 Explosion Venting.
- (3) NFPA No. 69 Explosion Prevention Systems.
- (4) NFPA No. 85F Pulverized Fuel Systems.
- (5) NFPA No. 91 Blower and Exhaust Systems.
- (6) NFPA No. 651 Manufacture of Aluminum or Magnesium Powder.
- (7) NFPA No. 654 Prevention of Dust Explosion in Plastics Industry.
- (8) NFPA No. 664 Prevention of Dust Explosions in Woodworking and Wood Floor Manufacturing Plants.

4.11 OVENS AND FURNACES.

4.11.1 Safeguards. Ovens and furnaces shall be constructed, installed, and protected in accordance with the following NFPA standards:

- (1) NFPA No. 86A Ovens and Furnaces.
- (2) NFPA No. 86B Industrial Furnaces.
- (3) NFPA No. 86C Industrial Furnaces Special Processing.

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5.0 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 the occupancy (See Appendix B, Occupancy Hazard Classification), the discharge density, design area, and the type of sprinkler system (wet or dry), construction and other building features.

5.1.2 Water Demand for Sprinklers. The water demand required for sprinklers shall be determined from Tables 5-1 and 5-2. Refer to Appendix A for occupancy classifications.

5.1.2.1 Design densities. The design densities indicated in Table 5-1 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. The design areas shown in Table 5-1 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 Tables 5-1 and 5-2.

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

5.1.5 Water Demand for Sprinklers (Special Facilities). Special requirements apply to some facilities, as indicated below.

5.1.5.1 Aircraft hangars. Water demands for aircraft hangars shall be in accordance with Chapter 4 of this handbook.

5.1.5.2 Warehouses (high piled or high rack storage). Water demands for warehouses containing high rack storage shall conform to NFPA No. 231C, Rack Storage of Materials. Water demands for warehouses containing high piled storage shall conform to NFPA No. 231, Indoor General Storage.

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TABLE 5-1

Water Demands for Sprinklered Facilities

Occupancy classification ¹	Sprinklers		Hose gal/min (L/min)	Duration of supply (minutes)
	Design density ² (gal/min)/sq ft (L/min/m ²)	Design area ³ sq ft (m ²)		
Light hazard	0.10(4)	3,000(280)	250(960)	45
Ordinary Hazard Group 1	0.15(6)	3,000(280)	500(1920)	60
Ordinary Hazard Group 2	0.20(8)	3,000(280)	500(1920)	75
Ordinary Hazard Group 3	0.25(10)	3,000(280)	500(1920)	90
Extra hazard	0.35(14)	3,000(280)	750(2820)	105
Ordinance plants (exposed powder area)	0.50(20)	Entire area	750(2820)	45
Rubber tire storage	0.60(25)	3,000(280)	750(2820)	150
Missile assembly		Entire area		

¹See Appendix B for occupancy definitions.

²These densities may be reduced to a minimum of NFPA No. 13 requirements for 3,000 ft² (280 m²) at the discretion of the Division Fire Protection Engineer if fire loading or interior finish warrant.

³For dry pipe systems increase design area by 30 percent.

5.1.5.3 Ordinance facilities. See Sections 4.4.2 and 4.9.

5.1.5.4 Rubber tire storage. These occupancies shall be in accordance with NFPA No. 231E, Storage of Rubber Tires.

5.1.5.5 Aircraft acoustical enclosures. See Section 4.4.7.

5.2 WATER DEMANDS FOR UNSPRINKLERED FACILITIES.

5.2.1 Hose Stream Demand for Unsprinklered Facilities. Fires in unsprinklered facilities require more water than fires in similar sprinklered facilities, because the application of water by hose streams is less efficient and begins later than application by sprinklers.

The ranges of water demands and duration for unsprinklered occupancies shall be determined by Table 5-2. The following factors affect these ranges and shall be used to determine the water flow demand:

- (1) Response time by fire department.
- (2) Firefighting access.
- (3) Exposures.
- (4) Type of construction.
- (5) Building height.
- (6) Building floor area.
- (7) Conflagration potential.

TABLE 5-2

Water Demands for Unsprinklered Facilities¹

Occupancy classification (see Appendix B)	Hose streams ¹ gal/min (L/min) at 20 lb/in ² (140 kPa) residual pressure	Duration ¹ (minutes)
Light hazard	750-1,500 (2820-5700)	60-120
Ordinary Hazard Group 1	1,000-2,000 (3780-7560)	90-150
Ordinary Hazard Group 2	1,500-3,000 (5700-11 340)	90-150
Ordinary Hazard Group 3	2,000-4,000 (7560-15 120)	120-180
Extra hazard	2,500-5,000 (9480-18 900)	150-240

¹Ranges based upon favorability of firefighting conditions as defined in Section 5.2 of this handbook.

