Topical Peer Review II Country Review Workshop
‘Fire Protection’
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National Presentation of the Czech Republic

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State Office for Nuclear Safety

List of candidate installations and their regulation

CANDIDATE OF THE CZECH REPUBLIC FOR TPR II – under the Article 8e (2) of NSD 2014/87/EURATOM

1. NPP
2. RR
3. Spent fuel storage
4. Waste Repositories

Candidate installations/regulation

TS 01.1 & 01.2

- **NPP**
  - Dukovany – 4 VVER 440/213 reactor units in the form of two double units
  - Temelín- 2 VVER 1000 pressurized water power reactors of serial design type V 320
- **RR**
  - LVR-15 - tank-type light water research reactor (thermal power of up to 10 MW)
- **SFS**
  - Temelín Spent Fuel Storage - dry storage represents both SFS Dukovany

REGULATION

Act No. 263/2016 Coll., the Atomic Act, as amended

implementing legislation - Decrees

Act No. 133/1985 Coll., on Fire Protection, as amended

implementing legislation – Decrees & technical standards

REGULATORS

THE CZECH REPUBLIC STATE OFFICE FOR NUCLEAR SAFETY - SÚJB

MINISTRY FOR INTERIOR - FIRE RESCUE SERVICE OF THE CZECH REPUBLIC - FRS

Candidate installations/regulation

TS 01.1 & 01.2

- The fire protection legislations is further extended by binding technical standards of the series „Fire safety of buildings“ and related.
- The content of the standards are requirements for ensuring a minimum level of fire safety, which shall be evaluated for a intended building within the design documentation, specifically in the fire safety design of the building.
- The Czech legal framework includes all areas of fire safety requirements in detail. In addition, both the Fire Rescue Service of the Czech Republic and the SÚJB have (within the scope of their competences and for a specific case) the possibility to determine certain technical standards as binding.
- Within the scope of its competence and authority, in accordance with the principles of the administrative bodies and international practice, the SÚJB issues nuclear safety guides (NSG).
  - NSG BN-JB-3.5 "Protection against Internal Fires
  - NSG No. BN-JB-3.3 "Categorization of safety functions and classification of systems, structures and components into safety classes" (selected FP systems assigned in class 3)
  - NSG No. BN-JB-3.1 “Nuclear Facility Design Requirements”
  - Other NSG that include fire safety assessment are NSG No. BN-JB-4.1 "Siting of Nuclear Installation - Assessment of Natural Phenomena" and No. BN-JB-4.2 "Siting of Nuclear Installation - Assessment of Man-Made Phenomena".
- The safety guides work up the requirements defined by WENRA in “WENRA Reactor Safety Reference Levels”.

Candidate installations/regulation

TS 01.1 & 01.2

STATE SUPERVISION

- The State Office for Nuclear Safety (SÚJB) is the independent central administrative body for the use of nuclear energy and ionizing radiation utilization
- The Fire Rescue Service of the Czech Republic (FRS) provide the organization and management of the state administration in the field of fire protection (organized within the Ministry of the Interior of the Czech Republic).
- The competence of the FRS is in the field of fire protection, crisis management, civil emergency planning, population protection and the integrated rescue system.
- Regional Fire Rescue Services ensure the performance in the field of fire prevention mainly the state fire supervision - in particular during fire inspections, building prevention, approval of fire risk assessments and identification of the fire causes.

ON SITE SUPERVISION

- Units of the company's fire rescue service (FRSU) established by legal entities that operate activities with increased or high fire risk, and the activities in these units are carried out by employees of legal entities as their profession.
- The territorial scope of the FRSU is the optimal distance to reach the point of intervention, the so-called „fire zone“; defined departure 2 minutes.
- FRSU responsibility is in the field of fire prevention, fire fighting and rescue. Involved in Regional Alarm Plans to cooperate with national FRS.
- Fire protection inspections by FRSU are carried out at regular intervals according to the requirements of the legislation, depending on the building degree of the fire risk. Inspection intervals are once, twice or four times a year, depending on building importance. Fire load checks are part of the FRSU preventive inspections of the building
- In addition to regular annual inspections of the operability of fire safety equipment, the following are carried out on the equipment during operation: 1x per month - activity tests for switchboards and related equipment, 1x every 6 months - tests of the operation of automatic fire detectors and equipment controlled by EFD.
- Hot works are managed by an internal methodology and are subject to approval by the FP department, which checks compliance with measures prior, during and after the work. Roles and responsibilities are regulated in the permit. Fire watch is present if necessary. Subsequently, checks are carried out to ensure compliance with the conditions, and after the work is finished, there is a site security check and checks aimed at preventing the reoccurrence of fire.
- **FRSU of NPP is required by Atomic Act**

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

DETERMINISTIC

The Fire Safety Solution Of The Building

- the building is divided into fire sections
- the fire risk is calculated for every individual fire section
- fire separation structures are designed and their fire resistance (in minutes)
- fire safety means and their quantity are designed (fire water, EFD, stable extinguishing systems , fire dampers, fire partitions ..).

The Fire Risk Assessment (FHA)

- the risks are defined according to the activities performed
- measures are proposed for risk elimination
- determination of the size of the FRS Unit and its equipment

The fire fighting documentation

- for individual buildings
- a list of risks that the FRSU may encounter
- recommends for a fire intervention and what adverse phenomena may be encountered here

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

DETERMINISTIC

Special "Fire Protection Assessment regarding Nuclear Safety" evaluates the links between fire protection and nuclear safety as well as radiation protection in reactor buildings.

