CSA Group

N293-12

Fire protection for nuclear power plants

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Note: *For information about the* ***Standards Update Service****, go to* ***shop.csa.ca*** *or e-mail* ***techsupport@csagroup.org****.*

Title: *Fire protection for nuclear power plants* — originally published October 2012

The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

Revised	Clauses 2, 6.8.4.4, 8.2.3.4, 8.3.4.1, 8.3.4.2, 10.1.4, 10.3.2, 10.4.3, 10.5.1, 10.5.2, 10.5.3, 10.6.2, 10.7.4, 10.8.2, 10.8.3, A.6.8.1.4(b), A.6.8.1.4(c), A.6.8.4.4, A.7.3.1.1.3, A.8.2.3.4.3, A.8.3.4.1, A.10.1.4, A.10.4.3(a), and A.10.8.3
New	10.4.2.1, 10.4.2.2, A.10.4.2.2, A.10.4.3, A.10.5.1, A.10.6.3, and A.10.7.4
Deleted	A.10.8.2

- Update your copy by inserting these revised pages.
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N293-12
Fire protection for nuclear power plants

1 Scope

1.1*
This Standard provides the minimum fire protection requirements for the design, construction, commissioning, operation, and decommissioning of nuclear power plants, including structures, systems, and components (SSCs) that directly support the plant and the protected area.

1.2*
External events such as an aircraft crash or terrorist attack are outside the scope of this Standard.

1.3
In CSA Standards, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; "may" is used to express an option or that which is permissible within the limits of the standard; and "can" is used to express possibility or capability.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.4
The values given in SI (metric) units are the standard. The values given in parentheses are for information only.

Δ 2 Reference publications
This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below.

CSA Group

CAN/CSA-B72[illegible]8.1 (R2013)
Installation code for lightning protection systems

C22.1-12
Canadian Electrical Code, Part I

CAN/CSA-C22.2 No. 0.17-00 (R2013)
Evaluation of properties of polymeric materials

C22.2 No. 2556-15
Wire and cable test methods

C282-09
Emergency electrical power supply for buildings

N285.0-08/N285.6 Series-12
General requirements for pressure-retaining systems and components in CANDU nuclear power plants/Material Standards for reactor components for CANDU nuclear power plants

N286-12
Management system requirements for nuclear facilities

N289.3-10
Design procedures for seismic qualification of nuclear power plants

N290.5-16
Requirements for the electrical power and instrument air systems of CANDU nuclear power plants

N290.6-16
Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident

CAN/CSA-W117.2-12
Safety in welding, cutting, and allied processes

CAN/CSA-Z94.4-11
Selection, use, and care of respirators

ANSI/UL (American National Standards Institute/Underwriters Laboratories)
ANSI/UL-586-2009
Standard for High-Efficiency, Particulate, Air Filter Units

ASME International (American Society of Mechanical Engineers)
B31.1-2012
Power Piping

ASTM International (American Society for Testing and Materials)
D323-06
Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)

EPRI (Electric Power Research Institute)
Fire Protection Equipment Surveillance Optimization and Maintenance Guide, 2003

FM (Factory Mutual)
7-101-2013
Fire Protection for Steam Turbines and Electric Generators

Bulletin 06-04

Government of Canada
Nuclear Safety and Control Act, SC 1997, c. 9, and Regulations

Transportation of Dangerous Goods Act, SC 1992, c. 34, and Regulations

IAEA (International Atomic Energy Agency)
INSAG Series No. 10, 1996
Defence in depth in nuclear safety

INSAG Series No. 12, 1999
Basic safety principles for nuclear power plants, 75-INSAG-3, Rev 1

Safety Reports Series No. 10, 1998
Treatment of internal fires in probabilistic safety assessment for nuclear power plants

Safety Reports Series No. 46, 2005
Assessment of defence in depth for nuclear power plants

Safety Standards Series No. NS-G-1.7, 2004
Protection against internal fires and explosions in the design of nuclear power plants: Safety guide

Safety Standards Series No. NS-G-2.1, 2000
Fire safety in the operation of nuclear power plants: Safety guide

NEI (Nuclear Energy Institute)
NEI 00-01 [Revision 3] (2011)
Guidance for Post-Fire Safe Shutdown Analysis

NFPA (National Fire Protection Association)
10-2013
Standard for Portable Fire Extinguishers

11-2016
Standard for Low-, Medium-, and High-Expansion Foam

12-2015
Standard on Carbon Dioxide Extinguishing Systems

12A-2015
Standard on Halon 1301 Fire Extinguishing Systems

13-2016
Installation of Sprinkler Systems

13E-2015
Fire Department Operations in Properties Protected by Sprinkler and Standpipe Systems

14-2016
Standard for the Installation of Standpipe and Hose Systems

15-2017
Standard for Water Spray Fixed Systems for Fire Protection

16-2015
Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems

17-2017
Standard for Dry Chemical Extinguishing Systems

17A-2013
Standard for Wet Chemical Extinguishing Systems

20-2016
Standard for the Installation of Stationary Fire Pumps for Fire Protection

22-2013
Standard for Water Tanks for Private Fire Protection

24-2016
Installation of Private Fire Service Mains and Their Appurtenances

25-2017
Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

30-2015
Flammable and Combustible Liquids Code

30B-2015
Code for the Manufacture and Storage of Aerosol Products

55-2016
Standard for the Storage, Use, and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders, and Tanks

69-2014
Standard on Explosion Prevention Systems

72-2016
National Fire Alarm Code

76-2016
Standard for the Fire Protection of Telecommunications Facilities

80A-2012
Recommended Practice for Protection of Buildings from Exterior Fire Exposures

92-2015
Standard for Smoke-Control Systems

101-2015
Life Safety Code

241-2013
Standard for Safeguarding Construction, Alteration, and Demolition Operations

291-2016
Recommended Practice for Fire Flow Testing and Marking of Hydrants

600-2015
Standard on Industrial Fire Brigades

701-2015
Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

750-2015
Standard on Water Mist Fire Protection Systems

780-2017
Standard for the Installation of Lightning Protection Systems

804-2015
Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants

805-2015
Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants

850-2015
Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations

921-2014
Guide for Fire and Explosion Investigations

1081-2012
Standard for Industrial Fire Brigade Member Professional Qualifications

1710-2016
Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public Career Fire Departments

1720-2014
Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments

2001-2015
Clean Agent Fire Extinguishing Systems

NIPF (Nuclear Insurance Pools' Forum)
International Guidelines for the Fire Protection of Nuclear Power Plants, 1997

NRCC (National Research Council Canada)
National Building Code of Canada, 2015

National Fire Code of Canada, 2015

SFPE/ICC (Society of Fire Protection Engineers/International Code Council)
SFPE Handbook of Fire Protection Engineering, 2016

ULC (Underwriters' Laboratories of Canada)
CAN/ULC-S102-10
Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

CAN/ULC-S102.2-10
Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous

CAN/ULC-S107-10
Methods of Fire Tests of Roof Coverings

CAN/ULC-S109-14
Flame Tests of Flame Resistant Fabrics and Films

CAN/ULC-S111-13
Standard Methods of Fire Tests for Air Filter Units

CAN/ULC-S114-05
Standard Method of Test for Determination of Non-Combustibility in Building Materials

CAN/ULC-S115-11
Standard Method of Fire Test of Firestop Systems

CAN/ULC-S126-14
Standard Method of Test for Fire Spread Under Roof-Deck Assemblies

CAN/ULC-S524-14
Standard for the Installation of Fire Alarm Systems

CAN/ULC-S537-13
Verification of Fire Alarm Systems

US Department of Energy
DOE-STD-1066-99
Fire Protection Design Criteria

USNRC (United States Nuclear Regulatory Commission)
Supplement No. 1 to Generic Letter 86-10, *Implementation of Fire Protection Requirements,* 1986

Other publications
Hill, J.P. "Fire Tests in Ventilated Rooms, Extinguishment of Fires in Grouped Cable Trays" EPRI NP-2660, 1982

3 Definitions and abbreviations

3.1 Definitions

The following definitions apply in this Standard:

Approved — acceptable to the authority having jurisdiction.

Authority having jurisdiction (AHJ) — the organization, office, agency, or individual responsible for approving or accepting equipment, materials, installation, or procedures according to the applicable Codes and Standards.

Building area — the greatest horizontal area of a building above grade within the outside surface of exterior walls or within the outside surface of exterior walls and the centre line of firewalls.

Central alarm and control facility (CACF) — a location within a building in which fire alarm control units, annunciators, and other life-safety-related equipment can be located for the purpose of command and control.

