

FIRE HAZARDS, FIRE RISK AND FIRE SAFETY ADEQUACY

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Fire Safety & Emergency Preparedness
for Nuclear Industry



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PRESENTATION OBJECTIVES

- Share Operating Experience (OPEX)
- Encourage discussion to improve fire safety

NUCLEAR SAFETY OBJECTIVES

Nuclear Safety Analysis must demonstrate how safety requirements are met.

Power Generating Plant

- Control
- Cool
- Contain
- Limit release of radioactive material



Facility with Radioactive Substances

- Limit release of radioactive material



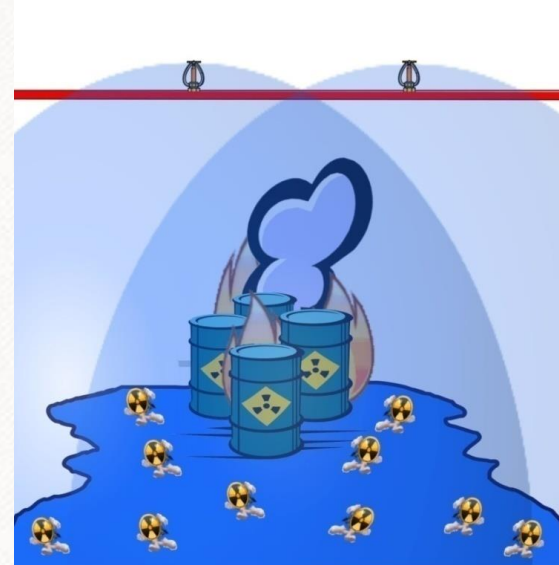
NUCLEAR REGULATION OF FIRE

Facilities that Process Handle and Store Nuclear Substances

Regulations require that a facility design minimize exposure and dose to workers, the public and the environment.

Must demonstrate that the fire protection goals and safety performance criteria are met.

Demonstration through
Fire Hazard Analysis



NUCLEAR REGULATION OF FIRE

Nuclear Power Plants

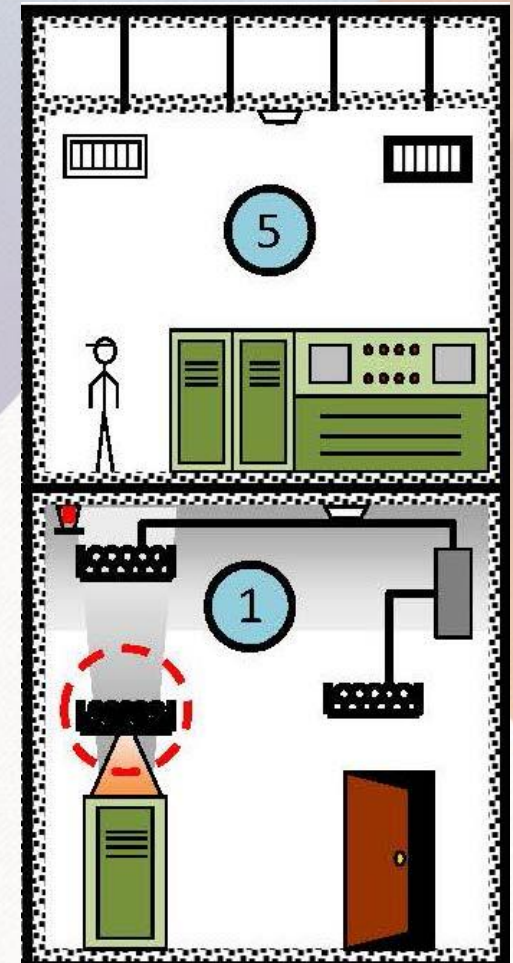
Regulations require that a facility design maintain structures, system and components required for safety in a configuration that permits the operations to meet nuclear safety objectives.

