STANDARDS FOR FALLOUT SHELTERS

PUBLIC FALLOUT SHELTERS and FALLOUT SHELTERS IN HOSPITALS

Prepared In Cooperation With

NATIONAL CONFERENCE OF STATES ON BUILDING CODES AND STANDARDS

FEDERAL EMERGENCY MANAGEMENT AGENCY
TR-87 ■ SEPT. 1979 ■ (Supersedes TR-36, May 1966)

An essential component of the National Fallout Shelter Program is the promulgation of guidelines for the construction of protected facilities in both the public and private sectors. Architects, engineers, builders, building officials, and all others in the construction industry need criteria and standards to guide their individual efforts toward meeting the national goal of providing protection from fallout radiation for everyone.

The standards in this publication represent the best and most current guidelines for public fallout shelters and fallout shelters in hospitals. Presented in a format which conforms to the style and language common for building codes, the fallout shelter standards are suitable for adoption by building departments in local governments, and for use by organizations and agencies which may be involved in emergency preparedness planning.

The Federal Emergency Management Agency extends its appreciation to the National Conference of States on Building Codes and Standards for assistance in preparing these standards in a style and form that offer clarity of concepts for the intended objectives.

Federal Emergency Management Agency

The National Conference of States on Building Codes and Standards (NCSBCS) has extended its assistance in the preparation of this document, not only because of its deep commitment to supporting programs of national need, but also because its membership and cooperating organizations can benefit from the guidelines which are intended to be compatible with normal practices in the building industry.

Among its objectives, NCSBCS seeks to bring about consistency of building standards—and when appropriate, uniformity of their application. NCSBCS therefore welcomes opportunities such as the one represented in this document to render assistance in order to achieve a consistency and useful format for these guidelines for fallout shelters.

National Conference of States on Building Codes and Standards

General hazards - files
CIVIL DEFENSE

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FOREWORD

Presented herein are standards relating to the design and construction of public fallout shelters and fallout shelters in hospitals. Explanations and background discussions relating to various provisions contained in the standards are included.

These standards are intended to serve as guides for the design and construction of facilities which provide protection from the fallout radiation effects of nuclear explosions. The standards may be applied to new or existing facilities in both the public and private sectors. If the standards are to be a part of the requirements for buildings, then they must be adopted as a part of the local or State building codes.

A standard establishes criteria to measure, test, compare, or judge characteristics of building design and construction, such as capacity, quantity, context, extent, value, quality, durability, and capability.

The purpose of a building code is to safeguard the life, health, and general welfare of all occupants of a building and those near the building. The term *building code* means collectively all laws regulating the design and construction of a building, including all auxiliary components such as electrical wiring, mechanical equipment, and plumbing.

A building code contains a number of standards which cover the various materials, systems, assemblies, and design procedures that are allowed. Generally, a standard is included in a building code either as a part of its text or by reference, and thereby becomes a part of the code.

A worthy objective is that these standards for fallout shelters become part of the nationally recognized model building codes, as well as local and State-adopted building codes. To that purpose, the standards are presented in a format that will permit the model code organizations and local and State governments to include them in their codes through adoption by reference.

The provisions of these standards address only those aspects of building design and construction which are unique to providing habitable space protected from the fallout radiation effects of nuclear weapons. Design and construction aspects of a conventional nature must comply with the provisions of local or State-adopted building codes.

The standards presented herein are minimum and do not preclude the designer from exceeding the requirements, except as may cause noncompliance with other requirements for the space which may be prescribed in other applicable codes.

THE FEDERAL EMERGENCY MANAGEMENT AGENCY

The Federal Emergency Management Agency (FEMA) is charged to provide for the protection of the civilian population and industry of the Nation. Its primary mission is safeguarding the Nation's resources of life, property, and industry from enemy attack. In addition, the Agency assists with preparedness and recovery programs necessitated by natural hazards which also create potential risks to the population, industry, and general economy of the Nation.

The greatest potential risk that the country faces today is from the serious and widespread harm which nuclear weapons are capable of producing. Although the blast and fire effects from these weapons of modern warfare are more severe and potentially harmful than weapons heretofore known or used, the effects of nuclear radiation are even more extensive and more hazardous. Fallout radiation respects no boundaries and is dangerous to all living things.

The national civil defense program emphasizes protection from fallout radiation. Fallout shelters are the principal elements of the Nation's protective shield, and FEMA and predecessor agencies have worked to provide such protection for as many people as possible. The degree of fallout protection recommended by FEMA is established from available information about the biological effects of nuclear radiation, estimates of the radiation environment which would result from nuclear attack upon the Nation, and correlations of these data with the types and functions of the populations to be protected.

It is because these parameters are different that fallout shelter standards are not the same for every situation. Two standards are presented in this booklet—one for public fallout shelters, another for fallout shelters in hospitals. There are additional standards for other situations—for example, standards for Emergency Operating Centers from which governmental activities are coordinated during emergency periods, and for industrial facilities which may involve essential services.

Fallout shelter programs conducted by FEMA have several components. Among these are research aimed at improving the characterization of the nuclear hazard and its effects, development of standards and design concepts for fallout shelters, training and education of design professionals so they may more effectively incorporate fallout protection in buildings, educating the general public regarding radiation hazards and protection concepts so they may be better prepared to respond effectively during and after nuclear attack, and assistance to local governmental units in preparedness planning and response activities.

The fallout shelter standards presented in this booklet are just one component—albeit an important one—among the several components of the National Fallout Shelter Program.

CODE ORGANIZATIONS

Model code organizations in the United States have evolved over the past years as a means for local building officials and others in the industry to share and exchange construction information that may have common applications.

The development and writing of codes for regulating building construction is a complex, time-consuming task encompassing numerous specialties and requiring a broad spectrum of expertise. Many building department officials have found it preferable to combine their knowledge and efforts in preparing building codes rather than each proceeding alone. Model building codes are a product of this combined work. These codes then may be recommended for adoption in local communities, counties, and States.

Another benefit that has been realized from the combined work of code organization members is a consistency of building codes among governmental jurisdictions which regulate construction. The construction trades, product manufacturers, and designers all benefit from this consistency—through improved efficiencies, simplified procedures, fewer variations in standards to be met, and less ambiguous regulations. Designers of buildings need only to reflect upon the complexities and inconveniences of meeting a different set of construction codes in every community to realize just how important a uniform code really is in their work.

Several code organizations have been established over the past years. Four organizations have promulgated model building codes that are widely used—namely, Building Officials and Code Administrators, International (BOCA), which publishes the *Basic Building Code*; International Conference of Building Officials (ICBO), which publishes the *Uniform Building Code*; Southern Building Code Congress International, Inc. (SBCCI), which publishes the *Standard Building Code*; and the American Insurance Association (AIA), which publishes the *National Building Code*. The first three named are controlled by member representatives of local and State governments who review and adopt provisions in their respective codes through democratic processes.

Memberships in the model code organizations include local building officials and representatives of construction organizations, trade organizations, product manufacturers, and design organizations. Working collectively, they develop codes for the range of building types which local building departments regulate.

