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NATIONAL ASSESSMENT REPORT

OF THE CZECH REPUBLIC

For the purposes of the Topical Peer-Review "Fire Protection" under the Nuclear Safety Directive 2014/87/EURATOM

Prague 2023

NATIONAL ASSESSMENT REPORT OF THE CZECH REPUBLIC for the purposes of the Topical Peer-Review "Fire Protection" under the Nuclear Safety Directive 2014/87/EURATOM

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Foreword

This report has been prepared for the purpose of the second Topical Peer-Review ("TPR"), which is required by the European Union´s Nuclear Safety Directive (NSD) 2014/87/EURATOM. The interval for the implementation of the TPR is set at least every 6 years starting in 2017. The topic of the first TPR was "Ageing Management". The ENSREG group chose fire protection as the second Topical-Peer-Review (TPR II) topic. The objectives of this assessment is mutual peer review of the established fire protection practices, to identify strengths and weaknesses in established provisions and identify findings for potential improvement, to share operating experience and also to provide a transparent and open framework for developing and implementing appropriate follow-up actions to address areas for improvement. In accordance with Article 8e (2) of NSD 2014/87/EURATOM, the TPR II scope should cover all nuclear installations licensed by the national regulatory body that are in operation or under construction on 30th June 2022.

The first stage of the peer review was to produce this national assessment report. The report is prepared in accordance with the Technical Specification for National Assessment Reports prepared by the TPR II working group of WENRA RHWG and approved by ENSREG. The Technical Specification defines the required structure and content of the national assessment reports. Since the scope of the TPR II is wide, ENSREG TPR II Board considered the proposal of the members of the TPR II WG and agreed to focus the TPR on a reduced scope of nuclear installations covered by the report, taking into account the radiation risk to the environment and the population.

The main goal of the national assessment report is to gather information on the chosen topic, based on which a peer comparison can be made. Therefore, in addition to listing the legal framework, the report focuses on the fire safety analyses performed for these nuclear installations, fire prevention, active fire protection and passive fire protection. The purpose is to provide sufficiently detailed information to allow a meaningful peer review of all participating countries.

The report does not contain any sensitive information subject to dual-use nuclear items controls and nuclear facility security arrangements.

The assessment, based on which the report was prepared, was performed (concluded) at the date 30th September 2023. If any of the facts presented in the report have changed between this date and the date of publication of the report, these differences will be included in the national presentation at the peer-review workshop.

1. General Information

1.1. Nuclear installations identification

Act No. 263/2016 Coll., the Atomic Act, defines a nuclear installation in the Czech Republic as:

1. A structure or operating unit that includes a nuclear reactor using a fission chain reaction or other nuclear chain reaction,

2. Spent nuclear fuel storage,

3. Storage of fresh nuclear fuel, unless it is part of another nuclear installation,

4. An enrichment plant, a nuclear fuel fabrication plant or a spent fuel reprocessing plant,

5. A radioactive waste storage facility, except a radioactive waste storage facility, which is part of another nuclear installation or other site where radiation activities are practised,

6. A radioactive waste repository, except a repository containing only natural radionuclides.

In the Czech Republic, the largest and so far the only operator of nuclear power reactors is company ČEZ, PLC, owner of two nuclear power plants: at Dukovany and Temelín. ČEZ, PLC, operates other separate nuclear installations in the site of nuclear power plants - the Intermediate Spent Fuel Storage and the Spent Fuel Storage at the Dukovany NPP and the Spent Fuel Storage at the Temelín NPP, in which the used nuclear fuel is stored in type-approved packages. The fresh nuclear fuel storages at the Dukovany NPP are located directly in the reactor buildings, while the fresh nuclear fuel storage at the Temelín NPP is operated in a separate building connected to the reactor units.

The nuclear installations are also two research reactors LVR-15 and LR-0, operated by the Research Centre Řež Ltd., and a high-level waste storage operated by Nuclear Research Institute Řež, PLC, in Řež near Prague.

The SÚJB permit for operation have also the school reactor VR-1 and the subcritical reactor VR-2 at the Faculty of Nuclear and Physical Engineering of the Czech Technical University in Prague (FJFI ČVUT).

The scope of nuclear installations include radioactive waste repositories (RWR), the operation of which is the responsibility of the state-established organisation Radioactive Waste Repository Authority (SÚRAO).

1.1.1. Qualifying nuclear installations for TPR II

Nuclear installation	Number of units	Type	Design	Starting	Operator
NPP Temelín	2	NPP	VVER 1000/320	2000-2004	ČEZ, PLC
Spent Fuel Storage Temelín	1	SFS	Dry Storage	2010	ČEZ, PLC
NPP Dukovany	4	NPP	VVER 440/213	1985, 1986, 1987	ČEZ, PLC
Intermediate Spent Fuel Storage Dukovany	1	SFS	Dry Storage	1995	ČEZ, PLC

Spent fuel storage Dukovany	1	SFS		2006	ČEZ, PLC
Research Reactor Řež	1	RR	LVR-15	1957 (1989)	Research Centre Řež Ltd.
Research Reactor Řež	1	RR	LR-0	1982	Research Centre Řež Ltd.
Spent Nuclear Fuel and High Level Waste Storage Řež	1	SFS, WS		1997	Nuclear Research Institute Řež, PLC
School Reactor FJFI	1	RR	VR-1 VR-2	1992 2023	ČVUT Prague
Dukovany Radioactive Waste Repository	1	RWR		1995	SÚRAO
Radioactive Waste Repository Richard near Litoměřice	1	RWR		1964	SÚRAO
Radioactive Waste Repository Bratrství	1	RWR		1974	SÚRAO

1.1.2. National selection of installations

From the candidate nuclear installations, the SÚJB selected those with the potential for significant radiological risks to the environment and the population caused or affected by fire, to enable a meaningful comparison of the level of fire protection provision and the feasibility and quality of the assessment.

Nuclear installations included in the NAR

Type	**Name**	**Representing**	**Additional information**
NPP	NPP Temelín		
NPP	NPP Dukovany		
SFS	Spent fuel storage Temelín	Intermediate fuel storage and Spent fuel storage Dukovany	Same permit holder ČEZ, PLC, similar requirements, similar measures and procedures
RR	LVR-15	Spent Nuclear Fuel and High Level Waste Storage Řez	Similar requirements, similar measures and procedures, common external power sources, common firefighting systems

Nuclear installations not included in the NAR

Installations with minimal radiological risk to the population and the environment

Name	Type	Technology	Status	Operator	Justification
LR0	RR	Natural cooling, power below 1 MW	In operation	RC Řež Ltd.	The LR-0 research reactor is zero power
VR-1	RR	Natural cooling, power below 1 MW	In operation	FJFI ČVUT Prague	The school's VR-1 reactor is zero power and is used for teaching students as well as training staff
VR-2	RR	Natural cooling, power below 1 MW	Commissioning	FJFI ČVUT Prague	The VR-2 school reactor is a zero power reactor and will expand activities at the VR-1 school reactor
Dukovany Richard Bratrství	RWR	Radioactive Waste Repository sites	In operation	SÚRAO	Storage in type-approved packages

Research Reactor LR0

The LR-0 research reactor in Řež is of zero power and used to measure the neutron-physical characteristics of power reactors.

School Reactors VR-1 and VR-2

The school reactor VR-1 is of zero power and it started operation at the ČVUT - Faculty of Nuclear and Physical Engineering in 1990. The reactor uses IRT-M fuel and it´s all equipment was manufactured in the former Czechoslovakia. The reactor serves in the teaching process of the FJFI ČVUT, in scientific research activities and for the needs of training specialists of the Czech nuclear industry. The school reactor is involved in international cooperation (TEMPUS, ENEN, NEPTUNO programmes) and cooperates with similar school reactors in England, the Netherlands and Austria. In October 2005, there were changed nuclear fuel from 36 % enriched fuel (HEU) to less than 20 % enriched fuel (LEU).

The VR-2 facility is located in the VR-1 reactor hall. Its basic feature is the impossibility of achieving an uncontrolled fission chain reaction. It will serve for both teaching and research activities, which should complement or extend the activities at the school's VR-1 reactor.

Radioactive waste repository

The Dukovany repository, located on the nuclear power plant site of the same name, covers an area of 13 370 m^2 and consists of 112 reinforced concrete chambers built on the surface. It is designed exclusively for the storage of low-level waste from the operation of the two Czech nuclear power plants Dukovany and Temelín, with a storage capacity of 55 000 m^3 .

The Richard repository is located near Litoměřice in one section of an underground complex of a former limestone mine. The repository is intended for the disposal of institutional waste generated by the health, industry, agriculture and research sectors.

The Bratrství repository is located in part of the former uranium mine of the same name. The repository is intended exclusively for the disposal of waste arising from health, industry and research containing naturally occurring radionuclides.

In all radioactive waste repositories, radioactive waste is stored in packages that meet the conditions for transporting low-level radioactive materials - in the event of a fire occurred during transport vehicle accident, the dispersion of radioactive materials would be so small that persons in the immediate vicinity would not receive a significant dose (less than the annual limit). From the point of view of nuclear and radiation safety assessment, the passive fire protection of the radioactive waste repositories ensures the package design. Active fire protection is provided in accordance with the requirements of the Fire Protection Act.

1.1.3. Key parameters per installation

For the purpose of description of individual nuclear installations, each nuclear installation is assigned additional letter to the recommended numbering of the NAR structure.

A. Temelín Nuclear Power Plant

The Temelín Nuclear Power Plant (Temelín NPP) consists of two nuclear units (main production units - MPU) with VVER 1000 pressurised water power reactors of serial design type V 320, each of which currently has an electrical output of 1080.3 MWe and the thermal output of one unit is 3120 MWt. The VVER-1000/320 reactors are Generation II pressurised water reactors. The reactors are in operation since 2004 (power production started in 2002). The basic nuclear safety assurance of the VVER-1000/320 design consists of multiple barriers against radioactive leakage, including containment and the concept of multiple redundancy of safety systems.

The reactor is cooled and moderated by the primary circuit water, the accumulated heat in the coolant is transferred to the secondary circuit water in steam generators. The reactor core consists of 163 fuel assemblies and 61 clusters arranged in a hexagonal array. A solution of chemically modified water with boric acid is used as the reactor coolant and moderator, and the fuel is the low enriched uranium isotope 235U.

The primary circuit pressure is maintained by pressurizer. The reactor cooling system (primary circuit) consists of four loops of main circulation pipe (DN 850), each loop is equipped with a main circulating pump (MCP) and a horizontal steam generator (SG). The reactor pressure vessel and primary circuit are designed for a pressure of 17.6 MPa at 350°C (operating pressure is 15.7 MPa at temperatures of 290-320°C).

The primary circuit equipment is located in a containment consisting of a cylindrical structure of pre-stressed concrete with an inner diameter of 45 m, enclosed by a hemispherical canopy. The inner surface of the containment is covered with a hermetically sealed steel lining. The containment is designed for a design pressure of 0,49 MPa and a design temperature of 150°C.

Inside the containment there are spent fuel storage pools where spent fuel from the reactor core is transferred. After the residual heat is reduced, the spent fuel is transferred to a type-approved B(U)S package and transported to a dry spent fuel storage whose capacity is designed for the expected lifetime of the plant

B. Dukovany Nuclear Power Plant

The Dukovany Nuclear Power Plant (Dukovany NPP) consists of 4 VVER 440/213 reactor units in the form of two double units (main production units - MPU), each MPU has its own building. The individual units are of identical technical design. The installed electrical capacity is 4 x 440 MWe, the thermal capacity of the individual reactors of the Dukovany NPP is 1 444 MWt. The VVER 440/213 reactors belong to the second generation of pressurised water reactors. The reactors are in operation since 1985 (Unit 1), 1986 (Unit 2) and 1987 (Units 3 and 4). The basic nuclear safety assurance for the VVER 440/213 design is based on a multiple barrier against radioactive leakage, including a hermetic confinement and the concept of multiple redundancy of safety systems. Currently all 4 units produce 510 MWe per reactor unit.

The reactor core is cooled and moderated by primary circuit water. Water circulation through the core is provided by the main circulation pumps. The heat is transferred to the secondary circuit water in steam generators. The reactor core consists of 312 fuel assemblies and 37 control rods arranged in a hexagonal array. A solution of chemically modified water and boric acid is used as the reactor coolant and moderator, and the fuel is low enriched uranium dioxide 235U.

The reactor cooling system (primary circuit) consists of six loops of circulating pipe (DN 500). Each of the loops is equipped with a main circulating pump, a horizontal steam generator and two main closing valves, which allow the separation of the leakage element of the loop. The primary loop also includes a pressurizer system that maintains the pressure of the primary loop. The reactor pressure vessel and primary loop are designed for an overpressure of 13,729 MPa at 350°C with nominal reactor pressure and temperature of 12,261 MPa and 297.2°C.

The reactor and the main components of the primary circuit are located in a hermetic zone (confinement) inside the reactor building, which consists of a reinforced concrete structure with a hermetic lining. The hermetic zone is a barrier against the release of radioactive substances into the environment and a design overpressure is 150 kPa and a temperature of 127°C.

In each reactor building there is spent fuel storage pool where spent fuel from the core is transferred. From there, after the residual heat has been reduced, the fuel is transported in type-approved B(U)S packages to a dry storage facility located in a separate building.

C. LVR-15 Research Reactor

The LVR-15 research reactor is located in the site of the Nuclear Research Institute in Řež near Prague. The permit holder is Research Centre Řež Ltd. (Centrum výzkumu Řež s.r.o.) The reactor has been in operation in its present form since 1989, when the original VVR-S reactor, in operation since 1957, was modernised. During the modernisation, the basic components of the primary circuit, including the reactor vessel, were replaced.

The LVR-15 is a tank-type light water research reactor housed in a non-pressurized stainless steel vessel under a shielding lid with forced cooling. The reactor uses IRT-4M type fuel with 19.7% 235U enrichment and an operating thermal power of up to 10 MW. The reactor operates in campaigns with a subsequent break of 10-14 days for maintenance and fuel change. The moderator and coolant is demineralized water, and the reflector consists of either water or beryllium blocks depending on the operating configuration.

The core of LVR-15 consists of an aluminium basket (the so-called separator) into which fuel assemblies, beryllium blocks, aluminium displacers and irradiation channels are loaded. The core grid arrangement is in an 8 × 10 cell rectangle. Of these, 28-32 cells are equipped with fuel assemblies, 12 fuel assemblies contain control rods. Some of the cells between the fuels are dedicated to probe channels. The periphery of the core use to house the active channels of the experimental loops, the rotating silicon irradiation channel, the tube mail, and the vertical irradiation channels. Other cells are equipped with beryllium reflectors or water displacers.

D. Temelín Spent Fuel Storage

The concept of SFS is based on the principle of dry storage. The main technological equipment of the SFF consists from gradually supplemented packages containing spent nuclear fuel.

The design of SFS is separate building. The operation of the storage is periodic and does not require the permanent presence of service. The SFS building consists of a rectangular-shaped hall, divided into an income and a storage part. In the income part, which takes the form of a three-storey extension to the hall structure of the storage part, there is the reception of packages into the store and their loading for transport. The income section also houses sanitary buildings for the service staff, warehouses and workshops, control and measuring rooms, air conditioning systems, electrical distribution room, and entrance corridors. A railway siding is introduced into the income part of the SFS, along which the spent fuel package is transported from the reactor building for storage.

The design of B(U)F type storage package ensures that the basic safety functions are met, in particular the required subcriticality of spent fuel, integrity, tightness and limitation of exposure to ionising radiation during all anticipated storage-related manipulations. The packages not only allow the storage of fissile materials but also comply with the requirements of the European Agreements on the International Carriage of Dangerous Goods by Rail (RID).

For reliable and safe operation, the SFS is equipped with technological devices and systems:

- -transport means for horizontal and vertical transport of packages between reactor units and SFS,
- -one electric bridge crane located in the income part of the SFS and two electric bridge cranes in the storage ships, including the respective slings for carrying package transfer,
- -the package monitoring system and other I&C system resources,
- -means of the radiation control system,
- -auxiliary equipment (electrical, EFS and others),
- -means for waste management, including radioactive waste.

At present there are 48 CASTOR 1000/19, 5 ŠKODA 1000/19 and 9 ŠKODA 1000/19M with spent fuel assemblies stored in in SFS Temelín.

The Temelín NPP spent fuel storage represents both SFSs in the fenced area of the Dukovany NPP site:

As of 7 March 2006 the intermediate storage of the Dukovany NPP is completely filled with 60 pcs of CASTOR 440/84 with a total of 5040 fuel rods. The operator periodically informs SÚJB about the evaluation of operation, results of periodic inspections and testing, radiation situation and fulfilment of limit conditions. The operating permit is updated every 10 years. Second Dukovany NPPSFS is located in close proximity to the intermediate SFS. The interim SFS and SFS are structurally connected and are operated as one organisational and operational unit. The spent nuclear fuel from the Dukovany NPP is currently stored in CASTOR 440/84M and ŠKODA 440/84 packages.

1.1.4. Approach to development of the NAR for the national selection

In the field of fire protection, there are effectively two national supervisory authorities: the State Office for Nuclear Safety (SÚJB), which is the central administrative body for the of nuclear energy and ionising radiation utilization, and the Ministry of the Interior of the Czech Republic, which is the central administrative authority for internal affairs, including fire protection (FP). In the field of fire protection, the competent regulator is the Fire Rescue Service of the Czech Republic (FRS ČR), to the extent and under the conditions stipulated by law. The competence of the Fire Rescue Service of the Czech Republic is in the field of fire protection, crisis management, civil emergency planning, population protection and the integrated rescue system.

The preparation of the NAR was organized in the SÚJB on the principle of project management: a team of contributors led by an authorised inspector of the Nuclear Safety Section of the SÚJB. The main contributors to the report texts are representatives of selected nuclear installations - fire protection specialists nominated by the operator's management. The other contributors are the inspectors of the SÚJB, who are involved in the assessment and inspection activities of fire protection (FP), Probabilistic Safety Assessment (PSA) and Periodic Safety Review (PSR). The primary sources of information are the Operational Safety Analysis Reports of the selected installation, inspection activities of the regulatory bodies and safety assessments results. The development of the NAR also made use of the SÚJB´s internal database systems: database for recording information and assessment of changes and modifications to the nuclear installations and database for evaluation of operating events. The Fire Rescue Service of the Czech Republic, as a competent supervisory authority in the field of fire protection, has comment on the fire protection status in the Czech Republic.

1.2. National regulatory framework

The legal framework of fire protection requirements for nuclear installations in the Czech Republic consists of two basic acts:

- Act No. 263/2016 Coll., the Atomic Act, as amended, and its implementing legislation (hereinafter referred to as the Atomic Act)
- Act No. 133/1985 Coll., on Fire Protection, as amended, and its implementing legislation (hereinafter referred to as the Fire Protection Act).