Fire is an accident event (common-cause) that must be evaluated

Demonstration through

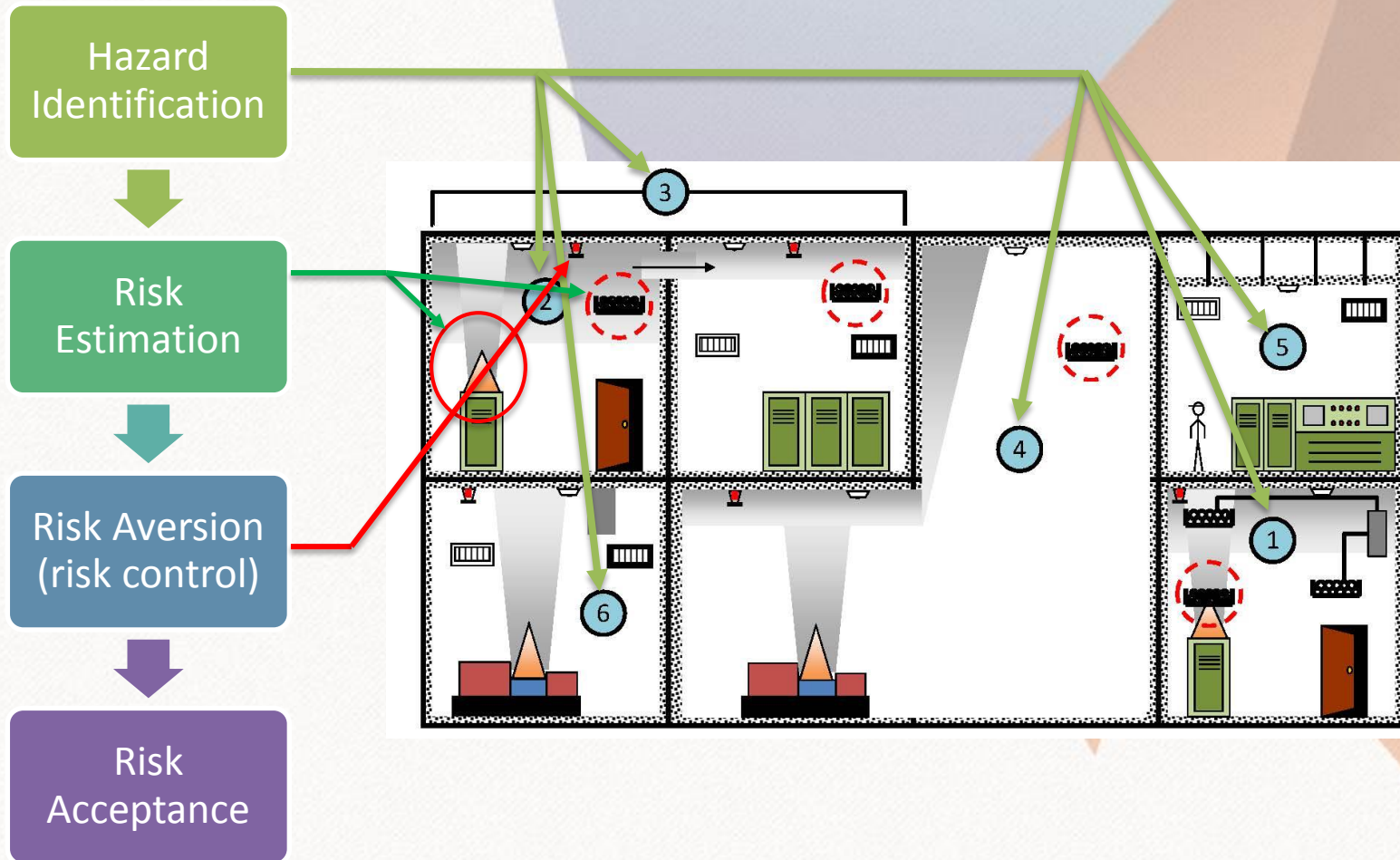
Fire Hazard Analysis

Fire Safe Shutdown Assessment



NUREG 1934 – NPP Fire Modeling
Application Guide

RISK ASSESSMENT PROCESS



ASSESSMENT METHODS

METHOD

- Deterministic (FHA/FSSA)
- Probabilistic (Fire PSA)

OBJECTIVE

- To demonstrate that fire (as a common-cause event) will not prevent achieving nuclear safety objectives.
- To demonstrate the probability of Core Damage is acceptable

OPERATING EXPERIENCE

- Share FHA and Fire PSA data

HAZARD IDENTIFICATION

METHOD

- Deterministic (FHA/FSSA)
- Probabilistic (Fire PSA)

START POINT

- Identify locations of safety systems
- Identify combustibles
- Identify ignition source probability

OPERATING EXPERIENCE

- Rooms with Safety Systems 90 (existing single unit NPP)
- Existing NPP Group 1 & 2 Systems Same Room
- Fire loss data structure should capture:
 - combustibles first ignited
 - energy of ignition
 - Equipment involved in ignition