In accordance with Decree No. 329/2017 Coll., fire risk assessments are prepared for buildings important from the point of view of nuclear safety and to the extent provided for by the Fire Protection Act.

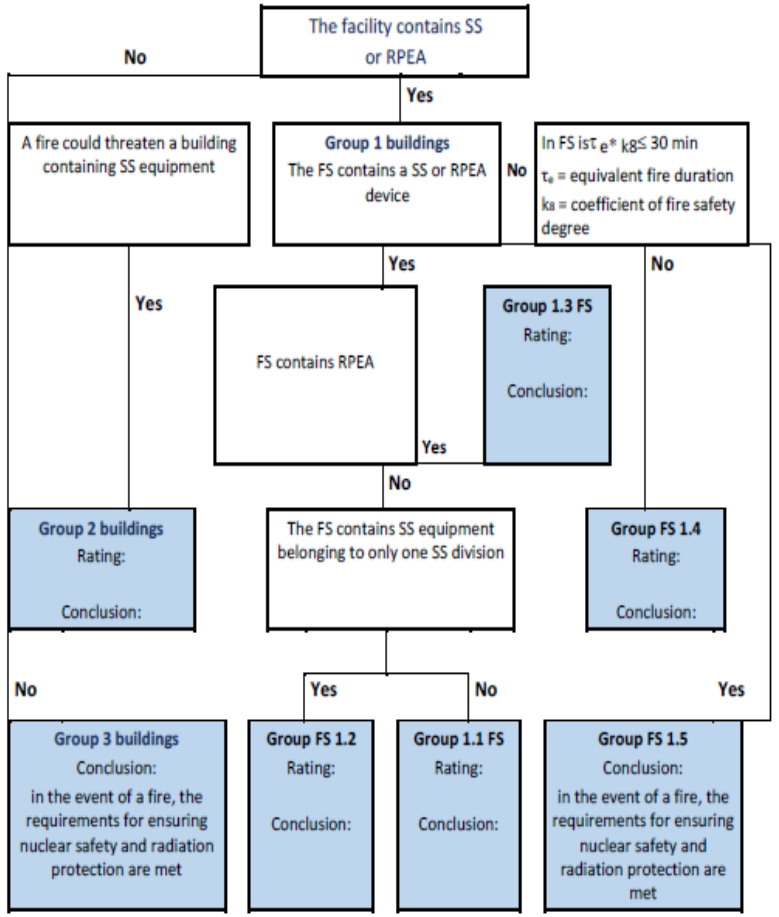
In order to assess whether a fire in any NPP building could cause a threat to nuclear safety or radiation protection, the buildings were divided into 3 groups according to the "Algorithm for Evaluation of Buildings and Fire Sections" according to the expected impact:

- Nuclear safety could be jeopardized (in the context of a fire) in the event of unacceptable damage to the safety system equipment ensuring the safe shutdown and nuclear reactor cooling.
- Radiation protection could be jeopardized (in the context of a fire) in the event of unacceptable damage to systems, equipment or structures that prevent unacceptable release of radioactive substances into the environment (important equipment and radiation protection areas).

Group 1 buildings - contain equipment of safety systems (SS) or important equipment and radiation protection areas (RPEA).

Group 2 buildings - a fire in these buildings could jeopardies, due to secondary effects, buildings containing safety systems that may be affected by the secondary effects of fires (heat, smoke from combustion) originating in these buildings.

Group 3 buildings - a fire in these buildings cannot affect buildings containing safety systems. This includes all other NPP buildings not classified in Group 1 or 2. A fire in a Group 3 facility cannot jeopardies nuclear safety or radiation protection.



Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

- Criteria for the selection of Group 2 buildings:
  - The building containing the safety systems is adjacent to the assessed building or is located in a fire hazardous area of the assessed building,
  - The building containing the safety systems is neither adjacent to the building under assessment nor located in a fire hazardous area of the building under assessment, but is located in such close proximity that it could be affected by a strong concentration of smoke or toxic combustion products from a fire in the building under assessment.
- Characteristics of Group 1.1.
- The equipment and components of safety systems belonging to two or all three divisions of safety systems are installed in fire sections classified in Group 1.1. Nuclear safety could be jeopardized if:
  - A fire (flames, heat, smoke) originating in the FS under evaluation will damage equipment or safety system components belonging to more than one division.
  - Fire action (extinguishing agent) in an evaluated FS will damage equipment or safety system components belonging to more than one division.
  - A fire originating in an evaluated FS will spread to one of the other FSs classified as Group 1 (1.1, 1.2 or 1.3). Such a fire spread may occur only in the event of loss of function (unacceptable damage) of the load-bearing structures installed in the evaluated FS or loss of function (unacceptable damage) of the fire-separating structures installed on the boundaries of the evaluated FS, including fire seals and fire dampers.
  - Smoke arising from a fire in an evaluated FS will spread to one of the other FSs classified in Group 1
  - The extinguishing agent (water, extinguishing foam) used in the fire-fighting operation penetrates one of the other FSs classified in Group 1.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