Closure — a device or assembly that is intended to close an opening through a fire separation or an exterior wall. Closures include doors, shutters, wired glass, and glass blocks, as well as components such as hardware, closing devices, frames, and anchors.

6.8.2.2
During the operation of the plant, transient materials shall be controlled so that they do not pose a hazard beyond the capabilities of existing fire protection measures. See Clause 8 for specific operational control measures.

6.8.2.3
Plant design shall incorporate storage facilities that can accommodate the greatest volume of transient combustible materials anticipated during operation and maintenance.

6.8.2.4
Storage facilities shall be located so that fire within the facilities does not adversely impact safety-related equipment located nearby.

6.8.2.5*
The facility shall be provided with storage rooms, to minimize the need for the temporary storage or staging of materials outside of storage rooms in the containment structure, reactor auxiliary building, and control room complex.

6.8.3 Control of combustible materials in HVAC equipment

6.8.3.1
Air-handling ducts, duct connectors, and plenums shall be made of non-combustible materials.

6.8.3.2
Air filter media (excluding charcoal filters and high-efficiency particulate air [HEPA] filters) used in air-handling systems shall meet the combustibility requirements of Class 1 in accordance with CAN/ULC-S111.

6.8.3.3
HEPA filters shall meet the combustibility requirements of ANSI/UL-586.

6.8.3.4*
Fire protection for charcoal filters shall be provided to ensure that fires do not spread beyond the filter housing and to prevent the uncontrolled release of contamination into the atmosphere.

6.8.4 Control of combustible materials in electrical equipment and cables

6.8.4.1*
Plant design shall minimize the use of plastics, wood, and other combustible materials in electrical equipment, cable raceways, and wiring racks.

6.8.4.2*
Electric and control cabinets shall be designed to minimize flame spread across adjacent cabinets.

6.8.4.3
Electrical cable trays and conduits shall be constructed of non-combustible materials.

6.8.4.4*
Electrical cables shall have a limited flame spread rating and produce a low level of smoke and corrosive gases. The wires and cables shall exhibit a maximum vertical char of not more than 1.5 m when tested in accordance with the vertical flame tray test (Method 2-FT4) test in CSA C22.2 No. 2556.

6.8.5 Control of flammable liquids and combustible liquids

6.8.5.1 General
In addition to the requirements of the NFCC, the handling, use, and storage of flammable liquids and combustible liquids shall meet the requirements of Clauses 6.8.5.2 and 6.8.5.3.

6.8.5.2* Use of flammable liquids and combustible liquids in design
The use of flammable liquids and combustible liquids in equipment for hydraulic power, lubrication, heat transfer, and electrical insulation shall be minimized. Where they cannot be eliminated, preference shall be given to liquids with a higher flash point.

6.8.5.3* Containment of combustible liquids
Systems containing combustible liquids such as lubrication oils and hydraulic oils shall be designed to minimize leakage of these liquids. In locations where an uncontrolled leakage of the liquid could jeopardize fire safe shutdown systems, the design shall provide devices to collect, divert, and safely contain leakages from pressurized and non-pressurized components in order to prevent the ignition of the oil or limit the size of fire and achieve fire safe shutdown.

6.8.6 Control of gases

6.8.6.1* Reducing the fire and explosion hazards of hydrogen
Systems containing hydrogen shall be designed in accordance with NFPA 55. In addition, the design shall meet the following requirements:
(a) Hydrogen supply cylinders shall be located apart from safety-related systems in order to prevent damage from fire or explosion.
(b) Where piping or tubing containing hydrogen is routed through fire compartments containing fire safe shutdown systems, piping or tubing shall be designed to retain pressure boundary integrity during and following a design basis earthquake.

6.8.6.2* Controlling the production of hydrogen and deuterium in processes
Systems that produce hydrogen or deuterium gas shall be designed to prevent the creation of an ignitable mixture. This can be achieved using venting, dilution, controlled combustion, or re-combination. The system shall be designed so that hydrogen control failure sets off an alarm in the main control room and initiates operator action.

6.8.6.3* Use of compressed gases
In addition to the requirements of the NFCC, storage containers and piping for compressed gases shall not be located in the main control room complex and in other fire compartments with safety-related systems unless they are required for equipment or operation within that area. In this case, the design shall assess potential failures of the compressed gas components during a fire and shall ensure that the nuclear safety objectives of Clause 5.4.1 are met.

6.8.6.4 Aerosol storage
Facilities for aerosol storage shall be designed in accordance with the NFCC and NFPA 30B.

6.8.7* Bulk storage of dangerous goods
Bulk storage of dangerous goods shall be
(a) located outdoors in detached storage buildings or cut-off rooms (see Clause 8.2.4 for additional handling requirements);
(b) located to limit exposures that can impact nuclear safety;
(c) separated from other buildings in accordance with the NFCC and NFPA 55; and

8.2.2 Housekeeping
Housekeeping shall be performed in such a manner as to minimize the probability of fire and the consequences resulting from a fire.

8.2.3 Minimization and management of combustibles

8.2.3.1 Combustible waste
Combustible waste shall not be allowed to accumulate at work areas. A program shall be established for the staging, handling, and/or collecting of combustible waste. The intent of Clause 8.2.3.1 is to reduce the amount of combustible material waste to a level as low as is reasonably achievable.

8.2.3.2 Combustible contents
The combustible contents of buildings shall be minimized and, where practical, non-combustible alternatives shall be used. Panels and screens shall be of non-combustible materials or approved materials having fire-retardant characteristics. Tarpaulins, fabrics, or plastic films shall be certified in accordance with the testing specified in NFPA 701 or CAN/ULC-S109.

8.2.3.3* Systems, structures, or components (SSCs)
When SSCs are replaced, repaired, or modified, combustible material components shall be identified and consideration shall be given as to whether there are non-combustible material alternatives available that can be substituted without impacting the design intent of the equipment.

Δ 8.2.3.4 Use and handling of combustible and transient materials

8.2.3.4.1*
Combustible and transient materials shall be stored in areas designed in accordance with Clause 6.5.1.

8.2.3.4.2
Combustible materials, including fire-retardant coated or treated combustible materials, shall not be stored in the containment structure or in areas designated as sensitive by the FPA.

8.2.3.4.3*
Transient materials shall be minimized and controlled.

8.2.3.4.4*
Wood shall only be used where there is no reasonable alternative. Where wood is used, it shall be qualified as fire-retardant-treated-wood in accordance with the National Code of Canada. Fire-retardant-treated-wood means wood or a wood product that has had its surface-burning characteristics, such as flame spread, rate of fuel contribution, and density of smoke developed, reduced by impregnation with fire retardant chemicals. Wood blocks larger than 150 × 150 mm shall not require fire-retardant treatment.

8.2.3.4.5*
Where wood is treated in accordance with Clause 8.2.3.4.4, it shall be inspected prior to each use to ensure that the treatment or coating is intact. Where the treatment or coating is not intact, the wood shall be re-treated or re-coated.

8.2.3.4.6
Where wood is treated in accordance with Clause 8.2.3.4.4, ends of wood pieces shall be treated or coated after the wood has been cut.

8.2.3.5 Fire protection for the handling, use, and storage of radioactive materials

8.2.3.5.1
Radioactive materials shall only be handled, used, and stored in areas designated for these purposes.

8.2.3.5.2*
Radioactive materials shall be stored in areas designed in accordance with Clause 6.8.8.

8.2.3.5.3
Combustible materials shall not be stored in the same fire compartment as radioactive materials unless the fire compartment is a radioactive waste storage room in accordance with Clause 6.8.8.

8.2.3.5.5*
Radioactive materials shall be stored such that they are protected from fires and firefighting activities.

8.2.3.6 Relocatable structures

8.2.3.6.1*
The control of fire loads in the protected area and areas under the scope of this Standard is essential to providing defence-in-depth fire protection. This includes controlling the construction, location, contents, and use of relocatable structures.

8.2.3.6.2*
Relocatable structures intended for human occupancy, including associated walkways, stairways, insulation, and skirting, shall comply with the requirements of this Standard and shall be
(a) constructed using non-combustible construction, as defined in the NBCC;
(b) located in accordance with the NBCC;
(c) assessed for additional fire protection provisions in accordance with the objectives of Clause 5.5;
(d) equipped with a fire alarm system in accordance with Clause 7.2. This system shall communicate with the CACF and provide information to identify a fire condition or trouble situation affecting a structure and shall identify the structure's location;
(e) equipped with portable fire extinguishers, in accordance with Clause 7.3.5;
(f) where located outside a building, assessed to determine whether an automatic fire suppression system is required in addition to the requirements of this Standard; and
(g) where located inside a building, protected by a fire suppression system that is installed in accordance with this Standard.