Other code organizations offer forums for exchange and resolution of common problems in the regulation of building construction and training for building officials and others in the industry. The National Conference of States on Building Codes and Standards (NCSBCS) and the Council of American Building Officials (CABO) provide coordinated review of recommended codes and standards, development of new or revised codes when the need arises, and cooperative understandings among independent regulatory jurisdictions. The National Academy of Code Administrators (NACA) provides training and education programs covering issues common to the code organizations.

All of the code organizations seek to advance the skills and knowledge of their memberships. Training programs—both administrative and technical—and publications, newsletters, and conferences are among their activities.

While no one of these activities is more important than the others to their memberships, the most valuable service code organizations render to the building industry is the codification of construction standards. This codification, which provides consistency of codes as well as common design criteria across governmental boundaries, is essential to the industry.

Standards developed by any organization are of little value unless they are known and used by the construction industry. Code organizations have the necessary communications networks to bring about the dissemination of appropriate building standards. Moreover, the review and adoption procedures followed by the code organizations give added assurance that a standard, when included in a code, is reasonable, workable and enforceable.

Adoption of an earlier version of a standard for public fallout shelters by three of the national model code organizations, and inclusion of that standard in their separate codes illustrate the services which these organizations offer to the building industry and the general public of the United States. As well, the national interest has been served by their actions. The model code organizations now have an opportunity to review, adopt, and disseminate these standards for public fallout shelters and fallout shelters in hospitals.

INTRODUCTION

Building codes have regulatory functions, but they also serve other purposes. Regulatory power, of course, is employed to safeguard the public health, safety, and welfare. Building codes also ensure that the intended activities within a building or space are possible, and they are an information resource from which design criteria are obtained.

Standards for various construction situations are included in building codes, either by reference or within the written text of the codes. These standards often are prepared by qualified persons or groups that may not be members of code organizations. The standards become a part of a building code only after review and adoption by the separate code organizations. In this process, a particular standard may be included in a code either in whole or only in part. The standards for fallout shelters presented in this booklet are intended for use in this way.

The intended purposes of this booklet are to identify essential elements of *functional* fallout shelters, to establish minimum standards for these essential elements, to state these standards in language and style common to building codes, and to provide sufficient explanation so that users of the standards may apply them with a reasonable degree of competency and certainty that the intended functions are possible or are accommodated. Because these fallout shelter standards also have multiple purposes, the booklet includes more information than normally would appear in a conventional standard. However, the booklet has been partitioned so that the standards appear separately for easy inclusion in local, State, or national model building codes.

Two standards are presented in this booklet—one for public fallout shelters, and one for fallout shelters in hospitals. These are defined later. The two standards are somewhat different, even though the nuclear hazard and effects are much the same for both situations. Different standards are established, because each type of facility has a different functional purpose and each facility services a different type of occupancy. The standard for fallout shelters in hospitals is the more extensive and rigorous—a reflection of the importance of such facilities, especially during emergencies.

These fallout shelter standards establish objectives to be met in the design of fallout shelters in new or existing buildings. They provide minimum criteria. In the Commentary, these minimum criteria are assigned priorities according to their importance in providing a habitable living environment protected from the fallout radiation effects of nuclear weapons. If all of the desired features of a fallout shelter cannot be provided in the original construction, then guidance is furnished regarding those aspects of fallout shelters which are more important—for example, radiation shielding.

These standards are not intended to establish expensive requirements for shielding or habitability of fallout shelters that may not be justified or required by the normal use of the building. Rather, encouragement is given to making optimum use of existing or normally required construction and systems to achieve the wanted fallout shelter, making only minor adjustments in space layouts, construction materials, and building systems as may be needed.

To some extent, every building provides a natural shield against fallout radiation, which is the nuclear effect of primary concern in fallout shelters. Often, through an awareness of fallout shelter requirements, building designers can enhance the inherent shielding characteristics of a space simply in the choices made during design, a process which normally affords several alternatives.

Since these standards are set forth as minimums, owners and designers are encouraged to exceed them when it is feasible to do so within financial and technical constraints. This applies to the radiation shielding level as well as to the shelter systems. The standards have been set at the lowest acceptable level commensurate with the nature of the hazard and its chance of occurrence. This philosophy recognizes that fallout shelters are, in a sense, insurance against an unpredictable risk, and that the need for fallout shelters will be essential to the Nation's population if nuclear attack should ever occur.

STANDARD FOR PUBLIC FALLOUT SHELTERS

Purpose

Section 1.0. The purpose of this standard is to establish minimum criteria for application to the design, construction, or designation of a space in a building or other facility as a fallout shelter.

Scope

Section 2.0. The scope of this standard extends to buildings, spaces, or other facilities designated for use as public fallout shelters.

Section 2.1. The standard establishes technical, architectural, and environmental criteria for public fallout shelters.

General

Section 3.0. The standard furnishes minimum criteria which provide for the protection of occupants from nuclear fallout radiation in spaces whose habitability and environmental characteristics are governed by the prevailing emergency situation and the essential lifesaving purpose of the fallout shelter. The criteria to be met typically are different from criteria ordinarily required for buildings and spaces having an everyday use.

Section 3.1. The standard indicates objectives to be met in the design and designation of fallout shelters in new and existing buildings. If all of the objectives cannot be met, then primary consideration shall be given to providing radiation shielding. In such instances, plans shall be developed to include the other fallout shelter features at a later time.

Section 3.2. This standard for public fallout shelters is a minimum standard. Nothing contained herein shall be construed to preclude exceeding this standard for any fallout shelter, except as may cause noncompliance with other requirements for the shelter space which may be prescribed in the local building codes.

Definitions

Section 4.0. The following definitions shall apply to all portions of this standard.

> *FALLOUT SHELTER* is any room, structure, or space designated as such and providing its occupants with protection at a minimum protection factor (PF) of 40 from fallout radiation resulting from a nuclear explosion.

PUBLIC FALLOUT SHELTER is any fallout shelter which is intended for use by or is accessible to the general public. Fallout shelters which are a part of a private residence and are intended for private use are not included.

SINGLE-PURPOSE FALLOUT SHELTER is a fallout shelter having no use or occupancy except as a fallout shelter.

DUAL-USE FALLOUT SHELTER is a fallout shelter having a normal, routine use and occupancy as well as an emergency use as a fallout shelter.

PROTECTION FACTOR, sometimes abbreviated as PF, is a numerical value which expresses the relation between the amount of fallout radiation that would be received in a protected location and the amount that would be received if unprotected in the same location.

EFFECTIVE TEMPERATURE is an empirical index which combines in a single number the effects of temperature, humidity, and air movement on the sensation of warmth and cold felt by the human body.

UNIT OF EGRESS WIDTH is 22 in.

Occupancy

Section 5.0. General. Nothing in this standard shall be construed as preventing the dual use or multiple use of normal occupancy space as fallout shelter space, providing the minimum requirements for each are met.

Section 5.1. Mixed Occupancy. The occupancy classification shall be determined by the normal use of a building or space. When a normal-use space is designed to have an emergency use as a fallout shelter in addition to the normal use, the most restrictive requirements for all such uses shall be met.

