# Fire risks and nuclear safety – a nuclear insurer's perspective



ENSREG TPR-2 Workshop Luxembourg September 9<sup>th</sup>, 2024

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### Fire Risks – a nuclear insurer's perspective

- $\circ$  Introduction
- o Overview of fire risks
- NEIL Loss Prevention Program
- $_{\odot}\,\text{NEIL}$  Observations and Trends
- Closing Thoughts

### What is NEIL?

Nuclear Electric Insurance Limited

- Head Office in Wilmington, Delaware, USA
- NEIL Overseas, Dublin, Ireland
- Mutual Company
  - Members in the US, Spain and Belgium
- NEIL insures power plants and other nuclear installations for:
  - Property damage
  - Decontamination expenses
  - Loss of earnings due to an accidental outage

### **NEIL Today**

#### Today – NEIL insures

- 94 Member operating Nuclear Power Plants in the U.S.
- 7 Member operating Nuclear Power Plants in Spain
- 5 Member operating Nuclear Power Plants in Belgium
- Through reinsurance and non-Member policies insurance capacity is provided globally (UK, Sweden, France, Netherlands, Germany, Canada, United Arab Emirates) to:
  - Operating Nuclear Power Plants
  - Nuclear Installations under construction
  - Nuclear Fuel Enrichment Facilities

### Why is NEIL here today?

 We all have a common interest – safe operation of Nuclear Power Plants and Facilities

• By sharing information, NEIL hopes to help to:

- Identify risks
- Identify and implement mitigating actions
- Prevent an incident that may impact the whole industry

## **Overview of Fire Risks**



### Fire Risks at Nuclear Installations

#### **o** Fire Initiation Sources

- Equipment-Related
- Hot Work
- Heating devices
- Smoking
- External exposures

#### Institute of Nuclear Power Operations INPO Insight

July 2024

Did you know... on average, an equipment-related fire has occurred every 9.5 days at a U.S. nuclear plant since late 2021? And that fire presents the highest risk to the core at most plants?

The WANO Fire Protection Industry Working Group Equipment-Related Fire Sub-Committee has examined months of data from equipmentrelated fires for actionable insights. Among the findings:

- In the U.S., from September 2021 through September 2023, 81 equipment-related fires occurred at 35 different plants. Of those, **15** percent were consequential, with **11** percent causing a manual or automatic reactor trip. Trends in the first six months of 2024 mirror trends through September 2023.
- Data from a limited number of international stations revealed that, in the same two-year period, 48 equipment-related fires occurred, with two of those resulting in automatic or manual reactor trips. That's one fire every 15 days in those stations.
- Both data sets show that for most of the fires, damage was limited to the component of origin and did not cause external damage.
- Fires occur at nearly equal rates in run-to-maintenance components and components requiring preventive maintenance, so both types should be treated with equal care.

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### Fire Risks at Nuclear Installations

#### $_{\odot}$ Consequence of fire is impacted by:

- Building construction
- Fire barriers / separation
- Storage, separation and continuity of combustible / flammable materials
- Drainage and containment of combustible liquids
- Provision of and access to manual fire fighting equipment
- Fire water supply
- Fire detection and fire suppression systems
- Fire brigade / fire fighting response

# NEIL Loss Prevention Program



### NEIL Loss Prevention Program

• Objectives of the NEIL Loss Prevention Program:

- Minimise the risk of a fire at insured installations
- Ensure fire risk is Acceptable and Homogenous across the NEIL Membership
- ${\scriptstyle \circ}$  Objectives are achieved by:
  - Identifying and communicating fire risks
  - Recommending and implementing risk mitigation measures

### **NEIL Strategy for Fire Loss Prevention**





### NEIL Loss Prevention Program

- 1. Loss Control Standards developed and maintained by NEIL Members
  - a) Boiler and Machinery Maintenance and Operation of Equipment
  - b) Design of Buildings, Structures and Fire Protection Systems
  - c) Fire Protection Programs & Fire Brigade Programs
- 2. Review of Loss Prevention Programs at Insured Installations
  - a) Evaluations
  - b) Design reviews
  - c) Reports
  - d) Follow-up
- 3. Update Members on important industry issues and trends

## **NEIL Loss Prevention Requirements**



### NEIL Loss Control Standards – Boiler & Machinery

- Operation and Maintenance requirements to minimise risk of a Loss:
  - Reactor Vessel
  - Steam Generators
  - Turbine Generator and Auxiliaries
  - Transformers, Generator Breakers, Iso Phase Bus
  - Diesel Generators
  - Boilers
  - Moisture Separators / Reheaters