Note: *The requirements of Clause 8.2.3.6.2 except for Clause 8.2.3.6.2, Item (e), do not apply to existing relocatable structures unless moved or relocated. These structures still require assessment under the FPA.*

8.2.3.6.3
A visual inspection of the fire alarm and fire suppression systems shall be performed after each relocation of the structure.

8.2.3.6.4*
Prior to the installation of a relocatable structure, the plant FPA shall be reviewed and the impact of the structure shall be assessed. Where the structure impacts the plant, the FPA shall be updated.

8.2.9.2*
Fire incidents shall be investigated. The depth of investigation or analysis shall be determined by the severity of the fire and risk to occupants, environment, and nuclear safety. The scope of any investigation related to economic loss shall be determined by the licensee.

8.2.9.3
The AHJ shall be notified of any incident that
(a) causes personal injury or property damage;
(b) results in the mobilization of the emergency response team; or
(c) causes fires that result in, or have significant potential to result in, an operating transient.

8.2.9.4
A system shall be developed for each plant that identifies and trends fire incidents, as well as any corrective actions taken. Where deficiencies are identified, action plans shall be developed and implemented to prevent the occurrence of similar incidents.

8.2.9.5
The investigation specified in Clause 8.2.9.2 shall also determine the impact on the future performance of the SSCs exposed to fire.

8.3 Maintenance of fire equipment

8.3.1 Inspection, testing, maintenance, and operation of fire protection equipment

8.3.1.1*
The inspection, testing, maintenance, and operation of fire protection equipment shall comply with the requirements of this Standard.

8.3.1.2*
A performance-based inspection, testing, and maintenance program may be implemented with the concurrence of the AHJ. The performance-based program shall be in accordance with Clauses 4.4 and 4.5 and the NFCC requirements for equivalencies or alternatives.

8.3.2* Impairments to fire protection systems
When a fire protection system is out of service, compensatory measures shall be provided. Impairments to fire protection systems shall be managed through the development of an impairment plan. The impairment plan shall meet the following requirements:
(a) The duration of the impairment shall be the shortest period possible.
(b) The AHJ shall be notified of the impairment within 24 h, and a copy of the impairment plan shall be submitted to the AHJ where
    (i) the impairment results in a fire protection system being unavailable to meet its design intent for a period longer than 12 h; or
    (ii) the fire protection system is specified in the FPA as protecting fire safe shutdown equipment.
(c) Post-maintenance testing shall be performed as required to ensure system functionality.
(d) Impairments shall be monitored and delays in return to service shall be reported to management.
(e) The impairment plan shall ensure that adequate measures are taken during the impairment to minimize the potential for increased risks.
(f) The industrial fire brigade shall be informed of all fire protection system impairments.
(g) A written procedure shall be developed and implemented to manage the impairment. As a minimum, the procedure shall include
    (i) compensatory measures to manage and minimize the risk associated with the impairment;

(ii) identification, tagging, and locking out of all impaired fire equipment and fire systems;
(iii) notification of impairment to appropriate personnel, including plant staff, off-site monitoring companies, in-plant and off-site emergency responders, and others affected by the impairment;
(iv) required action and notification following the return of impaired equipment and systems to operational service, including post-maintenance testing requirements;
(v) additional activities to minimize risk and ensure life safety; and
(vi) inspection and oversight necessary to monitor the implementation of procedures during the impairment.

(h) Compensatory measures shall be provided for impairments to the very early warning detection system(s) located in the control equipment room(s) and control computer room(s).

8.3.3 Inspections

8.3.3.1* Inspection requirements

In addition to inspection requirements of the NFCC, the following inspections shall be conducted:

(a) Combustible-material-free fire zones, as identified in the FPA, shall be inspected once per day to ensure that no unauthorized combustible materials or fire hazards are present. Where these areas are inaccessible, alternative measures shall be taken to ensure compliance.
(b) Welding and other hot work areas (permanent or temporary) shall be inspected at the start of work activities to ensure adequate provisions are in place to prevent the start of fire and to determine that the area is free of unnecessary combustible materials.
(c) Areas with high fire hazards and fire sensitive areas, as identified in the FPA, shall be inspected once per day for unsafe conditions that include unauthorized combustible materials, fire hazards, and obstructions to emergency response (e.g., firefighting actions).
(d) Doors that are identified in the FPA as fire barriers ensuring fire safe shutdown shall be inspected once per week.
(e) Fire barriers (including performance barriers) shall be inspected for degradation or violation. A minimum of 10% of fire barriers shall be inspected each year so that all fire barriers are inspected over a ten-year period.

8.3.4 Fire protection program audit

Δ **8.3.4.1***

The fire protection program audit shall

(a) be performed in accordance with CSA N286 by a qualified third party external to the owner or operator of the plant at least once every three years. The audit may be conducted over a three-year period, provided that all aspects of plant operation are reviewed at least once every three years in accordance with this Standard;
(b) be a representative assessment of each program element to confirm compliance with the appropriate fire protection Codes, Standards, and industry best practices; and
(c) review areas of identified weakness in the fire protection program and areas containing precursors to unsafe fire conditions.

8.3.4.2

The fire protection program audit shall, as a minimum, review

(a) documentation and records to demonstrate compliance with this Standard;
Note: *Compliance can include conformance with applicable Standards, use of industry best practices, and meeting inspection, testing, and maintenance requirements.*
(b) fire incidents and follow-up actions;
(c) the role of the industrial fire brigade and their responses to incidents;
(d) procedures related to the fire protection program;
(e) fire protection procedures for inclusion of industry operating experience and evolving industry standards;

(f) representative samples of the fire protection inspection, testing, and maintenance program;
(g) a sample of plant modifications to ensure compliance with the NBCC and NFCC, as well as to ensure that the impact on the FPA has been evaluated;
Δ (h) at least one emergency response team drill, through direct observation, and assessment of performance levels against matrices developed in accordance with the requirements of this Standard and the referenced NFPA standards;
(i) identified adverse conditions and their corrective actions, in addition to actual fire incidents. This review shall include the response or corrective actions of management and of the fire protection organization, including the industrial fire brigade;
(j) compliance with fire procedures by performing a field inspection of selected areas for procedures such as housekeeping and control of hazards; and
(k) the plant's documented fire protection program for compliance and alignment with Codes, Standards, and good practice.

8.3.5* Annual plant condition inspection

8.3.5.1
A plant condition inspection shall be performed by a qualified third party at least once per year.

8.3.5.2
The plant condition inspection shall consist of a visual inspection of the plant (i.e., a walkdown) to confirm compliance with this Standard and the NFCC.

9 Fire protection requirements for decommissioning

9.1 General

9.1.1 Decommissioning stages
Clause 9 specifies requirements for the three phases of the decommissioning process, which are
(a) mothballing;
(b) encasement; and
(c) dismantling and removal.

9.1.2 Laid-up state
Clause 9 is not intended to apply to plants in a laid-up state where the intention is to restart.

9.1.3 Fire safety requirements
Site fire safety shall be provided in accordance with the NFCC. Demolition activities shall be conducted in accordance with Division B, Section 5.6 of the NFCC and with NFPA 241.

9.1.4* Fire safety plan
A fire safety plan shall be prepared and maintained for all stages of decommissioning.

9.2* Mothballing

9.2.1 General
Mothballing is the stage of the decommissioning process when the reactor containment is retained but all fuel and radioactive materials are removed.

9.2.2 Fire protection assessment
The FPA shall be maintained through the mothballing phase of the plant.

9.2.3 Removal of unnecessary combustible materials
Where practical, combustible materials shall be removed from the plant.

9.2.4 Control of ignition sources
Ignition sources shall be managed in accordance with Clause 8.

9.2.5 Fire detection and alarms
Accessible areas of the plant shall be provided with a fire alarm system using detection as required by the NBCC and the FPA. The system shall signal an alarm at a constantly staffed location on site.

9.2.6 Fire exits
Fire exits shall be maintained in accordance with the NFCC.

9.2.7 Fire protection water supply
The fire protection water supply system shall be maintained to supply hydrants, standpipes, hoses, and all other fire protection systems in service in accessible locations.

9.2.8 Fire separation
Fire separation shall be provided and maintained in accordance with the FPA.

9.2.9 Protection of operating units
In multi-unit plants, the units can be at different stages in the decommissioning process. The FPA for the operating unit(s) shall include a review of the impact of the mothballed unit on the operating unit(s). Services (e.g., electricity, air supplies) routed through mothballed areas shall be protected.