1.2.1. National regulatory requirements and standards

Nuclear law

For the fire protection of nuclear facilities, the determining provision is Article 220 of the Atomic Act, which defines certain competences for the Fire Rescue Service of the Czech Republic. In particular, the Fire Service of the Czech Republic

- Participates in monitoring the radiation situation and performs monitoring at monitoring routes and sites,
- Stipulates the conditions for the fire protection of the nuclear installation,
- In the event of a radiation incident or radiation accident in the scope of its competence, immediately inform the population affected by the radiation emergency of:
  - The facts of a radiation incident or radiation accident,
  - The steps to be taken, and
  - Measures to be taken to protect the public, if necessary in the case,
- Prepare an off-site emergency plan,
- Cooperates with the permit holder and the competent regional authority to equip the population in the emergency planning zone with antidotes for iodine prophylaxis.

In addition to this competence, the Atomic Act adds further clarifying provisions, such as:

Article 8 prohibits the distribution and installation of a self-contained ionization fire detector (protection of individuals from public),

Article 25 specifies the obligation to proceed in accordance with internal regulations, including those issued on the basis of Act No. 133/1985 Coll.

Article 49 specifies the obligation to ensure the prevention, detection, elimination and suppression of fires and explosions and the limitation of their impact on safety and to provide a unit of the company's Fire Rescue Service in accordance with the Fire Protection Act.

The implementing legislation to the Atomic Act imposes additional obligations to operators of nuclear installations:

- Decree No. 378/2016 Coll., on the Siting of Nuclear Installations, stipulates the necessity of assessing natural fires and explosions and fires caused by human activity.
- Decree No. 329/2017 Coll., on the Requirements for the Nuclear Installation Design, imposes the obligation to:

- To establish requirements for equipment used in the manufacturing and processing of radioactive waste containing explosive or flammable substances,
  - Ensure that fire protection requirements are met in the design in general, including deterministic analysis,
  - To classify, according to the category of safety functions for the classification of selected equipment into safety classes, fire safety systems of safety class 3 (in Annex 1).
- Decree No. 358/2016 Coll. on the Requirements for Quality Assurance and Technical Safety and Assessment and Verification of Conformity of Selected Equipment, sets out technical requirements for selected equipment in terms of fire protection. In particular, the requirement for constructional selected equipment to be designed in such a way that in the event of a fire
  - The integrity and load-bearing capacity of the building structure is maintained for a specified period of time,
  - Its spread inside the building was limited by the spatial design and hermetic elements,
  - To limit its spread to neighbouring buildings,
  - Individuals could leave the building by emergency routes.
- Decree No. 162/2017 Coll., on the Requirements for Safety Assessment Under the Atomic Act, stipulates the basic requirements for conducting deterministic safety assessment, probabilistic safety assessment, periodic safety review, continuous safety assessment and special safety assessment.
- Decree No. 21/2017 Coll., on Assuring Nuclear Safety of Nuclear Installations, regulates the obligation to report a fire in the restricted area of a nuclear installation to the SÚJB.

Fire law

The Fire Rescue Service of the Czech Republic provide the organisation and management of the state administration in the field of fire protection, the basic part of which is fire prevention. 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. When fighting fires, Fire Rescue Services cooperate with the Police of the Czech Republic and other authorities, including the SÚJB.

Fire protection in general can be divided into a preventive and a repressive part and so the basic split of legal regulations in the field of fire protection is as follows:

Act No. 133/1985 Coll., on fire protection

- Decree No. 246/2001 Coll., on the determination of fire safety conditions and the performance of state fire supervision (Decree on fire prevention). Annex No 6 directly defines the list of nuclear power plant´s structures for which the operational fire safety equipment is checked at least once every 20 months.
- Decree No. 23/2008 Coll., on technical conditions of fire protection of buildings.
- Decree No. 460/2021 Coll., on the categorization of buildings in terms of fire safety and protection of the population.

Act No. 320/2015 Coll., on the Fire Rescue Service of the Czech Republic

- Decree No. 247/2001 Coll., on the organisation and activities of fire protection units.

These regulations further extended Decree No. 23/2008 Coll. by binding technical standards of the series ČSN 73 08xx - 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. Thus, the standards regulate in particular the following areas:

- Fire sectors
- Fire resistance of building elements and fire doors
- Fire sealing for openings
- Fire safety equipment and measures
- Building solution of structures
- Building construction
- Emergency routes
- Spacing distances and fire safety zones
- Technical and technological equipment
- Ventilation equipment
- Firefighting equipment
- Access roads
- Entrances and passages
- Entry areas
- Water supply for firefighting
- Portable extinguishers.

Only the most important and essential areas of fire protection contained in the technical standards have been listed.

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. A detailed listing of decrees and other related legislation and standards see the references.

General legally binding regulations related to fire protection

Act No.239/2000 Coll., on the Integrated Rescue System

Act No. 262/2006 Coll., the Labour Code, stipulates the employer's obligation to carry out regular training in the field of occupational health and safety. Details of employee training in fire protection stipulate Section 23 of Decree No. 246/2001 Coll. - the obligation to repeat the fire training every 2 years.

Act No.240/2000 Coll., on Crisis Management

Act No.241/2000 Coll., on economic measures for emergencies

Act No. 22/1997 Coll., on Technical Requirements for Products.

1.2.2. Application of international standards and guidance

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 further elaborate the requirements on nuclear safety, radiation protection, technical safety, radiation situation monitoring, radiation emergency management and security assurance and implementation of the principles of peaceful uses of nuclear energy and ionising radiation. The guides work up the requirements defined by WENRA in “WENRA Reactor Safety Reference Levels”. The NSGs are intended primarily to the permit holders for nuclear installations operation and offer a possible procedure to ensure that their activities in this area comply with the requirements of the Atomic Act, its implementing regulations and meet the relevant WENRA Reference Levels.

NSG BN-JB-3.5 "Protection against Internal Fires" copies the content and structure of the IAEA safety guide "Protection against Internal Hazards in the Design of Nuclear Power Plants, No. SSG-64" and transforms its content into the conditions of the Czech Republic. It also ensures the implementation of the relevant part of the WENRA Safety Reference Levels for Existing Reactors (Issue SV - Internal Hazards).

In addition, the NSG No. BN-JB-3.3 "Categorisation of safety functions and classification of systems, structures and components into safety classes" specifies a category of equipment without a safety class related to nuclear safety, including fire protection systems.

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".

In 2023, NSG No. BN-JB-3.1 "Nuclear Facility Design Requirements" was issued to provide an interpretation of the requirement to ensure the safety of a nuclear installation design in accordance with Czech legislation, taking into account international recommendations of WENRA and IAEA, and to explain the provisions of the Atomic Act and its implementing legislation on the processes associated with the design. The NSG should be used primarily in the preparation of safety documentation (including supporting studies and analyses), submitted continuously to the SÚJB throughout the life cycle of the nuclear installation, including certificates of assurance of prevention, resistance and protection of the nuclear installation against the effects of fire, explosion or combustion products at the nuclear installation.

The permit holders for nuclear installations operation (in nuclear power plants since the start of operation) implement recommendations of Safety Guide No. 50-SG-D2 (Rev. 1), "Fire Protection in Nuclear Power Plants", issued by the International Atomic Energy Agency (IAEA).

Areas involving fire protection issues are modifications and changes to nuclear installation and operating feedback.

Preventive and enforced fire protection changes, both notified to and permitted by the SÚJB, are assigned by the designated coordinator to a specialist and site inspectors who perform an assessment and record their comments on an assessment sheet, the conclusions and recommendations of which form the basis of the SÚJB's further action against the operator. The feedback assessment database operates in a similar manner. If any safety event resolved by the operator relates to fire safety, the coordinator refers the matter to the specialist. The specialist executes an assessment of event category and the adequacy of the remedial action and again record his/her comments on the assessment sheet.

The SÚJB has its own feedback system. For external feedback, an internal Direction set the rules for informing all inspectors about events at nuclear installations abroad, their investigation and measures taken. Where the causes or consequences of significant events at a non-nuclear installation may have a potential impact on the safety of the nuclear installation, events at non-nuclear installations in the Czech Republic or abroad may be analysed and subsequently included in the monitoring. The Direction also establishes the manner, procedure and scope of inspectors' activities during inspections focussed at the process of external feedback from the operational experience of nuclear operators.

Internal feedback system provides inspectors involved in inspections by information of operational events and the results of their investigations in their area of expertise. In addition to the inspection of the actual feedback process, inspectors review the progress and analysis of the checked events.

The defence in depth principle application

Defence in depth is a fundamental principle established in the Czech Republic by nuclear law. Outside the field of nuclear law, the Czech legal framework in the field of fire protection does not use the term "defence in depth", but the overview of documents in the Fire Law section shows that fire regulations also use similar principles and fully respect them. For fire protection systems, the principle of defence in depth describes in detail in the NSG No. BN-JB-3.5, Article 3.1.5:

Adequate redundancy of systems, structures and components, fire separation structures and a design solution that ensures safe operation, minimises the likelihood of fire, and limits its consequences shall be designed. It should include therefore:

(a) Preventive measures to avert the occurrence of fire,

(b) Systems available to ensure the early detection of fire, its imminent reporting and technical means, equipment, competence and organisational procedures for its early extinguishment or bringing under control; the possible consequences are to be limited,

(c) Physical barriers and technical means implemented to prevent the spread of the fire so that the required safety functions are fulfilled, including technical devices and means to reduce the extent of damage caused by any fire products or extinguishing agents used (heat and smoke extraction devices, collection of extinguishing agents used, etc.)

The NSG No. BN-JB-3.5, Article 1. 2 defines the principle of defence in depth itself.

Probabilistic Safety Assessment

Fire PSA is performed for the Dukovany NPP and the Temelín NPP in accordance with the requirements of Decree No. 162/2017 Coll., on Safety Assessment under the Atomic Act. The PSA, including the fire PSA for both Czech NPPs, is updated annually to reflect the current status of their design and procedures. 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).

Periodic Safety Review

The requirement to perform a PSR is one of the basic obligations of nuclear installation permit holders. This requirement elaborates in detail Decree No 162/2017 Coll., on Safety Assessment under the Atomic Act, and in NSG No. BN-JB-2.9 "Periodic Safety Assessment". The requirements for performing PSR implement the recommendations of IAEA Safety Standards Series No. SSG-25 "Periodic Safety Review for Nuclear Power Plants", IAEA, 2013 and take into account the requirements of the relevant WENRA SRL as well.

Continuous and specific safety assessment

Other requirements for the assessment, in accordance with the requirements of Decree No. 162/2017 Coll., which shall be applied also in the context of fire protection of the nuclear installation, are monitoring and recording of continuous assessment of all values and facts important for nuclear safety and radiation protection and performance of defined types of "special assessment". Special assessments include assessments of changes in the use of nuclear energy, assessments of radiation emergency and assessments in the event of suspected safety level reductions.

1.2.3. Inspection activities of regulatory bodies

SÚJB is not the primary regulatory body of the state administration in the field of fire protection. The legislation stipulates that it is the Fire Rescue Service of the Czech Republic (hereinafter FRS), or the regional Fire Rescue Service where the building is located. The main functions of the General Directorate of the Fire Rescue Service of the Czech Republic include the organisation and management of the performance of state administration in the field of fire protection. Regional Fire Rescue Services ensure the performance of tasks in the field of fire protection mainly as part of the performance of state fire supervision - inspections, building prevention, approval of fire risk assessments and detection of causes of fires.

The scope of the state fire supervision enforcement:

- Checking compliance with the obligations set out in the fire protection regulations.
- Assessment of construction or site-planning documentation, including approval of fire safety solutions (which is a deterministic risk analysis under specific legislation).
- Verifying whether the conditions of fire safety of buildings resulting from the assessed data and documentation according to the previous point have been complied with, including the conditions resulting from the issued Binding Determination.
- Approval of fire risk assessments for high fire risk activities (or for buildings with specific intervene conditions).
- Identifying the causes of fires.
- Checking the preparedness and availability of fire protection units.
- Imposing measures to remedy the deficiencies identified and checking its implementation.

FRS performs inspections of nuclear power plants on an annual basis, always on one selected building. FRS has performed a comprehensive inspection of all nuclear power plant buildings in 2013 at Temelín NPP. However, one of the conclusions was that due to the scope and documentation requirements of such an action and the resulting inadmissible duration of the entire inspection process, the feedback effect of the inspection process completely disappears. Thus, the FRS followed the path of annual inspections of one selected building from the list of risk buildings determined by deterministic analysis.

The control activities of the Regional FRS are mainly focused on the control of compliance with the obligations set out in the fire protection regulations, control of fire protection documentation and its compliance, equipment and activities of the local FRS unit and fire investigation. This fact has taken into account the SÚJB in the development of its own concept of fire protection regulation in the nuclear installation and the SÚJB's inspection activity focus on covering the remaining parts of the whole issue. The SÚJB continuously monitors the operation of the NPP and compliance with technical conditions for the equipment that is selected from the point of view of nuclear safety and assigned from the point of view of the fire protection (in nuclear safety, the equivalent of Safety Class 3). The SÚJB monitors changes and modifications made to the fire protection system equipment in terms of operation, failures and ageing management.

Thus the activities of the Regional FRS are focused on the issue as a whole, and the SÚJB supplements it by inspection the course of operation and the safety management system, which are areas where the FRS does not have both the capacity and the continuous possibility of information inputs. At least in the design stage of the implementation of fire safety equipment, the SÚJB has the opportunity to apply its requirements in the permitting procedure when assessing the upcoming changes.

In addition to the above-mentioned continuous monitoring of the status, the annual SÚJB basic inspection plan prescribes one inspection specialised on the issue of NPP fire protection. Its performance is based on approved instruction manual, which as far as possible focus on the areas of the SÚJB competence. The inspection protocol with a statement on each of the prescribed points is issued. Each protocol subsequently, after it’s submit to the responsible person of operator, is further reviewed by an evaluation committee, which may comment on the scope and quality of the inspection activity and recommend further procedures if necessary.

The cooperation between the SÚJB and the Regional FRS proceed both at the official national and working level. The legal regulation setting out the obligations of a unified procedure of the administrative bodies is the Act No. 500/2004 Coll., the Administrative Code and the regulators handle with cases of the same nature in correspondence. Major violations of the law under the responsibility of the competent authority are notified to the other authority by way of a submission. A specialist of the SÚJB is invited to and attends selected major conferences organized by the Fire Rescue Service of the Czech Republic, where identical issues are dealt with in a routine manner.

2. Fire Safety Analyses

The results of the fire protection analyses performed for each nuclear installation are included in the chapters of the Operational Safety Analysis Report. The assessment presented in the Operational Safety Analysis 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. Initiating events include internal and external fire events. Criteria of significance established for the assessment imply, inter alia, the obligation to prepare emergency plans for the nuclear installation under assessment.

2.1 Nuclear power plants

2.1.A. Temelín Nuclear Power Plant

2.1.A.1. Types and scope of the fire safety analyses

A number of works for the Temelín Nuclear Power Plant demonstrate an adequate level of fire protection:

- Technical reports on fire protection, which were prepared for all buildings. The fire protection technical reports determined the fire risk for each fire section, which was the starting parameter for the fire safety design of the respective building. In cases when technological and/or structural parts were modified during construction, supplements were drawn up.
- "Expert assessment of fire protection of buildings of the Soviet design zone", which was prepared to increase the level of fire safety in buildings designed in the former Soviet Union. The document described the main problems in the provision of fire protection and became the basis for the preparation of Supplement to the Initial Design No. 369.
- "Audit No. 5", which examined the design of significant nuclear power plant buildings in relation to the terms between fire hazards and safe shutdown of the nuclear reactor according to the criteria defined in US 10CFR50, Appendix R and NUREG-8000, Part 9.5.1 (1995).
- Supplement to the Preliminary Safety Analysis Report, in which the design of the nuclear power plant buildings was assessed and evaluated from the level of the initial design (November 1995).
- "Fire Protection Assessment regarding Nuclear Safety", which evaluates the links between fire protection and nuclear safety as well as radiation protection in reactor buildings.

In accordance with Article 23 par. 4 of 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. The fire risk assessments demonstrate that the requirements of national legal and normative regulations for ensuring fire safety in the structural and technological parts of the buildings are met.

In 2003 a coordination study was prepared – "Temelín NPP- IV.B construction, Increase of fire safety". The study set out the requirements for improving fire safety and the conditions under which these improvements can be implemented. The document is the basis for strategic decisions in connection with the gradual improvement of fire safety at the plant.

The baseline requirements were determined based on recommendations from several audits and comments from insurance companies. Locations for improved fire safety were identified. None of these "weak points" related to the potential impact of fire on nuclear safety, but intended to reduce potential economic losses. The study prepared Nuclear Research Institute Řež, Energoprojekt Praha division, which cooperated with TOTAL WALTHER, Stable Extinguishing Equipment s.r.o. in the determination of the concept of fire extinguishing systems and with COLT INEXCO ARGOSY, s.r.o. in the design of smoke and heat extraction systems.

The study addresses the following areas:

- Firefighting in bituminous areas,
- Addition of a CO_2 warning device in areas equipped with a stable extinguishing system,
- Turbine generator and turbine pump extinguishing system including pipe channels,
- Oil collector systems in seal oil management areas,
- Cooling system for the roof structure of the turbine hall and equipment for rapid heat and smoke extraction,
- Systems for increasing the fire resistance of the housing, including the doors of turbine halls and distribution rooms in the area of self-consumption transformers and reserve transformers,
- Internal fire water supply in containment,
- Replacement of the stable extinguishing systems (SES) using CO_2 in the turbine hall, distribution and central electrical control building with another type of SES using a less hazardous medium,
- Replacement of foam semi-stable extinguisher in diesel generator station (DGS) and common DGS with a stable extinguisher,
- Sprinkler system in the full-scale simulator,
- Extinguishing in workshop warehouses with stable or semi-stable extinguishing equipment,
- Stable or semi-stable extinguishing system in cable spaces central electrical control room building by another type of SES that will use a less hazardous medium,
- Sucking PYROCOOL extinguishing agent into a stable sprinklers in the oil holding areas at Main Reactor Unit.

In 2011, a "Technical Assistance" document was prepared to examine the suitability and addition of Electrical Fire Detectors (EFD) in selected areas of the reactor and auxiliary buildings. A fire risk analysis was made for each room and, where values were exceeded for rooms without fire risk, the actual values were verified on site.

In 2020, an "Assessment of the design of the ventilation systems and water cooling equipment" was prepared in terms of fire safety requirements in relation to nuclear safety and radiation protection of the bituminous line. The assessment focused on the implementation of the design requirements and the organisational measures of the operator prior to the start of and during the actual operation of the bitumen line to ensure the prevention of emergencies and spontaneous combustion of the bitumen product. Based on weak point’s identification the measures of the safety increase were proposed.

In 2020, an Analysis of the necessity of supplementing fire detectors in selected areas at the Temelín NPP was prepared.