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

5.2.2.1 Ship berthing and drydock facilities. The water demand for ship berthing and drydock facilities shall be as required by Waterfront Operational Facilities, NAVFAC DM-25 Series, and Drydocking Facilities, NAVFAC DM-29 Series.

5.2.2.2 Dwellings. The water demand for dwellings shall be as follows:

- (1) One-story - 500 gallons per minute (1920 L/min) for 90 minutes.
- (2) Two-story - 750 gallons per minute (2820 L/min) for 90 minutes.
- (3) Three-story and above - 1,000 gallons per minute (3780 L/min) for 0 minutes.

5.2.2.3 Petroleum oils and lubricants (POL) areas.

5.2.2.3.1 Above Ground Atmospheric POL Tanks. Table 5-3 provides fire flow rates for nonpressurized POL tanks.

5.2.2.3.2 Above Ground Pressurized POL Tanks. Table 5-4 provides fire flow rates for pressurized POL tanks.

5.2.2.4 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.

5.2.2.5 Yard storage. Factors influencing water demand requirements for outside yard storage are (1) size of storage area, (2) material hazard classification, and (3) separation. Water demand for yard storage is presented in Table 5-6.

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5.2.2.5.1 Size of Storage Area. The available storage area. Three ranges are presented; a) 0-10,000 square feet (0-929 m²); b) 10,000-25,000 square feet (929-2322 m²), and c) greater than 25,000 square feet (2322 m²).

5.2.2.5.2 Material Hazard Classification. Materials are classified according to the criteria used in NFPA Standard No. 231A, Recommended Safe Practices for Outdoor General Storage, which categorizes materials as noncombustible or combustible. Because of the increased fire hazard associated with high piled storage, the combustible classification was subdivided to reflect

TABLE 5-3

Atmospheric POL Tank Cooling Water

Tank Diameter		Fire Flow Rate	
feet	(meters)	gpm	(L/min)
0 - 65	(0 - 20)	500	(1920)
65 - 120	(20 - 36)	750	(2820)
120 - 155	(36 - 47)	1000	(3780)
155 - 200	(47 - 61)	1250	(4740)
200 or greater	(61 - .)	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 feet (15 m) or one tank diameter, whichever is greater, of the largest tank under consideration.

Note 2. Water requirements for special suppression systems, if used, is additional.

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TABLE 5-4

Pressurized POL Tank Cooling Water

Tank Group Size	Fire Flow Rate gpm (L/min)
Single tank (less than 30,000 gal. capacity) (113 550 liters)	250 (960)
Single tank (more than 30,000 gal. capacity) (113 550 liters)	500 (1920)
2 to 6 tanks (each tank less than 30,000 gal. capacity) (113 550 liters)	500 (1920)
2 to 6 tanks (each tank greater than 30,000 gal. capacity) (113 500 liters)	1000 (3780)
7 or more tanks, each tank less than 30,000 gal. capacity (113 550 liters)	1000 (3780)
7 or more tanks, one or more tanks greater than 30,000 gal. capacity (113 550 liters)	1500 (5700)
Minimum Duration: 240 minutes	

Note 1: Increase fire flow rate by 500 gpm (1920 L/min) for each atmospheric tank within 50 feet (15 m). Add 250 gpm (960 L/min) for each handling facility within that same distance.

Note 2: Water requirements for special suppression systems, if used, are additional.

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this increased risk. Therefore, materials have been classified as (1) noncombustible, (2) low-piled combustible (height less than 15 feet), and (3) high-piled combustible (height 15 feet or greater).

5.2.2.5.3 Separation. Consideration has been made to include the effects of exposure to adjacent storage, buildings or structures. Separation factors are computed using the following methodology.

First, the shortest distance between each exposed facility and the yard storage perimeter is determined. Next, Table 5-5 is used to determine an exposure factor for each exposed facility. Exposure factors for each exposed facility are summed to yield a single Separation Factor. For Separation Factors of 15 or greater, the required flow is that flow necessary for the Isolated Storage case (shown in Table 5-6), increased by 75 percent (i.e. multiply required Isolated Storage flow by 1.75). For Separation Factors less than 15, the percentage increase is determined by multiplying this Separation Factor by the value 5.17. For example, a Separation Factor of 10 yields a percentage increase of 10×5.17 or approximately 52 percent. Therefore, multiply the Isolated Storage flow by 1.52 to determine the required flow.

5.2.2.6 Vehicle parking areas. A minimum fire flow rate of 500 gallons per minute (1920 L/min) for a 2-hour duration shall be provided for all such facilities.

5.3 PRESSURE REQUIRED.

When hose streams are to be taken directly from fire hydrants without the use of a fire department pumper, the minimum residual pressure shall be 90 psi (620 kPa). When a fire department pumper is to be used, the minimum residual pressure shall be 20 psi (138 kPa).