9.3 Encasement

9.3.1 General
Encasement is the stage of the decommissioning process when all easily removed parts have been dismantled and removed, and remaining radioactive materials are encased inside some form of shielding structure.

9.3.2 Fire protection assessment
The FPA shall be maintained for the plant during the encasement phase, and the consequences of fires on the encased areas shall be assessed.

9.3.3 Removal of fire hazards
All combustible materials and ignition sources shall be removed from encased areas.

9.3.4 Fire separation
The encasement shall be constructed to ensure its integrity in the event of an external fire. The fire resistance of this encasement shall be determined by the FPA in accordance with the fire loading of the remainder of the protected area or the adjacent outside grounds.

9.3.5 Fire protection water supply
The fire protection water supply system shall be maintained to supply hydrants, standpipes, hoses, and all other in-service fire protection systems in accessible locations.

9.3.6 Protection of operating plants
In multi-unit plants, the units can be at different stages in the decommissioning process. The FPA for the operating unit(s) shall include a review of the impact of the encased unit on the operating unit(s).

9.4 Dismantling and removal

9.4.1 General
Dismantling and removal is the stage of the decommissioning process when all remaining parts of the plant are dismantled and removed or buried.

9.4.2 Fire protection assessment
An FPA shall be maintained during the plant dismantling and removal phase, and the consequences of fires shall be assessed.

9.4.3 Removal of fire hazards
Where practical, combustible materials shall be removed from the demolition site.

9.4.4 Fire hydrants
The fire protection water supply and fire hydrants shall be functional until work is completed.

9.4.5 Fire watch
After the removal of the building fire alarm system, fire detection shall be provided by a fire watch that makes regular rounds of the site. The fire watch shall continue until the building is demolished or until all fire hazards are removed.

9.4.6* Fire brigade
An on-site fire brigade shall be organized in accordance with Clause 10 and NFPA 600. The fire brigade shall remain in service until all fire hazards have been removed from the site.

9.4.7 Protection of operating units
In multi-unit plants, the units can be at different stages of the decommissioning process. The FPA for the operating unit(s) shall include a review of the impact of the unit being dismantled on the other unit(s). Services (e.g., electricity, air supplies) shall be protected during the dismantling phase.

10 Fire response capability

10.1 General

10.1.1 Fire hazards
Fire response capability commensurate with fire hazards shall be provided for the protected area and the buildings external to the protected area that are under the scope of this Standard for the life cycle of the plant.

10.1.2 Scope
Fire response capability shall include
(a) an industrial fire brigade;
(b) a response organization to provide overall control of fires;
(c) trained staff who are knowledgeable in the reporting of fires; and
(d) trained staff who are knowledgeable in the response to fires (e.g., evacuation procedures).

10.1.3 Firefighting
The industrial fire brigade required by Clause 10.1.2 shall provide advanced exterior and interior firefighting for the entire life cycle of the plant, with the exception of the encasement phase.

Δ 10.1.4* Fire analysis
An analysis of postulated fires shall be conducted to determine industrial fire brigade requirements. The fire analysis shall be documented and maintained.

10.1.5 Mutual aid
After the encasement is in place, the firefighting response required by Clause 10.1.2 may be provided by an off-site municipal fire department. The firefighting response of the municipal fire department shall meet the requirements of NFPA 1710 or NFPA 1720, as applicable, or an equivalent Standard.

10.2 Industrial fire brigade

10.2.1 General
The industrial fire brigade shall meet the requirements of NFPA 600 and NFPA 1081 unless otherwise specified in this Standard.

The requirement for an industrial fire brigade may be met by having a firefighting organization under contract to the licensee and located on site. The contracted organization shall meet the requirements of NFPA 600 and NFPA 1081.

10.2.2* Duties
Industrial fire brigade members shall have no other plant duties that prevent immediate response to a fire.

10.2.3 Personnel and equipment
The industrial fire brigade shall have sufficient personnel and equipment to protect safety-related plant areas.

10.2.4 Operations controlling authority
In the event of a fire, the industrial fire brigade leader shall inform the operations controlling authority (OCA) (i.e., the shift manager or shift supervisor) of the fire situation, firefighting actions, and fire progression. All firefighting operations shall be under the authority of the OCA. Decisions affecting plant safety shall be made by the OCA in consultation with the industrial fire brigade leader.

10.3 Pre-fire planning

10.3.1 General
The plant shall develop and maintain pre-fire plans. Pre-fire plans shall be available to the industrial fire brigade and to the OCA.

Δ 10.3.2 Scope
Pre-fire plans shall capture the information documented in Clause 10.1.4 and, as a minimum, detail the following:

(a) radiological hazards;
(b) chemical hazards;
(c) fire hazards;
(d) firefighting equipment;
(e) significant SSCs of nuclear safety;
(f) firefighting guidelines;
(g) fire protection water supply information; and
(h) electrical hazards.

10.3.3* Maintenance
Pre-fire plans shall be reviewed and updated as necessary, including when changes are made to the FPA.

10.4 Industrial fire brigade member qualifications

10.4.1* Fitness requirements
All industrial fire brigade members shall meet the medical fitness requirement for using a self-contained breathing apparatus (SCBA), in accordance with CAN/CSA-Z94.4.

10.4.2 Training

Δ **10.4.2.1**
All industrial fire brigade members shall receive training in plant design, including plant layout, major systems, and nuclear safety features, at levels appropriate for their specific response roles.

Δ **10.4.2.2**
An operational air management program shall be documented to ensure the health and safety of persons using SCBA in emergency responses.

The operational air management program shall ensure that

(a) each industrial fire brigade member is aware of
  (i) the air consumption rates; and
  (ii) how to care for the SCBA to prevent unnecessary damage;
(b) industrial fire brigade members
  (i) maintain situational awareness of egress routes and the point of no return when entering hot zones; and
  (ii) are relieved from hot zone duties and exiting the hot zone upon the annunciation of a low air alarm, except for circumstances where an alternative decision is justifiable; and
(c) the incident management system is structured such that situational awareness and accountability of the fire crew's air consumption is monitored.

Δ **10.4.3* Radiation protection**
All industrial fire brigade members shall receive radiation protection training, including the escorting of off-site mutual aid, at levels appropriate for their specific response roles.

10.5 Response coordination and drills

Δ **10.5.1* Incident management**
The incident management system shall be documented and include the ability to activate the emergency response organization.

Note: *An emergency response organization is an appointed group established to activate a response to a major incident.*

Δ **10.5.2 Mutual aid**
Where mutual aid agreements are entered into with local public fire departments or other private fire brigades, the agreement shall be documented. Where the mutual aid agreement is required to meet the needs analysis in Clause 10.1.4, a drill shall be run once a year to test the mutual aid agreement.

Δ **10.5.3* Drills**
A drill program shall be established that meets the requirements of NFPA 600.

10.6 Communication

10.6.1 General
The industrial fire brigade shall be equipped with an intelligible two-way communication system. Off-site firefighters shall have access to this communication system in order to communicate with the industrial fire brigade while on site.

Δ 10.6.2* Recording of communications
All radio communications during drills and incidents shall be recorded such that audio playback is available.

Note: *It is not intended that redundant communication systems be required. If the primary system becomes unavailable, reasonable compensatory measures should be provided.*

10.6.3 Security communication
The industrial fire brigade shall be able to communicate with security personnel.

10.6.4 OCA communication
The industrial fire brigade and the OCA shall be able to communicate with each other during the response to a fire.

10.7 Equipment

10.7.1 General
Protective clothing, respiratory protective equipment, radiation monitoring equipment, personal dosimeters, and fire equipment such as hoses, nozzles, and fire extinguishers shall be provided to the industrial fire brigade. This equipment shall be in accordance with all applicable Standards.

10.7.2 Applicable Standards
Personal protective clothing and equipment shall be in accordance with the requirements of NFPA 600 and NFPA 1081, including the Standards referenced therein, shall apply.

10.7.3 Readiness
All personal protective clothing and equipment shall be checked at the beginning of each shift to ensure it is functional and in a state of readiness.

Δ 10.7.4* Maintenance
Personal protective clothing and equipment shall be maintained in accordance with the manufacturer's instructions or applicable standards.

10.7.5 Self-contained breathing apparatus (SCBA)
The number of SCBA bottles and/or SCBA refilling capability shall be sufficient to ensure that the industrial fire brigade is adequately supplied during firefighting operations.

10.7.6 Compatibility of equipment
Off-site fire equipment, where needed, shall be compatible with on-site equipment or shall be equipped with adapters to ensure compatibility.

10.8 Industrial fire brigade performance criteria

10.8.1 General

The industrial fire brigade minimum performance requirements of Clause 10.8 are in addition to the other performance requirements specified in Clauses 10.1 to 10.7.