- Overview of the sections classified as radiation protection areas :
  - Rooms with ventilating iodine filters containing activated carbon,
  - Rooms for the reinforcement of RA substances by bituminization,
  - Storage cells of combustible RA waste,
  - Storage areas for low-level RA waste,
  - Storage of used RA oil (lubricant),
  - Fresh fuel storage,
  - Pipe bridge,
  - Spent fuel storage compartments/sections.
- All NPP buildings are constructed to ensure in case of any fire:
  - Nuclear safety and radiation protection,
  - Safe evacuation of persons from a burning or fire-threatened building, or part thereof, to the open air or to other areas not threatened by fire,
  - Restrain fire transmission to another building,
  - Restrain the spread of fire between individual fire sections within the building,
  - Effective intervention of firefighting units in firefighting and rescue work.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

PROBABILISTIC SAFETY ASSESSMENT

- The results of the fire protection analyses are included in the chapters of the Operational Safety Analysis Report. The assessment presented in the Report includes a set of postulated initiating events, which take into account the nature of the event, the type of occurrence and the frequency of the event occurrence.
- Fire is included in PSA of the Dukovany NPP and the Temelín NPP - the requirements of Decree on Safety Assessment under the Atomic Act. The PSA is updated annually to reflect the current status of the NPP design and procedures
- PSA Level 1 and Level 2 are performed for all operating modes, i.e. full power, low power and shutdown state and include nuclear fuel in the core and in the spent fuel storage pool.
- Every five years, a complete revision of the PSA is made taking into account the current state of the world-accepted methodologies and procedures, including an update of the reliability data used (Living PSA design).

Temelín NPP

The contributions of internal fires to the overall risk of unit operation - contribution to the unit operating risk (CDF risk measurement) to internal initiation events from internal fires is 4,34E-07 /yr (13.6 % to CDF = 3,19E-06/yr). Internal fires also contribute to the FDF risk evaluation, but only in the regime where all fuel is removed from the core; in this case their contribution to risk is 1.36E-08/year. In other regimes, the contribution of internal fires to the FDF is several degrees lower

Dukovany NPP

The contributions of internal fires to the unit operating risk (CDF risk measurement) to internal initiation events from internal fires is 7,05E-07/yr (20.3% to CDF = 3,42E-06/yr). Internal fires also contribute to the FDF risk evaluation, but only in the regime where all fuel is removed from the core; in this case their contribution to risk is $7.06E^{-07}$/year. In other regimes, the contribution of internal fires to the FDF is several degrees lower.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

MOST PENALISING SCENARIOS Temelín NPP

- The most complex fire scenario in the Temelín NPP is a fire of bearings lubricating oil of feed water supply turbine (FWST). The risk considered is in the possible domino effect of overheating or the disruption of the integrity of the steel parts of the technology, which will subsequently create additional oil leakage points. Collapse of structures will also occur as a result of loss of mechanical features due to thermal stress.
- If a fire occurs in the petroleum rooms of the turbine-generator and FSWT, which are separate fire sections equipped with a stable CO_2 extinguishing system, the consequences might not be as severe as in the case of leaks in the free-running oil lines in the turbine hall and intermediate engine hall respectively, where burning oil would be sprayed.
- In the event of a confluence of adverse circumstances, hydrogen (used for generator cooling) could also explode in connection with the fire. Based on this, the most complicated fire scenario is a fire resulting from a leak in the process oil lines between the 1st and 2nd section of the low-pressure section of the steam turbine, with a subsequent slow leak of oil (approx. 1 liter/s).

For this reason, a fire in the turbine hall is considered the most complicated fire scenario in the entire NPP.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

MOST PENALISING SCENARIOS Dukovany NPP

FHA assumes the most adverse variant of a fire in the entire nuclear power plant area in turbine hall

Frequency of fire

- Reactor building – main circulation pump 3,15E-04
- Turbine hall – main lubricant tank 3,82E-03
- Cable duct 1,12E-04

Intervention condition

- Reactor building – main circulation pump: increased dose rate; difficult access; hermetic spaces
- Turbine hall – main lubricant tank: a large amount of flammable liquid under pressure and a temperature exceeding 60 °C; large fire area; extinguishing equipment under el. tension
- Cable duct: difficult access; intervention on equipment under voltage
- Hydrogen storage: explosion hazard of a mixture of hydrogen and air

Fire load

- Turbine hall: large quantities of stored flammable liquids

Number of firefighters

- Turbine hall
- Diesel generator stations

Active fire protection

Fire detection (cf TS 03.2.1)

NPP

Strategy for the location of the detectors

- Quick spotting of a fire - the object is divided into detection zones (not necessary identical to sections)
- NPP: Initially, EFD was installed in strategically important spaces (electrical switchboards, cable ducts and spaces, control rooms, safety important cells,...); At present EFD with addressable detectors is installed in almost all spaces in every building.

The location of the detectors is determined by the design and according to the fire safety solution – according to environment, physical and chemical phenomena characteristic, layout, spatial, operational and special requirements

Selection of detectors

- their efficiency is as high as possible,
- not affected by the environment (e.g. flame detectors are installed at transformers),
- resist the environment (e.g. resistant to ionizing radiation),
- do not themselves affect the given space (e.g. in Explosion design)
- suitable as required by harmonized technical standard ČS EN 54-xx.

The EFD switchboards at RB have seismic classification 1a.

EFD protecting spaces where the SSC of safety systems are located is classified in safety class 3.

Active fire protection

Fire detection (cf TS 03.2.1)

NPP

Characteristics and location of detectors

Flame detectors

On outdoor transformers (power output, self-consumption and reserve transformers), on board main circulation pumps, diesel generator, hydrogen management. The flame detectors also control the corresponding stable extinguishing equipment.