5.4 DURATION OF WATER SUPPLIES.

The sources of the fire protection water supply shall be capable of furnishing the necessary flow and pressure for the duration indicated in the appropriate tables. Duration of water supplies for open head sprinkler systems is 45 minutes.

5.5 QUANTITIES OF WATER REQUIRED.

The 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 must be available at all times. Water supply for domestic, industrial, and other demands must be added to these requirements in order 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 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 normally required.

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TABLE 5-5

DISTANCE VS. SEPARATION FACTOR FOR YARD STORAGE

Separation Distance (in feet)	Separation Factor
0 - 10	5
11 - 25	4
26 - 50	3
51 - 100	2
101 - 150	1
over 150 feet	

TABLE 5-6

Yard Storage

Area/Material Classification	Isolated		Non-Isolated	
	Flow (gpm) (L/min)	Duration	Flow (gpm) (L/min)	Duration
I. 0-10,000 ft ² (0-929 m ²)				
A. Noncombustible	500 (1920)	120 min.	875 (3312)	120 min.
B. Combustible, Low Piled	1000 (3780)	120 min.	1750 (6624)	180 min.
C. Combustible, High Piled	1500 (5700)	120 min.	2625 (9937)	180 min.
II. 10,000-25,000 ft ² (929-2322 m ²)				
A. Noncombustible	750 (2820)	120 min.	1312 (4966)	120 min.
B. Combustible, Low Piled	1500 (5700)	120 min.	2625 (9937)	120 min.
C. Combustible, High Piled	2000 (7560)	180 min.	3500 (13 249)	180 min.
III. Greater than 25,000 ft ² (2322 m ²)				
A. Noncombustible	1000 (3780)	120 min.	1750 (6624)	180 min.
B. Combustible, Low Piled	2000 (7560)	180 min.	3500 (13 249)	180 min.
C. Combustible, High Piled	2000 (7560)	180 min.	3500 (13 249)	180 min.

¹ Separated from adjacent structures by at least 150 feet (46 m) on all sides.

² Adjacent storage or structures located within 10 feet (3 m) on all sides.

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5.5.1 Total Storage Capacity. The total stored supply shall be sufficient to meet the maximum required fire flow demand plus 50 percent of the average daily domestic consumption.

5.5.2 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.

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

5.6 SOURCES OF SUPPLY.

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

- (1) Two connections to a public water system (one connection is ample for a small activity, such as a Reserve Training Facility).
- (2) Elevated tanks or reservoirs.
- (3) Multiple pumps with adequate suction supply.

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

5.7 PUMPS.

5.7.1 Requirements. Pumps for fire protection shall have adequate capacity with reliable power and water supply. This equipment shall conform to requirements of NFPA No. 20, Centrifugal Fire Pumps. Fire pumps, prime movers, and all other equipment including automatic accessories shall be listed by Underwriters' Laboratories or approved by Factory Mutual.

5.7.2 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 will not be used where suction lift is required. A vertical shaft turbine pump will be used for suction lift.

5.7.3 Pump Starting Arrangement. Fire pumps must be arranged to start automatically except that they may be arranged for manual starting when other available water supply sources are capable of providing the demands for all automatic sprinkler and special fire suppression systems simultaneously with the domestic/industrial demands. All fire pumps require manual shutdown after starting. Automatic shutdown is not permitted except on complete consumption of reservoir water.

5.7.4 Pump Drive. When electric power is economically available from a reliable single power source or from two independent sources in accordance

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with NFPA No. 20, fire pumps will be electric motor-driven only. When such electric power supplies are not available, fire pumps will be diesel engine-driven. Spark ignited internal combustion engines will not be used to drive fire pumps.

5.8 DISTRIBUTION SYSTEMS.

5.8.1 Mains. Underground mains in water supply systems shall be installed in accordance with the requirements of NFPA No. 24, Private Fire Service Mains and Their Appurtenances. The distribution system shall be sized to accommodate fire flows plus domestic and industrial or flushing demands that cannot be restricted during fires. Distribution mains shall be looped to provide at least 50 percent of flow in case of a single break.

5.8.2 Valves. Control valves shall be provided in each source of water supply (such as at 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. All new valves shall be right-hand valves.

5.8.2.1 Drawings. Drawings shall be provided showing all control and sectional valve locations, valve sizes, and number of turns. All left-hand valves shall be clearly indicated on drawings.

5.8.3 Hydrants. Fire hydrants shall be Underwriters' Laboratories listed or Factory Mutual approved 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 No. 24, Private Fire Service Mains and Their Appurtenances, and NFPA No. 1963, Fire Hose Connections. Wet-barrel or California-type hydrants are preferable in areas where there is no danger of freezing. If local municipal departments use non-standard connections, adapters shall be made and supplied to engine companies that respond to station fires.

