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OPTIMUM BUILDING DESIGN FOR FIRE PROTECTION

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OPTIMUM BUILDING DESIGN FOR FIRE PROTECTION

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OPTIMUM BUILDING DESIGN FOR FIRE PROTECTION

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OPTIMUM BUILDING DESIGN FOR FIRE PROTECTION

1.0 INTRODUCTION

1.1 Purpose

Fire is an ever-present threat to buildings. However, updated design, materials, and methods can help to identify hazards and introduce ways of reducing or eliminating fire incidents.

This publication supports DRM 10-7/51, Building Design. It provides basic information on incorporating fire protection elements into building design. The aim is to reduce or eliminate the causes and effects of fire by giving special consideration to the problems during the planning and design phases.

1.2 Users

This publication is intended for departmental architects, engineers and designers in related disciplines, and Public Works Canada (PWC) staff and consultants engaged on DIAND projects.

1.3 Scope

This guideline applies to buildings within DIAND programs, such as schools, teacherages, houses, warehouses, and garages in all parts of Canada--urban, rural and remote.

2.0 CAUSES AND CONSEQUENCES OF FIRE

2.1 General Remarks

For details on fire losses, refer to the Fire Loss Report - Indian and Inuit Affairs, which is published annually.

2.2 Causes

The causes of fire, whether large or small, can usually be traced to:

a. inadequate design;
b. lack of supervision during construction, thus allowing the substitution of flammable materials;
c. improper methods of storing combustible materials and volatile liquids;
d. arson;
e. carelessness by users of equipment, facilities, or premises (for example, children playing with matches, grease buildup on stoves); or
f. weather conditions, such as lightning and transfer of fire by high winds.

Fires are also caused by careless smoking, locating campfires near buildings and spontaneous combustion.

2.3 Consequences

Besides the obvious loss of or damage to the building, fire has other serious consequences which can be decreased or eliminated by the proper design and selection of materials:

a. panic: one of the most dangerous effects of fire, especially when several persons are gathered in a confined area, or where persons are hospitalized, handicapped, or infirm;

b. injury or death;

c. heat: intensive heat giving a "flashover" effect, that is, very fast ignition when the temperatures reach a certain level;

d. gases: toxic or non-toxic, usually released when synthetic or natural materials burn, causing injury, death, or discomfort when inhaled;

e. smoke: if sufficiently dense and particularly in a confined space can cause suffocation, reduce visibility, and prevent escape and rescue; and

f. buckling and collapsing of structural members and systems, which can cause death and impede escape and rescue operations.

3.0 CODES AND STANDARDS

Federal, provincial and municipal fire codes and standards shall be adhered to when applicable. These could be over-ruled by more stringent local by-laws. The Fire Commissioner of Canada's office must be consulted during the design process for federal facilities; this is intended to eliminate fire protection related problems during the design and construction phases for these facilities.

When using the National Fire Code of Canada (NFC) it is important to appreciate the special relationship which exists between it and the National Building Code (NBC). The role of each with respect to fire safety can be summarized as follows:

a. The NBC establishes the standard of fire safety for the construction of new buildings, the reconstruction of buildings including extensions and alterations, buildings which are changing occupancy, and the upgrading of buildings to remove fire hazards.

b. The NFC establishes the standards for fire prevention, firefighting, and life safety for buildings in use, including standards for use when carrying out activities which may cause fire hazards, standards for maintenance of fire safety equipment and egress facilities, standards for portable extinguishers, limitations on building contents, and the establishment of fire safety

plans including the organization of supervisory staff for emergency purposes. This code also establishes the standards for prevention, containment, and fighting of fires originating outside buildings which may present a hazard to a community, and sets standards for the transportation of flammable and combustible liquids.