Section 5.2. Occupancy Separation. No occupancy separation is required between that portion of the space designed as a public fallout shelter and the remainder of the building. A plan indicating the fallout shelter space and its boundaries shall be furnished as a means of identifying the fallout shelter.

Section 5.3. Space. Space allowances for use as a fallout shelter shall be as follows.

(a) Floor Area. A minimum of 10 sq. ft. of net floor area shall be provided per shelter occupant. Partitions, columns, areas occupied by moveable furniture or other materials within the fallout shelter space, and any areas within the fallout shelter space used for storage of shelter supplies may be included in net area.

(b) Head Room. A minimum head room of 6.5 ft. shall be provided.

(c) Volume. A minimum of 65 cu. ft. of net volume shall be provided per shelter occupant. Net volume shall be determined using the net area calculated for the space.

Protection

Section 6.0. The minimum level of protection for public fallout shelters is PF 40. Protection factors shall be calculated using methods approved by the Federal Emergency Management Agency based upon publication TR-20 (Volume 1), *Shelter Design and Analysis—Fallout Radiation Shielding*, June 1976 edition.

Ventilation and Temperature

Section 7.0. Ventilation of the fallout shelter space shall comply with the standards of Appendix C, TR-20 (Volume 3), *Shelter Environmental Support Systems*, May 1978 edition, available from the Federal Emergency Management Agency.

Section 7.1. Fresh Air. A minimum of 3 cu. ft. of fresh air per minute per fallout shelter occupant shall be provided to prevent oxygen depletion and carbon dioxide buildup in the fallout shelter.

Section 7.2. Effective Temperature. The fallout shelter shall have a ventilation rate sufficient to maintain a daily average effective temperature of not more than 82°F (28°C) with at least a 90-percent reliability of not exceeding that value during the year. Effective temperatures shall be determined using procedures contained in the *Handbook of Fundamentals*, 1977 edition, prepared by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE). Zones of equal ventilation rates in cu. ft. of air per minute which meet the requirements of this section are shown in Figure 1.

Section 7.3. Ventilation Systems. Ventilation systems for public fallout shelters shall be designed to provide the ventilation rates required by Section 7.2. during periods when electric power may not be available from public service utilities. Emergency electrical generators or positive natural ventilation flow for fallout shelters may be used to meet this requirement.

Section 7.4. Temperature. A temperature of not less than 50°F (10°C) shall be maintained in the fallout shelter during the occupancy period.

Section 7.5. Air Intake. Ventilation systems shall be designed so that the outside air intake opening is positioned not less than 2-ft. above any surface on which radioactive fallout could be deposited. The air intake opening shall be hooded or positioned to prevent deposits of radioactive fallout on the intake face.

Section 7.6. Filters. Special filters are not required for ventilation systems for public fallout shelters. No filters are required for fallout shelter ventilation equipment if the face velocity at the outside air intake is less than 150 ft. per minute.

Lighting

Section 8.0. No special lighting is required for fallout shelters which receive natural light. Spaces without windows, above or below ground, shall be provided with a minimum lighting level of 2 footcandles at the floor. Normal lighting fixtures may be used for this purpose if they are powered by an emergency generator, or battery-operated lights may be used.

Structural

Section 9.0. Structural design of the fallout shelter shall comply with the local building codes. No special structural arrangements are required for public fallout shelters.

Section 9.1. Minimum Design Loads.

(a) Minimum Design Loads for Dual-Use Fallout Shelters. The design live load required for normal use shall apply for dual-use fallout shelters.

(b) Minimum Design Loads for Single-Purpose Fallout Shelters. The minimum design live load for floors in single-purpose fallout shelters shall be 40 lb. per sq. ft. The minimum design live load for roofs of single-purpose fallout shelters shall comply with the requirements of the local building codes.

Access and Egress

Section 10.0. Public fallout shelters shall have no fewer than two widely separated means of access and egress leading to other spaces of the building or directly to the outdoors.

Section 10.1. Means of access and egress for dual-purpose fallout shelters shall meet the requirements prescribed by the local building codes for normal, routine use of the space.

Section 10.2. Means of access and egress for single-purpose fallout shelters shall aggregate at least one unit of egress width for every 200 fallout shelter occupants. In no case shall a single opening be less than 24-in. wide.

Section 10.3. Emergency-type hatchways may be used as a means of access and egress, provided that at least one means of access and egress for the fallout shelter is a standard opening conforming to the requirements of the local building codes. Hatchways, if used, shall be a minimum size of 24-in. x 36-in.

Fire Resistance

Section 11.0. Fallout shelters shall meet fire-safety requirements as indicated below.

(a) Dual-purpose fallout shelters shall comply with requirements applicable for normal occupancy of the space.

(b) Single-purpose fallout shelters shall provide a flame-spread rating for interior surfaces not exceeding 200 on the flame spread scale and 450 or less on the smoke test scale when tested in accordance with ASTM E-84.

Hazards

Section 12.0. Hazardous utility lines, such as steam, gas, and oil lines, shall not be located in or near the fallout shelter unless provision is made to control such lines by valving or other approved means which permits shut-off of flow through the fallout shelter. Valving or other controls shall be readily accessible from the fallout shelter and shall conform with the local mechanical and gas codes.

Sanitation

Section 13.0. Toilets, either flush-type operating from the normal water supply system, or chemical or other types, shall be provided on the basis of one toilet per 50 fallout shelter occupants. Toilets may be outside the fallout shelter in other portions of the building provided that they may be reached by occupants of the fallout shelter without exposure to direct fallout radiation as defined in TR-20 (Volume 1), *Shelter Design and Analysis—Fallout Radiation Shielding*, June 1976 edition, available from the Federal Emergency Management Agency. Austere provisions, such as empty water containers, for disposal of waste may be considered as fulfilling this requirement.

Drinking Water

Section 14.0. A minimum of 3.5 gallons of potable water shall be available for each fallout shelter occupant. If it cannot reasonably be assumed that the public water supply system will be operational at all times when the fallout shelter may be occupied, then other means shall be provided for meeting this requirement. Storage tanks, trapped potable water in building lines, or auxiliary water wells at or near the premises may be used to fulfill this requirement.

Supplies and Storage

Section 15.0. Consideration shall be given to fallout shelter supplies and their storage, but provision of such supplies is not required. Supplies and other storage considerations for public fallout shelters are discussed in publication CPG 1-19, *Guidance for Development of An Emergency Fallout Shelter Stocking Plan*, July 1978, available from the Federal Emergency Management Agency.

Section 15.1. Radiation-measuring instruments, which may be furnished by the Federal Government for fallout shelters, shall be accommodated in secure storage space within the fallout shelter.