5.8.3.1 Installation requirements. All 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. In general, hydrants shall be located at least 50 feet (15 m) from the buildings they are intended to protect. 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 No. 24, Private Fire Service Mains and Their Appurtenances, except as modified in this handbook. Pumper connection should be perpendicular to the street to allow straight line connection to pumper.

5.8.3.2 Spacing requirements. A sufficient number of hydrants shall be provided so that the hose stream demand can be met without more than 750 gallons per minute (2820 L/min) from any single hydrant. Hydrants shall also be spaced in accordance with the following requirements:

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(1) All parts of buildings shall be reached by hose lays of not over 350 feet (110 m) with consideration given to accessibility and obstructions.

(2) A minimum of two hydrants shall be provided within 500 feet (150 m) of each building.

(3) Hydrants protecting warehouses shall be spaced a maximum of 400 feet (120 m) apart around the facility.

(4) Hydrants protecting aircraft hangars shall be located at 300 feet (90 m) maximum intervals, and there must be at least one hydrant at each corner of the hangar. Where required hydrants may obstruct aircraft movements, they shall be flush type.

(5) Hydrants protecting POL storage and distribution facilities shall be spaced at 300 feet (90 m) maximum intervals.

5.8.4 Pressure Regulating Valves. Pressure regulating valves are restricted in use on fire protection water systems by NFPA No. 24, Private Fire Service Mains and Their Appurtenances. Where essential, they shall be installed on individual services rather than on the main piping. Where pressure-regulating valves (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:

- (1) Control valves on each side of pressure regulating valves (PRVs).
- (2) Bypasses around PRVs.
- (3) Pressure relief valves on low pressure side of PRVs.

5.8.5 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.

5.8.6 Meters. Where meters are installed on water distribution systems they shall be Factory Mutual approved or Underwriters' Laboratories listed fire flow meters.

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6.0 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 it.

6.1.2 Application. The following factors shall be considered when determining the necessity and justification for automatic sprinkler installation in a given facility:

- (1) Life safety and occupancy hazard risks;
- (2) Exterior fire exposures presented by the facility;
- (3) Strategic or tactical importance of the facility or supplies housed therein;
- (4) The quantity of supplies or facilities involved relative to available supplies or facilities of the same type;
- (5) The ability to replace the facility or its contents;
- (6) Inherent fire hazards of the facility;
- (7) Monetary value;
- (8) Size of the facility in relation to available fire fighting resources; and
- (9) Permanency of the facility.

6.1.3 Protected Occupancies. Automatic sprinkler protection shall be provided in the following buildings:

- (1) Hospital buildings and other medical facilities.
- (2) Buildings of combustible construction used for the following:
 - (a) Confinement of military prisoners.
 - (b) Bachelor personnel quarters (barracks) and quarters with fire areas in excess of 5,000 square feet (450 m²) per floor or which are three stories or more in height.
- (3) Warehouses, sheds (including transit and pier sheds), and similar storage-type buildings which are:

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- (a) Mission essential.
 - (b) Severe fire hazard.
 - (c) Of high monetary value.
- (4) Technical, industrial, and commercial type buildings, including hangars, shops, and laboratories used for production, repair, experimental testing, electronics overhaul facilities, or other processes, services, or equipment, which are any of the following:
- (a) Mission essential.
 - (b) Severe fire hazard.
 - (c) Of high monetary value.
- (5) Buildings of combustible construction with fire areas in excess of 8,000 square feet (740 m²) or that are three stories or more in height.
- (6) Commissaries and exchanges having fire areas in excess of 8,000 square feet (740 m²).
- (7) Windowless or underground structures when the combustibility of the contents or life-safety features warrant the protection.
- (8) Storage and other areas of buildings of noncombustible or fire-resistive construction where moderate or large volumes of combustible materials are stored or which constitute fire or explosion hazards. These areas shall also be separated from the areas without sprinklers by fire partitions having at least a 1-hour fire-resistance rating and with fire doors of comparable rating at the openings.
- (9) Extra hazard occupancies as defined in Appendix B.
- (10) Buildings in which significant amounts of critical equipment or material are exposed by combustible construction, storage, or hazardous operations. Critical equipment or material includes training devices (such as flight, navigational, or gunnery). Sprinklered areas shall be separated from unsprinklered areas by partitions having a minimum fire-resistant rating of 1-hour.
- (11) Buildings used for the manufacture, testing, or processing of explosives, propellants, pyrotechnics, signaling equipment, and similar items.
- (12) Buildings five stories or higher, measured from lowest grade level.
- (13) Aircraft maintenance hangars (see paragraph 4.4.6).
- (14) Aircraft acoustical enclosures (see paragraph 4.4.7).