2.1.A.2. Key assumptions and methodologies

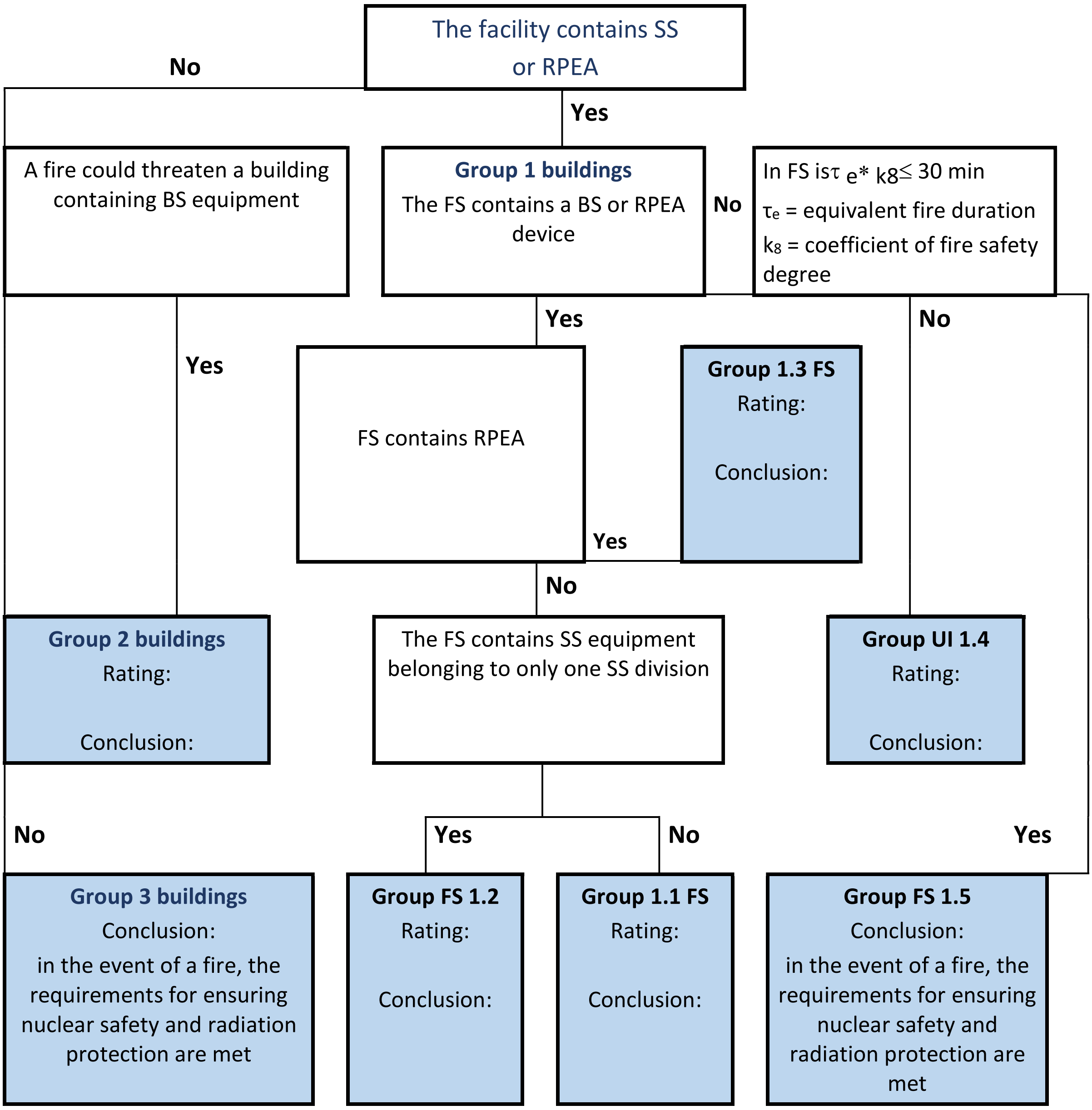
The basic normative regulations used for the individual systems of preventive measures design are the technical standards of fire safety in buildings. Together the recommendations of the IAEA Safety Guides, especially Safety Guide No. 50-SG-D2 (Rev. 1), Fire Protection in Nuclear Power Plants (hereafter referred to as IAEA 50-SG-D2), were respected.

Methodologies

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 jeopardised (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 jeopardised (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).

Algorithm for fire safety assessment of NPP buildings



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

Group 2 buildings - a fire in these buildings could jeopardise, 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.

Criteria for the selection of Group 2 buildings:

- the building containing the SS is adjacent to the assessed building or is located in a fire hazardous area of the assessed building,
- the building containing the SS 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.

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 jeopardise nuclear safety or radiation protection.

The fire sections (FS) of the assessed building can be divided into five groups:

the FS group	Description
1.1	SS equipment and components of multiple SS divisions are installed in the FS
1.2	SS equipment and components of only one SS division are installed in the FS
1.3	RPEA are located in the FS
1.4	there are no SS or RPEA equipment and components installed in the FS, but there is a higher fire load in the FS and therefore it must be examined in more detail whether the fire can affect the fire sections containing SS by secondary effects
1.5	no SS or RPEA equipment and components are installed in the FS and the FS is classified as a FS with a very low fire load that cannot affect adjacent fire sections

Since a fire in a FS classified in Group 1.5 cannot jeopardise nuclear safety or radiation protection, only FSs classified in Groups 1.1, 1.2, 1.3 and 1.4 are further evaluated.

The equipment and components of safety systems belonging to two or all three divisions of safety systems are installed in FSs classified in Group 1.1. Nuclear safety could be jeopardised if:

1. A fire (flames, heat, smoke) originating in the FS under evaluation will damage equipment or safety system components belonging to more than one division.
2. Fire action (extinguishing agent) in an evaluated FS will damage equipment or safety system components belonging to more than one division.
3. A fire originating in an evaluated FS will spread to one of the other FSs classified as Group 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.
4. Smoke arising from a fire in an evaluated FS will spread to one of the other FSs classified in Group 1.1, 1.2 or 1.3.
5. The extinguishing agent (water, extinguishing foam) used in the fire-fighting operation penetrates one of the other FSs classified in Group 1.1, 1.2 or 1.3.

Based on these characteristics, it is necessary, by answering predefined evaluating questions, to demonstrate an adequate level of fire protection in relation to nuclear safety and radiation protection.

Overview of the site classified as RPEA:

1. Rooms with ventilating iodine filters containing activated carbon,
2. Rooms for the reinforcement of RA substances by bituminisation,
3. Storage cells of combustible RS waste,
4. Storage areas for low-level RA waste,
5. Storage of used RA oil,
6. Fresh fuel storage,
7. Pipe bridge,
8. Spent fuel storage compartments.

Key Assumptions:

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.

The following fire prevention measures are taken at Temelín NPP:

- The amount of flammable substances and materials is limited.
- The spread of fire inside and outside buildings is prevented by setting fire sections.
- Building structures and materials used correspond to the fire risk in the fire sections.
- Safe evacuation of persons from the building is ensured.
- The distance between buildings and open fire areas is designed so that fire cannot spread between buildings.
- Technical and technological equipment and pipelines are designed, implemented and operated in such a way that the occurrence of fire is minimised and the activities necessary to ensure nuclear safety, fire protection and radiation protection can always be performed.
- The means and conditions for effective fire-fighting intervention are provided.

Restrictions on the use of flammable substances and materials

The use of flammable substances and materials in both the construction and technological parts is limited to the minimum necessary. In cases where the use of flammable substances and materials could not be excluded, technical and organisational measures are taken to limit or exclude the possibility of fire starting and spreading:

- Power cables and most low-current cables have enhanced resistance to the spread of fire, complying with IEC 332.3 category A, or IEC 331 tests, in all nuclear safety-important buildings.

- In the case of special cables (optic cables, coaxial cables) which could not be manufactured to meet the test according to IEC 332.3 category A in order to ensure their functionality, their resistance to the spread of fire is ensured by covering their entire length in steel tubes. These cables do not transmit power and cannot themselves be a source of fire.

- Inside the individual electrical and I&C cabinets, cables and other materials are of a common combustible type. Measures (fire sections, ventilation design) are implemented to prevent the negative effects of fire on these devices.

- Warehouses and compartments containing technological equipment with flammable liquids are designed and constructed according to ČSN 65 0201. They are equipped with catchers and emergency reservoirs to prevent uncontrolled flood of flammable liquids. The reservoirs and floors of rooms containing equipment with flammable liquids are made of non-flammable materials. In emergency reservoirs are installed in the emergency catchers to enable draining of the flammable liquid.
- A special category is flammable radioactive waste. Especially the activities in the reactor building are the source of these substances. These are (in most cases) low-level solid and liquid substances stored and processed in the radioactive media cleaning station. The method, handling and processing are subject to a special regime. Solid combustible substances are pressed; salts from liquid wastes are fixed by bituminisation.

In some cases, dangerous corrosive or toxic substances are present in the buildings. It can occur in small quantities in individual laboratories. Larger quantities are part of process equipment or are stored safely in chemical stores.

2.1.A.3. Fire phenomena analyses: overview of models, data and consequences

The document "Fire Risk Assessment" is elaborated for the buildings with activities performed with a high fire hazard and for construction buildings with an impact on the nuclear safety of the nuclear installation. The document contains a description of the building, building construction, technology, combustible materials in the building, ignition sources. Furthermore, the document describes the most complicated fire scenario with a calculation of the forces and resources needed to eliminate the fire.

The documentation is actualised as required by the Fire Protection Act. This document approves the South Bohemian Regional Fire Rescue Service. The latest version of the fire risk assessment of the 1st reactor turbine hall has approval issued on 18 April 2016.

Fire PSA is developed in accordance with the requirements of the Decree No. 162/2016 Coll. 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. The Fire PSA is not developed for SFS - spent nuclear fuel is stored in type approved packages.

The contributions of internal fires to the overall risk of unit operation are generally of little importance. The overall contribution to the unit operating risk (CDF risk measurement) to internal initiation events from internal fires is at 13.6% level.

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 and therefore negligible.

2.1.A.4. Main results/dominant events (permit holder´s experience)

The most complex fire scenario in the Temelín NPP is a fire of bearings lubricating oil of feed water supply turbine (FWST). The greatest 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 oil 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 loss 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 lubricating oil (approx. 1 litre/s). Taking into account the frequency of the service's activity, it has been determined that such a failure would result in a leak of approx. 10 m^3 of oil, which would partially flood over the platform at +15.00 m. Through the gap between the adjacent parts of the steam turbine and the gap between the platform and the steel channel in which the oil pipes are routed, the leaking oil will flow to the +0,00 m level. On the +0.00 m floor, oil will flow down the condensers and will partially flow into the milled channels. The oil will flow through the holes in the channels to floor - 5.00 m. At the -5.00 m level, the leaking oil will be collected in catch basins under the turbine generator stool and will partially flow into the cooling water pipe space that forms a catcher at the -8.20 m level. For this reason, a fire in the turbine hall is considered the most complicated fire scenario in the entire NPP. In other compartments (fire sections), fire caused damage will be limited in a positive meaning by the structural engineering design. The consequences will be less severe as the fire load in the other compartments with solid combustible substances is considerably lower. The damage will essentially only affect the equipment on which the fire occurred or the equipment in its immediate proximity. Repairing or replacing such equipment will be considerably easier and less time-consuming.

The binding conclusions that resulted from the evaluation of the possibility of effective fire elimination in the Temelín NPP site, part of the turbine hall, are presented in the following letters. The other binding technical, organisational and technological measures established by the fire risk assessment remain unchanged.

A. The measures to eliminate the most dangerous fire scenario in the area of sufficient forces and resources compared to the guaranteed 1st level of fire alarm for the given area confirms the necessity to establish the Fire Rescue Service Unit in the Temelín NPP (FRSU).

B. The minimum member of this unit shall not be less than 12 personnel per shift continuously ready to respond to an emergency.

C. The capacity of the external fire water supply meets the requirement of the necessary water supply for firefighting.

D. For extinguishing a fire occurring in turbine hall, a minimum of 2.2x 10 m^3 of special extinguishing agent Fomtec AFFF mixed with 1% water or an extinguishing agent of similar characteristics, miscible with Fomtec AFFF, shall be available.

E. Minimum equipment of the Temelín NPP FRSU with mobile firefighting equipment, respiration equipment and other equipment:

- CAS in technical design, with a pump capacity of at least 2000 l/min, water tank capacity of at least 2000 l and foam tank capacity of at least 100 l,
- CAS in a design for high-volume extinguishing, with a pump capacity of at least 3000 l/min, a water tank capacity of at least 8000 l and a foam tank capacity of at least 200 l,
- Automobile platform with a minimum range of 40 m,
- Positive respirators with a water capacity of the pressure flask at least 6 litres, filling pressure 30 MPa, in a minimum number of 18 pcs,
- Thermal camera.

2.1.A.5. Periodic review and management of changes

Any planned changes of the nuclear power plant site are submitted to the fire protection department for comments in design phase of the design. In the event that the Fire Protection Department (FPD) finds a discrepancy in the submitted documentation with respect to the legislative requirements, it will inform the sponsor of the change by recording a comment. If the proposed changes have an impact on the fire protection documentation, the FPD record the request for documentation modification. After the implementation of actions affecting the fire protection documentation, the documentation is revised to reflect the actual state of the building. All changes to the design of NPP are evaluated in terms of the requirements of the Atomic Act and the operator either apply for SÚJB permit prior to their implementation or notifies the SÚJB of the changes within the prescribed period.

After the implementation of the implemented actions with impact on fire protection, based on construction modifications or technology modifications, the documentation of the fire protection is corrected to reflect the current state of the equipment and buildings. Depending on the impact of the change, the necessity to modify the fire safety documentation is reassessed.

2.1.A.5.1. Overview of actions

Overview of actions with a direct impact on fire protection:

- Replacement detection type of the Electrical Fire Detection and Alarm (EFD) in the diesel generator station in the air heating rooms and intake chambers. In this action, SINTESO S-Line series multiprotocol detectors replaced the Algorex series multi-criteria detectors.
- EFD infrastructure replacement. This design resolved the replacement of the EFD system in external buildings (57 buildings), respectively sensors and exchangers, connected in the infrastructure communication circuit. All CZ-10 (MS9 series) and Algorex EFD exchangers (34 EFD exchangers) and EFD sensors (5220 detectors) were replaced. The fire detectors replacement "piece by piece" correspond to the replacement of the exchangers.
- Supplementation of the SE for the turbine-generator and turbine-pumps and fireproofing of the roof and supporting structures of the turbine hall in the following scope:
  1. Installation of systems to capture and contain leaking oil in the turbine-generator and turbine-pumps areas,
  2. Installation extinguishing systems of turbine generator and turbine pumps oil,
  3. Installation of heat and smoke extraction systems,
  4. Installation of a system to increase the fire resistance of the peripheral wall of the turbine hall in the area of the branch and reserve transformers,
  5. EFD installation at turbine generator and turbine pumps.
- Addition of video smoke detection to the turbine hall and intermediate turbine hall and measures for catching leaked oil. This requirement is a result (recommendation) of the modification team. The Production Director accepted the team's recommendation to implement measures to eliminate the risk arising from:
  1. Non-timely action of the existing EFD.
  2. Uncontrolled flood of leaked oil (possibly with water from the firefighting action) on floors +0.00 m and -5.00 m in the turbine hall and intermediate turbine hall.
- Replacement of fire pumps in the central water source station that did not met the necessary parameters for effective firefighting. The new fire pumps have higher performance parameters.
- Modernization of fire sealing in operational and administrative buildings of Temelín NPP (181 fire doors replaced).

2.1.A.5.2. Implementation status of changes

All changes have been completed.

2.1.A.6. Experience of the permit holder with fire safety analyses

2.1.A.6.1. Overview of strengths and weaknesses identified

In comparison to the Dukovany NPP, the Temelín NPP was designed according to the effective fire safety standards for buildings. The technical fire protection reports already cover the requirements set by the Atomic Act for deterministic analysis.

In cases modifications made to the technological and/or construction parts during construction, supplements to these reports were prepared. The technical fire protection reports and their supplements were discussed and approved by the relevant state authorities: the Office of Building Authority and the State Fire Inspectorate of the Fire Rescue Service.

Among others the most important was the supplement to the initial design No. 369 "Fire protection of buildings of the Soviet design zone". It described the main differences in the provision of fire protection and became the basis for the preparation of Supplement to Initial Design No. 369.

2.1.A.6.2. Lessons learned from events, reviews, fire safety related missions

The operator use following resources on good practice information:

- Information about events from other NPPs is analysed within the fire protection department and when found that a similar event could occur at NPP, the company implements measures to prevent the occurrence of a similar event in the fire protection documentation.
- FPD analyses any mission’s findings, which relate to fire protection, and findings to ensure improved fire safety enters into the fire protection documentation.
- Conference on fire protection and nuclear safety. Fire protection specialists obtain information on the latest trends in the field of fire safety. The information can be used to comment on new actions, or specialists recommend the implementation of these innovations at NPP.
- Evaluation of insurance companies – an operator always applies the proposed measures within a reasonable amount and as soon as possible.

2.1.B. Dukovany Nuclear Power Plant

2.1.B.1. Types and scope of the fire safety analyses

The Dukovany NPP has a number of works to demonstrate an adequate level of fire protection. These were mainly analyses required by legislation:

- Technical reports on fire protection, which were prepared for all buildings. The fire protection technical reports determined the fire risk for each fire section, which was the starting parameter for the fire safety design of the respective building. Supplements were made in cases of modifications to the technological or constructional part during construction. All technical fire protection reports were discussed with the Regional Fire Rescue Service of the Vysočina Region.
- Incorporation of the Dukovany NPP into the category of activities (09/2011) within the scope of the Fire Protection Act.
- The fire risk assessments (12/2019) are elaborated in the scope required for fire protection by the Decrees No. 246/2001 Coll. and No. 247/2001 Coll. The fire risk assessments prove compliance with requirements of national legislation and normative regulations for ensuring fire safety in the construction and technological parts of the buildings.
- Fire risk assessments required by Article 23 para. 4 of the Decree No. 329/2017 Coll. for buildings important for nuclear safety respect the scope required by the Fire Protection Act and

demonstrate that the requirements of national legislation and normative regulations for ensuring fire safety in the structural and technological parts of safety-significant buildings are met.

- In addition, voluntary analyses have been prepared, an overview of which is given in references.

Based on the results of the analyses, a large number of measures were implemented to improve the level of fire safety: expanding and improving the EFD, expanding and changing the stable extinguishing equipment, increasing the fire resistance of cables and cable channels, fire separation of individual important safety systems. The effect of fire extinguishing agent on technology, secondary effects of fire and fire extinguishing equipment, accidental activation of fire extinguishing equipment, secondary effects caused by direct action of fire or fire extinguishing equipment have been evaluated.

2.1.B.2. Key assumptions and methodologies

The basic normative regulations according to which the individual systems of preventive measures were designed are the technical standards of fire safety in buildings with respect of the recommendations of the IAEA Safety Guides, in particular Safety Guide No. 50-SG-D2 (Rev. 1), "Fire Protection in Nuclear Power Plants". The processing methodology used is conservative with the use of computer programs for fire safety calculations. Methodologies include conservative evaluation by engineering judgment, hand calculations and computer modelling.