Spot (optical-smoke, multi-sensor, thermal...)

In cable ducts, office spaces, electrical power distributors.

Linear detectors (smoke)

Administrative building.

Temperature-sensitive cable (detector in the form of an optical cable)

In cable channels

Smoke suction units

In electrical power distributors and turbo generator housing.

Push-button detectors

The buttons are either connected to the on-site EFD system, which does not control the downstream equipment, or to the fixed fire extinguisher system, which controls the relevant downstream equipment.

Buttons are also used to block extinguishing.

Active fire protection

Fire detection (cf TS 03.2.1)

NPP

EFD Control of individual functions:

- Starting Stable Extinguishers
- Turn off ventilation
- Control of fire dampers
- Control of heat and smoke removal equipment
- Closing the fire doors, including checking that the fire doors are closed
- Controls the SE, fire dampers, mixing devices
- Alarming to leave the area (acoustically and optically)
- Activate
  - the recorded evacuation announcement by radio
  - emergency lighting
  - elevators descend to the 1st floor.

The EFD system is fully addressable, each detector has its own unique address, which, when activated, is displayed on the control panel and in the graphic system.

EFD has detection and signaling on fault condition.

Possible detector malfunction is signaled in control room as the control panel must signal to the operator at least three basic states: OPERATION, FAILURE, FIRE.

EFD has backup power source - rechargeable battery

Active fire protection

Fire suppression (cf TS 03.2.2)

NPP

Location of the extinguishing systems and their characteristics

- The selection of areas protected by stable extinguishing is in the NPP design, where areas affecting nuclear safety were selected (cable duct in primary circuit, unit control rooms and its adjacent areas, cable ducts of secured power supply, electrical distributors, etc.).
- When choosing a fire extinguisher, its fire-fighting effects are taken into account in relation to the substances present in the given space, and last but not least, the impact on the environment is also addressed.
- In Fire Safety Solution the type, quantity and location of manual fire extinguishers are evaluated. The principle not to install water extinguishers in NPPs due to possible electric shock is adopted. Preferable are in use snow and powder fire extinguishers.
- Dukovany NPP
  - Originally all systems were to be water based. Already during construction, the premises of the unit control room and adjacent areas are protected by gas SE (NOVEC 1230 at present).
  - Over the years, the SE has been expanded to include other important buildings (DGS, oil lubricant management, transformers...), these are areas with a high fire load and are important for the operation of the power plant.
  - The DG is protected by two SE systems: the oil warehouse is protected by an aerosol SE and the DG engine room is protected by a water SE. Both systems are automatically started by EFD.
- Temelín NPP
  - The DG are protected by a semi-stable fire-extinguishing system (SFE). The SFE does not have its own fire extinguisher tank or its own fire extinguisher pump and works in cooperation with mobile fire equipment. It extinguishes on the basis of a foamed AFFF solution, which quickly spreads over the surface of the burning liquid and has high cooling effects.
  - Water stable fire extinguishing device is intended for extinguishing fires arising on power output transformers, self-consumption transformers (branch transformers) and backup power supply transformers. The device is designed in such a way that intensive cooling of the transformer is ensured simultaneously with extinguishing.

Active fire protection

Fire suppression (cf TS 03.2.2)

NPP

Stable extinguishing systems and their characteristics

ACTIVATED BY EFD

- Water SE protecting transformers is a non-watered SHZ with DM and DVM type spray nozzles (endangered of freezing in winter), which is triggered automatically by EFD – turning on fire pumps and supplying water to a transformer affected by fire. It can be started and stopped manually.
- Water SE protecting cable ducts, shafts and spaces is a non-watered SE with drencher heads (danger of damage in case of accidental activation). On the impulse of the EFD (on the basis of the impulse from 2 detectors), the pumps are started, which supply water to the entire fire department. Can be started and stopped manually.
- SE CO2 is spatial extinguishing with CO2 inert gas, which release inert gas into the protected space (an EFD impulse from 2 detectors). Before the release of gas (1 minute), there is a sound and lighting signal in the area calling to leave the area; using the blocking button is possible to extend the time of releasing the fire extinguisher for another minute after pressing the button. The discharge of the fire extinguisher can also be controlled manually from the unit control room or the operational center of the FRSU.
- SE KD200 is spatial extinguishing of FM200 gas, the same extinguishing system and logic as CO2. (Temelín NPP)
- Aerosol SE device uses the so-called inhibitory effect of ultra-fine fire extinguishing powder formed by inorganic non-toxic salts to act on fire flames. In the event of a fire, after it´s initiation the powder is emitted by the generators of the extinguishing aerosol together with a small amount of carrier inert gases into the extinguished space. This is spatial extinguishing and the logic is the same as for CO2. Only aerosols are applied at Dukovany.
- SE NOVEC 1230 (a replacement for the halon SE, which was banned due to adverse effects on the environment) is spatial extinguishing, in which the extinguishing gas NOVEC 1230 (FK-5-1-12) is used, and the logic is the same as for CO2. (Dukovany NPP)

Active fire protection

Fire suppression (cf TS 03.2.2)

NPP

- The dangerous effects of fire extinguishing systems
- The Stable Sprinkling System and High Pressure Pipeline Distribution in the reactor building and SE of system DGS are seismically resistant. The requirement is that they maintain functionality even during a seismic event.
- Any failure of EFD and dampers must not endanger other seismic resistant equipment.
- In the probabilistic risk assessment, fire water systems are included as a possible source that can cause internal flooding. Loss of water as a fire extinguishing agent are taken into account in the design of the system.
- Spaces that are protected by water stable extinguishing systems are connected to the industrial drainage system, and in case of extinguishing, the water flows into the industrial drainage system and then to the cleaning station.