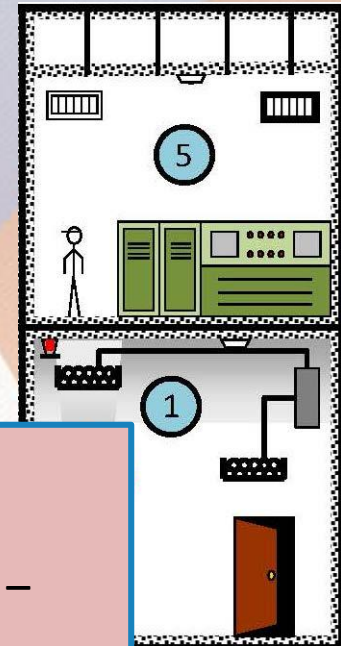
RISK ESTIMATION

Fire Scenarios

- Fire Severity Calculation
- Target Vulnerability

OPERATING EXPERIENCE

- Single Unit NPP Number of Fire Scenarios – 150
- Vulnerability Data Limited
- Scenarios can be shared:
 - Fire PSA
 - ERT Needs Analysis
 - ERT Preplanning



34 – NPP Fire Modeling Guide

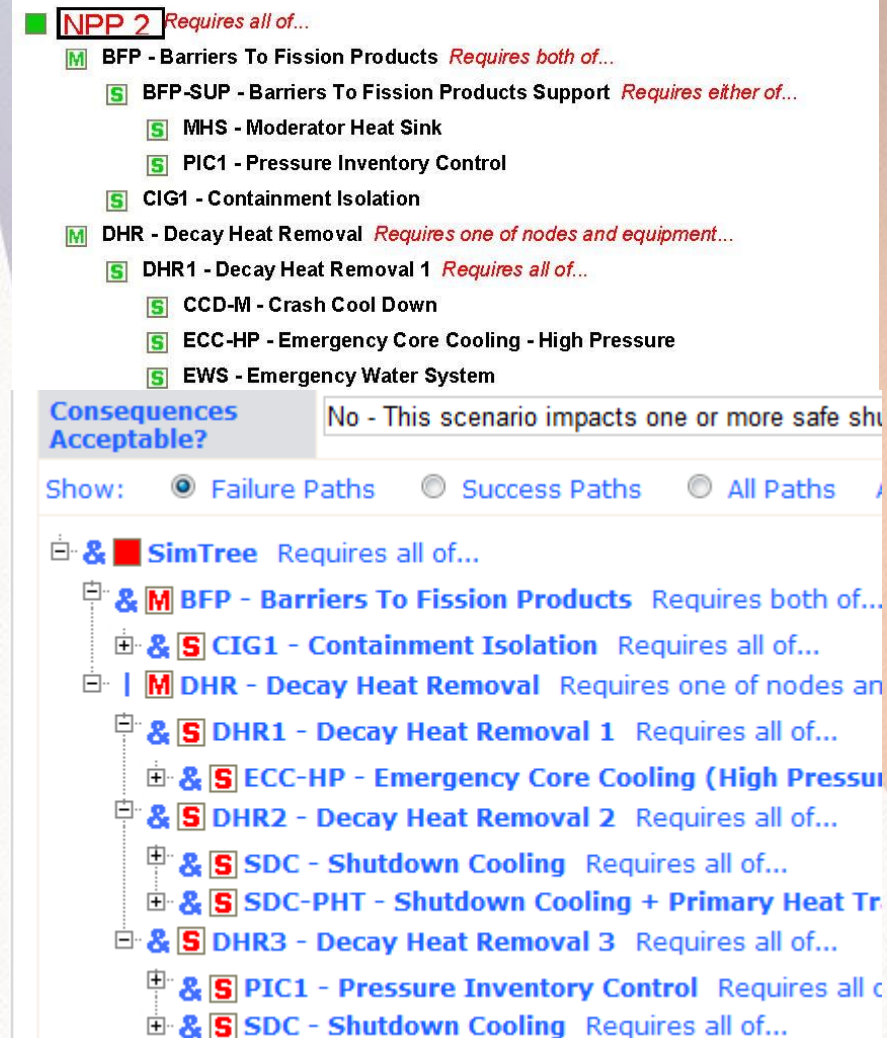
RISK ESTIMATION

IMPACT ON REACTOR SAFETY

- Demonstrate success path to achieve all safety performance criteria
 - Impact with fire protection not available
 - Consequences with fire protection available
- Demonstrate failure paths

OPERATING EXPERIENCE

- FHA/FSSA require team with operators, fire protection and nuclear safety specialists
- Operator emergency procedures for sensitive areas



FIRE SAFETY ADEQUACY

Is Protection Design Criteria adequate for Hazard Present?