The primary objective of the fire risk analysis is to demonstrate the safety of the systems required for the safe shutdown and cooling of the reactor. In the evaluation of fire protection for auxiliary safety systems has two parts

1. Fire protection of the fire section,
2. Effect of a fire inside a fire section on its other parts (separation, local passive protection).

All buildings design ensure in the event of any fire:

- Nuclear safety and radiation protection.
- Safe evacuation of persons from a burning or fire-threatened building or its part to the open air or to other non-fire-threatened compartments.
- Prevention of fire transmission to another building.
- Prevention of fire spread between individual fire sections inside the building.
- Effective intervention of firefighting units in firefighting and rescue work.

The following fire prevention at the Dukovany NPP implement:

- The amount of flammable substances and materials is reduced.
- The spread of fire inside and outside buildings is prevented by creating fire sections.
- Building structures and materials used correspond to the fire risk in the fire sections.
- Safe evacuation of persons from the building is ensured.
- The distance between the buildings and the design of the open areas disable fire spread between the buildings.
- Technical and technological equipment and pipelines design, construction and operation minimize the occurrence of fire and facilitate the activities necessary to ensure nuclear safety, fire protection and radiation protection any time.
- The means and conditions for effective firefighting intervention are provided.

Restrictions on the use of flammable substances and materials

The use of flammable substances and materials in both the construction and technological parts is limited to the minimum necessary. In cases where the use of flammable substances and materials could not be excluded, technical and organisational measures are taken to limit or exclude the possibility of fire starting and spreading:

- Power cables and most low-current cables have enhanced resistance to the spread of fire, complying with IEC 332.3 category A, or IEC 331 tests, in all nuclear safety-important buildings.
- In the case of special cables (optic cables, coaxial cables) which could not be manufactured to meet the test according to IEC 332.3 category A in order to ensure their functionality, their resistance to the spread of fire is ensured by covering their entire length in steel tubes. These cables do not transmit power and cannot themselves be a source of fire.
- Inside the individual electrical and I&C cabinets, cables and other materials are of a common combustible type. Measures (fire sections, ventilation design) are implemented to prevent the negative effects of fire on these devices.
- Warehouses and compartments containing technological equipment with flammable liquids are designed and constructed according to ČSN 65 0201. They are equipped with catchers and emergency reservoirs to prevent uncontrolled flood of flammable liquids. The reservoirs and floors of rooms containing equipment with flammable liquids are made of non-flammable materials. In emergency reservoirs are installed in the emergency catchers to enable draining of the flammable liquid.
- A special category is flammable radioactive waste. Especially the activities in the reactor building are the source of these substances. These are (in most cases) low-level solid and liquid substances stored and processed in the radioactive media cleaning station. The method, handling and processing are subject to a special regime. Solid combustible substances are pressed; salts from liquid wastes are fixed by bituminisation.

In some cases, dangerous corrosive or toxic substances are present in the buildings. It can occur in small quantities in individual laboratories. Larger quantities are part of process equipment or are stored safely in chemical stores.

2.1.B.3. Fire phenomena analyses: overview of models, data and consequences

The document "Fire Risk Assessment" is elaborated for the buildings with activities performed with a high fire hazard and for construction buildings with an impact on the nuclear safety of the nuclear installation. The document contains a description of the building, building construction, technology, combustible materials in the building, ignition sources. Furthermore, the document describes the most complicated fire scenario with a calculation of the forces and resources needed to eliminate the fire.

The documentation is actualised as required by the Fire Protection Act. This document approves the Vysočina Regional Fire Rescue Service. The latest approved version is dated December 2019 as revision 6.

Fire PSA is developed in accordance with the requirements of the Decree No. 162/2016 Coll. 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. The Fire PSA is not developed for SFS - spent nuclear fuel is stored in type approved packages.

The contributions of internal fires to the overall risk of unit operation are generally of little importance. The overall contribution to the unit operating risk (CDF risk measurement) to internal initiation events from internal fires is at 20.3% level.

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 and therefore negligible.

2.1.B.4. Main results and dominant events (permit holder´s experience)

In the fire hazard assessment, force and resource (FR) calculations for different fire scenarios based on the accepted calculation convention result:

- In areas with installed SE assumptions consider this equipment will be out of service and will not be considered in the FR calculation.
- The EFD, where installed, is functional.
- The EFD response to fire conditions is set within 1 minute (detection) and reporting to the FRSU dispatching immediately after detection.
- The calculation of the intensity of supply (litres per area) of high-pressure water per 1 m^2 will be about 40% litres per area of compact stream supply (according to the tests of VŠB Ostrava for jet type streamlines and pressure of 0.6 MPa). For calculation purposes, a conservative estimate of 40 % litres per area for a high-pressure jet delivered at 4 MPa or 20 MPa will be used.
- The intensity of foam delivery to m^2 is determined by the manufacturer or supplier of the foam.
- The covering of cables with fire-resistant material to prevent the spread of fire through the cable insulation is not considered.
- Installation of cables with reduced flammability is not considered.
- The 4 MPa high-pressure water jet with the NEPIRO nozzle and the 20 MPa high-pressure water jet (both splintered and full) with the TRIPLEX nozzle are capable of extinguishing electrical equipment with a voltage of up to 35 kV from a distance of 1 m.
- It is not necessary to determine the calculation of the water demand.

The Dukovany NPP has an inexhaustible supply of water from a dammed lake. Fire water is supplied from the technical water system by separate pumps. The transport pumps are 3 times redundant and there is sufficient fire water piping in the plant area.

According to these assumptions, force and resource calculations apply to these compartments:

1. Main circulation pump
2. Turbine halls
3. Cable channel
4. Paint warehouse Heřmanice
5. Hydrogen storage
6. Special building - fuel storage
7. Manufacturing building - changing room unclean - controlled area
8. Hazardous waste warehouse - paint warehouse
9. Auxiliary boiler room - warehouse
10. RA waste storage - storage bunker
11. Processing of RA waste - bituminous line
12. Documentation Centre - Archive
13. Diesel generator - engine hall
14. Fuel management DG
15. Block transformers.

On the basis of calculations, the minimum number of the Dukovany NPP firefighting personnel was determined as follows: 12 firefighters for the day shift (6:00 am to 6:00 pm) and 11 for the night shift (6:00 pm to 6:00 am - due to the limitation of fire supervision activities during night hours).

Among other technical measures, the Fire Risk Assessment stated:

- To equip the Fire Rescue Service Unit with respiration apparatus with a protection time of over 45 minutes for intervention in cable channels for at least 2 two-person groups.

- To equip the FRSU with suitable fire extinguishing equipment for extinguishing cable channels in view of the high temperature in confined spaces, the possibility of hidden spread and especially the risk of electric shock.
- When reconstructing buildings, ensure that the fire safety of buildings and technological complex is not compromised (consistent division into fire sections), proceed in accordance with the currently applicable fire safety legislation.

A few important milestones from the last years related to the update of the Fire PSA for the Dukovany NPP results:

- Addition of "Hydrogen Explosion or Turbine Hall Fire" event to PSA (added to PSA in 2010),
- Comprehensive review and update of the Fire PSA (implemented in 2018 - 2019).

2.1.B.5. Periodic review and management of changes

Any planned changes of the nuclear power plant site are submitted to the fire protection department for comments in design phase of the design. In the event that the Fire Protection Department (FPD) finds a discrepancy in the submitted documentation with respect to the legislative requirements, it will inform the sponsor of the change by recording a comment. If the proposed changes have an impact on the fire protection documentation, the FPD record the request for documentation modification. After the implementation of actions affecting the fire protection documentation, the documentation is revised to reflect the actual state of the building. All changes to the design of NPP are evaluated in terms of the requirements of the Atomic Act and the operator either apply for SÚJB permit prior to their implementation or notifies the SÚJB of the changes within the prescribed period.

After the implementation of the realized actions with impact on fire protection, based on construction modifications or technology modifications, the documentation of the fire protection is corrected to reflect the current state of the equipment and buildings. Depending on the impact of the change, the necessity to modify the fire safety documentation is reassessed:

- Fire Risk Assessment – following approval by the Regional FRS,
- Fire alarm guidelines,
- Fire orders,
- Fire evacuation plans,
- Documentation of firefighting.

2.1.B.5.1. Overview of actions

An overview of the most important events with a direct impact on fire protection:

- Replacement of stable halon fire extinguisher - the intention was to replace Halon 1301 extinguisher with FK-5-1-12 extinguisher in the areas at storey 9.6 m level, reported and assessed by the SÚJB.
- Ensuring the tightness of the fire sections following the replacement of the Halon 1301 - required for extinguishing with FK-5-1-12 extinguishing agent.
- Modification of the detection and control part of the EFD on the storeys - EFD modernization.
- Installation of additional ventilation systems on the storeys, necessitated by the installation of the new SE.
- Replacement of the Cerberus EFD system at main reactor units including the extension system - it was a complete replacement of the entire Cerberus EFD system by Siemens with Honeywell systems in all compartments and about 100 additional EFD sensors in important compartments, such as in the turbine-generator halls.

2.1.B.5.2. Status of implementation of changes

The replacing halon fire extinguishing systems with halon 1301 action, originally planned to be completed by 1 January 2020, was delayed due to demanding construction and technical modifications to the protected buildings. The lower efficiency of the new extinguishing agent compared to the original one and its different physical quality required resealing of all compartments. In addition, the installation of new ventilation components was necessary. These ensure both a higher airtightness of the ventilation system and a perfect mixing of the extinguishing agent with the air in the protected compartments. The complete implementation, including the successful final tests, was therefore completed in mid-2023.

2.1.B.6. Experience of the permit holder with fire safety analyses

2.1.B.6.1. Overview of strengths and weaknesses identified

The design of all the Dukovany NPP units originates in period before effectiveness of the construction standard ČSN 730804 "Fire safety of buildings - Production buildings". Therefore, the operator requested the Technical University of Ostrava – College of Mining Ostrava and the company M-servis Ostrava to provide a series of analyses to determine the state of fire safety by comparison with the requirements of the new standards. The positive finding is that the design was robust enough to meet the order of higher degree requirements of the new standards.

As "strengths" the operator evaluates:

- The EFD protects all safety important areas.
- Application of the Safety Requirements Supervision SW, where deficiencies are recorded not only in the area of fire safety. The deficiencies are further monitored, evaluated, trends of their development are determined, etc.
- The renewal of the fire equipment of the FRSU.
- Incorporation of the nuclear power FRSU into the state's alarm plans and enabling the unit to travel to the nearby area to cooperate with regional FRS units. Introducing the elements of cooperation and real distress cannot be replaced by any drill, which always lacks real distress.

In contrast, the following are assessed as "weaknesses":

- A number of changes to the buildings burden the documentation of buildings in terms of fire safety of buildings. The original documentation and subsequent changes are now being incorporated into one document.
- The water SE, which protects the cable compartments, is already obsolete. At present, the Dukovany NPP has developed a requirement for the selection of the most suitable method of securing the cable compartments by the SE. A working group has been set up to evaluate the different options.

2.1.B.6.2. Lessons learned from events, reviews, fire safety related missions

The operator uses following resources of information on good practice:

- Information about events from other NPPs is analysed within the fire protection department and when found that a similar event could occur at NPP, the company implements measures to prevent the occurrence of a similar event in the fire protection documentation.
- FPD analyses any mission’s findings, which relate to fire protection, and findings to ensure improved fire safety enters into the fire protection documentation.

- Conference on fire protection and nuclear safety. Fire protection specialists obtain information on the latest trends in the field of fire safety. The information can be used to comment on new actions, or specialists recommend the implementation of these innovations at NPP.
- Evaluation of insurance companies – company always apply the proposed measures within a reasonable amount and as soon as possible.

2.1.7. Regulator's assessment and conclusions on fire safety analyses

2.1.7.1. Overview of strengths and weaknesses identified by regulator

Both nuclear power plants have developed deterministic and probabilistic analyses that fulfil relevant requirements of Czech legislation.

The Temelín NPP and the Dukovany NPP are actively involved in international organisations of nuclear power plant operators in the world (WANO). They have established contacts for direct cooperation with several NPPs in Europe. This enables an active and effective exchange of operational experience with other operators. The system of adopting experience and knowledge from other NPPs, the so-called external feedback, is described in the methodology "Internal and external feedback from operational experience" and is ensured by the Operational Experience Management Department in cooperation with other departments of ČEZ, PLC, Overall, the system is focused on 5 basic programmes:

1. Processing of reports on external operational events (WANO-WER, IAEA-IRS).
2. Administration of information about events at ČEZ NPP to the WANO network.
3. Elaboration of Significant Operating Experience Reports and recommendations.
4. Direct exchange of information between operators (e.g. EDU - EBO, EMO, Paks...).
5. Good practice, Just in Time information.

The external feedback process has SW support in the form of the "Unified Record Tracking System" application (database common for internal and external feedback, near-miss events, record experience). Through this SW application, all relevant information obtained from WANO, INPO, IAEA sources (IRS, NEWS, PRIS) is registered and sent to the expert divisions/departments for information as "Events for Information" or for review and analysis as "Events for Further Use". Where appropriate, expert join the assessed external information with corrective actions at the NPP itself proposal: the training, incorporation into management and operational documentation, or technical change. The established "fault committee" monitor all corrective actions. The most significant events at foreign plants are communicated to the relevant personnel in training days.

In accordance with the requirements of the SÚJB, a basic set of operational safety indicators is defined, including:

- Unit availability factor
- Fuel reliability
- Number of INES events
- Number and severity of failure events
- Unplanned loss of power factor
- Containment tightness
- Number of fires in the NPP area
- Number of unplanned emergency shutdowns per 7000 hours of criticality
- Safety systems unavailability
- Number of unplanned fast reactor shutdowns and limiting system actuations
- Inoperability of monitored safety systems
- Number of unplanned safety system activations
- Number of Technical Specifications (TS) violations
- Number of temporary changes to TS

- Collective dose equivalent
- Number of INES incidents caused by employees
- Radioactive discharge activity.

The aim of the systematic and effective use of these indicators is to detect possible degradation of the safety level in time and, with the help of corrective measures, to achieve the restoration of the desired state or improvement of the safety level.

One of the important findings that can be stressed as a strong element is the inclusion of the FRSU of each nuclear power plant in the alarm plans of the state and the possibility of the unit's departure to the nearby surroundings to cooperate with the Regional FRS. The introduction of the elements of cooperation and real distress cannot be replaced by any training for the members of the Fire Rescue Service.

The slow implementation of the changes seems to be the weaker point at the moment, but this is due to the complexity and timeframe in complying with all legally binding requirements. As the Czech state is the majority owner of the utility ČEZ, PLC, a special law setting out the rules for public procurement is obligatory for large-scale supplies. Strict requirements for the established management system and quality proof are applied when selecting suppliers.

2.1.7.2. Lessons learned from inspection and assessment as part of the regulatory oversight

In terms of the use of analyses and related documentation, the inspection procedure mandatory include points relating to compliance with the requirements of the Technical Specification (Limits and Conditions document) and the operating regulations, i.e. documents directly based on the fire analyses. The fire protection inspections focus on the area of technical and documentary support for operations and its compliance with the requirements of the analyses.

The current annual revision of the Operational Safety Analysis Report includes both deterministic and probabilistic analysis of NPP fire protection and is subject to SÚJB regular assessment. Fire protection is then included in the Periodic Safety Review in the areas of "Design" and "Risk Analysis". PSR is organized at an interval of 10 years.

Inspection activities performed by the SÚJB and the Fire Rescue Service results, that both nuclear power plants are safe in terms of fire protection and become “a subject of interest” for increased activity in this area due to the specific conditions for intervention, evacuation and crisis management.

2.1.7.3. Conclusions drawn on the adequacy of the permit holder's fire safety analyses

Although the original Russian design of the Dukovany NPP originates before 1985 (the starting execution of the system of basic standards for fire safety of buildings in the Czech Republic), it has been continuously modified and supplemented. Therefore, a new analysis of all safety significant buildings is in place. The new analyses have shown that the buildings can meet the new conditions and requirements.

The Temelín NPP design was finally completed under the conditions of the Fire Protection Act at the time it was in force, and therefore no major change or reassessment of the buildings to meet the new requirements was required.

Whenever a new facility has been constructed on the site after start of NPP operation, such as new spent fuel storage facilities (in the Dukovany NPP permitted in 2002, in the Temelín NPP in operation since 2010), construction of new cooling ventilation building in the Dukovany NPP in 2015, a reassessment of all safety aspects including fire protection is obligatory.

The ČEZ understand the improvement of fire safety as a continuous process of ensuring the safety of the NPP as a whole and therefore it can be stated that the system of analyses and reviews of both nuclear power plants Dukovany and Temelín is adequate.

2.2. Research reactors

C. Research reactor LVR-15 in Řež

2.2.1. Type and scope of fire safety analyses

The fire protection measures implemented in the LVR-15 reactor building, especially in the compartments containing equipment important for nuclear safety, were assessed in the fire risk analysis of the LVR-15 reactor. As it is a stand-alone 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, which has the characteristics of a production facility, the assessment is based on ČSN 730804 requirements.

For the purpose of safety analyses, a set of postulated initiation 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. Criteria established for the assessment of significance - a frequency level of 10^{-7}/yr defines the limit at which an emergency plan for a nuclear installation shall be prepared. According to the PSA study, the level of risk of LVR-15 reactor operation, expressed in terms of the annual frequency of fuel damage in the reactor, is lower. Therefore, in accordance with Decree No 359/2016 Coll. on the details for ensuring the management of a radiation emergency, Research Centre Řež s.r.o. does not submit a proposal to the SÚJB for the establishment of an emergency planning zone for the LVR-15 reactor.

2.2.2. Key assumptions and methodologies

The building structures of the original design are assessed for fire resistance according to the previously valid standard ČSN 73 0823 under indirect fire action. The resistance of newer wooden door entrances to standard buildings is about 30 min according to the previously valid ČSN 73 0821, the resistance of external masonry 45 cm thick is 65 min at temperatures corresponding to usual fires. In the evaluation of the initial design, it was assumed that temperatures of several 1 000 °C are reached during the combustion of chemical gases and vapours based on light hydrocarbons; for these reasons, the above fire resistance was reduced to approximately 60 % according to the tabulated values of the applicable standard.

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 at a probable quantity of 60 t TNT for 15 min (temperature 310 to 2950 °C, radiation: 285-1000 kcal/kg TNT).

For internal fires, it is assumed that the fire will be signalled by the EFD system to the reactor operator's room, to the gatehouse and to the FRSU of Nuclear Research Institute Řež, PLC, of which LVR-15 is a part. After verifying the extent of the fire, the reactor operator will follow the internal emergency plan and emergency procedures (shut down the reactor and ensure its cooling).