Δ 10.8.2 Initial response

10.8.2.1

The industrial fire brigade members shall demonstrate at a frequency not exceeding one year, the following:

(a) donning turnout gear within 1 min upon tasking; and
(b) donning and activating an SCBA unit within 1 min upon tasking.

10.8.2.2

The results of the demonstration in Clause 10.8.2.1 shall be documented.

Δ 10.8.3* Set-up and intervention

During fire responses, the industrial fire brigade shall be capable of

(a) being accounted for within 2 min of an emergency response tone being sounded;
(b) establishing an incident command post within 10 min of notification of an emergency;
(c) providing size-up information to incident command within 12 min of notification of an emergency; and
(d) performing effective and sustained intervention through implementation of the fire attack plan (developed by incident command) within 15 min of being notified of a fire incident.

10.8.4 Evaluation

The capabilities required by Clauses 10.8.2 and 10.8.3 shall be evaluated by qualified persons.

(iii) Coverings, linings, and insulations are also required to meet Sentences 3.6.5.4.(3) and (4).
(iv) Plenums are required to be protected in accordance with Sentences 3.6.5.4.(5) and (6).

(c) For the insulation of pipes, Article 3.6.5.5 of the NBCC is to be referenced:
(i) If the temperature of the fluid is more than 120 °C, see Sentence 3.6.5.5.(1).
(ii) If the temperature of the fluid is less than 120 °C or if it is located in a horizontal or vertical service space, see Sentence 3.6.5.5.(2).
(iii) If the piping is in a room or space other than a service space, then Sentence 3.6.5.5.(3) is to be applied, which requires the flame-spread rating of the insulation and the flame-spread rating of the covering on the piping to have the flame-spread rating required for the interior finish of the ceiling of the room or the space. Since nuclear power plants are required to be of noncombustible construction, the provisions of Articles 3.1.5.10, 3.1.13, and in Clause 6.8.1.4 would be applied. In summary, this would require a flame-spread rating of less than or equal to 25 and a smoke developed classification of less than 100 when tested in accordance with CAN/ULC-S102 or 102.2, although some level of protection is required to achieve non-exposed foamed plastics in Clause 6.8.1.3.2.

(d) Flame spread ratings and smoke developed classifications are required to be provided for both the surface of the covering and any surface which would be exposed by cutting through the covering.

(e) A general discussion of exposed combustible insulation will be required, considering items such as
(i) exposed combustible insulation should be addressed in safe work practices such as hot work procedures;
(ii) combustible loading that should be considered in the plant's FPA; and
(iii) the limitation of combustible materials in performance barriers provided by spatial separation.

Δ **A.6.8.1.4(b)**

As commercial carpeting tested to CAN/ULC-S102 and CAN/ULC-S102.2 is not currently readily available the technical committee of CSA N293 has decided to accept test standards ASTM E648 and ASTM E662 for the determination of the flame spread rating and smoke development classification requirements. This position will be reviewed each time the standard is reviewed.

Δ **A.6.8.1.4(c)**

Where epoxy liner is applied as a coating on the containment concrete wall to reduce leakages under accident conditions, it is not considered a significant fire hazard and has been accepted within the industry.

A.6.8.2.5

The intent of Clause 6.8.2.5 is to ensure that a sufficient number of adequately designed storage rooms are incorporated into the design of the facility so that material in storage (short or long term) or staging is not located in open areas of the containment structure, reactor auxiliary building, or control room complex.

A.6.8.3.4

See DOE-STD-1066 for additional information on the design and protection of filters, including HEPA and charcoal filters, in nuclear facilities.

A.6.8.4.1

Prior to purchasing materials, designers should hold discussions with suppliers to find non-combustible materials or fire-retardant materials for components or parts. CAN/CSA-C22.2 No. 0.17 provides a test method for comparing the flammability of small samples of polymeric materials that may be used to find less combustible materials.

A.6.8.4.2

The requirements of Clause 6.8.4.2 may be met by maintaining a small air space between cabinet walls and sealing any openings across cabinets. Cable entry and exit points from cabinets may be provided with tightly fitted anchors or seals to reduce the potential for flame spread along cables. The seals on equipment cabinets are meant to prevent rapid flame spread along cables, but they do not require a fire protection rating.

Δ

A.6.8.4.4

Electric cables are the most extensive source of combustibles in the plant. As a minimum, the FT4 test rating from CSA C22.2 No. 2566 should be followed in order to comply with the NBCC requirement for the use of electrical cables in open building areas. "Length of char", as referred to in CSA C22.2 No. 2566, is the measure of flame spread.

The hazard of cable fires increases when cables are used in or near safety-related systems or control rooms. For these uses, the design should consider specifications more stringent than the FT4 minimum, including a lower flame spread limit, limited corrosive gas production, and limited smoke production. Designers should be aware that type testing of cables using a small and medium scale, such as a single cable or cable tray, does not always accurately represent the fire behaviours of cables used in real-life situations. Full-scale fire tests have indicated different and often more extensive flame spread than that shown in type testing. In addition, variations in cable manufacturing from batch to batch can result in a variance of fire test results. Designers of nuclear power plants should consider the use of non-halogenated cables.

A.6.8.5.2

Consideration should be given to toxicity and other undesirable effects of the liquids specified in Clause 6.8.5.2.

A.6.8.5.3

Reactor coolant pump motors and other oil-filled components inside containment structures are examples of locations where engineered oil collection and containment systems should be used.

A.6.8.6.1

The requirements of Clause 6.8.6.1 are aimed at reducing the exposure of fire safe shutdown systems and other safety-related systems to fire and explosion resulting from large releases of hydrogen. The remote location required for cylinders or bulk containers of hydrogen may be outdoor locations or indoor locations in large open plant areas away from safety-related SSCs. Piping or tubing that carries hydrogen and is routed through or near safety-related systems should be seismically qualified to prevent leakage of hydrogen in the event of an earthquake. The requirements of Clause 6.8.6.1 should be applied throughout the plant, but individual areas may be exempted where it is demonstrated by the FHA that there is no hazard to safety-related systems or operating personnel.

A.6.8.6.2

The production of hydrogen following severe accidents is part of the containment design and is beyond the scope of this Standard.

A.6.8.6.3

Compressed gases, including those that are flammable, toxic, or corrosive, can pose hazards to plant equipment, occupants, and firefighting personnel. The intent of Clause 6.8.6.3 is to reduce the potential for damage to safety-related SSCs and the adverse effects on control room operators. However, it is recognized that some compressed gases (e.g., P-10 gases for radiation monitors, breathing air stations, gaseous fire suppression systems, etc.) can be required inside the control room complex. When properly designed and located, these gases do not present a significant hazard to the SSCs or operators in the complex. Compressed gases can also be required for the operation of safety-related or process systems located adjacent to safety-related systems. In such cases, the FHA should identify the potential hazards of

known at the time of design, the system should be flexible so as to accommodate addition or relocation of detectors during commissioning and operation.

Where guidance on the installation of specific detection technology cannot be found in the NBCC or CAN/ULC-S524, design, installation, and testing should be in accordance with the appropriate manufacturer's requirements, NFPA 72, NFPA 76, or FM data sheets, and qualified in accordance with Clause 7.1.2. The application criteria should be documented as part of the design record.

A.7.2.2.3

"Very early warning detection technology" is a generic term referring to a type of technology and not a particular manufacturer's detectors.

The intent of Clause 7.2.2.3 is to ensure that fires are detected at their incipient stages, allowing operators to take mitigating action and allowing the industrial fire brigade to maintain main control room habitability, thus minimizing the impact on the control systems. The presence of the control room staff does not constitute an adequate compensatory measure. See Clause A.7.2.1.2 for additional information on very early warning detection.

A.7.2.2.4

Fire alarm system field components that contain electronic circuitry can be affected in their long-term performance by strong levels of ionizing radiation. Where the radiation field is strong (e.g., greater than .02 Gy/h), investigation should be undertaken to determine whether the reliability or performance of fire system devices is affected. Where necessary, detectors of the type unaffected by radiation (e.g., mechanical-type heat detectors) should be used, or the detector unit should be shielded such that the function of the detector is not compromised. Other sensitive field components should also be located in low-radiation areas or be shielded.

Heat detectors should be provided in large charcoal filter beds.

A.7.2.3.3

The possibility of visual signal devices causing strobe-induced seizures is to be addressed in the design specifications for the fire alarm system. See NFPA 72 for suggested methods of addressing this issue.