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6.1.4 Design Requirements. All sprinkler systems shall use equipment and devices listed by Underwriters' Laboratories or approved by Factory Mutual. Sprinkler systems for light, ordinary, and extra hazard occupancies shall follow applicable criteria set forth in NFPA No. 13, Sprinkler Systems, and NFPA No. 16, Foam Water Sprinkler and Spray Systems. The sprinkler water requirements are stipulated in Section 5.1 of this handbook. Sprinkler system layouts should not normally be included in contract drawings. Shop drawings shall be submitted by the sprinkler system contractor.

6.1.4.1 Hydraulic calculations. The required discharge densities and areas of discharge operation are given in 5.0, Water Supply for Fire Protection. Calculations shall follow the format of NFPA No. 13. Pipe friction losses and equivalent lengths of pipe for fittings and valves shall be in accordance with NFPA No. 13. The following shall also apply:

(1) Piping Layout. For discharge densities of 0.20 gallons per minute per square foot (8 L/min/m²) or less, the distance between lines shall not exceed that permitted by NFPA No. 13 for ordinary hazard occupancies. For discharge densities of more than 0.20 gallons per minute per square foot (8 L/min/m²), the distance between lines shall not exceed that permitted by NFPA No. 13 for extra hazard occupancies.

(2) Spacing of Sprinklers on Lines. The distance between sprinklers on lines shall be approximately the same as the distance between lines. In light hazard occupancies, heads on adjacent lines shall have a full stagger.

6.1.4.2 Sprinkler coverage. Where sprinkler protection is justified, the sprinklers shall provide 100 percent coverage. An exception is small area spot protection in buildings having a low order of hazard overall. Partitions of at least 1 hour fire resistive construction are required between sprinklered and unsprinklered areas.

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.

6.2 WATER SPRAY SYSTEMS.

6.2.1 Requirements. Design requirements for water spray systems shall conform to NFPA No. 15, Water Spray Fixed Systems For Fire Protection.

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6.3 FOAM SYSTEMS.

6.3-1 Requirements. The NFPA Fire Protection Handbook and the Factory Mutual Loss Prevention Data Sheets contain data and information concerning the installation and arrangement of foam systems for various types of Class B (flammable liquids) hazards. Foam installations shall be in accordance with NFPA No. 11, Foam Extinguishing Systems, and NFPA No. 11A, High Expansion Foam Systems, and NFPA No. 11B, Synthetic Foam and Combined Agent Systems.

6.3.2 Design. The installation shall be designed for use against fires in gasoline storage even though fuel oil may actually be stored, so that change in the type of fuel stored does not require any major change in design.

6.4 STANDPIPE SYSTEMS.

6.4.1 Requirements. Installation of 2-1/2-inch (64 mm) standpipe systems shall be in accordance with NFPA No. 14, Standpipe and Hose Systems. Standpipes with 2-1/2-inch (64 mm) hose outlets (without hose) shall be provided in stair towers of buildings greater than three stories in height.

6.5 DRY CHEMICAL SYSTEMS.

6.5.1 Application. Fixed dry chemical systems are suitable for protection of certain types of special occupancies and facilities, such as cooking exhaust systems, dip tanks, and other flammable liquid operations.

6.5.2 Requirements and Limitations. Requirements for installation and operation are contained in NFPA No. 17, Dry Chemical Extinguishing Systems. Dry chemical shall not be used in electronics occupancies.

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.

6.6.2 Design Requirements. Carbon dioxide systems shall conform to NFPA No. 12, Carbon Dioxide Extinguishing Systems. Where applicable, Underwriters' Laboratories listed or Factory Mutual approved components shall be used.

6.7 HALON 1301 SYSTEMS.

6.7.1 Application. Installations shall be limited to those applications described in 4.0, Special Occupancies and Hazards, of this handbook.

6.7.2 Design Requirements. Halon 1301 systems shall conform to NFPA No. 12A, Halogenated Fire Extinguishing Agent Systems, Halon 1301. Where applicable, UL listed or FM approved components shall be used.

6.8 PORTABLE EXTINGUISHERS.

6.8.1 Requirements. Portable extinguishers shall be provided in accordance with NFPA No. 10, Portable Fire Extinguishers. Portable fire extinguishers are not required in Government controlled family housing.

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7.0 ALARM AND DETECTION SYSTEMS.

7.1 FIRE REPORTING SYSTEMS.

7.1.1 Application. Fire reporting systems shall be installed in occupied areas and buildings as a means for automatically and manually reporting fires to station or base fire department headquarters or other central alarm location as required to implement fire fighting operations and emergency action. Such systems may be of either telegraphic, radio, or supervised conductor types. Extensions of fire reporting systems will require consideration of compatibility with existing equipment. Fire reporting systems shall not be provided at isolated small areas, ammunition and ordnance storage, and similar restricted areas where personnel are not generally expected to be present. Fire reporting systems are also not required in family housing areas that are remote from main built-up area of the activity or station.