2.2.3. Fire phenomena analyses: overview of models, data and consequences

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 in the walkway to the 1st gallery or in the operator's room itself. In the event of cable burning, the reactor will be shut down due to the failure of the 48 V supply voltage fuse in the el. distributor, resulting in the loss of power to the control rods electromagnets with a subsequent fall into the core. Possible damage to the power cables to the control rod drives would be equivalent to a power failure to these devices and will result in the control rods falling into the core. If fire subsequently affect the reactor pump /distribution compartment, the safety function of core cooling could be compromised - these scenarios would be equivalent to the electrical failure scenarios for which the established acceptability criteria are met.

Fire in the reactor hall during shutdown

This type of fire on the reactor cannot affect the safety function of shutdown and reactor subcriticality preservation, as the shutdown is done by inserting the rods into the bottom position, and this is a passive function without electrical power supply. A fire in the hall may present a radiation hazard if affect contaminated or activated combustible materials - the burning of the radioactive waste package is assumed. The burning of the package 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 signalled by the EFD system to the reactor operator room and the operator will shut down the reactor and activate 0cooling in accordance with the procedures in the internal emergency plan after verifying the extent of the fire. Industrial cameras connected to the reactor control room provide a visual overview of the reactor technology in the reactor hall and pump room. If the fire were to spread, it interrupts electrical power supply to the pumps and the reactor would be without forced heat removal. This initiating event is analysed in the core loss-of-flow failure.

The impact of forest fires and other continuous ground cover

Based on the requirements of Decree No. 378/2016 Coll., §12, the assessment of the impact of forest fires and other ground cover describe in more detail the Operational Safety Analysis Report (OSAR), used for next conclusions. This assessment evaluates the impact of natural fires on the LVR-15 reactor building in distance 5 km of the building and the most complex fire scenario in control room. In the event of a forest fire or other fire occurring directly on the Nuclear Research Institute site, Nuclear Research Institute Řež FRSU will be activated immediately. Any fire in the buildings that could spread to the forest or vice versa is detected in time and its further development is suppressed.

Assuming that a forest fire would occur in the vicinity of the LVR-15 building, due to its nature located in a steep slope (the fire tends to spread up the slope), the distance of the trees from the reactor building and the presence of the FRSU shift directly on the site in close proximity, it can be concluded that there will be no major threat to the LVR-15 reactor. In the event that a fire were to jump from the forest to the LVR-15 building, the building is equipped with a stationary fire water distribution system to each floor, portable fire extinguishers and a fire order for firefighting. The FRSU crew is able to intervene in the reactor building within 4 minutes from the fire alarm. Conclusion is that even natural fires do not affect the nuclear safety of the operation of the LVR-15 reactor.

2.2.4. Main results/dominant events (permit holder´s experience)

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 entire facility has classification as the category of activities with increased fire hazard, according to the Fire Protection Act.

In all these circumstances under investigation, such as the most complex fire scenario in the LVR-15 reactor control room or the most complex fire scenario in the LVR-15 reactor hall, the reactor will always safely shuts down and keep in a safe subcritical condition. 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 analysed in detail in Chapter 22 in OSAR - Loss of Working Electrical Power Sources - Failure of Both cooling Pumps). Thus, the fire may affect cooling operation, but will not melt the fuel cladding, and therefore will not release RA substances to the environment and endanger reactor operators.

Based on a preliminary assessment and investigation, both the conditions for the occurrence and spread of wildfires and the fire protection measures realization were evaluated. With the fire protection and firefighting system in site of Nuclear Research Institute Řež, the conditions for the safe operation of the LVR-15 nuclear installation are not affected.

2.2.5. Periodic review and management of changes

The fire protection evaluation can be divided into regular fire prevention actions and evaluation of changes fire impact.

Utility fire personnel perform regular fire risk assessment by regular checks in accordance with national fire prevention rules - site visits, checks of the fire technical system, random checks of fire watches, preparation and revision of firefighting documentation, revision of fire safety design documentation in accordance with new standards.

Part of the evaluation of preparedness for fire type events is the conduct of drills and emergency exercises with simulated fires in the technology and surroundings at an interval of at least 1 per 2years, including the participation of external units for training the necessary cooperation during an event.

Regular exercises focus at creating a situation with the need for cooperation with external units and other parts of the company. The exercises include an evaluation part to set up an action plan to implement possible improvements for the next period.

Evaluation of the technology change process classify the technology according to internal procedures according to its impact on safety. Essential is the evaluation of the change by the safety committee, whose members are specialists in the field of safety and protection against occupational hazards, who also take care of the fire protection agenda. The evaluation criteria for a change design include meeting the requirements of the Decree and the designed fire resistance conditions.

The areas and technologies assessed include cable lines, el. distributors, motors and other power equipment, and other equipment with increased fire risk. The EFD condition and state is monitored and assessed.

2.2.5.1. Overview of actions

Revision of the fire safety design (FSD) of the reactor building construction is from 2022. The documentation includes a description of the individual parts of the building, characterization of flammable substances and their location; determination of individual fire sections in the building, assessment of individual parts of the building from the point of view of fire, assessment of the technical equipment of the building and equipment for fire fighting

Revision of the firefighting documentation - in cooperation with the local FRS unit of the municipality, the firefighting documentation is revised at regular intervals in accordance with the implementation of changes, e.g. in the area of the location and nature of workplaces.

Periodic inspections of the reactor - in the management area of the company, a working unit for the supervision of classical risks, including fire, has been defined; a fire prevention officer and members of the fire watch have been defined for the reactor building itself. These members assure site walks at regular intervals, including taking a record of the status and progress of remediation, and the findings are reported to the company's management.

2.2.5.2. Status of implementation of changes

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. To reduce the fire risk, unused parts of the ventilation system and older experimental equipment are disposed of.

In the area of fire management documentation, this mainly involves updates to the layout of polyethylene type materials used as shielding for neutron horizontal beams in the building and revisions to the FRSU emergency response instructions with respect to changes in the use and location of ionizing radiation sources and the subsequent setting of the reactor control zone.

In the area of ageing management, mapping of current regulatory requirements and related standards are provided to meet the needs of further refurbishment of instrumentation and control systems of gas management systems of experimental equipment that has been preliminarily assessed as significant in terms of fire risk.

Individual exercises passed as planned - the last one in 2021 with the topic of a irradiation source shielding fire at the workplace requiring cooperation with external rescue services. The next fire exercise is planned in 2023.

2.2.6. Experience of the permit holder with fire safety analyses

The fire protection documentation - fire safety design of the facility and firefighting documentation - at the reactor building level is updated.

The evaluation of the technology itself more focuses on demonstrating and proving the capability to perform the safety functions of selected SSC also in the event of a fire initiating event. Following the establishment of basic equipment qualification requirements, additional requirements for retrofits and technology upgrades are established.

The monitoring of developments in the field of fire prevention and fire management is continuously incorporated into emergency and fire management procedures for members of FRSU. These are validated at regular intervals in the form of exercises.

2.2.6.1. Overview of strengths and weaknesses identified

The location of the FRSU on-site and the way of cooperation in the field of prevention, training and exercise of personnel influences positively especially the realization of exercises and drills in the field of firefighting.

The coming into force of the new standards in the area of conventional fire protection of the building imposes new requirements for the separation of fire sections, which the original LVR-15 design did not have. That results in necessary partial adjustments especially in the area of the location and design of fire seals and separation of fire sections (fire doors), requirements for the design of ventilation, etc.

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.

The specific use of a nuclear research facility (number of personnel in laboratories, reactor hall, etc.) limits the use of some automated halotron-based extinguishing agents.

Building constraints given by the original design limit the application of selected physical separation practices, particularly cable lines, as an appliance of preventing CCF events (typically fire). In these cases, further analyses are required to justify the graduated approach procedures (typically the expected extent of disruption to the safety function when the entire system is lost).

2.2.6.2. Lessons learned from events, assessments, fire safety related missions

No specific missions came to review the fire protection analysis. The INSARR mission in 2003 and 2020 respectively performed independent assessment of reactor operations. Although the mission is not directly focused on fire protection, these issues were also addressed in the assessment of general safety requirements - both with reference to the need for fire hazard reduction (disposal of older technologies) and the need for comprehensive instructions for personnel response (emergency procedures and emergency instructions).

The LVR-15 reactor has not been affected by a significant fire since the 1989 reconstruction. The last documented fire was in the reactor hall in the cable line, which was extinguished without limiting the operability of safety-significant equipment and the affected portion of the cable line was repaired.

2.2.7. Regulator’s assessment and conclusions on fire safety analyses

Nuclear Research Institute Řež, as the owner and utility of the entire site, and RC Řež, as the operator of the LVR-15 reactor, have prepared the necessary deterministic analyses that meet the requirements of the legislation and are based on the risk assessment. One of the important findings, which can be described as a good practice, is the inclusion of the internal FRSU in the region's alarm plans and the possibility of the unit's departure to the nearby surroundings to cooperate with the Regional FRS.

2.3. Fuel cycle equipment

There are no separate installations for the production, enrichment and reprocessing of nuclear fuel in the Czech Republic.

2.4. Dedicated spent fuel storage installation

Temelín SFS

The initial criterion for the assessment of the building structures in terms of fire safety in the SFS is the fire risk, which has been determined for each fire section. The methodology of ČSN 730804 determine the fire risk. In the fire safety design, according to the determined fire risk, all fire sections (except the elevator well) are classified as fire safety level I - (the elevator well is explicitly classified as fire safety level III according to ČSN 73 0804).

Safety analyses of the Temelín NPP SFS during normal operation and postulated incidents in detailed describe in the SFS Safety Analysis Report. Natural fires, fire in the SFS and explosion of technical gases are among the postulated initiating events. In the event of a forest fire or other external fire (fire of other continuous vegetation, etc.), the heat flux emitted by the fire, which may cause failure or malfunction of the SSCs, represents a potential threat to the nuclear safety of the NPP. The distance and area of forest and fields close to the Temelín NPP 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 the category of extended design conditions and meets the requirements of a realistic approach. Application of a conservative approach in the form of "largest existing aircraft" is not required. The analyses performed indicate that 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.

2.5. Waste storage facilities

It was not selected due to its minimal significance in terms of the combination of radiation and fire risk. The fire protection of the radioactive waste repositories located in sites of the Dukovany Nuclear Power Plant and the Nuclear Research Institute in Řež, are included in the analyses of the nuclear installation as a whole.

2.6. Facilities in decommissioning

There are currently no decommissioned nuclear facilities in the Czech Republic.

3. Fire Protection Concept and Its Implementation

Each nuclear installations is assigned by additional letter in the recommended chapter numbering for the purpose of description in Chapter 3:

3A – The Temelín NPP

A number of works for the Temelín NPP demonstrate an adequate level of fire protection. These included:

- Technical reports on fire protection for all buildings. The reports determined the fire risk for each fire section, which was the initial parameter for the fire safety design of the respective building.
- "Expert assessment of fire protection of buildings of the Soviet design zone", which was prepared to increase the level of fire safety in buildings designed in the former Soviet Union.
- "Audit No. 5", which examined the design of significant nuclear power plant buildings in relation to the relationship between fire hazards and safe shutdown of the nuclear reactor according to the criteria defined in US 10CFR50, Appendix R and NUREG-8000, Part 9.5.1 (1995).
- The Operational Safety Analysis Report, in which the design of the nuclear power plant buildings was assessed and evaluated after commissioning.
- "Nuclear Fire Protection Assessment", which evaluates the links between fire protection and nuclear safety as well as radiation protection in the reactor building.
- Fire hazard assessments, which are currently prepared in accordance with Section 23(4) of Decree No. 329/2017 Coll. for the following buildings important from the point of view of nuclear safety:

- Reactor buildings
- Auxiliary Building - Warehouses and workshops of the controlled zone
- Auxiliary Building - Changing Rooms and Laboratories in the controlled zone

- Auxiliary building - RA media cleaning station
- Switchboard rooms
- Turbine halls
- Diesel generator, compressor and feed-water station
- Common diesel generator station
- DGS petroleum management
- Reserve power Switchboard building
- Connecting bridges between the auxiliary and the reactor buildings
- Ventilation chimney for auxiliary building
- Cable channels connecting buildings important for nuclear safety.

In 2003 a coordination study “the Temelín NPP – IV.B construction, Fire safety increase” set out the requirements for improving fire safety and the conditions under which these improvements can be implemented. The document is the basis for strategic decisions in connection with the gradual improvement of fire safety at the plant. The initial requirements were determined based on recommendations from several audits and comments from insurance companies. Locations for fire safety improvements were identified. None of these "weak points" relate to the potential impact of fire on nuclear safety.

3B – The Dukovany NPP

In the original design of the Dukovany NPP, the buildings were divided into two groups - zones:

- ✓ -the so-called "Soviet design zone", which included buildings and systems directly related to nuclear energy technology and nuclear safety,
- ✓ -the so-called "Czechoslovak design zone", in which the other buildings were located.

In the "Soviet design zone", the design of fire protection systems was basically designed according to Soviet standards and regulations. These were the following buildings:

- Reactor building (foundation part, hermetic part)
- Auxiliary Building
- Diesel generator, compressor and pumping stations
- Compressor station
- Central feed-water station

The Dukovany NPP fire protection system is based on the original Soviet design concept of "defence in depth". The concept of this DiD is based on the interconnection of fire prevention and fire suppression solutions and is based on:

- Fire prevention (selection of materials, operational inspections of fire risk compartments),
- Early detection and extinguishing of fires (EFD, extinguishers, sprinklers, mobile means, etc.),
- Preventing the spread of unextinguished fires (fire separation structures, Fire Rescue Service Unit, external FRS units).

This original design concept has been updated to meet the requirements of national regulations, standards and the additionally formulated the fire protection targets.

From the contract for the Soviet technical design of the Dukovany NPP and its evaluation results, the basic specification states, that the design documentation of the Soviet zone will be prepared on the basis of Soviet standards. The Czechoslovak standards and regulations would apply to the extent that it would not affect the conception and design of the equipment and the concept of nuclear safety given by Soviet regulations. In the "Czechoslovak design zone", the fire protection systems were designed fully in accordance with Czechoslovak legislation and technical regulations, taking into account the IAEA 50-SG-D2 recommendations.

In the USSR, the basic requirements for fire safety were based on production categories only. This method provides only an approximate estimate, as other important parameters that substantially describe the fire risk in a building are not considered. These include, in particular, the assessment according to the type and quantity of combustible substances, the geometry of the space and the method of ventilation.

Fire protection design improvements

Due to the fact, that the Soviet design documentation did not contain a comprehensive fire protection solution, there was no coordinated solution of individual professions (especially ventilation), the documentation described only partial solutions of fire protection in the construction and technological part and primarily due to the different concept of fire safety standards in the Soviet Union and Czechoslovakia, it was necessary to elaborate the design solution, so that it was in accordance with the concept of valid standards and regulations in Czechoslovakia and international standards were respected.

Concept of design solution for Fire Protection of Nuclear Power Plants

The design concept of the fire protection of the Dukovany and Temelín nuclear power plants is based on the requirements for nuclear safety and radiation protection. The design aim is to create such conditions and prerequisites, that during operation it will be ensured that any fire that occurs in the NPP (despite the preventive measures taken) will not be the cause of non-compliance with any of the general safety requirements specified in the applicable decrees in the field of nuclear law (currently Decree No. 329/2017 Coll.) and in IAEA 50-SG-D2.

These general safety requirements state that there must be:

1. Assured safe shutdown of the reactor and its safe shutdown state preservation,
2. Ensured the residual heat removal from the reactor core after shutdown,
3. Ensure mitigation of the releases of radioactive substances so that any releases do not exceed the limits set.

Fire risk assessments are prepared to the extent required by the Fire Protection Act. The fire risk assessments demonstrate that the requirements of national legal and normative regulations for ensuring fire safety in the construction and technological parts of selected buildings are met.

3C – The Research Reactor LVR-15

The objective of the fire protection concept in the LVR-15 reactor building is to ensure nuclear safety, radiation protection and protection of life and health of workers and property.

The fire protection implements three levels

- Preventive measures of fire inception,
- Systems for detecting and extinguishing fires,
- Preventing the spread of fire and ensuring nuclear safety requirements during fires.

In terms of nuclear safety, the reactor systems shall ensure that even in the event of a fire:

- Safe shutdown of the reactor,
- Dissipation of residual heat after reactor shutdown,
- To limit the release of RA substances into the environment below specified limits.

Structure of fire protection provision

Fire Prevention Section:

- Professionally Qualified Person of Nuclear Research Centre Řež,
- Fire prevention officers,
- Preventive fire patrols,
- Persons in charge of fire supervision,
- Persons in charge of fire protection during non-working hours and during possible reduced operation - on the basis of a contract with Nuclear Research Institute Řež PLC

Fire Repression Section:

- The company's FRSU - on the basis of a contract with Nuclear Research Institute Řež PLC,
- Preventive fire patrols,
- Persons in charge of fire supervision.

3D – The Spent Fuel Storages

The design concept of the fire protection design of the Dukovany and Temelín SFS is based on the requirements for nuclear safety and radiation protection. The aim of the design is to ensure create conditions and prerequisites, that any fire occurring in the NPP site, NPP buildings or SFS (despite the preventive measures taken) during SFS operation will violate none of the general safety requirements specified in the applicable nuclear decrees.

3.1. Fire prevention

3.1.A. Fire prevention at the Temelín NPP

Fire protection is ensured by the consistent application of the "defence in depth" approach, which creates the following three levels (barriers) in relation to fire protection:

1. Preventive measures - to forestall fire as far as possible.
2. Fire detection, reporting and extinguishing systems - to ensure, that a fire that occurs despite preventive measures, is detected and reported immediately after its occurrence and means are available for prompt extinguishing.
3. Fire separating structures - prevent the spread of an unextinguished fire outside the fire section so that it not endangers the performance of the basic safety functions of the nuclear power plant.

The aim of the Temelín NPP fire protection design was to ensure a balance between all three of these levels of defence in depth. This was based on the following principles and procedures:

1. The routes and locations of equipment and individual components of all safety systems providing the NPP safety functions defined by the design have been identified, including identification of their redundancy and integration into the safety system divisions; equipment and components of systems related to nuclear safety have also been identified.
2. The individual buildings were divided into fire sections to ensure:
   a) Compartments containing redundant equipment and components of safety and nuclear safety related systems separated to Fire sections.
   b) Fire separation of site, which are namely listed in the Czech normative regulations, i.e.:
      - protected emergency routes
      - shafts and turbine halls of evacuation and fire lifts
      - elevator, installation and cable shafts, cable rooms, cable channels
      - ventilation units except those serving only one single fire section
      - control and computing centres with an area greater than 100 m^2

- electrical el. distributor rooms with an area greater than 100 m^2, transformer chambers
- Workrooms and compartments that shall form separate fire sections according to the relevant standards (especially according to ČSN 65 0201).

c) Easy and safe escape of persons from each fire section.
d) Rapid and effective intervention of FRSU.
e) Separation of high fire risk workrooms or workrooms with a higher probability of fire occurrence and spread from other operations.
f) Limitation of the number of hatches in fire separating structures.
g) The possibility of exhausting combustion products outside the building.
h) Limitation of the extent of damage.