A.7.3.1.1.3(q)

Operating experience and live fire testing have demonstrated the potential severity of turbine generator (and their appurtenance) fires. FM 7-101 and related documents and bulletins contain protection criteria that should be followed for fire suppression system design prescribed by this Standard. The protection criteria for fire suppression system design criteria include

(a) elimination or mitigation of unenclosed oil fire hazards;
(b) ceiling sprinkler protection;
(c) local deluge/sprinkler protection for unenclosed oil fire hazards;
(d) spill containment and emergency drainage;
(e) structural steel protection; and
(f) emergency shutdown plan.

The following table is a summary of the major design criteria in FM 7-101 and related bulletins, coordinated with the requirements of this Standard, and is presented for convenience. Designers should refer to the source documents for complete design criteria.

Δ A.7.3.1.1.3

The following Standards should be referenced and used, where applicable, for design guidance and good engineering practice:

(a) NFPA 804;
(b) NFPA 805; and
(c) NFPA 850.

Protected area	Sprinkler system type	Density	Design area of operation, m^2 (ft^2)	Nominal K-factor, L/min/$kPa^{0.5}$ (US gpm/$psi^{0.5}$)	Sprinkler spacing, m (ft)	Criteria
Roof						Perform an FHA to prevent structural collapse and roof deck fire. The combustible construction specified in FM 7-101 and Bulletin 06-04 is not permitted.
Above operating floor, unenclosed oil spray fire source	Deluge sprinklers	345 kPa (50 psi) minimum-end head pressure	Extending at least 1.52 (5) beyond spray source	11.0 (8.0)	1.52 × 1.52 (5 × 5) horizontally; 1.83 (6) vertically above source	Install a minimum of nine deluge sprinklers over potential oil spray sources such as flange connections, bearings, and seals. Sprinklers should be installed 1.83 m (6 ft) vertically above the release source in a grid.
Below operating floor, clearance from floor to head < 4.57 m (< 15 ft)	Closed sprinklers	12.2 L/min/m^2 (0.30 US gpm/ft^2)	465 (5000)	11.0 (8.0)	3.05 × 3.05 (10 × 10)	Install 141 °C (286°F) rated sprinklers under solid ceilings and 74 °C (165°F) rated sprinklers under open grating subject to local heat sources. Water shields might be required.
Below operating floor, clearance from floor to head > 4.57 m (> 15 ft) and < 9.14 m (< 30 ft)	Closed sprinklers	16.3 L/min/m^2 (0.40 US gpm/ft2)	465 (5000)	16.0 (11.0)	3.05 × 3.05 (10 × 10)	Install 141 °C (286°F) rated sprinklers under solid ceilings and 74 °C (165°F) rated sprinklers under open grating subject to local heat sources. Water shields might be required.
Structural steel protection	Closed sprinklers	10.2 L/min/m^2 (0.25 US gpm/ft^2)	Area based on (1 linear foot section) × (1 web width + 1 flange width)	11.0 (8.0)	3.05 (10) maximum vertical spacing	3.05 m (10 ft) maximum rundown. Install sprinklers where horizontal obstructions interrupt the wetting of the surface by rundown.

Notes:
(1) *A hose stream allowance of* 2850 L/min *(750 US gpm) should be provided.*
(2) *Oil containment diking should be provided in accordance with this Standard.*

A.7.3.3.7

The minimum sprinkler density necessary to provide the level of protection expected of the water spray system is 10.19 L/min/m^2 (0.25 US gpm/ft^2) for the surface area of oil-filled transformers and 6.1 L/min/m^2 (0.15 US gpm/ft^2) for the adjacent non-absorbing ground areas. Where adjacent transformers are separated by a fire separation, a 950 L/min (250 US gpm) minimum hose stream demand should be included in the water supply. Where adjacent transformers are not separated by a fire separation, a 2850 L/min (750 US gpm) minimum hose stream allowance should be included.

A.7.3.4.1

Where special extinguishing systems are provided to replace automatic sprinkler protection, attention should be paid to system design to ensure that the level of reliability meets the fire protection objectives and that the methodology is acceptable to the AHJ.

A.7.3.5

Due to the hazards inherent to turbine generator areas (halls), wheeled units or foam carts should be provided in addition to the portable fire extinguishers required by NFPA 10.

A.7.3.6.2

The hydrant spacing requirement of 75 m (250 ft) is consistent with industry standards for nuclear power plants (i.e., NFPA 804, NFPA 805, and NIPF's *International Guidelines for the Fire Protection of Nuclear Power Plants*).

Hydrant locations should also take into consideration building entry points and fire hazards in the exterior areas.

A.7.3.6.3

NFPA 24 allows hydrants to be installed on yard main systems, provided that the demand for large hoses (88.9 mm [3.5 in] and larger) is added to the attack hose and sprinkler system demands, and these demands are in turn added to the water supply requirements.

A.7.3.7 (a)

The requirement in Clause 7.3.7, Item (a), is consistent with FM 7-101 and other loss prevention Standards and provides an adequate manual firefighting water supply for a turbine generator fire.

A.7.3.7 (b)

The need for a Class I standpipe system is based on the technical requirements of NFPA 13E and NFPA 14. Class II does not provide adequate firefighter protection, except for incipient fires.

A.7.3.8.2

Areas to which firefighting access is required include

(a) the reactor building;
(b) all areas covered by standpipe systems;
(c) cable spreading areas;
(d) confined spaces that have a combustible material load;

Note: *A confined space is a space where, because of its construction, location, or contents, or due to work activity therein, hazardous gas, dust, or fumes can accumulate or an oxygen-deficient atmosphere can be created.*

(e) areas where service or maintenance personnel might have to enter to perform their duties; and
(f) elevated platforms that house a fire load.

See NFPA 101 for guidance on access restrictions for industrial equipment.

A.7.4.1

The intent of Clause 7.4.1 is to ensure that all fire protection systems as a minimum comply with requirements stated in the NBCC for seismic design of non-structural components and equipment. The seismic evaluation would determine if the building is a post-disaster building and/or if seismic design is needed based on the site classification, seismic spectral response acceleration value and importance factor for the building. Where seismic design is required by the NBCC, NFPA 13 provides comprehensive seismic bracing guidelines for fire protection systems referenced in NFPA 13, NFPA 14, NFPA 15 and NFPA 20.

A.8.1

Clause 8 applies to the life cycle of the plant and areas under the scope of this Standard, beginning with the construction phase.

A.8.2.1.6

Fire safety training, including the use of extinguishers, can be delivered through a variety of means, including demonstrations, computer-based training, video presentations, and practical sessions. The training needs analysis might determine that hands-on training is required.

A.8.2.3.3

The intent of this Clause is to reinforce the requirement to have processes in place to minimize combustible loading in the nuclear facilities. Control of modifications, work control processes, and employee fire protection training address this requirement.

A.8.2.3.4.1

Clause 8.2.3.4.1 does not refer to combustible material that is part of a system or operating equipment, but material that is in permanent storage (i.e., stock).

The operational requirements of this Standard, including restrictions on the location of storage of material, apply to both existing and new facilities. Where a facility (new or existing) requires storage in areas, rooms, or configurations that do not comply with the requirements of this Standard, a CCR, FHA, and FPA, as specified in Clause 4.6, are required to demonstrate and document that the proposed configuration will meet the fire protection goals, objectives, and intent of this Standard. Concurrence by the AHJ is required for the equivalency or alternate solution. See Clauses 4.3 to 4.6 for further guidance.

Δ A.8.2.3.4.3

Means of controlling transient materials include a permitting system where risk is assessed, designated transient material areas, and just-in-time delivery.

During outages, fire risk should be maintained at an acceptable level, taking into account that work activities and the volume of combustible material in the plant will increase in order to support the outage. The inspection program should address the higher risk of transient combustible materials during outages (e.g., through increased inspection frequencies). It is understood that transient materials are not always combustible; however, they can result in a delayed fire response or egress.

A.8.2.3.4.4

Due to the superior durability and performance of pressure-treated wood, it should be used where available. Where pressure-treated wood is unavailable, wood treated on the surface with fire-retardant material may be used.

A.8.2.3.4.5

A monitoring and treatment program is necessary to ensure conformance with Clause 8.2.3.4.5.

A.8.2.3.5.2

Clause 8.2.3.5.2 does not refer to radioactive material that is part of a system or operating equipment, but material that is in permanent storage (i.e., stock).

A.8.3.1.1

The fire protection equipment specified in Clause 8.3.1.1 includes automatic sprinkler systems, other special extinguishing systems, portable extinguishers, water supplies for fire protection, standpipe and hose systems, fire alarm systems, and emergency power installations.