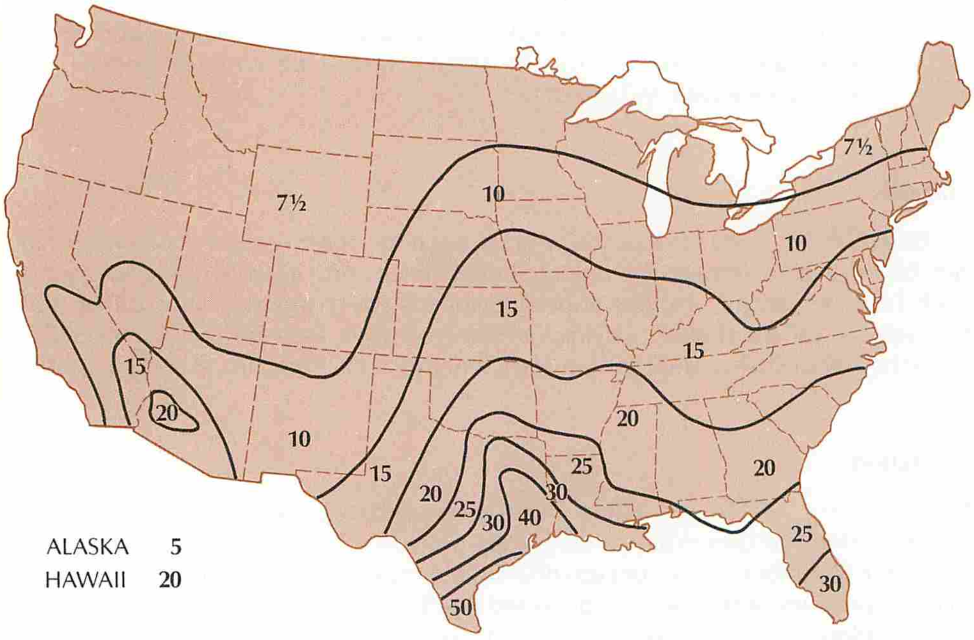

Figure 1

Zones of Equal Ventilation Rates (CFM per person)

STANDARD FOR FALLOUT SHELTERS IN HOSPITALS

Purpose

Section 1.0. The purpose of this standard is to establish minimum criteria for fallout shelters in hospitals. Fallout shelters designed in compliance with this standard should be capable of functioning in a radioactive fallout environment as operating facilities furnishing austere medical care for in-patients, and providing emergency treatment as required.

Scope

Section 2.0. The scope of this standard extends to spaces for patients, spaces for a minimum level of nursing care, emergency treatment spaces, spaces for medical isolation, and other facilities designated for use as fallout shelters in hospitals.

Section 2.1. This standard establishes technical, architectural, and environmental criteria for fallout shelters in hospitals.

General

Section 3.0. The standard furnishes criteria which provide for the protection of medical patients and medical staff from nuclear fallout radiation in spaces for which habitability and environmental characteristics are governed by the prevailing emergency situation and the essential lifesaving purpose of the fallout shelter. The criteria to be met typically are different from criteria ordinarily imposed upon spaces and facilities in hospitals having an everyday use.

Section 3.1. The standard indicates objectives to be met in the design and designation of fallout shelters in new and existing hospitals.

Section 3.2. The standard for fallout shelters in hospitals is a minimum standard. Nothing contained herein shall be construed to preclude exceeding this standard for any fallout shelter in a hospital, except as may cause noncompliance with other requirements for hospitals when other uses of the space are involved besides use as a fallout shelter.

Definitions

Section 4.0. The following definitions shall apply to all portions of this standard.

FALLOUT SHELTER is any room, structure, or space designated as such and providing its occupants with protection at a minimum protection factor (PF) of 40 from fallout radiation resulting from a nuclear explosion.

HOSPITAL FALLOUT SHELTER is any hospital area which is designated as such for patients and medical staff, including spaces where hospital services and emergency surgery may be performed.

PUBLIC FALLOUT SHELTER is any fallout shelter which is intended for use by or is accessible to the general public, including use by nonpatient-care employees and hospital visitors. Fallout shelters which are a part of a private residence and are intended for private use are not included.

PROTECTION FACTOR, sometimes abbreviated as PF, is a numerical value which expresses the relation between the amount of fallout radiation that would be received in a protected location and the amount that would be received if unprotected in the same location.

EFFECTIVE TEMPERATURE is an empirical index which combines in a single number the effects of temperature, humidity, and air movement on the sensation of warmth and cold felt by the human body.

CONTROL CENTER is a command post or operations headquarters within the hospital fallout shelter for use by the hospital administrator and his staff during an emergency.

UNIT OF EGRESS WIDTH is 22 in.

Occupancy

Section 5.0. General. Nothing in this standard shall be construed as preventing the dual use or multiple use of normal occupancy space as fallout shelter space, providing the minimum requirements for each are met.

Section 5.1. Mixed Occupancy. The occupancy classification shall be determined by the normal use of a building or space. When a normal-use space is designed to have an emergency use as a fallout shelter in addition to the normal use, the most restrictive requirements for all such uses shall be met.

Section 5.2. Occupancy Separation. No occupancy separation is required between that portion of the space designated as a fallout shelter and the remainder of the building, except as prescribed in Section 8.2. A plan indicating the fallout shelter space and its boundaries shall be furnished as a means of identifying the fallout shelter.

Hospital Fallout Shelters

Section 6.0. Hospital fallout shelters shall be designed in conformance with the requirements furnished hereafter.

Public Fallout Shelters

Section 7.0. Public fallout shelters in hospitals shall be in accordance with the technical standard for public fallout shelters furnished in this booklet. *(Note:* TR-87, *Standards for Fallout Shelters, should be referenced if this standard for fallout shelters in hospitals is used separately.)*

Hospital Fallout Shelter Space

Section 8.0. General. Floor areas and volume allowances for space used as a hospital fallout shelter shall be provided as follows.

Section 8.1. Patient Areas. A minimum of 35 sq. ft. of net floor area, based upon nominal bed capacity, shall be provided per patient for ward and treatment rooms reserved exclusively for patient use, as contrasted with staff or public use.

Section 8.2. Patient-Care Staff Areas. A minimum of 15 sq. ft. of net floor area per staff member engaged in patient care shall be provided for staff quarters. Staff space shall be separated from public fallout shelter space by partitioning or other physical barriers.

Section 8.3. Height of Space. A minimum head room of 6.5 ft. shall be provided in hospital fallout shelters.

Protection

Section 9.0. The minimum level of protection for hospital fallout shelters is PF 100. Protection factors shall be calculated using methods approved by the Federal Emergency Management Agency based upon publication TR-20 (Volume 1), *Shelter Design and Analysis—Fallout Radiation Shielding,* June 1976 edition. In calculating protection factors, the radiation dose contribution to the shelter occupants coming from entranceways, ventilation ducts, and other openings in the shelter's barriers shall be considered. The protection factor for a space shall be the least protected location in the space.

Ventilation and Temperature

Section 10.0. Ventilation. Ventilation of a hospital fallout shelter shall comply with the standards contained in TR-20 (Volume 3), *Shelter Environmental Support Systems*, May 1978 edition, available from the Federal Emergency Management Agency.

Section 10.1. Fresh Air. A minimum of 7 cu. ft. of fresh air per minute per shelter occupant shall be supplied to the hospital fallout shelter space.

Section 10.2. Effective Temperature. The hospital fallout shelter space shall have a ventilation rate sufficient to maintain a daily average effective temperature of not more than 70°F (21°C) with at least a 90-percent reliability of not exceeding that value during the year. Effective temperature shall be determined using procedures contained in the *Handbook of Fundamentals*, 1977 edition, prepared by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE).