Passive fire protection

Compartmentation (cf TS 03.3.1)

NPP

Methods for determining suitable fire barriers

- All fire separation structures are described in the original design (the Fire Safety Solution)
- Selection and properties are based on calculations of the fire risk of individual fire sections –> set grades of the level of the risk
- The minimum fire resistance is determined in the Fire Safety Solution - 90 minutes for separation structures of safety systems.
- The fire resistance of NPP structures is higher than the minimum requirement.
- Individual analyzes (PSA, PSR) recommended dividing fire sections into smaller parts (a recommendation in the framework of nuclear safety)
  - In majority sections were divided into smaller parts and separated by building structures.

Compensatory measures

Additional structure or coating

Fire cells are to be set – separation by distance

Administrative temporary restrictions (in case of structure degradation)

Passive fire protection

Compartmentation (cf TS 03.3.2)

NPP

Maintenance of fire dampers

- Inspection according to the manufacturer's requirements (1/2 and 1 year) by testing
  - functionality
  - integrity of all FD parts
  - connection to the EFD (if any).
- Reoccurring defects result in repair or change entire fire damper

Temelín NPP (in controlled area mainly) use Mandík fire damper containing INTUMEX fire material, which increases in volume when the temperature rises above 130°C and seals up („bake“) the area of the fire damper. Those FD tighten the protected area from smoke.

- Findings:
  - Cracked, damaged damper leaf (bent, does not fit, chipped off, etc.).
  - Damper spring not working.
  - Damper lever damaged.
  - Damper corrosion.
- Defects on the dampers began to occur after 20 years of operation, the check for new dampers is without findings.

Conclusion

TS 01.3 and TS 04

NPP

- A new fire protection standard has been updated for both NPP locations, where there are new rules for recharging information technology equipment in the NPP and recharging battery vehicles.
- In Temelín NPP modification „turbine halls resilience“ is being completed
  - extinguishing turbine bearings,
  - modification of CO2 extinguishing on lubricant management .

The NAR includes information valid up to September 2023.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.2)

RR

DETERMINISTIC

The fire safety solution of the building

- the building is divided into fire sections
- the fire risk is calculated for every individual fire section
- fire separation structures are designed and their fire resistance (in minutes)
- fire safety means and their quantity are designed (fire water, EFD, stable extinguishing systems , fire dampers, fire partitions ..).

The fire risk assessment

- the risks are defined according to the activities performed
- measures are proposed for risk elimination
- determination of the size of the FRS Unit and its equipment

- For the purpose of safety analyses, a set of postulated initiating events was created, which take into account the nature of the event, the type of occurrence and the frequency with which the initiation event can occur.
- The loads that were considered in the calculations of the buildings, systems, structures and components of the LVR-15 reactor resistance were external fires - burning of the gas cloud.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.2)

RR

The analyses with possible impact on the safety functions of the reactor cover following events selection:

- Fire in reactor hall or operator's room during reactor operation
  - As the impact of the fire, it is considered that the movement in the hall will be impossible and can be assumed the possible endangering of the reactor protection and control system cabling -> reactor shut down
- Fire in the reactor hall during shutdown
  - Cannot affect the safety function of shutdown and reactor subcriticality preservation, as the shutdown is done.
  - If affect contaminated or activated combustible materials - the burning of the radioactive waste is not classified as a radiation emergency.
- Fire in other compartments of the building
  - For internal fires, it is assumed that the fire will be signaled by the EFD system to the reactor operator room and the operator will shut down the reactor
- The impact of forest fires and other continuous ground cover
  - The distance of the trees from the reactor building and the presence of the FRSU directly on the site in close proximity, it can be concluded that there will be no major threat to the LVR-15 reactor - the building is equipped with a stationary fire water distribution system to each floor portable fire extinguishers and a fire order for firefighting.

- The fire risk of the buildings important for nuclear safety is relatively low (expressed both by the fire safety degree of selected buildings and by the values of the accidental fire load) according the analysis result.
- The most complex fire scenario in the LVR-15: fire in reactor control room or reactor hall - the reactor will always safely shuts down and keep in a safe subcritical condition. Detection of fire: EFD and cameras.
- In the event of a fire in some specific rooms, the reactor cooling function required following shutdown may be affected. The malfunction of reactor cooling after reactor shutdown is a non-serious fuel damage event (DEC A) and will not cause melt the fuel cladding, and therefore will not release RA substances to the environment and endanger reactor operators
- PSA is being developed.

