Fire Protection Regulatory Approach for Nuclear Power Plants in Canada

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Outline

- Regulatory Overview
- Fire Protection Program
- Fire Event
- Recent Enhancements at Canadian NPP’s
- Comments on Draft Guidelines
- Closing Remarks
Canadian Nuclear Safety Commission (CNSC)

Regulates the use of nuclear energy and materials to protect the health, safety and security of Canadians and the environment, and to implement Canada’s international commitments on the peaceful use of nuclear energy.

CNSC Regulates All Nuclear-Related Facilities and Activities

- 19 operating nuclear reactors at 4 sites
- G2 recently shutdown (GSS)
- 5 uranium mines in Saskatchewan
- 8 processing and fuel fabrication facilities
- Major research facilities (government and universities)
- Hospitals and industrial users
Fire Protection Goals

• The regulatory fire protection goals are to ensure:
  – Health and safety of persons;
  – Protection of the environment; and
  – Nuclear safety.
    • Achieving and maintaining the reactor in subcritical conditions;
    • Achieving and maintaining decay heat removal;
    • Maintaining the integrity of the fission product boundaries; and
    • Limiting the release of radioactive materials that are located outside the reactor.
Regulatory Framework - Operating Licence

• The CNSC’s regulatory model for fire protection is based upon the implementation of the defense-in-depth concept to fire protection in areas important to safety, with the following objectives:

1. Prevent fires from starting;
2. Detect rapidly, control, and extinguish promptly those fires that do occur;
3. Minimize the consequences of fires, provide protection for structures, systems, and components important to safety so that a fire that is not promptly extinguished will not prevent the safe shutdown of the plant;
4. Control severe nuclear facility conditions and mitigate the consequences of severe accidents; and
5. Mitigate radiological consequences of significant releases of radioactive substances.

• The multiple layers of fire protection provided by the defense-in-depth concept provide reasonable assurance that weaknesses or deficiencies in any echelon will not present an undue risk to fire protection goals.
General Overview continued

Regulatory Framework - Operating Licence

• To achieve the defense in depth, and to ensure an effective management of fire safety at Nuclear Power Plants.
  – Power Reactor Operating License (PROL) through Licence Conditions requires that: The licensee shall implement and maintain a Fire protection program in accordance with CSA standard N293 FIRE PROTECTION FOR NUCLEAR POWER PLANTS
Regulatory Framework - CSA Standards

- CSA N293 establishes the fire protection requirements for the design construction, commissioning, operation, and decommissioning of CANDU nuclear power plants to address the fire protection goals and objectives.

- CSA N293 requirements include:
  - Design requirements (e.g., fire detection and alarm system, fire suppression, fire resistance rating of building structures, building materials, egress);
  - Operational requirements (e.g., control of ignition sources, ITM of fire protection features, control of flammable, combustible materials);
  - Fire Protection Program requirements;
  - Fire safety assessment requirements (e.g., code compliance, fire hazard assessments, fire safe shutdown analysis);
  - Fire response; and
  - Decommissioning.
Fire Protection- Compliance Verification

• The fire safety performance of NPPs is evaluated by CNSC staff using the results of activities planned through the CNSC Compliance Verification Program:
  
  ➢ Desk-top reviews (Technical Specialists):
    – Design modification, Fire Protection Program, Audits, Alternatives and performance based approaches, inspection, testing and maintenance reports;
    – Fire Hazard analysis, Fire Safe shutdown assessment, Code compliance review, and Probabilistic Fire Analysis methodologies and results;
    – Event Reports.
  
  ➢ On-Site Inspections (Technical Specialists and full-time On-Site Inspectors)

• All compliance activities are fully documented and record the objective evidence that is the basis of the compliance results
Fire Protection Program

- The FPP ensures that the requirements of the NSCA, associated regulations and codes and standards identified in the licensing basis are implemented in a planned, coordinated and controlled manner.

- The FPP describes specific features such as administration controls and personal requirements for:
  - Identifies policies, procedures, processes, standards and support documents that are in place to ensure adequate fire protection at the licensed facility;
  - Identifies the fire protection organization and their responsibilities;
  - Preparing and maintaining documentation related to fire protection (e.g. design of the plant, Fire safe shutdown analysis, fire hazard assessment);
Fire Protection Program

- Managing changes that affect fire protection (design, analysis, and operation, including impairments and compensatory measures);
- Managing the storage and handling of flammable liquids, combustible liquids, compressed gases, and radioactive materials;
- Inspection, testing, and maintenance of fire protection design features and equipment;
- Controlling transient combustible material and non-combustible material;
- Managing fire safety during work activities;
- Fire reporting;
- Controlling sources of ignition;
Fire Protection Program

- Preparing, implementing and maintaining pre-fire plans and fire safety plan;
- Emergency Response;
- Training;
- Performance monitoring; and
- Providing quality assurance for the activities specified in the fire protection program.
Fire Event Overview