7.1.2 Requirements. Alarm reporting systems shall conform to NFPA No. 1221, Public Fire Service Communications, or NFPA No. 72D, Proprietary Protection Signaling Systems and shall provide the following where applicable:

- (1) Transmission of coded signals to fire department headquarters and other central locations.
- (2) Permanent record of alarm signal, time, and date.
- (3) Automatic supervision of alarm initiating circuits.
- (4) Automatic conditioning for transmission of signals under line fault conditions or single ground, single open, or both.
- (5) Automatic testing of radio signaling devices.

7.1.3 System Design. Basic fire alarm systems shall be designed in accordance with applicable requirements of NFPA Standards No. 72D, or NFPA No. 1221. Contract drawings shall indicate locations of boxes, panels, registers, auxiliary signaling devices, bells, horns, location lights, batteries, and other system components. Wiring diagrams shall be schematic to permit variations peculiar to equipment of different manufacturers. Specifications shall explicitly describe functional, quality, and test requirements.

7.2 EVACUATION FIRE ALARM SYSTEMS.

7.2.1 Requirements. Fire evacuation alarm systems shall be installed in accordance with NFPA Standards No. 72A, Local Protection Signaling Systems, and No. 72D, Proprietary Protective Signaling Systems. Evacuation fire alarm systems shall be provided in:

- (1) All buildings as required by NFPA No. 101, Life Safety Code. These systems shall be arranged to transmit signals to a central alarm location or fire department, where possible.
- (2) Barracks, UOPH, UEPH and similar sleeping facilities.
- (3) All buildings which require that the automatic fire detection system be connected to a central alarm location or fire department.

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7.3 FIRE DETECTION SYSTEMS.

7.3.1 Requirements. All fire detection installations shall conform to the applicable provisions of NFPA Standards Nos. 72A, Local Protective Signaling Systems, 72D, Proprietary Protective Signaling Systems, 72E, Automatic Fire Detectors, and 74, Household Fire Warning Equipment. Detection systems shall be arranged to alert building occupants of an alarm condition and to transmit a signal to a central alarm location or fire department. Where a station fire department does not exist, alarms shall be transmitted to a constantly attended location. Single station detectors as required in one- and two-family housing do not require transmission.

7.3.1.1 Detection systems are required for the following:

- (1) All areas requiring detection systems by NFPA standards.
- (2) Bachelor officers and enlisted personnel housing (UOPH and UEPH). Refer to Section 4.2.1 of this handbook.
- (3) Family Housing. Refer to Section 4.2.2 of this handbook.
- (4) Electronic Equipment Installations. Refer to Section 4.3.5 of this handbook.
- (5) Ordnance Facilities. Refer to Section 4.4.2 of this handbook.

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APPENDIX A. CLASSIFICATION OF OCCUPANCIES

A-1 CLASSIFICATION OF OCCUPANCIES. Occupancies shall be categorized by one of seven major occupancy classification groups specified in the Uniform Building Code. Classifications are Group A, B, E, H, I, M or R.

A-1.1 GROUP A OCCUPANCIES. This classification consists of the following:

(1) Division 1. Any assembly building with a stage and an occupant load of 1000 or more in the building.

(2) Division 2. Any building or portion of a building having an assembly room with an occupant load of less than 1000 and a stage.

(3) Division 2.1. Any building or portion of a building having an assembly room with an occupant load of 300 or more without a stage, including such buildings used for educational purposes and not classed as a Group E or Group B, Division 2 Occupancy.

(4) Division 3. Any building or portion of a building having an assembly room with an occupant load of less than 300 without a stage, including such buildings used for educational purposes and not classed as a Group E or Group B, Division 2 Occupancy.

(5) Division 4. Stadiums, reviewing stands and amusement park structures not included within other Group A Occupancies.

A-1.2 GROUP B OCCUPANCIES. This classification consists of the following:

(1) Division 1. Gasoline service stations, garages where no repair work is done except exchange of parts and maintenance requiring no open flame, welding or use of highly flammable liquids.

(2) Division 2. Drinking and dining establishments having an occupant load of less than 50, wholesale and retail stores, office buildings, printing plants, base police and fire stations, workshops using materials not highly flammable or combustible, storage and sales rooms for combustible goods, paint stores without bulk handling.

Buildings or portions of buildings having rooms used for educational purposes with less than 50 occupants in any room.

(3) Division 3. Aircraft hangars where no repair work is done except exchange of parts and maintenance requiring no open flame, welding or the use of highly flammable liquids.