Active fire protection

Fire detection (cf TS 03.2.1)

RR

ELECTRICAL FIRE DETECTION

- An electronic fire detection system (EFD) is installed in the LVR-15 reactor building to detect fire. It was reconstructed in 2016.
- The Zettler Expert EFD exchanger is a powerful electrical fire alarm system with MZX technology, which was originally developed for operation in the most challenging environments, the system is highly resistant to external influences such as electromagnetic interference or false alarm sources.
- The system provides detailed status information, guarantees a rapid response to all system events, combines ease of use with high performance. EXPERT is capable of operating even in the most demanding conditions.
- With the ability to detect a wide range of fires, from flame burning to smoldering fires, the combined optical and thermal multi-sensor detector is the preferred choice for many applications.
- The EFD on the building is equipped with 50 optical-smoke detectors, 1 thermal detector, 2 linear interactive Fireray detectors, 2 optical in-floor detectors and 10 push-button detectors.
- Indoor addressable pushbutton detectors with programmable status LED are used. The pushbutton design meet all safety requirements, allowing rapid communication of a manually declared fire alarm with the EFD exchanger.
- The exchanger (informative) is located in the security room of the building.
- The EFD system is not classified with a requirement for seismic resistance. The EFD is designed according to ČSN 73 0875 and ČSN 34 2710 in the scope of the Fire Safety Solution.
- EFD system has sensors with an address.
- The control panels have a backup power supply for 24 hours.

Active fire protection

Fire suppression (cf TS 03.2.2)

RR

- The reactor hall and adjacent administrative parts of the building are equipped with fire water distribution systems. Portable fire extinguishers are added in defined areas of the building.
- The use of water in firefighting is limited as much as possible, inert substances are preferred - carbon dioxide, powder, CAFS - dry foam. Water only in extremely necessary cases and in small quantities (mist, splinter stream).
- Water sources, fire extinguishing agents :
  - Portable extinguishers (powder and snow),
  - Internal hydrant systems,
  - Pressure ventilation of partially protected emergency routes (both four-storey staircases), they can also be used as internal emergency routes for access to individual floors (they are fire separated, ventilated),
  - Outside the building there are underground hydrant systems on the site water supply line.
  - The Vltava River is used as the main source of firewater in the area.
- The building is equipped with ventilation system and retrofitted with fire dampers.
- In the event of a radiation incident associated with fire, the ventilation system is equipped with nine fire dampers. The dampers close automatically when the inlet media temperature reaches 68 °C.
- The damper upstream of the fan and the other upstream of the iodine filter are operated only in emergencies.
- Any extinguishing agent that enters the controlled zone will automatically be considered potentially contaminated and must be treated as radioactive waste. The hall is equipped with water outlets to a system of contaminated liquid waste collection tanks based on 3 tanks.

Passive fire protection

Compartmentation (cf TS 03.3.1)

RR

- LVR-15 is a separated four-storey building with five operational units - the main four-storey laboratory building, the reactor hall, the technical annex, the small residues annex and the ventilation centre.
- The application of basic fire protection rules is integral part of the reactor design - division into fire sections and their separation by suitable means.
- The basic prevention procedures include:
  - Redundancy (selected systems are multiply backed up),
  - Diversification (the function is handled by multiple systems based on different principles),
  - Spatial separation and physical separation.
- The following fire sections are gradually being created:
  - FS 1 - reactor hall with expeditionary center,
  - FS 2 - reactor operator room,
  - FS 3 - fuel storage area,
  - FS 4 - diesel generator,
  - FS 5 - battery rooms - accumulator rooms,
  - FS 6 - individual floors with laboratories,
  - FS 7 - staircases on both sides of the building (partially protected emergency routes).

Passive fire protection

Compartmentation (cf TS 03.3.1)

RR

- The reactor hall forms a fire separated area. All cables are fire-sealed at the exit from the hall to the laboratory wing. Doors with increased fire resistance fit all openings from the hall to the laboratory wing. Metal doors are installed from the hall to the outside area and to the hall extension.
- The risk of fire spread is reduced by fire fillings, dividing of technical equipment, in particular risers, valve of fire dampers, closing and separation of the ventilation system, etc.
- The two staircases on both sides of the building, which form ventilated, partially protected emergency routes, are properly fire-proofed.
- The building structures of the original design are assessed for fire resistance according to the previously valid technical standard.
- The resistance of newer wooden door entrances to standard buildings is about 30 min, the resistance of external masonry 45 cm thick is 65 min at temperatures corresponding to usual fires.
- The changes in the area of revision of elements separating fire sections - new fire doors and revision and replacement of fire seals followed the new documentation of the fire safety solution.
- In some cases, the original design of the equipment does not have the exact qualification requirements set or their certificates documented - the reconstruction therefore includes the determination of requirements, the processing of certificates and the subsequent installation of new parts.

Passive fire protection

Ventilation management (cf TS 03.3.2)

RR

- The ventilation system of the LVR-15 reactor is classified to the selected equipment of the reactor. The principle of negative pressure ventilation meets the requirement:
  - Creating and maintaining negative pressure in selected areas - in the pump room and the areas under the reactor, under the reactor lid and in the wet stack, in the reactor hall and hot cell operator rooms, in the hot cells and at the liquid radioactive substance tanks.
  - Extraction of active and harmful gases and aerosols of radioactive substances from selected areas into the ventilation stack.
  - Filtration of exhausted active and harmful gases and aerosols of radioactive substances, fresh air supply and hot air heating of the reactor hall and annex.
- The risk of fire spreading through the ventilation systems prevents the use of fire dampers. All air exhausted by the ventilation systems is forced into the ventilation stack.
- The ventilation in the reactor hall provide the required air exchange. The exhaust is compensated by fresh air supply through supply systems with possible preheating.
- Ventilation of the space below the reactor lid (above the reactor water level) is sufficient to dilute the radiolysis hydrogen to a non-explosive concentration.
- The LVR-15 reactor building has two fresh air intake systems equipped with air conditioning units. These systems supply the reactor hall, hot cell operator's room and hot cells. Each system is equipped with automatic and manual gas-tight shut-off valves that allow remote and local control of individual piping branches. Each system is fitted with a fire damper at the entrance to the ventilation center and parts of the systems located inside the ventilation center are fire insulated.
- All supply and extract equipment are manually started from electrical distributor in the operator's room. Once started, the system can be switched to automatic operation.