Section 10.3. Temperature. A temperature in the hospital fallout shelter space of not less than 65°F (18°C) shall be maintained during its occupancy period.

Section 10.4. Emergency Power. Ventilation systems for hospital fallout shelters shall be designed to provide the required ventilation rates during periods when electric power may not be available from public service utilities. To meet this requirement, auxiliary electric generators shall be used to operate the ventilation systems in hospital fallout shelters.

Section 10.5. Air Intake. Ventilation systems shall be designed so that the outside air intake opening is positioned not less than 2-ft. above any surface on which radioactive fallout could be deposited. The air intake opening shall be hooded or positioned to prevent deposits of radioactive fallout on the intake face.

Section 10.6. Filters. Special filters are not required for ventilation systems in hospital fallout shelters, other than those used in normal hospital operation. No filters are required for hospital fallout shelter ventilation equipment if the face velocity at the outside air intake is less than 150 ft. per minute.

Section 10.7. Ducts. Ducts for the ventilation systems in hospital fallout shelters shall permit cut-off of ventilation air to unnecessary hospital spaces during an emergency period.

Section 10.8. Recirculated Air. Air shall not be recirculated from contiguous wards, decontamination rooms, treatment rooms, toilets, chemical pits, or other areas which could contaminate the air supply into the hospital fallout shelter space.

Structural

Section 11.0. Structural design of the hospital fallout shelter shall comply with the local building codes. No special structural arrangements are required for hospital fallout shelters.

Section 11.1. The design live loads required for normal hospital use shall apply for hospital fallout shelters.

Access and Egress

Section 12.0. Hospital fallout shelters shall have no fewer than two widely separated means of access and egress leading to other spaces of the building or directly to the outdoors.

Section 12.1. Means of access and egress shall aggregate at least one unit of egress width for every 50 fallout shelter occupants. One or more means of access and egress to the hospital fallout shelter space shall be at least 40-in. wide to permit passage of hospital beds. In no case shall a single opening be less than 24-in. wide.

Section 12.2. Passageways, corridors, and aisles in patient-care and other emergency use areas of the hospital fallout shelter shall have a minimum width of 6 ft.

Fire Resistance

Section 13.0. Hospital fallout shelters shall meet fire-safety requirements applicable to normal occupancy of the space.

Lighting

Section 14.0. General. Lighting shall be provided in the hospital fallout shelter space with minimum illumination levels as prescribed below.

Section 14.1. Treatment Rooms. A minimum lighting level of 100 foot-candles shall be provided at treatment tables.

Section 14.2. Patient Areas. A minimum lighting level of 25 footcandles at desk height shall be provided.

Section 14.3. Sleeping Areas. A minimum lighting level of 2 footcandles at the floor shall be provided.

Section 14.4. Emergency Lighting. Lighting in hospital fallout shelter areas shall be connected to emergency power to maintain the illumination levels prescribed in Sections 14.1., 14.2., and 14.3. during periods when the normal power supply may be out.

Section 14.5. Battery-Operated Lights. Trickle-charged, battery-operated emergency lights shall be provided in corridors, hospital operating rooms, and essential work areas for use in event of complete power failure.

Emergency Electric Generator

Section 15.0. General. In the normal operation of a functional hospital, standby emergency power is necessary to provide continuous service to critical areas with or without fallout protection. Hospitals therefore normally are equipped with emergency electric generators which can be used during radioactive fallout conditions.

Section 15.1. Facilities and Systems Served. Emergency electric power shall be made available to operate the following facilities and systems, as a minimum, in the hospital fallout shelter during emergency conditions.

(a) Fallout shelter ventilation system.

(b) Fallout shelter lighting.

(c) Emergency water supply pumps.

(d) Emergency sewage ejection.

(e) Medical and surgical treatment areas.

(f) Boiler feed water pump.

(g) Emergency refrigeration in the hospital fallout shelter area.

(h) Emergency air-conditioning in the hospital fallout shelter area.

Section 15.2. Disconnects and Switching. Disconnecting devices and switching gear shall be provided to direct the emergency supply of power to essential equipment and systems in the hospital during emergency periods.

Section 15.3. Radiation Shielding of Equipment Spaces. Spaces containing the emergency electric generator, controls, and distribution panels shall be provided with radiation shielding of a minimum protection of PF 40. Access to the emergency generator, control room, and distribution panels shall be shielded with the same minimum protection level of PF 40.

Section 15.4. Power Outlets. Planning layouts of the hospital fallout shelter shall be furnished indicating electric power requirements to operate necessary medical equipment during emergency periods, and emergency power outlets shall be located in the hospital fallout shelter area as may be necessary to operate the equipment.

Section 15.5. Venting. Emergency engine-generator sets shall have separate vents and shall be heat-isolated from areas to be used by fallout shelter occupants.

Section 15.6. Fuel Storage. Emergency engine-generator sets shall include a storage tank having a minimum fuel supply capacity sufficient for at least 2 weeks of continuous operation.

Water Supply

Section 16.0. Potable Water. A minimum of 5 gallons of potable water for each patient and 1/2 gallon per person for patient-care staff shall be provided for daily consumption and use in the hospital fallout shelter during a minimum confinement period of 2 weeks. Water supply may be from storage tanks, wells, or individual containers placed in or near the fallout shelter space. The minimum requirements established herein are for all purposes, including drinking, cooking, and sanitary purposes.

Section 16.1. Supply Lines and Outlets. Supply lines from the emergency water storage tanks or well to the hospital fallout shelter space shall be provided, unless individual containers are used. Water supply outlets shall be provided in the food preparation, medical treatment, decontamination, isolation, emergency operating, and other hospital service areas which may require an immediate water supply during emergency periods.

Section 16.2. Treatment. Hypochlorinator equipment and an adequate supply of high-test calcium hypochlorite shall be provided for treatment of nonpotable water which may be drawn from emergency sources.

Section 16.3. Installation. Installation of the emergency water supply system and associated equipment shall conform to the local plumbing code.

Section 16.4. Fire Protection. When possible, standpipe systems shall be cross-connected to emergency water sources so that water will be available to upper stories for fire fighting during periods of emergency occupancy of the hospital fallout shelter. Cross-connected standpipe systems shall provide protection from contamination of potable water in accordance with local health department standards or the local plumbing code.

Sanitation

Section 17.0. General. Provision shall be made for the collection and disposal of garbage, trash, and human waste in such a way as to preclude the creation of unsanitary conditions or offensive odors.

Section 17.1. Fixtures. Toilets and lavatories shall be made available on the basis of one toilet and one lavatory per 35 hospital staff and patients in the hospital fallout shelter space. When emergency water supply permits, regular flush-type toilets and standard lavatories shall be provided. Chemical toilets shall be provided as a supplement to regular toilets, or in lieu thereof, in case the normal water supply system becomes inoperative.

Decontamination

Section 18.0. General. A separate, enclosed decontamination space shall be provided at or near the entrance to the hospital fallout shelter space.