3. When it is not possible to locate redundant equipment and components of safety systems or safety-related systems in separate fire sections (containment, control room, emergency control room, cable space under control room, etc.), fire protection systems shall be designed to limit the spread of fire in these fire sections and to eliminate unacceptable effects of fire or the fire protection systems themselves on the redundant safety systems.
4. Passive systems were preferably designed, i.e. systems whose functionality does not depend on energy supply.
5. In the construction and technological part of the design, the use of flammable materials and fire-hazardous substances was (as far as possible) excluded or at least limited; in cases where it was not possible to implement this principle, such flammable (or fire-hazardous substances) with more favourable fire-technical characteristics were chosen and their quantity was limited to the necessary minimum.
6. For each fire section, the fire risk was determined, according to which the requirements for the type and fire resistance of individual types of structures were determined.
7. Equipment for fast, reliable and automatic fire detection has been proposed.
8. Manual, semi-stable and stable systems (gas, foam and water) of fire extinguishing, sprinkling and cooling were proposed; water extinguishing, sprinkling and cooling systems installed in selected spaces where equipment and components of safety systems are located were designed as redundant, including the water source.
9. The design has determined the types, numbers and locations of fire extinguishers as the primary means for firefighting; the design includes the solution of the number of employees of the company's firefighting unit and its technical means.
10. Devices and measures have been designed to eliminate or limit the secondary effects of fires or fire suppression, sprinkler and cooling systems on operating personnel and on safety and other systems; devices and measures have been designed to limit accidental or unwanted activation of fire suppression, sprinkler and cooling systems.
11. The equipment and components of fire protection systems intended to limit the consequences of failures of components and constructions of safety systems classified in safety classes have been classified as selected equipment in accordance with the applicable decree and their design, manufacture, installation and operation are subject to a quality management system.
12. An assessment of the adequacy of NPP fire protection was performed; the assessment was realized out in accordance with IAEA 50-SG-D2.

3.1.A.1. Design considerations and prevention means

The fire protection design of the Temelín NPP is documented in:

a) Initial design IV.B, part B. Summary construction design, chap. B.2.6.7 Fire protection,
b) Technical reports on fire protection, which are part of the design documentation of individual buildings,
(c) Sub-initial design No. 369 "Fire protection solutions in the Soviet design zone".

Special attention focused on fire protection in the design and implementation of so-called "important buildings", where safety systems, systems related to nuclear safety, or buildings to which safety-significant buildings are immediately functionally connected, are located.

The following fire prevention systems are implemented at Temelín NPP:

- The amount of flammable substances and materials is reduced,
- Preventing the spread of fire inside and outside buildings by creating fire sections,
- Building structures and materials shall be used which correspond to the fire risk in the fire sections,
- Safe evacuation of persons from the building is ensured,
- The distance between the buildings and the design of the open areas are such that fire cannot spread between the buildings,
- Technical and technological equipment and pipelines are designed, implemented and operated in such a way that the occurrence of fire is minimised and the activities necessary to ensure nuclear safety, fire protection and radiation protection can be performed at all times,
- The means and conditions for effective fire-fighting intervention are provided.

3.1.A.2. Overview of arrangements for management and control of fire load and ignition sources

Restrictions on the use of flammable substances and materials

In accordance with the recommendations of the IAEA safety guides, the use of flammable substances and materials in both the construction and technological parts is limited to the minimum necessary. In cases where the use of flammable substances and materials could not be excluded, the following general technical and organisational measures are taken to limit or eliminate the possibility of fire starting and spreading, or to limit the secondary effects of a fire:

a) In all nuclear safety-relevant buildings, power cables and most low-current cables are of a design with increased resistance to the spread of fire, complying with IEC 332.3 category A, or IEC 331.

b) Power cables and most low-current cables have enhanced resistance to the spread of fire, complying with IEC 332.3 category A, or IEC 331 tests, in all nuclear safety-important buildings.

c) In the case of special cables (optic cables, coaxial cables) which could not be manufactured to meet the test according to IEC 332.3 category A in order to ensure their functionality, their resistance to the spread of fire is ensured by covering their entire length in steel tubes. These cables do not transmit power and cannot themselves be a source of fire.

d) Inside the individual electrical and I&C cabinets, cables and other materials are of a common combustible type. Measures (fire sections, ventilation design) are implemented to prevent the negative effects of fire on these devices.

e) Warehouses and compartments containing technological equipment with flammable liquids are designed and constructed according to ČSN 65 0201. They are equipped with catchers and emergency reservoirs to prevent uncontrolled flood of flammable liquids. The reservoirs and floors of rooms containing equipment with flammable liquids are made of non-flammable materials. In emergency reservoirs are installed in the emergency catchers to enable draining of the flammable liquid.

f) A special category is flammable radioactive waste. Especially the activities in the reactor building are the source of these substances. These are (in most cases) low-level solid and liquid substances stored and processed in the radioactive media cleaning station. The method, handling and processing are subject to a special regime. Solid combustible substances are pressed; salts from liquid wastes are fixed by bituminisation.

g) In some cases, dangerous corrosive or toxic substances are present in the buildings. They are found in small quantities in individual laboratories. Larger quantities are part of process equipment or are stored safely in chemical stores.

3.1.A.3. Experience of the permit holder with the fire prevention implementation

The inspection plan of the Temelín NPP fire protection department is entered and maintained in electronic form. The inspections are planned as monthly and cover the supervision of the fire protection area. Throughout the calendar month, there are performed continuous inspections according to the Inspection Plan and other random and extra inspections. The results of the inspections are included in the "NPP Safety Surveillance Report". In 2022, a total of 942 surveillance activities were performed and the percentage of non-conformities detected is at a very low level (2022: 73/942). Non-compliances are usually caused by human factors (e.g. improper storage of combustible materials, closing of fire doors) and are promptly corrected. All findings from compliance monitoring are recorded in the 'Correction and Prevention System' database. In addition, a training and education plan is established, which includes lessons learned from non-conformances cause by human factor. In the Czech Republic, training of employees in fire protection is mandatory. Tactical exercises and drills on the use of diversionary alternative mobile means for handling severe accidents are performed in NPPs. Non-compliances identified during the exercises are immediately rectified on site.

The FRSU makes man hoist to incidents outside the NPP site several times a year. In most cases, the unit has gone out for technical interventions and to provide technological assistance and in some cases it has been a false call. During the last 5 years, the FRSU unit was called to 17 fires outside the NPP site within the Integrated Rescue System of the Czech Republic.

3.1.A.3.1. Overview of strengths and weaknesses

Overall, the fire safety of the Temelín power plant can be assessed at a very good level. The company's FRSU provides fire prevention and fire repression at a very good level. The unit is well prepared for repressive intervention. In appearance to the low frequency of actual fires and the deployment of the FRSU for their elimination, the unit's professional training focuses more on firefighting practice, for example through simulators.

3.1.A.3.2. Lessons learned from events, reviews fire safety related mission

Mission WANO

Throughout the mission, inspectors gather findings and observations. At the end of the mission, the inspectors present their findings to NPP management and make an agreement which findings will be accepted by management. Subsequently, the Action Plan with deadlines for findings elimination is developed and in the following period the mission findings are solved according to the agreed schedule. During the follow-up mission, the inspectors NPP management present how the findings from the previous mission are solved.

Inspections of the Fire Rescue Service

The Fire Rescue Service of the Czech Republic inspections are performed randomly and the findings from these inspections are immediately removed. The Temelín NPP Fire and Rescue Service evaluates the inspection findings and takes corrective measures to ensure that the same or similar findings are not repeated.

Screening of ČEZ, PLC

In 2020, a screening was conducted on the topic of "The system of compliance with legislative requirements related to operating fire protection equipment and fire safety equipment in CEZ Group companies". Important conclusions were the requirements related to operating nuclear power plants:

- Terminologically unify the system of fire sections assignment.
- Update management documentation:
    - In terms of defining interfaces to management control systems,
    - Verify and set up interfaces in the Equipment Care Department between all administrators of each management area related to fire safety equipment,
    - Establish the organisation of fire protection in the fire protection and emergency preparedness documentation and supplement the inspection by own employees.
- As part of the training, familiarize Equipment Care Department administrators with fire analyses (what the fire safety system they manage protects and why).

3.1.B. Fire prevention at the Dukovany NPP

Fire protection is ensured by the consistent application of the "defence in depth" approach, which creates the following three levels (barriers) in relation to fire protection:

1. Preventive measures - to forestall fire as far as possible.
2. Fire detection, reporting and extinguishing systems - to ensure, that a fire that occurs despite preventive measures, is detected and reported immediately after its occurrence and means are available for prompt extinguishing.
3. Fire separating structures - prevent the spread of an unextinguished fire outside the fire section so that it does not endanger the performance of the basic safety functions of the nuclear power plant.

The aim of the Dukovany NPP fire protection design was to ensure a balance between all three of these levels of defence in depth. This was based on the following principles and procedures:

1. The routes and locations of equipment and individual components of all safety systems providing the NPP safety functions defined by the design have been identified, including identification of their redundancy and integration into the safety system divisions; equipment and components of systems related to nuclear safety have also been identified.
2. The individual buildings were divided into fire sections to ensure:

i) Compartments containing redundant equipment and components of safety and nuclear safety related systems separated to Fire sections.

j) Fire separation of site, which are namely listed in the Czech normative regulations, i.e.:

- protected emergency routes
- shafts and turbine halls of evacuation and fire lifts
- elevator, installation and cable shafts, cable rooms, cable channels
- ventilation units except those serving only one single fire section
- control and computing centres with an area greater than 100 m^2
- electrical el. distributor rooms with an area greater than 100 m^2, transformer chambers
- Workrooms and compartments that shall form separate fire sections according to the relevant standards (especially according to ČSN 65 0201).

k) Easy and safe escape of persons from each fire section.

l) Rapid and effective intervention of FRSU.

m) Separation of high fire risk workrooms or workrooms with a higher probability of fire occurrence and spread from other operations.
n) Limitation of the number of hatches in fire separating structures.
o) The possibility of exhausting combustion products outside the building.
p) Limitation of the extent of damage.

3. When it is not possible to locate redundant equipment and components of safety systems or safety-related systems in separate fire sections (containment, control room, emergency control room, cable space under control room, etc.), fire protection systems shall be designed to limit the spread of fire in these fire sections and to eliminate unacceptable effects of fire or the fire protection systems themselves on the redundant safety systems.
4. Passive systems were preferably designed, i.e. systems whose functionality does not depend on energy supply.
5. In the construction and technological part of the design, the use of flammable materials and fire-hazardous substances was (as far as possible) excluded or at least limited; in cases where it was not possible to implement this principle, such flammable (or fire-hazardous substances) with more favourable fire-technical characteristics were chosen and their quantity was limited to the necessary minimum.
6. For each fire section, the fire risk was determined, according to which the requirements for the type and fire resistance of individual types of structures were determined.
7. Equipment for fast, reliable and automatic fire detection has been proposed.
8. Manual, semi-stable and stable systems (gas, foam and water) of fire extinguishing, sprinkling and cooling were proposed; water extinguishing, sprinkling and cooling systems installed in selected spaces where equipment and components of safety systems are located were designed as redundant, including the water source.
9. The design has determined the types, numbers and locations of fire extinguishers as the primary means for firefighting; the design includes the solution of the number of employees of the company's firefighting unit and its technical means.
10. Devices and measures have been designed to eliminate or limit the secondary effects of fires or fire suppression, sprinkler and cooling systems on operating personnel and on safety and other systems; devices and measures have been designed to limit accidental or unwanted activation of fire suppression, sprinkler and cooling systems.
11. The equipment and components of fire protection systems intended to limit the consequences of failures of components and constructions of safety systems classified in safety classes have been classified as selected equipment in accordance with the applicable decree and their design, manufacture, installation and operation are subject to a quality management system.
12. An assessment of the adequacy of NPP fire protection was performed; the assessment was realized out in accordance with IAEA 50-SG-D2.

3.1.B.1. Design considerations and prevention means

The fire protection design of the Dukovany NPP is documented in:

a) The initial design and in the Whole Power Plant Design Basis document, including fire protection solutions,
b) Technical reports on fire protection, which are part of the design documentation of individual buildings,
c) Based on the analyses, recommendations of WANO, SÚJB and others, a number of changes were made to improve fire safety.

Particular attention was paid to fire protection in the design and implementation of so-called "important buildings", where safety systems, systems related to nuclear safety, or buildings to which safety-significant buildings are immediately functionally connected, are located.

The following fire prevention measures are in place at the Dukovany NPP:

- The amount of flammable substances and materials is reduced,
- Preventing the spread of fire inside and outside buildings by creating fire sections and belts,
- Building structures and materials shall be used which correspond to the fire risk in the fire sections,
- Safe evacuation of persons from the building is ensured,
- The distance between the buildings and the design of the open areas are such that fire cannot spread between the buildings,
- Technical and technological equipment and pipelines are designed, implemented and operated in such a way that the occurrence of fire is minimised and the activities necessary to ensure nuclear safety, fire protection and radiation protection can be performed at all times,
- The means and conditions are provided for the implementation of effective fire intervention.

3.1.B.2. Overview of arrangements for management and control fire load and ignition sources

Restrictions on the use of flammable substances and materials

In accordance with the recommendations of the IAEA safety guides, the use of flammable substances and materials in both the construction and technological parts is limited to the minimum necessary. In cases where the use of flammable substances and materials could not be excluded, the following general technical and organisational measures are taken to limit or eliminate the possibility of fire starting and spreading, or to limit the secondary effects of a fire:

a) In all nuclear safety-relevant buildings, power cables and most low-current cables are of a design with increased resistance to the spread of fire, complying with IEC 332.3 category A, or IEC 331.

b) Power cables and most low-current cables have enhanced resistance to the spread of fire, complying with IEC 332.3 category A, or IEC 331 tests, in all nuclear safety-important buildings.

c) In the case of special cables (optic cables, coaxial cables) which could not be manufactured to meet the test according to IEC 332.3 category A in order to ensure their functionality, their resistance to the spread of fire is ensured by covering their entire length in steel tubes. These cables do not transmit power and cannot themselves be a source of fire.

d) Inside the individual electrical and I&C cabinets, cables and other materials are of a common combustible type. Measures (fire sections, ventilation design) are implemented to prevent the negative effects of fire on these devices.

e) Warehouses and compartments containing technological equipment with flammable liquids are designed and constructed according to ČSN 65 0201. They are equipped with catchers and emergency reservoirs to prevent uncontrolled flood of flammable liquids. The reservoirs and floors of rooms containing equipment with flammable liquids are made of non-flammable materials. In emergency reservoirs are installed in the emergency catchers to enable draining of the flammable liquid.

f) A special category is flammable radioactive waste. Especially the activities in the reactor building are the source of these substances. These are (in most cases) low-level solid and liquid substances stored and processed in the radioactive media cleaning station. The method, handling and processing are subject to a special regime. Solid combustible substances are pressed; salts from liquid wastes are fixed by bituminisation.

g) In some cases, dangerous corrosive or toxic substances are present in the buildings. They are found in small quantities in individual laboratories. Larger quantities are part of process equipment or are stored safely in chemical stores.

3.1.B.3. Experience of the permit holder with the fire prevention implementation

The inspection plan of the Dukovany NPP control department is entered and maintained in electronic form. The inspections are planned as monthly and cover the supervision of the fire protection area. Throughout the calendar month, there are performed continuous inspections according to the Inspection Plan and other random and extra inspections. The results of the inspections are included in the "NPP Safety Surveillance Report". In 2022, a total of 998 surveillance activities were performed and the percentage of non-conformities detected is at a very low level (2022: 55/998). Non-compliances are usually caused by human factors (e.g. improper storage of combustible materials, malfunctioning of fire doors, operability of emergency lighting, limited access to fire extinguishers and hydrants) and are promptly corrected. All findings from compliance monitoring are recorded in the "Correction and Prevention System" database. In addition, a training and education plan is established which includes lessons learned from non-conformances caused by human factors. In the Czech Republic, training of employees in fire protection is mandatory. Tactical exercises and drills on the use of diversionary alternative mobile means for handling severe accidents are performed in NPPs. Non-compliances identified during the exercises are immediately rectified on site.

The FRSU makes man hoist to incidents outside the Dukovany NPP site several times a year. In most cases, the unit went out for technical interventions and to provide technological assistance. During the last 5 years, the FRSU was called to 38 fires outside the Dukovany NPP site within the Integrated Rescue System of the Czech Republic.

3.1.B.3.1. Overview of strengths and weaknesses

Overall, the fire safety of the Dukovany NPP can be assessed at a very good level. Fire prevention and fire repression, which are provided by the company's FRSU, operate at a very good level. The unit is well prepared for repressive intervention. Due to the low frequency of actual fires and the deployment of the FRSU to tackle them, the unit's personnel professional training focuses more on firefighting drill.

The "weaknesses" still include the influence of the human factor, in particular violations of fire regulations when using electrical appliances, failure to comply with the obligations and conditions of the permit when working with open flames (welding) or handling flammable materials. Also, difficulty to modify some fire systems due to design features of constructions is considered as weakness.

3.1.B.3.2. Lessons learned from events, fire safety related mission evaluations

Mission WANO

Throughout the mission, inspectors gather findings and observations. At the end of the mission, the inspectors present their findings to NPP management and make an agreement which findings will be accepted by management. Subsequently, the Action Plan with deadlines for findings elimination is developed and in the following period the mission findings are solved according to the agreed schedule. During the follow-up mission, the inspectors NPP management present how the findings from the previous mission are solved.

Inspections of the Fire Rescue Service

The Fire Rescue Service of the Czech Republic inspections are performed randomly and the findings from these inspections are immediately removed. The Dukovany NPP Fire Rescue Service evaluates the inspection findings and takes corrective measures to ensure that the same or similar findings are not repeated.

Screening of ČEZ, PLC

In 2020, a screening was conducted on the topic of "The system of compliance with legislative requirements related to operating fire protection equipment and fire safety equipment in CEZ Group companies". Important conclusions were the requirements related to operating nuclear power plants:

- Terminologically unify the system of fire sections assignment.
- Update management documentation:
    - In terms of defining interfaces to management control systems,
    - Verify and set up interfaces in the Equipment Care Department between all administrators of each management area related to fire safety equipment,
    - Establish the organisation of fire protection in the fire protection and emergency preparedness documentation and supplement the inspection by own employees.
- As part of the training, familiarize Equipment Care Department administrators with fire analyses (what the fire safety system they manage protects and why).

