Recent events, operating experience related to fire protection

2nd Topical Peer Review – 1st Stakeholder Engagement event

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Introduction

Purpose

Focus on actual issues from the field

Avoid programmatic reviews

- Brief review of operating experience related to fire risk
- Sources available to JRC
- Limited to last 10 years

Sources reviewed

IRS database (IAEA/NEA)

- International relevance
- 70-100 reports per year
- Worldwide coverage
- Voluntary reporting, based on mutual interest
- Design & Operational safety

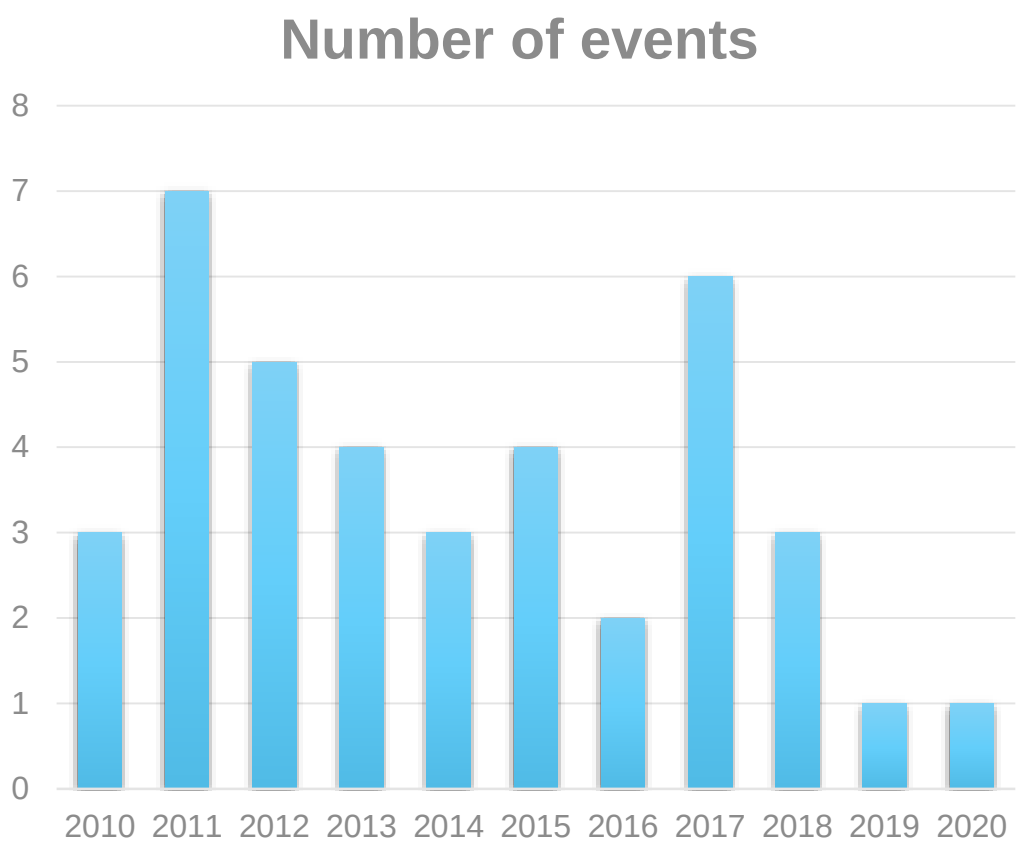
OSART missions (IAEA)

- Peer reviews conducted in 2004-2018
- Worldwide coverage
- Focused on Operational Safety

Literature review

- Topical studies
- Synthesis reports
- Peer-reviewed papers

Summary of fire opex in IRS



39 events related to fire reported in the last years, (~ 5% from total)

Most of them are rated INES 0 or 1

A few additional events linked to flooding caused by fire protection systems

Summary of fire opex in IRS (1/6)

2010 – Arc flash in breaker cubicle (INES 2)

- Initial fire at a breaker cubicle
- Arc flash fire within the cubicle during restoration attempts, hours later
- The arc flash breached the rear of the cubicle and caused damage to other equipment

- Inadequate crew response led to loss of RCP seals cooling for more than 10 min

- High energy arc flash potential to propagate across safety divisions, or from non-safety to safety divisions

Summary of fire opex in IRS (2/6)

2012 – Fire on Reactor Coolant Pump (INES 1)

- Oil leak due to mechanical damage caused a fire on a Reactor Coolant Pump during operation, followed by a reactor trip
- Fire alarms triggered, but TV cameras did not show any fire -> sprinklers not initiated
- Internal fire-fighting team entered Containment and extinguished the fire manually