Section 18.1. Facilities. The decontamination space shall include a dressing area, shower, and storage for contaminated and fresh clothing, and shall be sized to accommodate the intended emergency use.

Section 18.2. Shielding. The decontamination space enclosure shall provide fallout radiation shielding for adjoining hospital fallout shelter spaces, with a minimum protection level of PF 100.

Communications

Section 19.0. Radio. The hospital fallout shelter space shall be equipped with a radio transmitter, battery-operated receivers, and an installed antenna to permit contact between the hospital control center and civil defense authorities during emergency periods.

Section 19.1. Telephone. The hospital fallout shelter space shall be provided with regular telephone service for use when telephone systems are in operation during emergency periods.

Section 19.2. Intercommunications. Provision shall be made for communications to and from the hospital control center and the hospital fallout shelter during emergency periods by at least two of the following methods: telephone, intercom, selective channel public address system, or messenger.

Section 19.3. EMP Protection. Electromagnetic pulse (EMP) protection shall be provided for communications equipment and communications emergency electric generator. EMP protection shall conform to standards contained in publication TR-61-B, *EMP Protective Systems*, July 1976 edition, available from the Federal Emergency Management Agency.

Supplies and Storage

Section 20.0. General. Essential shelter supplies shall be stored within the hospital fallout shelter space when feasible, or within easy access of those spaces. As a minimum, space for food, water, radiation detection equipment, sanitary kits, bunks, and other necessary furnishings and supplies shall be considered in determining the amount of storage space to be provided.

Section 20.1. Food Storage. A supply of canned food of types appropriate to patient care and hospital staff shall be stored for use during a period of emergency confinement of up to 2 weeks. The capacity of the general hospital food lockers and normal food storage areas may be considered in meeting this requirement.

Section 20.2. Other Storage. Consideration shall be given to space requirements for storage of small items such as radiation detection equipment, sanitary kits, hand basins, and chemical toilets.

Section 20.3. Security. Storage areas for emergency supplies shall provide security from pilfering and protection from moisture and other potentially damaging environmental conditions. When crawl spaces are used for storage of supplies, items shall not be placed directly on the earth.

Section 20.4. Sleeping Facilities. Bunks or cots should be included in the design of a dual-use hospital fallout shelter. Storage of these may be outside the shelter area prior to their placement within the hospital fallout shelter space during emergency periods.

COMMENTARY

Fallout shelters are for the purpose of protecting people from the hazards of fallout radiation, which is one of the effects of nuclear explosions. The basic consideration in the fallout shelter concept is that protection from fallout radiation is essential to the life and health of people for a short period of time immediately after the radioactive fallout contaminates a region. The limited time during which protection is necessary from the fallout radiation ranges from a few days to approximately 2 weeks, depending upon the intensity of the radiation hazard.

Because there is need for immediate protection from the fallout radiation, fallout shelters are emergency-use facilities. Their fundamental requirements are that they provide shielding from the radiation hazard, that essential life-support systems are present, and that they are immediately available.

The fallout shelter standards given in this booklet are minimum standards intended to meet the above-stated requirements. The standards have been developed by the Federal Emergency Management Agency and its predecessor agencies, and they result from extensive theoretical and applied research. Fallout shelters which meet these minimum standards will be relatively austere living environments, but the essential purpose of sustaining life and health of the protected populations will be preserved.

THE RADIATION HAZARD

Nuclear radiation has the ominous characteristic of destroying living cells of all types. This characteristic has both good and bad aspects. One beneficial aspect of radiation is that it can be used in controlled situations for the treatment of cancer. However, in uncontrolled situations and in large amounts, radiation also will cause serious impairment of health, or death.

Fallout radiation resulting from nuclear explosions will vary in amount and intensity from location to location due to a variety of conditions which affect its physical behavior. Unfortunately, most of the influencing conditions are not predictable, so generalizations must be drawn from research data, and assumptions must be made regarding distribution patterns and intensities of the radiation for use in planning to mitigate its effects. The standards presented herein are based upon a number of generalizations and assumptions about the fallout radiation hazard.

Radiation effects upon the health of humans will not be immediate for the radiation intensities that will occur in most fallout situations. Initial signs of radiation sickness among exposed populations may appear in hours, days, or weeks, depending upon the dosage received.

Humans also have different tolerance levels for radiation. A healthy adult will be affected less than a child or infirm person when exposed to the same radiation dose. Further, the period of time during which a person is exposed to radiation has an influence upon the damaging effects. A radiation dose received across many months or years will be less hazardous than the same dose received during a shorter period of several days.

Another characteristic of nuclear radiation is that the radiation emissions decrease with time. This is known as radiation decay. The rate of decay will vary with the type of radioactive isotope. The characteristic isotopes found in fallout radiation have a decay rate which can be approximated by the so-called *seven-ten rule*. According to this rule, radiation decay will bring about a reduction in radiation emissions to a level of one-tenth the earlier value with every seven-fold increase in time. This means that a radiation emission rate of 1,000 Roentgens (R) per hour measured at a time soon after a nuclear detonation will decay to an emission rate of 100 R per hour at a time 7 hours after detonation, and to a further reduction of 10 R per hour at a time 49 hours after detonation.

The significance of this radiation decay characteristic to fallout shelter planning is that protection from the fallout radiation needs to be provided for only a limited time. The normal decay process will reduce the radiation dosage to a tolerable level within a period ranging from a few days to approximately 2 weeks.

Fallout shelters cannot fully eliminate the radiation dosage. This is not possible except in only a few situations where massive barriers exist. However, fallout shelters can reduce the intensity and quantity of radiation reaching the occupants to levels and dosages that are tolerable. Reduction is achieved principally with heavy walls and roofs (barriers) placed between the sheltered population and the fallout radiation source field. The needed construction mass in walls and roofs already is present in many buildings.

The amount of radiation entering a sheltered space through barriers will vary as the mass of the barriers varies. More massive barriers mean that less radiation will penetrate into the shelter space.

The degree of radiation shielding provided by a fallout shelter is measured in terms of its protection factor. Quite simply, a protection factor for a shelter is the ratio of the amount of radiation that would be received at an unshielded location compared to the amount of radiation that would be received at the same location with the protective barriers present. Thus, a protection factor of 40 (written as PF 40) for a specific location in a shelter means that location will receive only 1/40th of the amount of radiation that would be received in the same location with the barriers removed.

The Federal Emergency Management Agency has determined that a protection factor of 40 will provide adequate protection for public fallout shelters. For PF 40 protection, only 2½ percent of the open-field radiation will reach the shelter location for which the PF was calculated.

FALLOUT SHELTERS

There are a variety of situations for which fallout shelters are needed. One such situation is the protection of the general population during that time period when the fallout radiation is hazardous to life. In general, public fallout shelters have the function only of providing protection from nuclear fallout radiation. However, there are some activities in our society which must be accommodated even during periods of extreme hazards. Health-care service is one such activity.

There are other activities which need to be established and maintained during emergency periods, such as mobilization of emergency manpower and equipment resources and coordination of essential government functions. Facilities in which these emergency governmental services are managed are called Emergency Operating Centers.