3.1.C. Fire prevention LVR-15

The Fire Prevention Department consists of:

a) Professionally Qualified Person in Fire Protection (PQP FP) in Research Centre Řež

b) Fire Prevention Officers (FPO)

c) Preventive Fire Patrols (PFP)

d) Persons in charge of fire supervision

e) Persons in charge of fire protection during non-working hours and during possible reduced operation - on the basis of a contract with Nuclear Research Institute Řež PLC

Professionally qualified person in fire protection (PQP FP)

a) Organises and monitors the fulfilment of the Research Centre's obligations arising from legal and other regulations.

b) Professionally manages the activities of employees entrusted with tasks in the field of fire protection (i.e. especially fire prevention officers and fire prevention patrols),

c) Participates in the teaching and professional training of Research Centre employees on fire protection.

d) Processes and maintains unified documentation on fire protection:

- Documentation of inclusion in the category of activities with increased fire risk,
- Determination of the organisation of fire protection assurance,
- Fire alarm guidelines,
- Fire regulations for workplaces with increased fire risk,

- Thematic plans and timetables for staff training and training of fire prevention patrols and fire prevention officers,
- Copies of documents from employee training on fire protection, documents on training of members of fire prevention patrols and fire prevention officers,
- Other documentation of the fire protection according to legislation.

e) Cooperates with the heads of departments in the development of fire regulations.

f) Establishes (in writing) the conditions and principles for compliance with fire protection in activities with increased fire risk.

g) Monitors the establishment of fire watches or persons in charge of fire supervision at places where activities with increased fire risk (or activities requiring special fire safety measures) are performed and ensures the appropriate professional (theoretical and practical) training of employees assigned to preventive fire watches or persons in charge of fire supervision.

h) Provides training for senior staff on fire protection.

i) Expresses its opinion from the point of view of fire protection on construction changes and changes in technology or on the use of workplaces (places) that could affect the interests of fire protection.

j) Methodically manages the activities of the fire prevention officers (carrying out regular preventive inspections of workplaces at least once a month, including keeping the relevant documentation - fire book).

k) In cooperation with the FRSU Commander, participates in ensuring that the FRSU conducts a verification exercise at least once a year.

l) Personally attends all fire inspections performed by the FRS of Czech Republic.

m) In cooperation with FRSU Commander, provides and submits information and documents to the Statutory Representative to carry out the reporting of each fire to the Regional FRS.

n) If he/she finds deficiencies that may immediately lead to the occurrence of fire, he/she is entitled to order measures aimed at eliminating this danger or to stop the operation or activity; he/she shall also inform the company Director without delay.

Fire Prevention Officer

The company director appointed a fire prevention officer to carry out preventive fire inspections in the preventive sphere and is methodically subordinate to the Fire Prevention Officer. The function of the fire prevention officer perform the employee in addition to his/her work assignment.

The purpose of preventive fire inspections is mainly to check compliance with fire protection regulations and to identify any deficiencies and defects. Preventive inspections of workplaces and other places shall take into account the type of activity, the manner in which the place or equipment is used and the associated fire risk; performing at least once a month.

Fire prevent officer perform particularly the following tasks:

a) Check and ensure the performance of fire protection tasks within the scope set out in the Directive and in accordance with the instructions of the Fire Protection Office.

b) Carry out inspections of workplaces and other places and equipment (including means of fire protection and fire safety equipment) and record the results in the fire book, discuss the identified defects with the head of the workplace, to whom they submit a proposal for defect elimination (including the deadline).

c) Hand over for inspection by the Fire Protection Officer fire books at regular intervals (at least quarterly).

d) Cooperate with the head of the workplace and the Fire Safety Officer in the development of fire regulations and alarm orders.

e) In case of building modifications, especially fire-hazardous work, check compliance with the established fire protection measures, or propose their addition.

f) Participate in training for fire prevention officers (organized by the Fire Prevention Officer; training at least once a year).

g) Cooperate closely with the relevant FRSU employee in providing material and technical equipment for fire protection (e.g. in deploying and checking the condition of portable fire extinguishers).

Preventive fire patrol

A Preventive Fire Patrol is established at workplaces with at least three employees, where activities with increased fire hazards are performed based on inclusion in the fire risk categories and the proposal of the fire protection officer as permanent or for the duration of the fire risky activity. The preventive fire patrol performs tasks in the field of fire prevention and repression. It operates directly at the workplace and is appointed by the relevant manager from among its employees, who also appoints its commander. A list of the members, including the terms of reference and tasks, shall be displayed in a visible place.

Employees assigned to the preventive fire patrols are required to undergo appropriate training and verification of knowledge acquired through training. The training shall be performed by the fire protection's PQP.

Preventive fire patrols tasks in the field of prevention:

a) To ensure that fire safety requirements and regulations are observed during work activities and to guide employees to the necessary vigilance and caution in terms of fire safety.

b) Ensure that electric and gas devices and other appliances are switched off at the end of working hours and before leaving the workplace.

c) To ensure regular cleaning and tidiness of workplaces, removal of dust and combustible waste, especially from equipment and places where there is a risk of ignition.

d) To supervise the safe condition of basic fire extinguishing equipment within its area of competence.

e) Ensure that access to fire protection, signalling and telephone equipment is not obstructed.

f) Ensure that emergency routes and manipulation areas are clear.

g) Report any defects in fire protection measures to the head of the workplace and the fire protection officer with a proposal for their elimination.

Preventive fire patrols tasks in the area of repression (in case of fire):

a) To carry out the initial fire-fighting intervention and rescue of endangered persons; if this is not possible due to the extent of the fire or lack of fire-fighting forces and means, immediately declare a fire alarm and call for fire assistance (fire-fighting unit) in the manner specified in the fire-alarm guidelines.

b) Take measures to prevent the spread of fire (e.g. closing fire caps, fire openings, flammable substance supply, switching off electricity, removing flammable substances, pressurized flasks, radioactive substances and other risk factors).

c) To carry out tasks and measures resulting from the fire evacuation plan or emergency instructions for workplaces with radioactive substances and other increased hazards.

d) Cooperate with the intervention commander upon arrival of the fire protection unit.

Persons in charge of supervision during and after activities with increased fire risks

Duties and authorisations of persons responsible for fire supervision in one-off activities with increased fire risk:

a) Before starting the work, familiarise themselves with the nature of the work and the hazards involved (familiarisation is part of the training provided by the PQP).

b) Before starting work, check the condition of the workplace (e.g. whether there are free emergency routes, whether the workplace is equipped with extinguishers etc.), including compliance with the measures set out in the "welding order". Arrange with all persons involved in the activities in question (see 'Welding order') on cooperation.

c) Monitor the fire situation at the workplace during the activities, including whether conditions change during the work. Do not leave the workplace while work is being performed; fire supervision must also be performed when work is interrupted. If conditions change, the person is authorised, inter alia, to stop the work until the conditions are in the line with those laid down in writing in the 'welding order' in order to prevent fire.

d) Do not leave the place designated for fire supervision during the entire period of fire supervision, even during a short break in work.

e) Upon completion of activities, check all areas at risk and check or implement the measures imposed in the post-work order. Hand over the workplace in writing to the designated person named in the order who will provide follow-up supervision for a minimum of 8 hours.

f) In the event of a fire, take immediate initial action using a fire extinguisher or fire hydrant.

g) In case it is found that it is not possible to eliminate the fire at the workplace using the available extinguishing means, immediately declare a fire alarm at the workplace and call for effective assistance (fire alarm room of Nuclear Research Institute Řež PLC). Until the arrival of firefighters, provide firefighting intervention and evacuation of persons. Upon arrival of the firefighters, be at the disposal of the intervention commander.

Ensuring fire protection during non-working hours and in times of reduced operation

Fire protection during non-working hours (or during reduced operation) is ensured by:

a) FRSU personnel on the basis of a contract with Nuclear Research Institute Řež PLC, Research Centre workplace,

b) The site security personnel on the basis of a contract with Nuclear Research Institute Řež PLC,

c) Other personnel according to the relevant instructions of the Research Centre Director or his/her delegate.

Employees entrusted with the care of fire protection at this time, must be properly acquainted with all facts relevant to fire protection. For this purpose they must know:

a) All Research Centre buildings, and especially all permanent workplaces where activities with increased fire hazards are performed or where such activities have been performed once or for a short period of time on the basis of a welding order or other permission or approval of the Professionally Qualified Person (e.g. welding or other work with open flames, work with flammable liquids, etc...), as well as workplaces where "REPORTED OPERATIONS" are performed.

b) The location and operation of fire protection equipment and fire safety equipment, in particular portable extinguishers and the method of their use.

c) The method of immediate announcement of a fire alarm set out in the fire alarm guidelines and the summoning of the fire protection unit of the FRSU.

The duties of persons responsible for the provision of fore protection during non-working hours are:

a) Checking for fire hazards by regular walks and paying particular attention to areas where activities with increased fire risk are performed. The first checking walk shall be performed immediately after employees have left the workplace.

b) Immediately rectify the observed defects in the area of fire protection; if it is not possible to do so, ensure their rectification by reporting this fact to his/her superior.

c) If a fire occurs somewhere, try to extinguish it using the available means; if it is not enough to extinguish it with one's own strength, immediately summon effective help and other persons according to the procedure set out in the fire alarm order or emergency instructions according to the internal emergency plan.

d) Take all measures important for a successful and quick intervention of the FRSU (making water sources available, clearing roads, etc.).

Only an employee who has the necessary qualifications for this activity is designated to perform tasks related to fire protection of the Research Centre during non-working hours and in times of reduced operation.

3.1.C.1. Design considerations and preventions means

The application of basic fire protection rules is integral part of the reactor design - division into fire sections and their separation by suitable means. Related design assumptions relate to the fulfilment of nuclear legislation requirements for the classification and qualification of equipment performing safety functions, followed by the application of procedures for the prevention of simple failure and common cause failure criteria which typically includes fire. 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 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.

In the hall, the cables lead in a steel and sheet metal enclosed cable tray connecting the first floor gallery with reactor vessel, where the cables of the reactor protection system and experimental equipment located in the reactor hall are lead. Along the walls of the hall, the cables of auxiliary equipment are lead. Polyethylen brick shielding blocks are located in the reactor hall; designated area at the rear of the hall houses locate the press capable low-level radioactive waste.

The originally undivided reactor building is being divided into fire sections subsequently during use, the division is not complete and finished. 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.

Part of the prevention is also an EFD system with sensors in selected areas of the reactor according to the determined risk level in the fire design of the building. The output signal lead to the central control room of the FRSU with a permanent presence of personnel.

3.1.C.2. Overview of arrangements for management and control of fire load and ignition sources

Organizational measures

The organizational measures for ensuring fire protection throughout the entire area of Nuclear Research Institute Řež, PLC, are regulated in the organizational directive of Nuclear Research Institute OSM No. 24 “Determination of organizational of fire protection in Research Institute”. Fire protection in the Research Centre is dealt with in the contract with Nuclear Research Institute Řež, PLC and in the organizational directive "Ensuring fire protection - Determination of organisational provision of fire protection in the Research Centre". For prevention and evacuation, a five-member preventive fire patrol and a separate preventive officer are appointed.

Construction and technical measures.

The following requirements are set out for proposals and modification:

- The reactor technological systems shall be designed to not cause a fire by its operation or its failure.
- The amount of combustible materials must be minimised.
- Equipment important from the point of view of nuclear safety must be designed to meet fire protection requirements.
- Non-flammable and reduced flammable materials must be used for nuclear safety important equipment.
- The materials of the building separation constructions, including firelocks, have adequate fire resistance.
- Fire dampers are installed in the ventilation system.
- Cable routes are sealed.
- EFD is installed.
- Doors with increased fire resistance between the corridors and staircases of the reactor building and staircase ventilation are installed.

These requirements were met before the building was approved.

3.1.C.3. Experience of the permit holder with the implementation of fire protection

3.1.C.3.1. Overview of strengths and weaknesses

Fire protection is implemented as part of the company's overall risk management and risk prevention system (general safety). It is defined in the approved management system programme as a special process with a designated guarantor and at the same time as one of the qualification criteria for the nuclear installation design itself. In the company's central management department there are persons with the necessary fire protection qualifications and support functions are defined in the operation.

Thanks to the presence of the FRSU on site and the introduction of fire prevention personnel as part of the company's central management system, it is possible to fully implement all fire prevention requirements both into the company's central procedures and directly into the operational and incident response management procedures at the facility.

The original parts of the reactor building and parts of the technology date back to 1955. Fire standards have advanced since then and the original design of the facility limits the application of newer practices (full physical separation, automated fire suppression systems, etc.).

3.1.C.3.2. Lessons learned from events, review fire safety related mission.

The INSARR mission (2020) resulted in recommendations in the area of prevention - limiting the amount of equipment on the hall, disposal of older experimental equipment and establishing more precise documentation for emergency management, which was gradually introduced.

Regular drills and exercises are also part of the operation – performing of evacuation drills in an interval of at least once a year. Firefighting drills at least one per 2 years. Exercises include observers and findings are summarised in a final report with deficiencies and recommendations for further implementation.

3.1.C.3.3. Overview of actions and implementation status

Reactor shut down and cooling is essential to ensure the operation of the technology even in the event of a fire - in some cases this requires operator intervention. During the simulated inhabitability exercise of the control room due to fire and smoke, one of the currently implemented measures was to provide evacuation masks for the control room personnel so that they would be able to activate safety functions (shutdown, core cooling) even in case of partial smoke and then evacuate themselves.

3.1.D. Fire prevention at the Spent Fuel Storage

3.1.D.1. Design considerations and prevention means

The SFS is divided into smaller fire-bounded units - fire sections for the purpose to localize a fire to one fire section and prevent its spread to another fire section or compartment. The FRSU access to buildings ensure internal NPP roads from the open space. A fire water supply of adequate capacity is nearby.

In the construction technical design, non-combustible structures (reinforced concrete, brick, steel, etc.) are used, which have adequate fire resistance. When steel structures are used, if the unprotected steel structure does not achieve the required fire resistance, the resistance is increased by fire scratch coat, painting or lining. The use of combustible materials is limited as far as possible. Combustible materials have been used in some cases for doors and floor slabs.

The initial criterion for the assessment of individual construction structures in terms of fire safety in the SFS is the fire risk, which has been determined for each fire section. The methodology of ČSN 730804 determine the fire risk.

Passive or active means are used to reduce the secondary effects, especially smoke, heat and toxic combustion products, which spread from the original fire inception to other compartments not directly affected by the fire. To reduce the secondary effects of the fire, established systems and equipment ensure:

- The safe evacuation of persons from a burning or fire-threatened compartment.
- Limiting the spread of fire between individual fire sections within the building.
- Limiting the spread of fire outside the building.
- Conditions for effective intervention of FRSU in firefighting and rescue work.
- Controlled smoke ventilation during and after a fire.

The secondary effects of a fire include the damage and endanger that may result from the use of fire extinguishing agents.

3.1.D.2. Overview of arrangements for management and control of fire load and ignition sources

There are no other buildings near the SFS facility. There is only a very limited amount of open fire areas in the SFS building itself. The fire hazardous area in front of them extends to a maximum distance of 2,8 m. The fire safety design demonstrate that no fire hazardous area extend into any fire open area of any other fire section of the SFS, thus preventing fire transfer between fire sections.

For all products ensuring fire safety, the fire technical characteristics (such as fire resistance, fire spread index, reaction to fire) are proven by test results, certificates and declarations of conformity with legislation requirements. Fire-fighting documentation has been created prior to the start of operation

3.1.D.3. Experience of the permit holder of the implementation of the fire prevention

The fire prevention of the SFS fully comply with the requirements of the legal and normative fire regulations of the Czech Republic. Regarding the usage mode and stable operating conditions, no changes are made except for those related to the entire nuclear power plant site (e.g. replacement of sensors).

3.1.4. Regulator's assessment of the fire prevention

3.1.4 A & B Regulator's assessment of the fire prevention of NPP

3.1.4.1. Overview of strengths and weaknesses in fire prevention

The fire prevention system is well elaborated and implemented in the internal procedures documentation system of Utility. At the same time, the Utility committed to follow the recommendations set out in the NSG No. BN_JB_3.5 "Protection against internal fires" in its operating regulations.

In recent years, there has been a change in the storage of records of fire protection activities in digital form. This has been proved in the speed up of access to the recorded data. A monitoring system of the status of the EFD, stable sprinklers and fire water systems has also been developed.

3.1.4.2. Lessons learned from inspections and assessment of fire prevention as part of regulatory oversight

The experience from inspection activity shows that problematic actions in the area of fire safety do not occur directly from the departments and personnel responsible for fire protection. They occur indirectly, i.e. in connection with this issue. A major problem in the implementation of design changes and innovations is space limitation in the buildings, the economic aspect as well as the legal requirements in the provision of contractor activities. The consequence is then the postponement of the replacement of certain fire safety items so that they work as long as possible. If there is the slightest complication in the design of the new equipment, it is then necessary to proceed to temporary operation with equipment that is functional but already beyond its expected or legally stipulated service life.

3.1.4.C. Regulator's assessment of the fire prevention of LVR-15

From the results of the evaluation of the LVR-15 Safety Analysis Report, it can be concluded that the fire prevention system is sophisticated and follows the regulations of the owner of the site of Nuclear Research Institute Řež, PLC Since the start of the construction of the Řež site and after the start-up of the VVR-S research reactor (today LVR-15) in 1957, appropriate measures have been gradually implemented in the operation of the reactors, which have respected the requirements of the applicable fire protection legislation.

3.1.4.D. Regulator’s assessment of the fire prevention in SFS

The fire prevention system is elaborated and supported by the internal procedures documentation system of operator and fully corresponds to the way the SFS is operated.

3.2. Active fire protection

3.2.A. Active fire protection at the Temelín NPP

3.2.A.1. Fire detection and alarm provisions

Fire detection and alarm in all the Temelín NPP buildings provided the electrical fire detection and alarm system (EFD). The EFD system is a set of fire detectors, exchangers, interconnecting cabling and additional devices, the purpose of which is to acoustically, optically and graphically signal the location of a fire. In addition to this activity, the EFD system continuously monitors the function of its own critical components and immediately signals their possible failure.

3.2.A.1.1. Design approach

The EFD system is designed according to Czech normative regulations, especially ČSN 342710, ČSN 730875, related standards and according to the technical conditions of the equipment manufacturer. In addition, the IAEA 50-SG-D2 recommendations were also respected.

The types of fire detectors are designed and realized depending to the parameters of the products developed by heating, carbonization, ignition or combustion of the materials present in the given protected area. When selecting the type of fire detectors and determining their location in the protected space, the environment of the protected space is also taken into account, e.g. radiation, humidity, temperature, airflow, etc. In cases where the environment does not permit the placement of a fire detector in the protected space, detectors are located in an adjacent space and alternative monitoring methods are used (e.g. sampling of the gaseous atmosphere from the protected space and its deflection to a fire detector located in an adjacent space).

A fire alarm signalled by an EFD is unambiguous, clearly recognizable and not interchangeable with any other warning signal. The SIEMENS EFD system is implemented in all buildings located in the NPP. In buildings located outside the NPP, this system is installed in the building Zámeček Březí and Water station Hněvkovice.