Open parking garages.
Heliports.

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(4) Division 4. Ice plants, power plants, pumping plants, cold storage and creameries.

Factories and workshops using noncombustible and nonexplosive materials.

Storage and sales rooms of noncombustible and nonexplosive materials.

A-1.3 GROUP E OCCUPANCIES. This classification consists of the following:

(1) Division 1. Any building used for educational purposes through the 12th grade by 50 or more persons for more than 12 hours per week or 4 hours in any one day.

(2) Division 2. Any building used for educational purposes through the 12th grade by less than 50 persons for more than 12 hours per week or 4 hours in any one day.

(3) Division 3. Any building used for day-care purposes for more than six children.

A-1.4 GROUP H OCCUPANCIES. This classification consists of the following:

(1) Division 1. Storage, handling, use or sale of hazardous and highly flammable or explosive materials other than flammable liquids.

(2) Division 2. Storage, handling, use or sale of Classes I, II and III-A liquids; dry cleaning plants using Class I, II or III-A liquids; paint stores with bulk handling; paint shops and spray-painting rooms and shops.

(3) Division 3. Woodworking establishments, planing mills, box factories, shops, factories or warehouses where loose combustible fibers or dust are manufactured, processed, generated or stored; and pin-refinishing rooms.

(4) Division 4. Repair garages not classified as Group B, Division 1.

(5) Division 5. Aircraft repair hangars.

(6) Special Provisions. In buildings used for educational purposes, vocational shops, laboratories and similar areas need not be classified as Group H Occupancies, provided:

A. Such areas are separated from classrooms other than the classroom directly related to the use by not less than a 1-hour fire-resistive occupancy separation.

B. Such areas are separated from each other by not less than a 1-hour fire-resistive occupancy separation unless the uses are determined to be compatible.

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- C. In any room in a Division 1, 2, or 3 Occupancy in which volatile, flammable liquids or hazardous materials are stored or used, energy consuming equipment shall not be used unless such equipment has been listed specifically for the hazardous atmosphere that may develop.
- D. In Division 4 Occupancies, devices which generate a spark or glow capable of igniting gasoline vapors shall not be installed or used within 18 inches of the floor.
- E. The requirements of the UBC Fire Code shall be met when applicable.

Where an approved spray booth constructed as specified in the UBC Fire Code is installed, such booth need not be separated from other Group H or Group B Occupancies.

A-1.5 GROUP I OCCUPANCIES. This classification consists of the following:

(1) Division 1. Nurseries for the full-time care of children under the age of 6 (each accommodating more than five persons).

Hospitals, sanitariums, nursing homes with nonambulatory patients and similar buildings (each accommodating more than five persons).

(2) Division 2. Nursing homes for ambulatory patients, homes for children 6 years of age or over (each accommodating more than five persons).

(3) Division 3. Mental hospitals, mental sanitariums, jails, prisons, reformatories and buildings where personal liberties of inmates are similarly restrained.

A-1.6 GROUP M OCCUPANCIES. This classification consists of the following:

(1) Division 1. Private garages, carports, sheds and agricultural buildings.

(2) Division 2. Tanks and towers.

A-1.7 GROUP R OCCUPANCIES. This classification consists of the following:

(1) Division 1. Hotels and apartment houses.

(2) Division 2. Not used.

(3) Division 3. Dwellings and lodging houses.

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APPENDIX B. OCCUPANCY HAZARD CLASSIFICATION

B-1. CLASSIFICATION OF OCCUPANCIES. The principal occupancy classifications are light hazard, ordinary hazard and extra hazard and are dependent upon the degree of fire hazard present. Typical examples are listed under each classification. The basic hazard classification of an occupancy does not, in all instances, categorically 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.

B-1.1 LIGHT HAZARD OCCUPANCIES. Occupancies or portions of other occupancies where the quantity and combustibility of 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). The following are examples of Light Hazard Occupancies:

Churches and Chapels	Gymnasiums
Clinics (Dental, Outpatient)	Hospitals
Data Processing Areas	Mess Areas
Disciplinary Barracks	Offices
Dispensaries	Photographic Processing Areas
Dwellings	Schools
Drill Halls	

B-1.2 ORDINARY HAZARD GROUP 1 OCCUPANCIES. Occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stock piles 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 liquids, in closed containers, are allowable in quantities up to about 20 gallons (75 L). The following are examples of Ordinary Hazard Group 1 Occupancies:

Armories	Sheet Metal Shops
Bowling Alleys	Shipfitting Shops
Clubs (Officer, Enlisted Personnel, etc.)	Kitchens
Commissaries	Small Stores
Exchanges	Theatres and Auditoriums
Forge Shops	Welding Shops
Machine Shops	
Printing Shops (Using inks having flash points above 110°F (44°C))	

B-1.3 ORDINARY HAZARD GROUP 2 OCCUPANCIES. Occupancies or portions of other occupancies where quantity and combustibility of contents is moderate, stock piles 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 up to about 50 gallons (200 L).