- Deaerators
- Turbo-pumps
- Electric Motors & Driven Pumps
- Switchyard Equipment
- Cranes & Lifting Equipment
- Circuit Breakers
- Batteries

### NEIL Loss Prevention – Design Requirements

#### **Fire Protection Design**

- $\circ$  Buildings
- **o** Fire Protection Water Supply
- Fire Suppression and detection systems
- Electrical Services
- HVAC Systems

- $\circ$  Transformers
- $\circ$  Cooling Towers
- Bulk flammable gas and combustible liquid storage
- Containment and drainage of combustible oil
- $\circ$  Radioactive storage
- Interior and Exterior coverings

### NEIL Loss Prevention - Design Requirements

#### $\circ$ Buildings

- Construction materials
  - Non-combustible for critical buildings
- Fire barriers / Spatial Separation
  - Specific requirements for various locations
- Interior finish



### NEIL Loss Prevention - Design Requirements

- Fire Protection Water Supply
  - Water source
    - Open source / tanks
    - Capacity 90 minutes largest auto suppression system + 1890 l/min hose allowance
    - Multiple suctions or multiple tanks for supply to critical buildings
  - Fire Pump Stations
    - Designed to NFPA 20 or other Acceptable Code
    - Pumps UL Listed / FM approved (or other Acceptable)
    - Single impairment at fire pump station will not impair fire water supply
    - Auto start of fire pumps
    - Fire pump alarms to control room or other 24-hour manned location

### NEIL Loss Prevention - Design Requirements

#### Fire Protection Water Supply

- Fire Mains, Hydrants, Standpipes
  - Designed to NFPA or other acceptable standard / code
  - Fire Mains looped around grouped Critical Buildings
  - Minimum required flow and pressure available with least demanding portion of fire mains loop out of service
  - Fire Hydrants UL Listed, FM Approved or other acceptable
  - Insured structures no more than 160 m from a hydrant



NEIL Loss Prevention - Fire Protection Program Requirements

### **NEIL Loss Prevention - Program Requirements**

#### **Fire Protection Programs**

- Fire Brigade
- Control of ignition sources
- $\circ$  Hot work
- Housekeeping
- Fire protection system
  operability

- Fire barriers
- Combustible oil containment and drainage
- Warehouse operations
- Temporary services
- New nuclear fuel storage



### NEIL Loss Prevention – Program Requirements

#### $\circ$ Hot Work

- Based on NFPA 51B
- Acceptable administrative procedures covering:
  - Permits
  - Work Area Preparation
  - Fire Watch



### NEIL Loss Prevention – Program Requirements

#### $\circ$ Housekeeping

- Control of transient combustibles
- Unobstructed access to fire protection equipment
- Combustible free zone around heat generating sources
- Fire protection analysis for combustible material staging locations
- Leak Management Program
- Turbine Building floor drains



### NEIL Loss Prevention – Program Requirements

#### Fire Protection System Operability

- Impairment Program
- Testing and Inspection Program
  - Fire Mains and Hydrants
  - Fire Water Storage Tanks
  - Fire Pumps
  - Suppression Systems
  - Standpipe and Hose
  - Alarm and Detection Systems
  - Valves
  - Portable Extinguishers





 The following observations and trends are from evaluations of Loss Prevention Programs at:

- NEIL Member Nuclear Power Plants in Europe and the USA
- NEIL Non-Member Nuclear Power Plants in Europe, Canada and UAE
- NEIL Non-Member Uranium Enrichment Facilities in Europe

 $_{\odot}$  Measures are implemented to resolve issues at NEIL Member NPPs

Mitigating measures communicated to non-Members

#### ${\scriptstyle \circ}$ Buildings and structures

- Power Block buildings generally constructed from Acceptable non-combustible materials
- Separation and fire barriers generally meet the NEIL requirements
  - Some exceptions in Turbine Buildings
  - Some other barriers accepted on basis of Fire Safety Analysis
- Combustible or limited combustible internal structures
- Fire barriers at transformers do not always fully protect the exposure
- Some ancillary buildings (e.g. warehouses, offices, workshops) constructed from combustible or limited combustible materials without fire suppression systems