Passive fire protection

Ventilation management (cf TS 03.3.2)

RR

- When designing ventilation systems from the point of view of fire safety, the procedure was followed according to technical standards.
- The risk of fire spread is reduced by penetration fire seals, by separation of technical equipment, in particular risers, implementation of fire closing and dividing of the ventilation system
- In the event of a fire-related incident, the ventilation system is equipped with nine fire dampers: in the supply systems in the space behind the fan, in the extract systems in the basement of the ventilation behind the supply to the building. The damper upstream of the fan, the other upstream of the iodine filter are operated only during emergencies. The dampers close automatically when the inlet media temperature reaches 68 °C. The supply systems are located in the basement of the laboratory part of the building. The air is exhausted by natural exhaust, from the laboratories equipped with fume cupboards and from the battery rooms by fans located on the 3rd floor of the building.
- The radioactive substances ventilation system is equipped with absolute filters - these are connected as the main ones. Iodine filters are connected to the circuit in the event that increased activity is identified in the ventilation circuits.
- The air conditioning of the reactor operator room and the adjacent operator room of pressurized water loop is designed separately. Two-part air conditioning units are installed in these rooms. In the probes room there is a CHICO unit. The air is filtered, cooled in the summer and humidified in the winter, or heated in an electric heater. The air temperature and humidity is regulated.

Maintenance of fire dampers

- The basic verification of fire dampers function is their inspection by the supplier at least once a year:
  - identification of the damper, opening of the inspection hole and checking of closing and opening, the movement of the fire damper leaf, the visual check of corrosion presence and the integrity of the fire insulation from the fire separation structure, inspection of cabling, triggering mechanisms and cleaning.
  - Specific actions are given by the manufacturer's documentation.

Conclusion

TS 01.3 and TS 04

RR

- **Significant improvements resulting from PSR, FSA, OPEX, updated regulations and insurers requests, and potential updates since the NAR production**

The NAR includes information valid up to September 2023.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.3)

Spent fuel storage

All 3 spent fuel storage installations are located in the area of NPPs

The initial criterion for the assessment of the building structures in terms of fire safety in the SFS is the methodology of ČSN 730804. There are elaborated:

The Fire Safety Solution Of The Building

- the building is divided into fire sections
- the fire risk is calculated for every individual fire section
- fire separation structures are designed and their fire resistance (in minutes)
- fire safety means and their quantity are designed (fire water, EFD, stable extinguishing systems , fire dampers, fire partitions ..).

The Fire Risk Assessment

- the risks are defined according to the activities performed
- measures are proposed for risk elimination
- determination of the size of the FRS Unit and its equipment

The PSA is not developed for SFS - spent nuclear fuel is stored in type approved packages.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.3)

Spent fuel storage

RESULTS

- In the fire safety design, according to the determined fire risk, all fire sections are classified as fire safety level I.
- Natural fires, fire in the SFS and explosion of technical gases are among the postulated initiating events.
- The distance and area of forest and fields close to the NPP/SFS makes this type of fire negligible in terms of thermal effects.
- The explosions of technical gases that may occur cannot cause an accident with radiological consequences.
- The analysis of a deliberate attack by a large transport aircraft on a SFS falls into DEC. The mechanical effects of the accident are not of such magnitude as to cause the spent fuel package leakage.
- A fire in an SFS can lead to dangerous consequences only if the temperature to which the package will be exposed or the time for which it will be exposed to temperature exceeding the parameters which the package shall meet according to the requirements of the type approval procedure. This is a temperature of 800 °C and a duration of 30 minutes (fire analyses include the document among the type approval documentation).
- All load-bearing and fire-dividing structures adjacent to the fire section in which the package storage is located shall have a fire resistance of at least 60 minutes.
- All adjacent fire sections are equipped with electrical fire detection and alarm and the FRSU have the information about the fire immediately after it occurs and shall take the necessary measures to locate the fire and to eliminate it.
- In the design in part "Fire safety solutions" all fire safety criteria and their fulfilment were evaluated in detail. In most cases, the initial requirements are met by a considerable margin.

Active fire protection

Fire detection (cf TS 03.2.1)

Spent fuel storage

- The SFS building is equipped with an electrical fire detection system and appropriate fire extinguishing that cannot adversely affect nuclear safety.
- The SFS compartments and rooms are protected by the EFD system with EFD SIEMENS - SINTESO S-LINE and EFD video smoke detection.
- Automatic and push-button fire detectors are located in the building.
- The detectors are connected to the new EFD exchanger and the information from this exchanger is send to the fire alarm room located in the FRSU of the NPP.

Active fire protection

Fire suppression (cf TS 03.2.2)

Spent fuel storage

- The SFS building is not equipped with a stable extinguishing system.
- The fire water supply system is designed according to technical standards. Wall hydrants are located in the building and the corresponding types of portable or mobile fire extinguishers are installed.
- It is not possible to conduct effective fire-fighting intervention from the outside of the building, and therefore internal intervention routes are established, which enable effective fire-fighting intervention to be conducted through the interior of the building in all areas of the building where there is a possibility of fire.