Higher protection factor levels and shelter environments of higher quality are established for Emergency Operating Centers and hospitals than for public fallout shelters, in order to give added assurance that the emergency staffs can perform their work effectively and efficiently. The Federal Emergency Management Agency recommends that these types of emergency service facilities have a protection level of PF 100 or better.

PUBLIC FALLOUT SHELTERS

Public fallout shelters are facilities providing protection from fallout radiation which are intended for use by the general public during emergency periods. These do not include private fallout shelters in residences and other buildings which are not intended to be available to the general public, although the standards are the same for both.

Basic Considerations

Public fallout shelters have but one purpose—to provide the minimum necessary protection from fallout radiation in a minimum life-sustaining environment. The minimum protection level for public fallout shelters is PF 40. The minimum life-sustaining environment consists of a supply of drinking water, tolerable temperature and humidity (these are combined in a human comfort factor called *effective temperature*), sanitary facilities, adequate fresh air, and low-level lighting if natural light is not available in the shelter. These are the basic elements covered in the standard for public fallout shelters.

The standard for public fallout shelters includes a few other items which relate to a general concern for the public safety and welfare, such as access and egress, fire safety, and proximity of hazardous materials or systems. These considerations are addressed in all building codes. They are included in the standard for public fallout shelters, not because they are essential to the purpose of protecting occupants from fallout radiation or to sustaining life, but because prudent design for the public safety requires their consideration. In addition, the standard includes consideration of fallout shelter supplies and their storage. These are not required for a public fallout shelter, but their presence may be desirable in otherwise austere living conditions.

Dual Use

Public fallout shelters need not be separate, single-use facilities. Indeed, all buildings offer some degree of fallout protection; although some buildings provide better protection than others, and not all have protection factors high enough to qualify as public fallout shelters. This characteristic of inherent radiation shielding in all buildings, with PF 40 or better shielding in some, makes it possible to designate either all or parts of some buildings as public fallout shelters. The buildings or spaces therein which may be designated as public fallout shelters typically have an everyday use, and in that sense they are called *dual-purpose shelters*. Most public fallout shelters are of this type.

Identifying The Shelter

Since it often is the case that only part of a building will provide protection of PF 40 or better, the suitable shelter space must be identified for users, including its boundaries and limits. Diagrams of floor plans are one way to do this; trained shelter managers offer another way.

A Minimum Standard

As is the case with most building standards, minimum criteria which meet the intended objectives are given in the standard for public fallout shelters. The principal reason is to keep the cost for meeting the standard to the lowest possible level and yet meet the desired objectives. Accordingly, there should be no hesitation to exceed the standard for public fallout shelters, provided that the particular building situation and economics permit.

Radiation Shielding

As indicated in the description of the radiation hazard above, the fundamental objective of a fallout shelter is that it provide protection from fallout radiation for occupants. Suitable radiation shielding is the most important feature that any shelter offers and should be given priority attention in establishing any fallout shelter.

Higher protection factor values, if they can be achieved with little or no extra effort, are especially worthy of consideration. The advantages of minimizing the amount of radiation that a person receives are indicated in the preceding discussion of radiation effects upon living tissue. The ultimate measure of the amount of radiation received, of course, is the protection factor. If protection factors greater than PF 40 can be achieved, they certainly should be provided.

Temperature

The maximum effective temperature value for public fallout shelters is higher than would be permitted in spaces used daily. The effective temperature value of 82°F (28°C) for public fallout shelters is an upper limit of tolerance for sedentary people, and should not be exceeded. Fully occupied fallout shelters in warm, humid climates are especially likely to produce effective temperatures in excess of the upper limit value unless large air-flow volumes are provided.

Because heat buildup occurs in a relatively closed fallout shelter at full or nearly full occupancy, a minimum dry-bulb temperature of 50°F (10°C) normally can be maintained without adding heat to the space. Dry-bulb temperatures that are too high will be the usual situation rather than temperatures that are too low for comfort.

Ventilation

Proper ventilation of fallout shelters is, perhaps, the second most important consideration. Fresh air—that is, oxygen—is essential to sustain life. Ordinarily, this is not a great concern for buildings which are designed for daily use. We take for granted that a fresh air supply is introduced into building spaces through normal ventilation, which may be either natural air flow or mechanically driven air flow.

Fallout shelters present new ventilation problems. First, the very purpose of a fallout shelter usually results in it being a relatively closed space, possibly a basement or an interior space. Natural ventilation is restricted in such circumstances, and mechanical (forced) ventilation cannot be relied upon, because electric power cannot be assured to remain available during and after a period of nuclear attack. Second, when a fallout shelter is fully occupied up to its limit, which is one person in every 10 square feet of floor area, the consumption of oxygen, discharge of carbon dioxide, buildup of unpleasant odors, and heat and moisture buildup from occupants combine to create nearly intolerable conditions in spaces which have poor or no ventilation.

For these reasons, the ventilation system of a fallout shelter must be carefully checked. If natural ventilation is to be used, then the air-flow volume must be sufficient to meet the health and comfort conditions as prescribed in publication TR-20 (Volume 3), *Shelter Environmental Support Systems*, Appendix C, "Ventilation Requirements for Fallout Shelters," May 1978 edition, available from the Federal Emergency Management Agency. If deficiencies are found, then either the shelter occupancy must be reduced, or forced ventilation must be provided. If forced ventilation is to be used, then a reliable power supply to the fans must be assured to maintain the required air-flow volume.

Potable Water

A supply of drinking water is the only other feature of public fallout shelters which is essential to sustain life for periods longer than just a few days. Accordingly, provision must be made for the needed water. 3.5 gallons of potable water per shelter occupant are to be provided. This amount is based upon a 14-day shelter stay-time, or one quart per day, and is for drinking purposes only. No other uses are included in the base amount. If other uses of water are expected in the fallout shelter, such as for sanitary purposes, then the storage capacity must be increased.

There are several ways in which the required drinking water can be provided in a fallout shelter. The one way not to be counted upon is the public water main. Public water supply systems are likely to be disrupted during a period of nuclear attack--either due to power failure which could render pumping stations inoperative or due to breakage of the water lines at some remote point. This means that the emergency water supply must be at or near the fallout shelter—either storage tank(s) or a well at the site. Water can be stored either in permanently installed tanks or in individual containers. Occasionally, it will be possible to obtain the required water from that trapped in building lines. In such cases, a suitably located outlet valve will be needed to withdraw the water.

HOSPITAL FALLOUT SHELTERS

Hospital fallout shelters are among that class of protected facilities which also have an emergency operational purpose. Hospitals must prepare to provide radiation protection for a population whose health most likely is poor and who therefore have a lower tolerance level for radiation exposure and for adverse environmental conditions. Hospitals also must provide a protected work space for medical and health-care staff who serve the patients and who may be called upon to give medical treatment to new patients. For these reasons, the fallout shelter standard for hospitals is more restrictive (a higher standard) than is the standard for public fallout shelters.

