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FIRE PROTECTION AT NPP

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NUCLEAR DAYS

INTRODUCTION TO FIRE PROTECTION

FIRE PROTECTION IS VERY IMPORTANT - Fire is considered a dominant contributor to the total risk of core damage for most facilities. The relative contribution of events to **core damage frequency in one nuclear power plant is 45% due to internal fire** (The second most common with a 44% contribution is seismic).

THE BROWNS FERRY FIRE (MARCH 22, 1975)

This fire plays a significant role in the fire safety of nuclear facilities, until then fundamental rules for fire protection had not been introduced. Cause of the fire was ignition of polyurethane foam used in cable penetrations. Fire propagated through the penetration in the cable spreading room wall, causing major damage in the reactor building. **All of the emergency core cooling systems for the Unit 1 reactor were rendered inoperable and portions of Unit 2. The fire and its aftermath revealed some significant inadequacies in design and procedures related to fires. The fire protection programs we know today are a direct result of this fire and its lessons learned.**

METHODS OF FIRE PROTECTION

historically, two methods have been used for the design of fire protecion systems in NPP

DETERMINISTIC METHOD

One of the prescriptive requirements related to the fire protection requirements for safe shutdown capability. The regulation prescribes that the trains will:

- Have a 3-hour barrier between them
- Have 6.1 m of separation, automatic fire suppression, and fire detection, or
- Have a 1-hour barrier between them, automatic fire suppression, and fire detection

Need to comply with all 3 conditions - sometimes impossible.

PERFORMANCE-BASED METHOD

The risk-informed performance-based approach considers risk insights as well as other factors to better focus attention and resources on design and operational issues according to their importance to safety. **This approach relies on a required outcome rather than requiring a specific process or technique to achieve that outcome. It allows licensees to focus their fire protection activities on the areas of greatest risk.**

The deterministic method required a large amount of money to accomplish 20 feet of separation. Hundreds of exceptions were granted, so a second method was developed that is based mainly on risk probabilities (The vast majority of facilities today use the probabilistic method). (1)

IMPORTANT FUTURE TECHNOLOGIES:

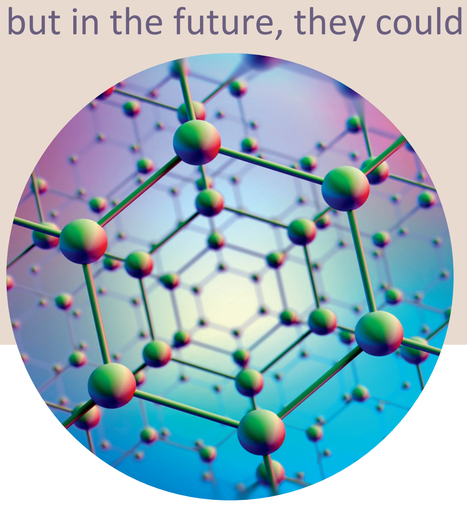
This poster is devoted to **future technologies** (I will introduce you to four technologies) that could be part of fire safety in nuclear facilities. At the moment, we use these systems minimally, but in the future, they could play a significant role in increasing the safety of nuclear power plants.

AI – Machine learning

AI can help **improve fire detection algorithms and reduce false alarms.** By analysing data from different sensors, AI can detect unusual patterns and warn staff of potential problems that could lead to a fire. **They can also assist with strategy during a fire**, significantly increasing the overall efficiency and speed of fire suppression.

Integrating predictive maintenance techniques can help identify potential fire hazards by monitoring the critical condition of equipment. Predictive maintenance can greatly enhance early failure detection and streamline the maintenance process.

01



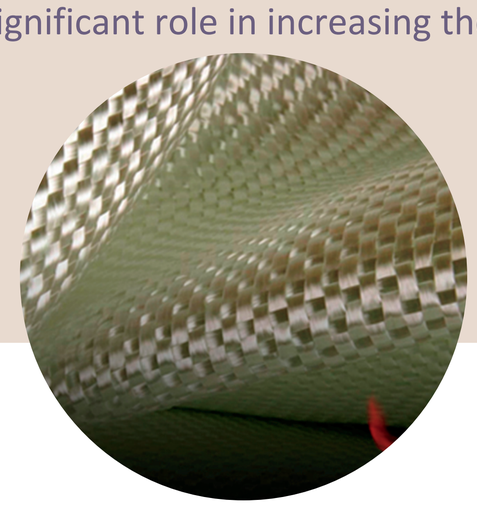
NANOTECHNOLOGY

Nanomaterials can increase **the thermal and mechanical properties of building materials or cables**, making them **more resistant to fire and other extreme conditions.**

However, it should be noted that the development of new materials may also affect the conditions for the emergence and spread of threats, as well as the type of compounds emitted in the environment.

The development of nanotechnology will also influence the development of **flame-retardant electrical cables.**

02



COATING-ISULATION

Insulation and special flame-retardant coatings can greatly advance critical infrastructure in nuclear power plants. **These coatings can delay the spread of fire, which in turn allows personnel to respond more effectively.** When a fire occurs, the temperature of the structures affected by the fire increases and the coating begins to perform its function. The substances involved in eliminating the effects of the fire are activated.

New methods of designing electrical systems can also greatly help with the potential risk of fire due to faults in cable chambers.

03

ROBOTIC SYSTEMS

A robotic firefighting system specifically developed for nuclear facilities **can minimize the potential impact on human lives,** where a robot could replace a human on the front lines fighting a fire. They can be used especially in challenging areas of a nuclear power plant. (2) These systems are **expanding rapidly thanks to the development of leading robotic manufacturing companies,** i.e. Boston Dynamics. The installation of radiation detectors on robots is being developed at UMASS Lowell. **The development of artificial intelligence and machine learning can greatly help robotic systems in industry**

04

TRAINING IMPACT

The important factor of increasing the level of fire safety is undoubtedly in the technological part, but it is necessary to move in **personnel training and drill.** Coordination of human resources greatly enhances the effectiveness of fire safety. **At the same time, it is very important to focus on following rules and learned procedures, otherwise they will be meaningless.**

CONCLUSION

The most important thing for the implementation of these technologies will be **overcoming the legislative processes** (also the development of these technologies in other fields and ensuring high reliability). Thanks to the development of artificial intelligence, another method for fire protection may be developed. It will be interesting to observe this trend already in the development of small modular reactors.

Historically, **new technologies have always had to prove their safety and profitability in the financial market.** In turn, technology development can **reduce operating and acquisition costs in the future**, making **nuclear power more competitive.**

References

[1] Fire Protection for Operating Reactors. Nuclear Regulatory Commission [online]. March 20, 2020 [cit. 2023-07-26].Available from: https://www.nrc.gov/about-nrc/fire-protection/op-reactors.html

[2] Steven James Hill. The Future is Now: Emerging Technologies in Fire Protection. Total Fire Protection Asia Co.

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