The Codes have been developed as complementary and coordinated documents in order to minimize the possibility of conflict. To ensure effective application, it is important that fire and building officials be conversant with each other's fire safety standards. Designers must also be fully conversant with these standards. Fire and building officials should be involved in the review and approval of plans with respect to fire safety prior to granting a building permit and when inspecting buildings. This is the only way to ensure that all known hazards have been considered and that a satisfactory standard of fire safety has been achieved.

4.0 DESIGN ELEMENTS REQUIRING SPECIAL CONSIDERATION

4.1 Site Planning

Buildings should be adequately spaced, as provided for in the applicable code, to prevent fire from "jumping" from one building to another, (the prevailing wind direction has a strong bearing on this). Locating buildings in clearings will diminish the risk of ignition during a forest or grass fire.

4.2 Water Supply

Supply municipal water services (wells, water-mains, reservoirs etc.) that provide water of adequate volume and pressure.

4.3 Architectural Design

4.3.1 Egress

4.3.1.1 Definition

Exit from a building is most important in life safety concerns. "Means of egress", according to the NBC, means "a continuous path of travel provided by a doorway, hallway, corridor, exterior passageway, balcony, lobby, stair, ramp or other egress facility or combination thereof, for the escape of persons from any point in the building, floor area, room, or contained open space to a public thoroughfare or other approved open space, and includes exits and access to exits".

4.3.1.2 Non-residential Exits

Exits should be clearly visible, accessible, and marked with illuminated signs having auxiliary battery lighting. Exit doors must open to the way of escape, and be wide enough to take the "occupant load" of the building.

Areas outside exits must be free of obstructions to allow speedy evacuation.

Distance between exit doors and number of exits per square metre shall conform to the requirements of the NBC.

4.3.1.3 Residential Exits

Residential exits must conform to the requirements of Part 9 of the NBC.

4.3.1.4 Main Entrances - Public Buildings

Foyers, lobbies, etc., should be free of obstructions such as fixed furniture. Finishing materials on walls, ceilings, and furniture should not emit toxic gases when on fire. For interior design purposes, these areas can be made fire-proof or resistant

through the use of non-flammable and non-toxic materials and fire-retardant sprays. Finishes and materials must at least conform to the NBC and the NFC.

4.3.1.5 Corridors

Corridors must be free of obstructions and wide enough to accommodate maximum traffic according to the building's function and occupant load (see NBC). Fixtures such as fire hose cabinets and drinking fountains should be recessed rather than protruding into corridors.

4.3.1.6 Stairs and Ramps

Avoid complex sets of stairs. Straight flights are recommended, with risers permitting easy ascent and descent, within the limits of the NBC. Split-level designs, which produce short flights with excessive turns and landings, should be avoided. Handrails should be of a size and shape to provide easy support. Single risers are dangerous and should be avoided; ramps should be provided instead.

4.3.1.7 Doors, Windows, and Walk-in Closets

Doors and windows should open in the direction of escape and have simple opening mechanisms. Sliding doors or window units should be avoided as they may jam when subjected to extreme temperatures, especially if fabricated out of metal. For the same reason metal frames should be avoided if used with metal sliding units. Windows and escape hatches should be placed low enough to permit easy escape (especially for children and incapacitated persons). This is left to the discretion of the designer. In clinics and homes for the infirm, door sills should be flush with floors to allow speedy passage of trolleys and wheel chairs during evacuation. Exit doors must have panic hardware, which cannot be locked from the inside.

4.3.2 Compartmentalization

When designing the functional components of larger buildings with a view to fire safety, separate closed areas are preferred to the "open planning" concept. Compartmentalization helps confine fire, smoke, and gases to more manageable areas. It allows more time for firefighting personnel and equipment to arrive on the scene and may prevent the building from being totally destroyed. It may also provide a temporary haven from fire in another part of the building in cases where escape to the exterior is difficult or impossible.