 $\circ$  Fire Protection Water Supply

- Acceptable fire water supply at NEIL Member sites
- Fire pumps and valves not UL Listed, FM approved or otherwise certified for fire protection service Members and non-Members outside USA
  - Additional analysis required to determine if equipment suitable
- Fire pumps not provided with auto-start non-Member
- Fire pump testing
  - Auto start not being verified during run tests Member and non-Member
  - Performance test not being run at all flow points (0%, 100%, 150%) non-Member
  - Pumps not being run for required duration during tests Non-Member

Fire Protection System Impairments

- NEIL notified of Fire Suppression System Impairments > 90 days
  - Increased impairments due to aging systems / obsolescence
  - Increased impairments on fire water supply tanks, mains
  - Problems isolating sections of fire mains non-functioning valves
- Fire water supply impairment may impair multiple suppression systems
- Acceptable Impairment programs not being implemented at some sites
  - Impairments without Acceptable restoration plans
  - > 3 long term (> 180 days) impairments at the site
  - Impairments not repaired as scheduled or frequently re-scheduled

### **NEIL Fire Risk Observations**

- Turbine Building Fire Protection
  - Spray fire in the turbine building
    - Flange guards on oil lines
  - Procedures to isolate oil sources and purge hydrogen in the event of a turbine building fire
    - Procedures not in place at non-Member sites
  - Turbine building drains and containment
    - Drains obstructed Member & non-Member
    - Maintenance programs not in place at some sites
      - Member & non-Member





### **NEIL Fire Risk Observations**

#### Transformer failure

- Transformer failure and fire is the most common claim at NEIL
- What we have seen in a recent incident
  - Separation did not fully protect the exposure damage was caused to adjacent transformer
  - Deluge system impairment had not been reported

Temporary Electrical Services and Equipment

- Temporary equipment in place permanently
- Extension cables / Temporary electrical supplies
  - Used for permanent applications
  - Acceptable maintenance not being performed
  - Interconnected multi-plug extension leads
  - Exposed to damage due to configuration
- Non-approved electrical equipment (e.g. heaters)
  - No maintenance program
  - Inadequate separation from combustible material





#### $\circ$ Housekeeping

- Acceptable procedures in place at all Member sites
- Negative trend with housekeeping at some sites:
  - Procedures not being consistently applied
  - Accumulation of combustible material in Radiologically
    Controlled Area
  - Storage of combustibles without permit or analysis especially in RCA
  - Combustible fluid leak management program
    - Not being applied correctly at some Member sites
    - No program in place at some non-Member sites



Housekeeping:

- Obstruction of fire-fighting equipment
- Obstruction of access to storage areas
- Non-approved storage of materials
- Combustible free zone (1m) not maintained around heat sources



 $\circ$  Hot Work

- Acceptable procedures in place at all Member sites
  - Some deviations in application of procedures have been observed
- Procedures at non-Member sites do not always comply with NEIL requirements, e.g.
  - Duration of Hot Work permits permit duration > 24 hours
  - Preparation / inspection of work area
  - Fire watch not maintained after hot work completed

#### Lithium-ion batteries

- Lithium-ion batteries may pose an additional fire risk
- NEIL developing standards for Lithium-ion batteries
- o "Behind the Meter" equipment increased risk of fire?
  - Battery Energy Storage Systems
  - Hydrogen production
  - Solar panels
- Staff turn-over at Member sites
  - Site leadership turnover impacting oversight
  - Fire protection engineer turnover impacting expertise

Decommissioned Nuclear Power Plants

- Fire risk is generally reduced
- Fire protection systems can be decommissioned reviewed on-a-case by case basis
- Change of occupancy of buildings fire risk needs to be assessed
- New structures and equipment introduced for decommissioning fire risk needs to be assessed
- Hot Work associated with dismantling equipment may increase fire risk Acceptable hot work procedures need to be applied

## **Closing thoughts ....**



### Closing thoughts .....

• Nuclear Safety Culture is important to minimise fire risk:

- **<u>Plant Leadership</u>** buy-in, direction and monitoring the fire protection programs
- Guidance and reinforcement of the programs by the plant <u>Fire Protection</u> <u>department</u>
- **Everyone** at the plant aware of fire risks and responsible for minimising that risk
- External Stakeholders (Regulators, Insurers, WANO, OSART, Local Fire Departments, etc.) also have a part to play in minimising Fire Risk
  - Help identify fire risks
  - Communicate and help implementation of mitigating measures



Thank you