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Small amounts of flammable liquids may be exposed as required by normal operations. The following are examples of Ordinary Hazard Group 2 Occupancies:

- Air Rework Facilities
- Boiler Rooms
- Electrical Maintenance Shops
- Engine and Generator Rooms
- Laboratories
- Laundries
- Refrigeration and Air Compressor Rooms
- Switchgear Rooms

B-1.4 ORDINARY HAZARD GROUP 3 OCCUPANCIES. Occupancies or portions of other occupancies where quantity or combustibility of contents is high and fires of high rate of heat release are expected. Moderate, scattered amounts of flammable liquids in closed containers are allowable in quantities up to about 50 gallons (200 L). Small amounts of flammable liquids may be exposed as required by normal operations. The following are examples of Ordinary Hazard Group 3 Occupancies:

- Piers and Wharves
- Vehicle Repair Garages
- Ordnance Plants (without exposed powder)
- Woodworking Plants

B-1.5 EXTRA HAZARD OCCUPANCIES. Occupancies or portions of other occupancies where quantity and combustibility of contents are very high, or where flammable liquids, dust, lint, or other materials are present, introducing the probability of explosion and rapidly developing fires with high rates of heat release. The following are examples of Extra Hazard Occupancies:

- Flammable and Combustible Liquids (not high piled or high rack storage)
- Warehouses (not high piled or high rack storage)

B-1.6 SPECIAL OCCUPANCIES. Special occupancies are facilities or areas which cannot be assigned a specific classification because of special protection requirements. Refer to the appropriate chapters or paragraphs of this handbook for fire protection guidance. This classification includes, but is not restricted to, the following occupancies:

- Aircraft Hangars
- Engine Test Cells
- Missile Assembly
- Ordnance Plants (exposed powder areas)
- Rubber Tire Storage
- Warehouses (high piled or high rack storage)
- Foam Rubber or Plastic Storage

Note: Refer to National Fire Protection Association Fire Codes for occupancies not listed.

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REFERENCES

(Publications containing criteria cited in this manual)

ANSI Codes available from American National Standards Institute (ANSI), New York, N.Y. 10018.

ANSI A17.1b, Safety Code for Elevators, Dumbwaiters, Escalators,
and Moving Walks.
ANSI-C2, National Electrical Safety Code.

API Publications Standards available from American Petroleum Institute (API), Washington, D.C. 20037.

ASME Code available from American Society of Mechanical Engineers (ASME), New York, N.Y. 10017.

ASME Boiler and Pressure Vessel Code.

ASTM Standards available from American Society for Testing and Materials (ASTM), Philadelphia, PA 19103.

ASTM D-92, Flash and Fire Points by Cleveland Open Cup, Test for
ASTM E-84, Test Method for Surface Burning Characteristics of Building
Materials.
ASTM E-119, Standard Methods of Fire Tests of Building Construction and
Materials.
ASTM E-814 Fire Tests of Through-Penetration Fire Stops.

Armed Services Explosives Safety Board Publications available from U.S. 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.

Army Corps of Engineers Publication available from Department of the Army, Office Chief Engineer/DAEN-ASP, Forrestal Building, Washington, D.C. 20314.

EM385-1-1, General Safety Requirements.

Army Corps of Engineers Guide Specification available from Department of the Army, Publications Depot, Alexandria, VA 22304.

CEGS-08701, Hardware Prison-Locking Devices.

Department of Defense Publications available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

DOD 4270.1-M, Construction Criteria Manual.
DOD 5154.4S, DOD Ammunition and Explosives Safety Standards.

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U.S. Department of Commerce Publications available from U.S. Government
Printing Office, Washington, D.C. 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.

U.S. Department of Housing and Urban Development Publications available from
U.S. Government Printing Office, Washington, D.C. 20402.

HUD 4900.1,	Minimum Property Standards, Single Family.
HUD 4910.1,	Minimum Property Standards, Multi-Family.

CUSTODIANS:

ARMY-CE
NAVY-YD
AF-04

PREPARING ACTIVITY:
NAVY-YD
PROJECT NO. FACR-0153

FIRE PROTECTION ENGINEERING

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)*

1. DOCUMENT NUMBER MIL-HDBK-1008		2. DOCUMENT TITLE Fire Protection for Facilities Engineering Design & Construction	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one) <input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER (Specify): _____	
b. ADDRESS (Street, City, State, ZIP Code)			
5. PROBLEM AREAS			
a. Paragraph Number and Wording:			
b. Recommended Wording:			
c. Reason/Rationale for Recommendation:			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	