- Reactor Coolant Pump damaged (one seal destroyed, but RCS integrity maintained)
- Fire remained limited, but the presence of oil in RCS insulation materials could have potentially led to a more serious situation

- A “confirmed fire” criterion should be established in advance

Summary of fire opex in IRS (3/6)

2015 – Installation of cables without proper separation (not INES-rated)

- Safety-related cables from different divisions found intermingled
- Control cables were laid on by removing the separation plates intended to prevent propagation

- No damage, as there was no actual fire, but serious potential consequences
- Different areas affected, including cable room below the Main Control Room
- Operation of multiple reactors for extended periods of time without proper division separation

- Respect of basic fire safety principles cannot be taken for granted
- Procurement technical review and contractor oversight for cabling installation are critical

Summary of fire opex in IRS (4/6)

2015 – Inadequate fire management (INES 0)

- Fire on a 115 VDC cabinet, causing a loss of feedwater and some control room indicators
- Extinction efforts hindered by intervention team unfamiliar with equipment (smoke extraction dampers). Shift supervisor left the control room to support firefighting in the El. Building
- Inadequate crew response led to reactor trip and safety injection

- Fire damage limited to the non-safety related cabinet originating the fire
- During the complex reactor transient, pressurizer became “solid”, with repeated opening of safety valves

- The simultaneous management of a fire and a complex reactor transient can be overwhelming for the crew
- Presence of sufficient senior operators at MCR at all times is essential

Summary of fire opex in IRS (5/6)

2017 – Arc flash in breaker cubicle due to foreign material (INES 1)

- Works involving cutting of carbon fiber materials were in progress in an electrical room
- Conductive fibers entered a 4 kV cabinet and created an electrical bridge from the bus bars to the wall of the cubicle.
- The high-energy arcing fault caused the 4 kV bus fault and a strong blast

- One worker present in the room was injured
- The blast blew open and destroyed the fire door to an adjacent switchgear room, resulting in smoke propagation (although the door was compliant with the licensing basis and design requirements

- Design requirements and standards ensuring the isolation of damage caused by fire and blasts within electrical cabinets might need to be reviewed

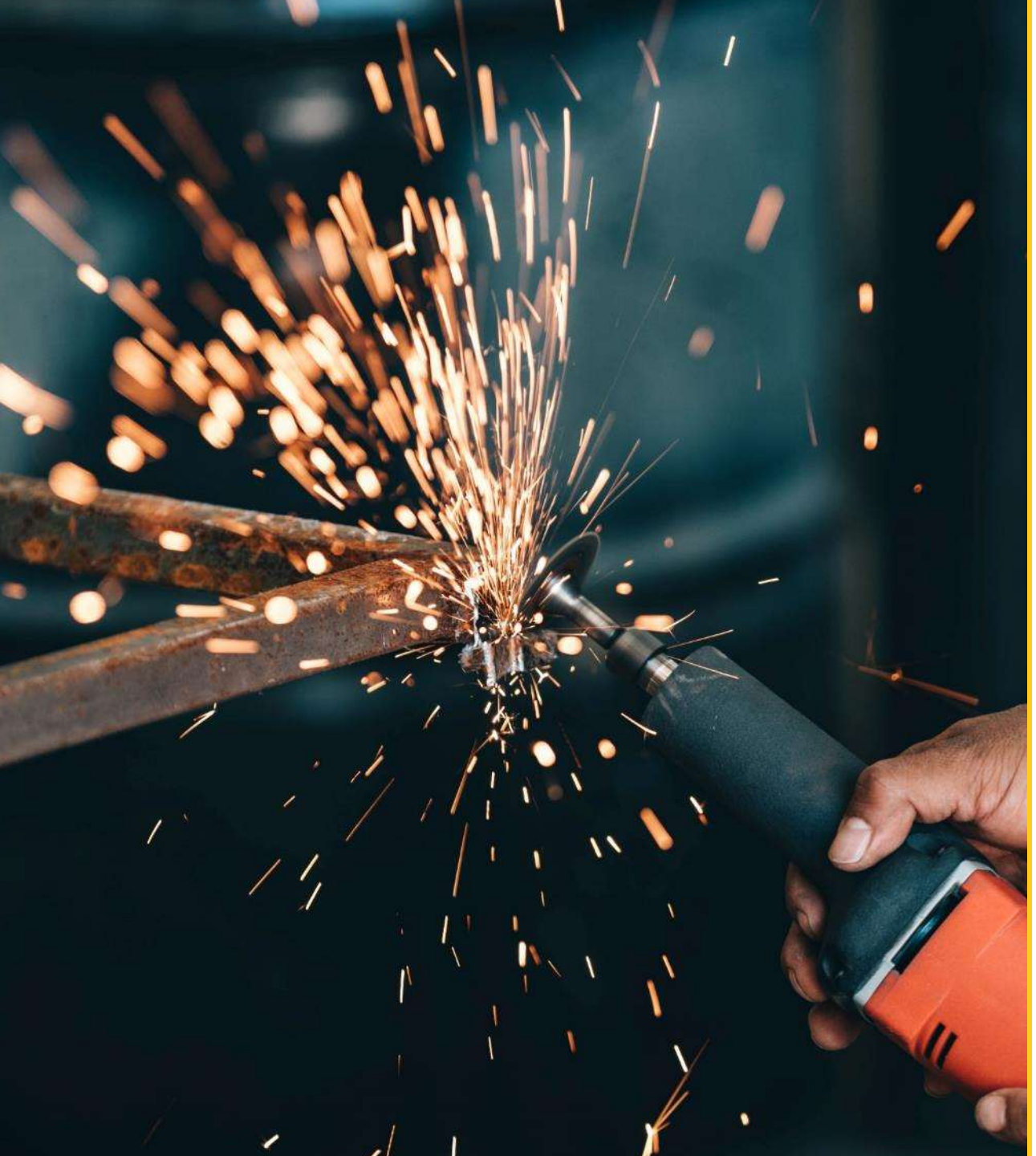
Summary of fire opex in IRS (6/6)