4.3.3 Storage Rooms and Storage Areas (Non-domestic)

Rooms and areas designated for storage of flammable or volatile materials and liquids must be carefully considered relative to other rooms in the building. Ideally they should be placed on outside walls, with exit doors opening to the outside. There must be adequate ventilation. Doors and frames should be metal, close automatically, and have mechanisms activated by fusible links. Special attention should be given to jointing details--especially where different materials such as brick and steel are to be joined--to ensure that gases, smoke, and liquids do not leak through to other areas. Again, there should be compliance with the NBC and NFC.

4.3.4 Construction Methods and Materials

Depending on the intended occupancy, buildings are classified as of combustible or non-combustible construction, which establishes the requirements as to the allowable materials and methods of construction. Each component of a building, for example, wall, floor or column, should be of material or a combination of materials constructed to provide the necessary fire resistance and separation rating as required by the NBC. Special attention should be given in the design of buildings and the selection of noncombustible and fire retardant materials, particularly in remote and isolated locations where firefighting resources are limited and the loss and replacement of a facility has much more impact on the community.

The designer should also bear in mind that by specifying as many noncombustible or fire retardant materials as possible in the design of the building, he/she can make the building more arson-resistant. Statistics show that arson is an important cause of fires on reserves and in settlements.

4.3.5 Incinerators and Fuel Storage Tanks (Exterior)

Incinerators and fuel storage tanks must be located at least the minimum distance from buildings as provided for in the applicable code. Incinerators must be encased in a wire mesh screened compound at least 1.8 m high, with a lockable child-proof door. They should have spark arrestors (see DRM 10-7/54, School Design).

5.0 CONSTRUCTION

All efforts must be made by the supervisory staff during construction to strictly enforce proper installation of fire prevention related materials and equipment as provided in the design. This applies to all types of construction (general contract, day-labour, etc.). Failure to provide the required protection and fire separation may result in unnecessary loss of life and property.

6.0 FIRE SUPPRESSION SYSTEMS

Where NFC regulations require the use of manual or automated fire suppression systems, the type, capacity and arrangement of this equipment for federal buildings must receive prior approval from the Fire Commissioner of Canada (FC). The procedures are in FC standard No. 12 "Approval of Design and Construction".

7.0 DETECTION AND ALARM SYSTEMS

Installation of fire detection and alarm systems is compulsory in federal buildings classified as "public use". It is also being incorporated more and more in

all types of housing, either voluntarily or because of local regulations. The systems are divided into two main categories: manual and automatic devices.

Manual alarms are activated by the person(s) detecting fire. Automatic devices detect fire or smoke automatically and activate an alarm. Some also activate a fire extinguishing system.

Today's field of automatic detection and alarm systems is very wide and sophisticated. New devices continually enter the market. A specialist's assistance might be required when choosing a system and equipment. Details of the proposed system must be approved by the FC. In preparing design, refer to FC Standard No. 10, "Policy", and No. 12, "Approval of Design and Construction".

8.0 MAINTENANCE

When selecting a fire suppression, detection or alarm system, a designer should give careful attention to the complexity of the system under consideration: degree of specialty and frequency of maintenance is particularly important for buildings in remote areas.

9.0 RELATED PUBLICATIONS

Canadian Electrical Code - Part 1 "Safety Standard for Electrical Installations", Current edition. Canadian Standards Association, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3.

Fire Commissioner of Canada Standards - Current edition, Public Works Canada.

DRM 10-7/26, Fire Protection

EA-HQ-84-08, Fire Loss Report 1983 Indian and Inuit Affairs.

TDS-51-45, Review of Submissions - Preliminary Design and Outline Specifications.

TSD-51-46, Review of Submissions - Working Drawings and Specifications.

National Building Code - Current edition and supplements, National Research Council Canada, Ottawa, Ontario K1A 0R6.

National Fire Code - Current edition, National Research Council Canada, Ottawa, Ontario K1A 0R6.

Ramsey, C.G., and Sleeper, H.R. - Current edition. Architectural Graphic Standards. New York, London, Sydney, Toronto. John Wiley and Sons, Inc.