A.8.3.1.2

The performance-based approach specified in Clause 8.3.1.2 may follow the guidance provided in EPRI's *Fire Protection Equipment Surveillance Optimization and Maintenance Guide* or other recognized performance-based maintenance Standards. A performance-based approach uses measurable or calculable outcomes to ensure fire safety and can provide more flexibility as to the means of meeting the intent of this Standard. A performance-based approach establishes performance as the primary basis for decision making and incorporates

(a) measurable or calculable parameters that exist to monitor the system, including plant performance; and
(b) objective criteria to assess performance that are based on risk insights, deterministic analyses, and/or performance history.

The objective-based national Codes (i.e., the NBCC and NFCC) specify objectives and functionality of requirements that can be used to develop alternate solutions. These objectives and functionality levels can assist in establishing levels of performance specified by Code requirements.

A.8.3.2

Clause 8.3.2 is intended to reduce the notification requirements for system components or equipment impairments as required by some Codes and Standards, and to apply only to significant impairments that affect the design basis of the system. The management of the impairment and the mitigation of fire risk posed by the impairment is the responsibility of the licensee. The notification of the AHJ is intended to assist the AHJ in its regulatory oversight role.

Fire protection systems and other design features important to fire protection include the fire alarm and detection systems, automatic fire suppression systems, major manual firefighting equipment, site water supply, passive fire barriers, and smoke control systems. Any one of these might be unavailable as a result of planned testing and maintenance or random failures. A fire suppression system that is deployed during a fire also becomes unavailable until refilled or restored. Unavailable components in these systems and features can have different levels of impact on the overall fire protection of the plant. For example, a plugged sprinkler head has a lower level of impact than a sprinkler system that has been shut off, which in turn has less impact than a loss of fire protection water supply on site. Similarly, a failed fire detector has less impact than failure of the fire alarm system.

The purpose of the impairment plan is to preclude operators making arbitrary and hasty decisions after an impairment has occurred. The impairment plan should list all fire protection systems and design features, and then categorize impairment levels based on the importance of items to the function of the system and to the overall fire protection. For each category, a range of action items should be suggested, including reporting, temporary compensatory measures, and repair or recovery. In addition to considering the importance of the impaired items, the impairment plan may also consider the frequency of fires and the frequency of a fire protection system or design feature being called into duty. These considerations can help determine the necessary actions and their priorities in a more rational and practical manner. The impairment plan can also be useful in identifying any spare parts or materials that are needed.

A.8.3.2 (c)

The appropriate level of post-maintenance testing should be established by those most knowledgeable about the impaired system.

A.8.3.2 (g) (v)

Additional activities to minimize risk and ensure life safety can include the limiting of hot work, relocation of laydown areas, and provision of flashlights.

A.8.3.2 (h)

To maintain main control room habitability and to minimize impact on control systems, compensatory measures are required to ensure fires are detected at their incipient stage. The presence of main control

room panel operators and licensed staff should not be considered as providing the compensatory measures.

A.8.3.3.1 (a)

Where controlled access exists (e.g., in the moderator room or vault), the measures used to confirm or monitor access are considered adequate to meet the requirements of Clause 8.3.3.1, Item (a). Remote cameras may also be employed to check these areas.

Δ A.8.3.4.1

A qualified third-party reviewer may work under his/her CSA N286 quality assurance program or under the licensee's quality assurance program. Best practices may be satisfied by demonstration of use of operating experience.

A.8.3.4.1 (a)

For the purposes of Clause 8.3.4.1, Item (a), a qualified third party is a multi-disciplinary team of knowledgeable and experienced persons with direct experience in fire protection, fire safety audits, and nuclear power reactors. The multi-disciplinary team should be led by a senior fire protection expert.

A.8.3.5

The annual inspection specified in Clause 8.3.5 is intended to assess compliance with the operational requirements of this Standard and the NFCC. The fire protection program audit specified in Clause 8.3.4 is a detailed assessment of fire program compliance that includes procedures.

A.9.1.4

The elements of a fire safety plan are specified in the NFCC.

A.9.2

During the mothballing stage, the inventory of radioactivity remains significant, and the plant remains under surveillance. However, the fire load in the plant is reduced, as less plant activity significantly lowers the probability of fire occurrence. The consequences of fire in terms of life safety, radiological releases, and economic loss are also significantly less.

A.9.4.6

The intent of Clause 9.4.6 is not to require a dedicated fire brigade, but to ensure that some fire protection service is maintained to address current fire protection needs.

Δ A.10.1.4

The analysis of postulated fires specified in Clause 10.1.4 is intended to assess personnel and equipment needs. This analysis should consider fire growth, fire size, and any difficulties responding to or accessing a fire.

The fire analysis should be performed to

(a) define the most demanding fire hazards;
(b) determine the requirements for extinguishment;
(c) determine the required equipment to deliver the appropriate extinguishing agent;
(d) determine personal protective equipment requirements;
(e) determine training requirements; and
(f) determine the site's fire response capabilities and expectations.

A.10.2.2

The definition of "industrial fire brigade" specified in NFPA 600 applies to Clause 10.2.2.

The members of the industrial fire brigade need to be able to respond in an appropriate timeframe in accordance with their roles and responsibilities. While firefighters need to have drop-and-go work, other industrial fire brigade support members work under timeframes appropriate for their fire brigade roles, and thus may have other duties.

A.10.3.3

Pre-fire plans should be reviewed and updated at least once every three years.

A.10.4.1

NFPA 600 and 1081 physical fitness requirements apply, in addition to those requirements of CSA N293, Clause 10.4.1. Clauses 4.5.1 and 4.1.2.1 and Item (2) of NFPA 600 and 4.1 and 4.3.3 of NFPA 1081 require the documentation of training requirements, including fitness and entrance requirements via the documented program, including initial and annual fitness requirements and testing.

Δ A.10.4.2.2

Operational air management should be a fundamental component of any robust training program to ensure that skills and education are provided to maximize firefighter survivability. The operational air management program should clearly define the requirements for all industrial fire brigade members on how to safely operate in SCBA and to manage their air supply to ensure that the safe exit of hot zones is performed upon the annunciation of the low air alarm. The operational air management program should also clearly define how industrial fire brigade members should treat, manage, and protect all components of their SCBA such that foreign objects do not enter the regulator or face piece and that all components of the SCBA are protected from misuse and poor treatment.

Δ A.10.4.3

The radiation protection training that is received by the industrial fire brigade members allows the industrial fire brigade members to respond to any area in their facility without escort requirements.

The industrial fire brigade members may be supported by radiation technicians at the facility to provide appropriate decontamination or alternative provisions should be provided to allow an expedient return to service of the industrial fire brigade.

Δ A.10.5.1

The emergency response organization should be trained such that emergency response organization members in the emergency operations centre involved in the fire response can follow all radio communications and understand the terminology being used by the industrial fire brigade to be able to communicate the status of the response with the OCA.

The incident management system program should include, but is not limited to, the following:

(a) a defined effective span of control and the ability of the command structure to be flexible and adaptable to all types of incidents;
(b) the ability to implement and establish a unified command structure when off site agencies are responding;
(c) clearly defined roles and responsibilities of the incident commander and the overall command structure;
(d) the implementation of a stationary, clearly visible and identifiable command post and the location of the command post is communicated to all those involved in the response;
(e) the ability to implement an accountability system that accounts for, as a minimum, the number of persons on the fire ground, location, and tasks of persons on the fire ground, air management, and dose management; and
(f) the development on an incident action plan that is implemented at the incident and is continually updated and communicated throughout the duration of the response.

Δ A.10.5.3

The drill program should be developed to incorporate drills with different types of challenges in them to continually test the competencies of the industrial fire brigade. Scenarios that involve single or multiple casualties, firefighters down, maydays, and failure of firefighting equipment or engineered suppression systems should be incorporated into the fire drills.

A.10.6.2

Recording the communications during drills allows for post-incident review and the documentation of lessons learned. This record can be electronic or hard copy.

Δ A.10.7.4

Maintenance requirements pertain to all equipment provided to the industrial fire brigade.

During day-to-day operations, drills and incidents, personal protective clothing, and equipment should be handled in a manner that will not damage them or subject them to increased chance of failure. Industrial fire brigade members should ensure that

(a) face pieces, regulators, and air lines
    (i) are protected;
    (ii) are not exposed to foreign impediments; and
    (iii) are not left to hang freely from air lines; and
(b) firefighting equipment is protected from damage as applicable and is positioned to prevent injury to firefighters.

Δ A.10.8.2 [*Deleted*]

Δ A.10.8.3(a)

The requirement in Clause 10.8.3 Item (a), for the industrial fire brigade to account within 2 min does not necessarily require assembly at a single fixed location, and the plant may choose to use the direct response model. It should be noted that this Standard requires the implementation of an incident management system, including personnel accounting for all fire responses regardless of the model employed.