Hospital fallout shelters, like public fallout shelters, are less than optimum facilities. Their essential purpose is to accommodate health-care services during extremely adverse conditions. The standard is lower than ordinarily is applied to medical facilities. However, to permit minimum health-care services without endangering the lives of patients or medical staff, the standard for fallout shelters in hospitals is more than the minimum life-sustaining standard that is acceptable for public fallout shelters.

Priorities in the importance of features also exist for hospital fallout shelters. These are indicated in subsequent paragraphs.

Radiation Shielding

The fundamental objective of a hospital fallout shelter is that it provide protection from fallout radiation for both patients and patient-care staff. An additional objective is that protection also be provided in essential medical treatment and surgical facilities which must continue to function even in the most adverse conditions. It may be that temporary facilities will need to be established in the hospital in order to maintain these services in a protected environment during a fallout radiation emergency. Temporary facilities for bed patients also may be needed in protected locations away from normal service wards.

The standard for fallout shelters in hospitals is not specific about how facilities used daily are to be utilized in emergency situations. This is a matter to be decided by each hospital administrator after assessing the radiation shielding potential of each hospital area and the medical services organization of the hospital. However, suitable fallout radiation protection is the primary consideration for hospital fallout shelters, as is the case for public fallout shelters. All other considerations must give way to this basic requirement.

A Minimum Standard

The standard provides minimum criteria for hospital fallout shelters. These criteria cover patient areas, medical treatment spaces, surgical facilities, staff spaces, and support facilities. Other spaces in the hospital which may be used as public fallout shelter areas are not covered in the standard. Such facilities should meet the standard for public fallout shelters.

The standard for fallout shelters in hospitals is nonspecific with respect to the number and size of areas to be allocated to each of the various patient-care, medical, and surgical functions. These functions are different for nearly every hospital, and the particular needs for each hospital are best determined by its administrator. However, minimum space requirements are prescribed for patient-care shelter areas.

There should be no hesitation on the part of hospital planners to exceed the standard for hospital fallout shelters, provided that the particular building situation and economics permit. Protection factor values higher than the minimum PF 100 are worthy of consideration if they can be achieved with little or no extra effort.

Ventilation

Ventilation of the hospital fallout shelter area is among several additional considerations, the importance of which is exceeded only by the need for suitable radiation shielding. An adequate supply of fresh air, an acceptable effective temperature level, a reasonably comfortable dry-bulb temperature level, and control of air circulation to avoid transfer of contamination are among the more important health and comfort factors affected by ventilation of the hospital fallout shelter space.

Health and comfort needs both for an active staff and for inactive patients must be met by the ventilation system. Since active persons (medical staff) and inactive persons (bed patients) have different temperature and humidity comfort levels, ventilation systems in hospitals require more precise control than do ventilation systems in public fallout shelters. Also, the ranges of tolerable fluctuation of fresh air supply, temperature, and humidity are narrower for hospital fallout shelters. Accordingly, the ventilation standard for hospital fallout shelters is more restrictive.

Fresh air supply requirements are greater for hospitals than for other types of shelters. This is to accommodate patients whose need for oxygen may be greater than the needs of healthy persons, and hospital staff whose activities may result in greater oxygen consumption than sedentary occupants of a public fallout shelter. The fresh air supply for hospital fallout shelters therefore is more than twice that required for public fallout shelters.

Air-conditioning may be required in some hospital fallout shelters in order to maintain a tolerable effective temperature in a relatively closed space, especially for those shelters in warm, humid climates. And, heating may be required in some northern climates in order to maintain temperature levels sufficient for bed patients.

Lighting

Lighting is another essential need for most medical services, including those rendered in emergency situations in a hospital fallout shelter. Unlike public fallout shelters, hospital fallout shelters must include emergency lighting at intensity levels commensurate with the critical nature of the medical services performed in a particular space or area. This lighting must be connected to an emergency generator to assure that failure of the public power system will not disrupt medical treatments in process or life-support systems which most likely are electrically operated. In addition, battery-operated lights should be placed in critical areas of the hospital fallout shelter to provide backup lighting.

Emergency Power

The need at all times for ventilation, lighting, powering of medical equipment, and, possibly, air-conditioning means that hospital fallout shelters must have emergency electrical power available. Most hospitals already have emergency generators which provide electrical power for essential medical facilities during periods of normal power outages that occasionally occur. Emergency power for the hospital fallout shelter also is essential.

Normal power outages usually are of short duration compared with the possible 2-week period that a hospital fallout shelter could be occupied. As a result, hospital equipment and building systems connected to the emergency generator system designed for normal power outages often will be less extensive than may be needed for the hospital fallout shelter. It may be necessary to increase the size of the emergency power system or to supplement it with additional equipment in order to provide sufficient power to the fallout shelter to carry the additional power loads that may not be included in the normal emergency generator installation.

Also, switching and other controls may need to be installed to permit shut-down of systems in the hospital not necessary to the fallout shelter functions, or to direct the emergency power into the hospital fallout shelter area and to equipment essential in the fallout shelter.

Sanitation

Sanitation is another aspect of hospitals which requires special attention in fallout shelter areas. Provision must be made for collection and disposal of garbage, trash, and human waste in a way to preserve necessary sanitary conditions in the hospital fallout shelter.

If a water supply is available during emergency periods when the fallout shelter may be occupied, then disposal of garbage and human waste can be done relatively easily by normal methods; that is, disposals and standard toilets. If extra water is not expected to be available during emergency periods, then alternative methods of disposal must be employed, such as chemical toilets for human waste and closed containers for garbage and trash.

Communications

Communications, both within the hospital fallout shelter space and externally, are another special need for hospital fallout shelters. Among its several roles during and after a nuclear attack, a hospital may be called upon to render medical services to casualty cases; that is, to persons other than its own patients. Such medical services may need to be rendered within the hospital or possibly at some remote location. Coordination of these services, either within the hospital or at other locations, will be highly desirable, both for reasons of efficiency and for allocation of medical resources.

The local civil defense Emergency Operating Center will be the source of casualty information during a nuclear emergency. Thus, communications with that local operations center is desirable.

Communications for the hospital can be handled most effectively through a hospital control center from which information involving medical services can be assessed in terms of required actions, and from which information can be passed on to the medical staff within the hospital fallout shelter by various communications methods. Because of the importance of effective communications during emergency periods, alternative systems are to be provided for backup communications.

Supplies and Storage

Essential medical, reserve food, and other supplies will be needed in every hospital fallout shelter. Some of these supplies may be moved into the hospital fallout shelter area at the time of the emergency, such as food from hospital kitchens, medical equipment and supplies, linen, and beds. Other supplies, such as radiation detection equipment, basic or reserve food items, and, possibly, water may require permanent storage in the hospital fallout shelter area.

It is desirable that the storage of supplies be convenient for periodic checking or replacement. If the storage areas are inconvenient, then periodic checking may be neglected, with the result that the stored items may not be useable or operable when needed.

A Comprehensive Standard

It should be evident that some elements of the standard for fallout shelters in hospitals involve building construction and mechanical systems which are integral to the building; whereas others involve facilities utilization which are matters of management. These are not always differentiated in the standard. Rather, all features of an operational hospital fallout shelter are treated. How each particular element of the standard is met is left to the judgement of each hospital administrator.

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