• January 1, 2013
• Multi-unit station
• Unit was in guaranteed safe shutdown and was in the process of returning to service following a scheduled maintenance outage
• Source was Lube Oil Purification unit located in an area identified as being low safety significance by the licensees’ Fire Safe Shutdown Analysis (FSSA) – i.e. “conventional side”
• Industrial Fire Brigade (IFB) response was appropriate and timely (2 mins from notification)
• Initial attack with 20lb CO2 and dry chemical extinguishers followed by wheeled 350lb ANSUL dry chemical extinguisher
Overview

• Estimated time from initial observation to suppression 8 mins
• Initial flame height extended approximately 40 feet
• The automatic sprinklers were isolated (i.e. impaired) as part of the outage
• Sprinkler heads and structural steel cooling water sprays at the elevation above did operate
• Skid heater was “turned off” but remained energized
• No injuries
• Electrical circuit interaction to safety related equipment remote from the fire occurred and was not predicted by the FSSA.
• The licensees fire investigation was appropriate
Event Conclusion

- Event was a significant fire in a conventional area of the facility – Purifier skid and approx. 104 cables (722 wires) damaged
- Did not challenge the safety of the plant
- Did result in unanticipated and not previously analyzed electrical faults on safety related equipment remote from the event area
- Issues with the implementation of the impairment program
- Damage scenario not considered “High” risk as alternate equipment was credited in the FSSA
Heat Exchanger of similar type for comparison

Damaged Unit 1 Heat Exchanger – Back Side
Damaged Unit 1 Heat Exchanger – Front Side

Damaged light fixture and cable pans above the Heat Exchanger
Fire Safety Improvements Implemented at Canadian Nuclear Power Plants

• CANDU NPPs were designed using the state-of-the-art codes & standards and best international practices existing at the time of construction

• Considerable improvements in fire protection for Canadian NPPs to meet modern codes, standards and best industry practices includes:
  – Updated fire safety assessment in accordance with CSA N293-07;
  – Enhancement to operational practices leading to measurable reductions in fire risk; and
  – Completed safety upgrades including design modifications such as diking around pumps, additional fire detection and suppression systems, fire barriers, shielding, etc.
Fire Safety Improvements Implemented at Canadian Nuclear Power Plants

• Licensees have revised their fire protection programs based on analyses that
  – Consider potential fire hazards;
  – Determined the effects of fires in the plant on the ability to safely shutdown the reactor or on the ability to minimize and control the release of radioactivity to the environment; and
  – Specified measures for fire prevention, fire confinement, fire detection, automatic and manual fire suppression, and post-fire safe-shutdown capability.

• Upgrade based on lessons learned from Fukushima accident are being implemented at all NPPs in order to address extreme events and their combinations well beyond the original design basis.
Comments on IAEA Draft Fire Protection Guidelines

• Comprehensive covering most applicable areas

• The objective, scope and how this document relates to other IAEA documents (e.g. NS-G-1.7 – Design and NS-G-2.1 – Operation) is not clear

• Fire protection goals and objectives not clearly stated

• Recommend revising structure (see following slides)

• Some additions and deletions recommended
Comments on IAEA Draft Fire Protection Guidelines

• Full editorial review required
• Recommend task force groups for specific sections
• Figures and tables should be referenced in the text
• Tables in Appendix I do not appear to be completed with a consistent understanding (the question being asked is not clear)
Recommended order of Information

1. INTRODUCTION
   1.1. BACKGROUND
   1.2. OBJECTIVES AND SCOPE
   1.3. USERS
   1.4. DOCUMENT STRUCTURE

2. FIRE PROTECTION OVERVIEW
   Include fire protection goals and objectives
   2.1. PRINCIPLE OF FIRE PROTECTION
   2.2. FIRE PROTECTION IN NPP (delete or move to Appendix)

4. FIRE PREVENTION-FIRE PROTECTION PROGRAM or FIRE SAFETY MANAGEMENT
   4.1. ORGANIZATION AND MANAGEMENT
   4.2. FIRE PREVENTION ACTIVITIES
   3.4. INSPECTION, TESTING, and MAINTENANCE (ITM)
   4.3. QUALITY ASSURANCE
Recommended order of Information

3. FIRE PROTECTION SYSTEMS DESIGN REQUIREMENTS
   3.1. GENERAL
   3.2. PASSIVE PROTECTION SYSTEM
   3.3. ACTIVE FIRE PROTECTION SYSTEMS

6. FIRE RISK SAFETY ANALYSIS
   6.1. GENERAL
   6.2. FIRE HAZARD ANALYSIS
   6.3. SPECIAL CONSIDERATIONS

5. EMERGENCY RESPONSE
   5.1. ORGANIZATION
   5.2. MANUAL FIRE-FIGHTING CAPABILITIES
   5.3. TRAINING AND DRILLS
Closing Remarks

• CNSC has a comprehensive, systematic and mature regulatory approach to manage fire protection to ensure the protection of health, safety, security and the environment while respecting Canada's international obligations.

• CNSC staff is eager to share knowledge, ideas, experiences and lessons learned in assisting with the development of the IAEA fire protection guidelines.
Questions & Answers