Δ A.10.8.3

Effective and sustained intervention by firefighters, which can include the industrial fire brigade and off-site responders, is required within 15 min of notification of a fire incident, in accordance with the fire attack plan developed by the incident commander. The fire attack plan should be developed based on the brigade's standard operating procedures/guidelines, pre-incident plans, and the incident size-up developed for the facility.

Effective and sustained intervention are the actions of the team as a whole. In general, Clause 10.8.3 requires that the brigade act in an offensive or defensive fire attack. Actions such as discharging a single small capacity chemical fire extinguisher or simply initiating an unmanned monitor without further actions are not considered adequate to meet the requirements of Clause 10.8.3, Item (c).

Where direct response model is used, assembly may be demonstrated through radio communications with the incident command to establish accounting and the location of the responders.

A.11.1

Systematic fire protection assessments are important in implementing and maintaining a successful fire protection program in a plant. To ensure this systematic assessment, FPA are required. The requirements of Clause 11 are based on deterministic assessment, as this reflects the current status for most operating plants and takes into account the fact that the fire protection program is linked to and based on FPA.

It is not the intent of Clause 11to disallow the use of probabilistic methods, which are currently being used in the assessment of fire in many plants. Probabilistic safety assessments (PSAs) for fire are used for CANDU and other nuclear power plants in various countries. These assessments are used in most cases to supplement a deterministic FPA and have provided valuable insights into plant design and operation, including the identification of dominant risk contributors, comparison of the options for risk reduction, and consideration of the cost versus risk and benefit analysis. However, fire PSA does not necessarily address compliance with the fire protection Codes, Standards, and Regulations that are in force at a particular plant.

Guidelines for the preparation and regulatory review of PSAs are available in documents such as NFPA 805 and IAEA Safety Report Series No. 10, *Treatment of Internal Fires in Probabilistic Safety Assessment*. Where it is desirable to use a probabilistic approach, the safety analyst and the regulator should agree to this approach, including the assessment method and criteria used, prior to starting the assessment.

A.11.2.1

While a number of minimum fire protection features are prescribed in this Standard, FPA identify additional area-specific requirements for meeting applicable fire protection goals and objectives.

Experience has shown that data and assumptions contained in FPA that are based on design documents alone can miss specific elements of complex installations. It is good practice to verify the FPA using a field inspection that is conducted when the plant installation is essentially complete.

A.11.2.2

During the life of the plant, changes can be made to plant structures and systems or to the approved operating procedures. These changes can be permanent or temporary. This Standard intends for all changes to be reviewed prior to implementation or at the earliest opportunity by a qualified person (e.g., the plant fire protection engineer) to determine whether there is any significant impact on fire protection. This should be done by reviewing the FPA for the areas affected by the changes in order to determine whether the changes increase the fire hazards or decrease the levels of protection specified by the FPA. The review should identify suitable compensatory measures, where necessary, to maintain the fire safety levels originally established for the plant.

The FPA should be revised to reflect permanent changes. A revision of the FPA is not necessary where the change is temporary and the fire protection status is expected to revert to original levels. Temporary changes, such as those needed for an outage, are addressed in Clause 8.

Operational changes should be evaluated for their impact on the FPA. These are changes to the approved operating procedures and practices.

A.11.3.1

The FPA is expected to consider all parts of the protected area and areas that are external to the protected area but under the scope of this Standard, even though some locations might not have nuclear safety-related systems or fire hazards. To complete an assessment in a cost-effective manner, analysts may use screening tools to identify those areas that have no nuclear safety concerns. The screening criteria and results should be documented. Analysts may use more complex assessment tools for areas with varying degrees of impact on nuclear safety.

A.11.3.2

Fire hazards and the systems required to ensure safe reactor shutdown can differ according to the status of the reactor. The main objective of an FPA is to demonstrate adequate fire protection for the plant when the reactor is on power. Once the reactor is shut down and cooled down, only a few systems are required to maintain sub-criticality and decay heat removal. A more qualitative assessment may be used. However, during an outage, the frequency and consequences of fire can increase in some plant areas as a result of maintenance, testing, and refurbishing activities. Such an increase should also be considered in the FPA. In general, it can be assumed that the FPA of the reactor at full power will bound the cases when the reactor is starting up or shutting down, but this should be confirmed for each plant.

A.11.4

The defence-in-depth principle requires prevention measures to reduce the likelihood of a fire, requires fire detection and suppression systems for the suppression of fire, and requires fire mitigation measures to limit fire damage. This principle requires more than one fire protection measure to achieve the safety objective, even if a single measure has been demonstrated to be adequate by the FPA. For example, where a fire separation is provided between two redundant fire safe shutdown components, the FPA might determine that the fire resistance rating is adequate to prevent fire propagation across the fire separation and therefore conclude that one of the two redundant components will remain available. The plant fire protection design should employ the defence-in-depth principle in order to determine whether additional barriers or fire suppression measures should be provided to reduce the reliance on a single fire separation.

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Preface

This is the fourth edition of CSA N293, *Fire protection for nuclear power plants*. It supersedes the previous editions published in 1987, 1995, and 2007.

This edition of CSA N293 includes changes arising from new knowledge, operating experience, and comments from users of the Standard. These changes include clarification of the Standard's scope and significant reorganization of its content. CSA N293 has also been revised to be a more objective-based Standard, to be consistent with the 2010 editions of the *National Building Code of Canada* (NBCC) and *National Fire Code of Canada* (NFCC). A CSA Group standard currently under development (CSA N393) will address situations outside the scope of this Standard.

Fire protection concepts and performance requirements are detailed in Clause 5, and more detailed requirements for achieving these concepts and performance are provided in Clauses 6 to 11. In addition, explanatory material and special formatting have been added to clarify the content: an asterisk (*) beside a clause number identifies those clauses for which further information is provided in Annex A.

Users of this Standard are reminded that the site selection, design, manufacture, construction, installation, commissioning, operation, and decommissioning of nuclear facilities in Canada are subject to the *Nuclear Safety and Control Act* and Regulations. The Canadian Nuclear Safety Commission might impose requirements additional to those specified in this Standard.

The CSA N-Series Standards provide an interlinked set of requirements for the management of nuclear facilities and activities.

The CSA N286 Standard provides overall direction to management to develop and implement sound management practices and controls, while the other CSA nuclear Standards provide specific requirement for the technical requirements that support the management system.

This standard works in harmony with CSA N286 and does not duplicate the generic requirements of CSA N286, however it may provide more specific direction for those requirements.

This Standard was prepared by the Technical Committee on Fire Protection for Nuclear Power Plants, under the jurisdiction of the Strategic Steering Committee on Nuclear Standards, and has been formally approved by the Technical Committee.

Notes:

(1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

(2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

(3) *This Standard was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this Standard.*

(4) *To submit a request for interpretation of this Standard, please send the following information to* ***inquiries@csagroup.org*** *and include "Request for interpretation" in the subject line:*
(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;
(b) provide an explanation of circumstances surrounding the actual field condition; and
(c) where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.
Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are available on the* Current Standards Activities *page at* ***standardsactivities.csa.ca****.*

(5) *This Standard is subject to periodic review, and suggestions for its improvement will be referred to the appropriate committee. To submit a proposal for change, please send the following information to* ***inquiries@csagroup.org*** *and include "Proposal for change" in the subject line:*
(a) Standard designation (number);
(b) relevant clause, table, and/or figure number;
(c) wording of the proposed change; and
(d) rationale for the change.

N293-12
Fire protection for nuclear power plants

1 Scope

1.1*
This Standard provides the minimum fire protection requirements for the design, construction, commissioning, operation, and decommissioning of nuclear power plants, including structures, systems, and components (SSCs) that directly support the plant and the protected area.

1.2*
External events such as an aircraft crash or terrorist attack are outside the scope of this Standard.

1.3
In CSA Standards, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; "may" is used to express an option or that which is permissible within the limits of the standard; and "can" is used to express possibility or capability.

Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material.

Notes to tables and figures are considered part of the table or figure and may be written as requirements.

Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.4
The values given in SI (metric) units are the standard. The values given in parentheses are for information only.

2 Reference publications
This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below.

CSA Group

CAN/CSA-B72-M87 (R2008)
Installation code for lightning protection systems

C22.1-09
Canadian Electrical Code, Part I

C22.2 No. 0.3-09
Test methods for electrical wires and cables

CAN/CSA-C22.2 No. 0.17-00 (R2009)
Evaluation of properties of polymeric materials