2020 – Not compliant fire barriers (INES 1)

- Fire resistance of penetration seals found to be not compliant

- No actual fire occurred, only potential consequences
- The failure of the seals affected would not have compromised the safe shutdown
- But there was a common cause potential – other, more safety relevant seals could have been affected

- Technical review of procurement processes and oversight of contractors is essential
- Use of operating experience can prevent many events



Fire opex from OSART missions (1/5)

Ignition sources

Issues related to welding, flame cutting, soldering, brazing, grinding etc. without proper control or smoking in inappropriate areas

- Hot works performed without permit, risk analysis, and/or compensatory measures.
- Workers cutting a pipe with a disk, with sparks spreading over areas with flammable materials.
- Hot works performed by a worker alone, with fire detection disabled, without supervision or fire watch, and without nearby fire extinguishing means.
- Personnel observed smoking in prohibited areas, or butts found close to flammable materials

Fire opex from OSART missions (2/5)

Combustible materials

Administrative controls not always ensure that fire loads are within the design basis and that fire risk is minimized

- Excessive, uncontrolled amount of oil or flammable solvents stored without appropriate control or in inappropriate areas.
- Unnecessary use of wood when non-combustible alternatives are available (as pipe support or scaffolding, plywood used as temporary floor protection, stored wooden pallets, …)
- Unnecessary use of combustible materials in interior decoration and furniture, such as panelling, coverings, fabrics, plastic floor coverings, suspended ceiling, raised floors, building insulation, partitions, wooden or plastic furniture, …

Fire opex from OSART missions (3/5)

Fire barriers

Issues related to the inadequate design, installation, maintenance or surveillance of fire barriers

- Numerous fire barriers absent, such as unsealed cable and pipe penetrations going through two different fire cells, sometimes since the startup of the plant.
- Insufficient separation between redundant trains of the same system that could lead to fire-induced common cause failure.
- Inadequate surveillance program for fire barriers.
- Multiple visible deficiencies in fire door barriers, such as fire doors poorly manufactured and installed, or with broken locks, without reliable automatic closing system, with doors left open without reason, sometimes blocked with wooden wedges, or with excessive gaps between the door and the door frame or the floor.
- Ventilation ducts with missing or deficient fire dampers.
- Absence of fire-resistant covers in cable trays.

Fire opex from OSART missions (4/5)

Drills

Drills are not always sufficiently frequent, realistic or comprehensive, compromising the effectiveness of the fire response

- Some members of the on-site fire brigades not trained to extinguish real fire, or not familiar with all plant areas
- On site fire brigade personnel not trained under actual large fire conditions (with extensive smoke, heat conditions)
- Insufficient frequency of the refresher training (for instance: only once per year or even less).
- Fire drills and exercises conducted only with the plant fire brigade, without involving the external fire brigade.

Fire opex from OSART missions (5/5)

Response time

Organizational issues lead to excessive delay in responding to fire

- Fire brigade waiting for an escort to enter building
- Responsibilities spread over several departments, slow decision-making
- No central information on location, size of fire
- Slower response in weekends, night shifts
- No direct communication between off-site brigade and main control room

Conclusions

Thank you

European Commission