Generally demonstrated by compliance with protection standards (CSA, NFPA, UL)

OPERATING EXPERIENCE

- Demonstration of compliance actually involved demonstration of four performance criteria



FIRE SAFETY ADEQUACY

Is Protection Design Criteria adequate for Hazard Present?

Performance Criteria for Protection Measures

- **Appropriate**
- Effective
- Reliable – Equipment
- Reliable - Maintenance

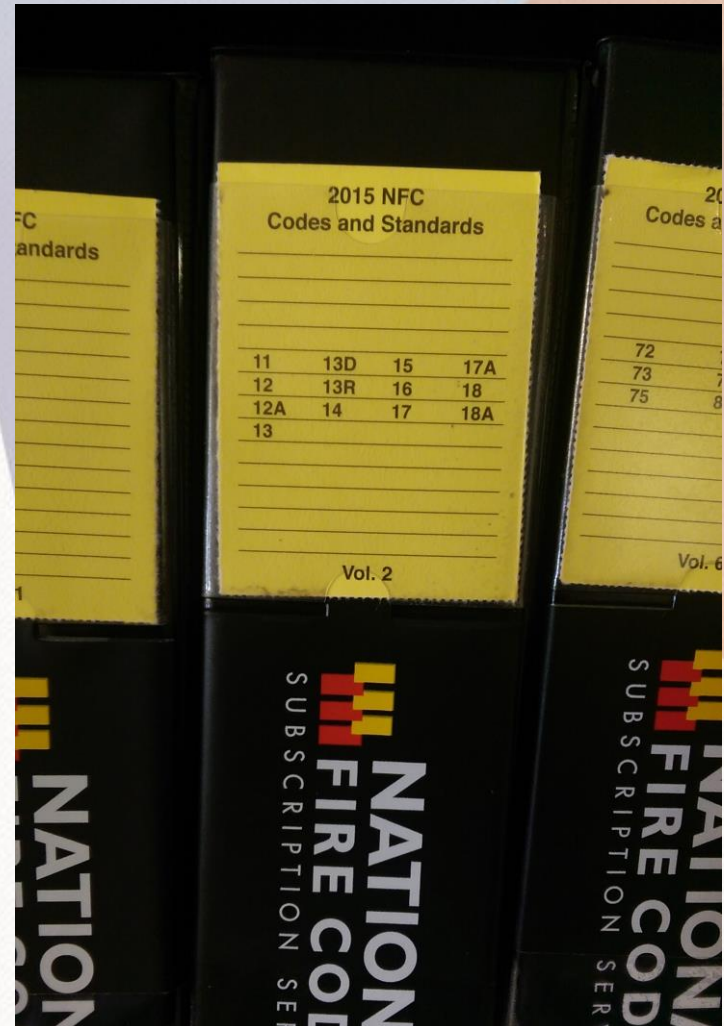
Legend		● Satisfactory		○ Limited (Depends upon Composition and Fuel)		■ Not General (Depends upon Composition and Fuel)		□ Unsatisfactory		Generalized Description of Fire Extinguishing Agent Exclusive of Additives for Specified Physical and Chemical Properties		Fire Classification		Method of Fire Extinguishment				Remarks		
												A	B	C	D	Covering of or Coating of Fuel (Fuel Shutoff)	"Cooling" (Reduction of Heat)		"Blanketing" (Reduction of Air)	Inhibition of Flame Chain Reactions
		Surface Fires Solid Mat'ls		Liquid Flammable Fuels		Elect. Hazards		Metallic Fires												
		Non-water Soluble		Water Soluble																
* 1	Gases	Nitrogen, Argon, Etc.		□	●	●	●	□				✓				Seldom used				
	Gases	Carbon Dioxide		□	●	●	●	□			✓	✓								
	Gases	Halogenated Hydrocarbon		□	●	●	●	□						✓						
* 4	Liquids	Halogenated Hydrocarbon		○	●	●	●	□						✓						
5	Aqueous Modified	Water (Solid Stream)		●	□	□	□	□			✓									
6		Water (Spray or Fog)		●	●	●	●	○			✓	✓								
7		Water + Detergent		●	■	■	□	□		✓	✓									
8		Water + Thickening Agent		●	□	□	□	□		✓	✓									
* 9		Water Slurry		●	□	□	□	□		✓	✓									
10		Water + Alkaline Salt		●	■	■	□	□		✓	✓					"Loaded Stream," Fire Retardant				
11		Foam (Protein or Deter. Base)		●	●	□	□	□		✓						Both Chemical & Air Foam				
12	Aqueous Modified	Foam (Protein & Insol. Soap Base)		●	○	●	□	□		✓										
*13		Synthetic Fluids		●	□	□	●	●		✓										
14	Solids	Sodium Bicarbonate Base Powder		□	●	●	●	□			✓		✓			Standard Dry Chemical				
15		Potassium Bicarbonate Base Powder		□	●	●	●	□			✓		✓			Extra Effective Dry Chemical				
16		Potassium Carbamate Base Powder		□	●	●	●	□			✓		✓			Double Extra Effective Dry Chemical				
17		Neutral Potassium Chloride		□	●	●	●	□			✓		✓			Equally Effective with Comparison to #15				
18		Acidic Ammonium Phosphate Base Powder		●	●	●	●	■		✓	✓		✓			ABC or Multi-purpose Dry Chemical				
19	Solids	Granular Graphite or Salt		□	□	□	□	●		✓										