Passive fire protection

Compartmentation (cf TS 03.3.1)

Spent fuel storage

- The SFS is divided into smaller fire-bounded units - fire sections. Their purpose is to confine a fire to one fire section and prevent its spread to another fire section or building.
- The spread of fire between individual fire sections is prevented by consistently delimiting each fire section by fire-dividing structures, which achieve fire resistance corresponding at least to the specified degree of fire safety.
- Non-combustible structures (reinforced concrete, masonry, steel, etc.) with adequate fire resistance are used in the structural engineering design.
- The SFS compartments are designed and equipped so that it is possible to perform a quick and effective intervention of FRSU.

Passive fire protection

Ventilation management (cf TS 03.3.2)

Spent fuel storage

- The ventilation solution respects all the previously mentioned aspects and accordingly the individual parts of the SFS are suitably ventilated.
- The storage area, as a controlled area with a high heat load and no permanent staff presence, is ventilated by aeration (natural ventilation).
- The reception area, divided into controlled area and outside controlled area, where the staff presence is permanent but periodic, is mechanically ventilated forced.

Conclusion

TS 01.3 and TS 04

Spent fuel storage

The NAR includes information valid up to September 2023.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.4)

Waste

- NPP RAW is reprocessed in the NPP area in separate building
- RR RAW stored in dedicated building
- RAW Repository is subject to fire hazard assessment according to Fire Protection Act:

The Fire Safety Solution Of The Building

- the building is divided into fire sections
- the fire risk is calculated for every individual fire section
- fire separation structures are designed and their fire resistance (in minutes)
- fire safety means and their quantity are designed (fire water, EFD, stable extinguishing systems , fire dampers, fire partitions ..).

The Fire Risk Assessment

- the risks are defined according to the activities performed
- measures are proposed for risk elimination
- determination of the size of the FRS Unit and its equipment

- RAW is stored in barrels which shall fulfil the crtiteria of ADR, 2006/117/Euratom, IAEA No. SSR–6 (Rev. 1)
- Individual barrel has to have certificate based on special testing. Test include fire resistance prove.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.4)

Waste

NPP RAW reprocessing building

- The bitumenization line is in operation only when necessary when one of the tanks in the intermediate storage of liquid RAW is filled. The system therefore works in batches based on the amount of waste produced during the operation of the NPP wastewater treatment system.
- The system is followed by a ventilation system with filtration for the needs of technological venting.
- For the possibility of the bituminous product catching fire, fire ventilation is provided together with water extinguishing, which must prevent the occurrence of fire and thus the use of fire ventilation to remove the arising flammable gases and combustion products to prevent the formation of an explosive concentration and to reduce the temperature in the room.
- Exhausted gases and smoke are released into the ventilation chimney after cooling and purification.
- In the event that a fire occurs, the fire is detected immediately (within 60 seconds) and the company's FRSU members arrive within 3 to 4 minutes of its notification.
- The resistance of the system against Internal fires, internal explosion is ensured by the arrangement of the system or of its subsystems and controls according to OLC, the EFD system and the barrel cooling system.
- Since the reprocessing system fulfills its safety function only in DiD1 and DiD2, the equipment is resistant to internal influences at the level of common industry standards.

Fire safety analysis

Fire safety analysis (FSA)
(cf TS 02.4)

Waste

- NPP RAW repository in Dukovany NPP

- It consists of 112 reinforced concrete pits arranged in four rows. RAW from Temelín NPP is also stored there.
- When the pit is filled it is poured by concrete.
- Fire protection is ensured by FRSU of NPP.

- RAW repository

- So-called institutional waste, which is produced in the healthcare, industry, agriculture and research sectors, has been disposed of here.
- Barrels are stored in caves and following the detailed inspection and the re-packaging of some of them, the individual disposal chambers were backfilled with concrete.

Conclusion

TS 04

The NAR includes information valid up to September 2023.

All permit holders for nuclear installation operation have the fire prevention system well elaborated and recorded in their internal management documentation system.

In the conception of the described nuclear installations plays a significant role especially the establishment and permanent presence of Company´s Fire Rescue Service Unit, which effectively covers all activities in the field of fire protection with a link to the crisis management of the state. The operators thus have an internal "fire authority" of competent personnel who act both preventively and proactively in meeting the requirements of the legislation.

In recent years, massive digitization has been adopted. In this regard the permit holders introduce to store records of fire protection related activities in digital form. This makes it easier for all those involved in the provision of fire protection to access the recorded data quickly.

The fire and nuclear law in the Czech Republic have implemented the binding regulations of the European Union in. The nuclear law has implemented other recommendations of international bodies and organisations (especially WENRA and IAEA).

The adopted arrangement minimize the likelihood of fires by eliminating combustible materials and potential ignition sources from safety important compartments. It covers as well continuous detection and extinguishing fires, preventing the spread of fires by separation, mitigating secondary fire effect and maintaining safety functions identified as necessary in case of fire, including protection of relevant SSCs. Identification of fire hazards at an early stage in the design is required and realized. Adequate maintenance, control, and in-service inspections focus on components of fire detection or ventilation systems.

THANK YOU FOR YOUR ATTENTION

Hana Renová

With support