FIRE SAFETY ADEQUACY

Is Protection Design Criteria
adequate for Hazard Present?

Performance Criteria for
Protection Measures

- Appropriate
- **Effective**
- Reliable – Equipment
- Reliable - Maintenance



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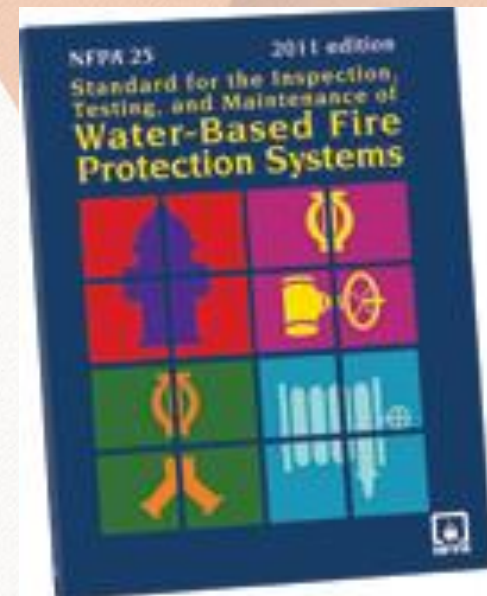
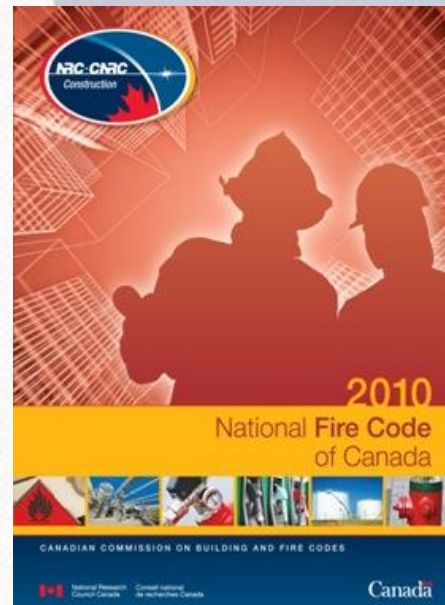


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FIRE SAFETY ADEQUACY

EMERGENCY RESPONSE

- Conduct ERT Need Analysis
- Demonstrate ERT Capability

OPERATING EXPERIENCE

- Defining the number of firefighters on ERT subjective with existing standards (CSA, NFPA)
- Defining qualifications of team members difficult



FIRE SAFETY ADEQUACY

DEFENCE-IN-DEPTH

- Preventing Fires
- Fire Detection and Suppression
- Limiting the Effects of Fire

SINGLE UNIT NPP

- Fire Protection Program
Fire Sensitive Rooms – 100
- Rooms with detection and/or automatic suppression – 85
- Required fire barrier analyzed - 850

FIRE SAFETY ADEQUACY LIFE CYCLE MANAGEMENT

PLANT LIFE CYCLE

- Design
- Commissioning
- Operations
- Management of Change
- Refurbishment
- Decommissioning

DAY-TO-DAY OPERATIONS

- Hot work permits
- Transient combustible permits
- Management of Change

OPERATING EXPERIENCE

- To control costs need a system to store required data and assessment results
- Need quality program to define and control processes

THANK YOU

Fire Hazard, Fire Risk and Fire Safety Adequacy

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