The Cerberus AlgoRex EFD system is installed in the reactor buildings, diesel generator, compressor and water supply buildings, the DGS fuel handling, the cable channels connecting the construction buildings, the control centre building and Zámeček Březí. The Cerberus AlgoRex EFD guarantee high reliability of detection, high diagnostic capabilities and high immunity against false and unwanted alarms. In addition, this system is characterised by extremely high electromagnetic compatibility. The SIEMENS SINTESO S-LINE EFD system is installed in SFS, el. distributor rooms, turbine halls, pumping stations, exchanger stations, DGS and cable channels. In addition, an EFD video smoke detection system is installed in the SFS and turbine hall.

The EFD systems (exchangers, fire detectors, cabling) installed in the reactor buildings, DGS and in the cable channels connecting the DGS and reactor buildings classification is selected equipment safety class 3.

3.2.A.1.2. Types, main characteristics and performance requirements

Main components of the system

The SIEMENS EFD at the Temelín NPP is a modular system composed of individual components providing detection of a fire, transmission of a signal, signal evaluation, fire alarm announcement, and possibly control of other fire protection systems.

Fire detectors

More than 10,000 fire detectors of the following types are installed in the NPP:

a) Ionisation - the most sensitive type of detector, which reacts to visible and invisible smoke (more than 2000 units installed).
b) An optical-smoke detector that responds to visible smoke.
c) A dual-spectrum flame detector that responds to the oscillation of an open flame.
d) A heat detector that responds to temperature increases.
e) Multi-criteria (combined) detector AlgoRex and SINTESO - new generation detector, working on the principle of measuring and comparing several different variables characteristic for fire (more than 5000 units installed).
f) Linear: the transmitter of the detector sends out an optical beam, which the receiver (which can be located up to 100 metres far from the transmitter) evaluates according to the amount of smoke obscuration.
g) Gas: it is a natural gas sensor reacting to the presence of a certain concentration of gas in the air (these detectors are installed in Gas boiler room).
h) Intake system (e.g. VESDA, WAGNER, STRATOS) - an active smoke detection system providing continuous intake of air sample from the restricted area and its evaluation by an electronic unit. The intake pipe network consists of 1 to 4 pipes, each pipe containing a number of intake holes, each intake hole is comparable to a spot smoke detector.
i) Video smoke detection system - uses a conventional CCTV camera connected to a central unit, analyses incoming images frame by frame and decides if they contain smoke. It ignores other ongoing events. The sensitivity of the system is programmable for different quantities and sensitivities of smoke. The detector uses a unique evaluation technology ("Image Processing") that is capable of measuring the physical features of the smoke and determining a "composite attenuation" value. These parameters are used to determine the total light attenuation due to smoke in the camera's field of view. This value represents the instantaneous value, at any point in time. This feature allows the system to detect smoke efficiently and quickly even when traditional detection techniques are ineffective (aspirating, linear and spot smoke detectors). If smoke is detected, an alarm is raised according to user-defined criteria. Relay outputs allow connection to any EFD exchanger or other evaluation unit.
j) Push-button manual fire detector.

The fire detectors are installed in mounting sockets that are connected to the fire lines. The fire lines are implemented with a return line (two-wire line), which ensures the signal from the fire detector to the EFD exchanger even in the event of mechanical damage or interruption of the fire line. Two types of fire lines are implemented in the NPP buildings:

a) Collective fire lines - the sequence of the detector in the line is not indicated for individual fire detectors. This means that the EFD exchanger does not specify the exact location of the fire and only provides information about the fire occurring somewhere on the fire line. These lines are only implemented in buildings that are not important for nuclear safety.
b) Addressable fire lines - each fire detector in the line has its own individual unique address, so the EFD exchanger can precisely specify the certain detector that indicates a fire or fault, which also specifies the exact location of the fire.

At the Temelín NPP, preferably addressable fire lines are implemented, and in all cases the detectors installed in these lines are grouped into zones or groups. The assignment of detectors to groups (zones) is realized in program (in the EFD exchanger software) and does not depend on which line or in what sequence the detectors are installed on the line. The groups are basically formed by room or by fire section.

In cases where the EFD controls a stable extinguishing or sprinkler system, the unintentional activation of which is undesirable, the fire detectors installed in the relevant room are grouped into two groups, each group containing different types of detectors (in most cases one group contains only ionisation detectors and the other group contains only optical-smoke detectors). This ensures a logical dependency of the activating of the stable extinguisher (SE) or sprinkler stable extinguisher (SSE). In the Temelín NPP, a 2 out of 2 logic is implemented, which means that the actuation of the SE or SSE will only occur when both groups detect a fire.

In buildings with installed the EFD AlgoRex or SINTESO system, it is not necessary to group fire detectors with different detector types, as the very nature of multi-criteria detector operation ensures logical dependencies in many variations. The logical 2 out of 2 selection is implemented by a special software definition - the so-called MULTI zone. The command signal functions only after two detectors from this zone (room) have been activated.

All fire detectors installed at the Temelín NPP are numbered; the identification number of each detector is marked on a tag located in close proximity to the detector. The doors of the rooms protected by the EFD system are also marked with a red and white sticker with the word EFD.

EFD exchangers

EFD exchanger are the basic building unit of the EFD system and their basic function is optical acoustic signalling of detected fire.

Each EFD exchanger also performs self-diagnostic functions and in the event of a fault in the fire detector, fire line, exchanger or electrical power supply, this condition visually and acoustically signals with simultaneous display of the fault code on the exchanger display. In the event of a fault or power failure, the EFD exchanger automatically powers an independent battery source. The battery capacity ensures emergency power supply for at least 24 hours.

In addition to the fire alarm, some of the EFD exchangers, either directly or via the I&C WEC, control other devices that ensure the fire safety of the building:

a) Starting a stable extinguisher.
b) Signalling the position of selected fire dampers in ventilation piping.
c) Control of selected fire dampers in the ventilation pipes.
d) Signalling the presence of combustion products in selected ventilation piping.
e) Control of selected ventilators.

There are three types of EFD exchangers installed at the Temelín NPP:

a) Exchangers CZ-10.
b) CC-11 exchangers - the exchangers are part of the Cerberus AlgoRex system.
c) FC20xx exchangers - of the SINTESO system manufactured by SIEMENS.

All EFD exchanger installed in the Temelín NPP are connected to communication circuits and are connected to the MM8000 extension system.

EFD extension system

Each EFD exchanger can operate either independently or in a network with an extension system. If the exchanger operates independently, it can provide only basic information - the location of the fire. However, by networking the EFD exchangers and connecting them to an EFD extension computer system, a range of other important information can be indicated in the event of a fire.

In the entire the Temelín NPP all EFD exchangers are connected to FCnet/LAN/CERLOOP communication circuits and are connected to the MM8000 extension computer system, which provides computer processed text or graphic output information on work monitors and the BARCO visualization wall, accurately identifying the area in which the fire is detected, activated loops and fire detectors. In addition, this system also allows the processing and display of intervention texts containing other relevant information.

The MM8000 add-on system includes the following devices:

- 3 servers of the MM8000 system. The main server in dual HW design, connected by the Marathon Ever Run software application is located in the server room of the FRSU building, monitors all EFD systems and controls the Barco display wall. The other two servers at reactor building 1 and 2 monitor only their own part of the EFD systems and control the respective synoptic boards. The servers are interconnected by an MM8000 VLAN.
- EFD monitors/workstations - optically and acoustically signal a fire and display on the monitors the address of active fire detectors, the position of fire dampers, including relevant intervention texts and graphic displays.
- Printer - prints out detected fires including the relevant intervention texts.
- BARCO wall, used for the overview display of the whole NPP area, or the image from the monitors of designated workplaces or the image from fire video detection cameras.
- Synoptic board at the main reactor building - displays floor plans of all floors of the main building (Reactor Building, Turbine hall, Switching Room) and visually indicates in which room or space of fire inception. In addition, the activation of the stable extinguishing system is signalled.

In addition to the MM8000 extension system, a monitoring and control system for EFD equipment communications is implemented. This system acts as a back-up communication system to transmit basic information in case of failure of the basic extension system.

Structure of the extension system

The EFD system is connected by the FCnet/LAN/Cerloop communication network and is divided into two logical groups:

a) Reactor Units 1 and 2 - the circuit includes all the EFD exchangers serving the following buildings: the Reactor Building, the Turbine hall, the Switchgear Room, the Diesel Generator, Compressor and Water Station, the DGS Oil Supply, the cable channels connecting the DGS and main reactor building, the power output transformers, the self-consumption transformers, the reserve power transformers and their connecting cable channels.

b) Outdoor buildings - infrastructure. This circuit includes all EFD exchangers that serve other buildings on the NPP site. The individual exchangers are located either directly in the protected building or at the fire alarm station of the FRSU.

Signalling locations

Optical and acoustic signalling of a detected fire and other important information about the fire and the EFD status listed below are routed from the individual circuits of the EFD exchangers to these workstations:

Fire station - fire station of the FRSU (two workplaces)

Both workplaces at the FRSU are equipped with two monitors - one with a graphical display (visualization of the incident site, maps, or graphics and hierarchical tree of the system) and the other with text logs and reports. The workstations in the other buildings are equipped with one monitor. The workstation at the FRSU is connected to the BARCO screen wall.

The first workplace of the FRSU consists directly of one of a pair of servers. Two monitors and a control keyboard and mouse are led out of the server via extenders. The workstation is configured in the system as the main workstation, i.e. with the possibility of control. If the main workstation is functional, all other workstations will only display events without control.

The second, backup workstation consists of a separate workstation in minitower design. Two monitors and a control keyboard and mouse are led out of the workstation via extenders.

Both workstations at FRSU have access to two network printers for printing text and graphical outputs from the MM8000 application.

The audio output from the main workstation on the server is led through a combiner (mixing console) in the command centre to the speakers of the display wall in the fire station of FRSU for acoustic signalling of the extension s. For backup purposes, the audio output is also connected simultaneously to the loudspeakers of the MM8000 workstation at the FRSU.

Building of central electrical control room - shift engineer's workplace

The unit provides interactive textual and graphical information on the situation of EFD systems. The data for the workstation is provided by a master server in the fire station of FRSU.

Reactor Building - Unit Control Room

The workstation provides interactive text and graphic information about the situation of EFD systems. At the same time, it functions as an MM8000 server for connecting subordinate workstations and provides control of synoptic tables of the relevant part of the system.

Reactor building – emergency control room

The workstation provides interactive text information from the exchangers of the system EFD blocks on an LCD monitor.

Control centre building - operating room

The workplace provides graphical information on the synoptic board of the NPP general.

Shelter under the administration building - technical support centre

The unit provides interactive textual and graphical information on the situation of EFD systems. The data for the workstation is provided by the parent server in the fire station of FRSU.

EFD system in the Reactor Building

In the reactor buildings of both Main Production Buildings, the EFD AlgoRex system is implemented, which, in addition to detected fire, provides the following additional functions: activating the water system and water non-system SSE, signalling the position of all fire dampers, controlling selected fire dampers, controlling fans of selected ventilation systems, signalling the presence of combustion products in the ventilation piping of selected ventilation systems. The EFD system consists of two mutually independent systems:

- System EFD, which protects all rooms and areas of the containment and surrounding building envelope where the system SSE is installed:
  The EFD system exchangers are located in rooms that form separate fire sections. Each exchanger is connected to 6 addressable fire lines. This device is classified as a nuclear safety related system and is made up of three separate and independent branches (3 x 100% backup) classified in their respective safety systems divisions. Each protected room is served by the respective addressable fire lines of all three branches of the EFD system, with at least 2 fire detectors installed in each protected room on each of the three fire lines.

- Non-system EFD, which protects other rooms and areas of the containment and surrounding building envelope (including ceilings and double raised floors) that are not protected by system EFD:

Non-system EFD exchangers are located in a room that forms a separate fire section. At least 2 fire detectors shall be installed on the fire line in each protected room in which an SSE is installed. The reactor hall and the transport corridor are protected by linear fire detectors. In selected ventilation systems, intake chambers with fire detectors are located upstream and downstream of the iodine filters. The non-system EFD is electrically powered from a Category III secured power system. In each of the steam generator boxes, a smoke intake system is installed instead of point detectors, the outlets of which are connected via an addressable unit to the existing EFD round line.

System and non-system EFD (exchangers, fire detectors, cabling) are classified as safety class 3.

All system and non-system EFD exchangers are connected to the communication circuit and are introduced into the MM 8000 extension system.

In the emergency control room there are parallel control panels of the exchangers of the system EFD, which form an independent system and are designed to ensure their functionality both in case of failure of the MM 8000 extension system and in case of possible destruction of the unit control room.

The cabling of fire lines and the cabling connecting the EFD exchangers to the circuit shall be in accordance with IEC 331. The cabling for the connection of the synoptic board and the cabling for the ventilation equipment return signal shall be in accordance with IEC 332.3 category A. The cabling of the fire lines connecting the fire detector plinths is in steel tubes. The cabling of the fire lines in the containment shall be in steel tubes or in steel troughs. The cabling of the individual branches of the EFD system shall be separated from each other by space separation.

EFD exchangers are connected to an emergency power source – battery accumulators. The batteries are installed directly in the EFD exchangers and their capacity provides emergency power supply for 24 hours.

3.2.A.1.3. Alternative/temporary provisions

Temporary measures to ensure the required fire safety are applied e.g. during shutdowns of fire safety equipment, repairs, modifications and maintenance. Temporary measures propose professionally qualified person in fire protection and subsequently submit it for approval to the Regional Fire Rescue Service of the Czech Republic, which assesses and approves the proposed measures or orders further measures that must be observed. Temporary measures include, for example: increasing the number of firefighters in shifts, increased inspection and patrolling activities or continuous surveillance of certain areas, increased number of portable fire extinguishers in the building, placement of firefighting monitors with prepared hose lines, etc.

3.2.A.2. Fire suppression provisions

The function of stable extinguishers (SE) and semi-stable extinguishers (SSFE) is quick extinguishing of any fire that occurs in the area protected by those extinguishers.

The stable sprinkling and cooling extinguishers (SSE), in case of fire, sprinkle and cool the space, building and technological structures and equipment located in the area protected by the SSE. Simultaneously SSE protect technology from the thermal effects of the fire and at the same time to sprinkle and cool the combustible materials located in protected area and to prevent the spread of fire.

The type of extinguisher was selected according to:

a) Conditions specified in generally binding regulations (fire protection regulations, technical standards).
b) Instructions and statements of the ministry of the interior authorities (individual assessment of fire protection means), opinions of the state fire supervision.

c) The manufacturer's technical conditions.

The actual technical design respected:

a) The flammable substances (type, quantity, method of storage and arrangement, fire technical characteristics, reaction to extinguishing agents) and according to international recommendations,
b) The time between system start-up and the start of its operation.
c) The effect of the extinguishing agent on equipment, in particular equipment important for the reactor safe shutdown.
d) Possible consequences for the operator.

All equipment and components used to initiate and control the relevant extinguisher or sprinkler and cooling extinguishers shall be located in a different fire section from that protected by those extinguishers. This requirement does not apply to components that are directly used for extinguishing or sprinkling (extinguishing strips and nozzles) and EFD components that give the impulse to activate the extinguishers (automatic fire detectors including associated wiring).

When the SE or SSE activated automatically or manually, the ventilation system (if installed in the fire section) automatically shut down. In fire sections of protected main cooling pumps, the ventilation system automatically shut down only when SSE activated automatically. In fire sections of the central electrical control room protected by stable sprinkler extinguishers, the ventilation do not shut down.

All doors of rooms that protect SE or SSE are marked with a blue and white (in case of water systems) or yellow and white (in case of gas systems) plate with the inscription “stable extinguisher”.

3.2.A.2.1. Design approach

Stable extinguishers or sprinkling and cooling extinguishers design comply with Czech normative regulations and methodologies approved by the Ministry of Interior; IAEA Recommendation 50-SG-D2 has been respected. The systems realized in the NPP site are water stable extinguishers, water sprinkling and cooling extinguishers, CO2 gas stable extinguishers, FM 200 gas stable extinguishers, foam stable extinguishers, foam semi-stable extinguishers and local gas stable extinguishers.

3.2.A.2.2. Types, main characteristics and performance expectations

Water Stable Sprinkling Extinguishers

The equipment is designed for sprinkling and cooling of main circulating pump (MCP), important cable rooms, important cable risers, MCP oil management rooms and oil management rooms feed water pumps in the reactor building in the event of a fire. Each of these compartments protected by two independent systems:

1. System SSE
2. Non-systemic SSE

System SSE

This equipment classification is a nuclear safety related and consists of three completely separate and independent systems (3 x 100% backup) included in their respective safety systems divisions. The SSE system is a selected equipment safety class 3 and is designed in seismic resistance category 1b. The containment wall bushings, shut-off valves, check valves located at the containment boundary is selected equipment safety class 2, and are designed in seismic resistance category 1a.

Main components:

a) Firewater distributor. Each system has its own firewater distributor, which is connected to the corresponding firewater tank via an electrical shut-off valve and a fire pump.

b) Distribution pipes from the firewater distributor to individual fire sections located in the building. From each of the three firewater distributors there is one branch pipe for each fire section, on which an electrical shut-off valve is installed. Downstream of the electrical shut-off valves, the branch pipes designated for the respective fire section shall be connected to a common distribution pipe, which feeds the firewater to the fire section. This ensures that water from any of the three systems can be supplied to each fire section. Electrical shut-off valves are installed in the rooms forming a separate fire section.
c) Distribution pipes from the firewater distributor to the individual fire sections located in the containment. One distribution pipe exits from each distributor and is routed to the containment via a hermetic bushing. A shut-off valve is installed on the distribution pipe upstream of the hermetic bushing and a check valve is installed on the pipe downstream of the hermetic bushing (in the containment). The distribution piping of all three SSE systems are branched in the containment so that the distribution piping of all three systems are routed to each fire section (except the fire sections of the MCP motors). Before entering the fire section, an electrical shut-off valve is installed on each distribution pipe.
d) The extinguishing strips, which are located in cable rooms between cable trays and in cable risers under the ceiling of the room. The extinguishing strips are fitted with spray nozzles. The nozzles are directed so that the water covers both the surface of the cables and the steel structures of the cable trays and cable grids. In the oil tank room of the MCP, the sprinkler strips are located around the perimeter of the oil tanks and the nozzles are directed so that the water will spray and cool all the equipment in the room.

Main components of the SSE for MCP protection

a) In the containment, branch pipes from the above described distribution pipes of all three systems exit into the pipe ring installed on the inner perimeter of the containment. An electrical shut-off valve is installed on each branch pipe. For each of the 4 fire sections, a distribution pipe fitted with another electrical shut-off valve exits the pipe ring and feeds firewater to the fire section.
b) The extinguishing strips are installed around the perimeter of the MCP and are fitted with FYRHEND ANGUS water spray nozzles. Each fire section is extinguished by 6 of these nozzles, which are directed so that the water covers both the surface of the MCP and the supporting structures.

Non-system SSE

The non-system SSE is not implemented as redundant. The equipment is designed, in the event of a fire, for sprinkling and cooling of the oil management rooms located in the reactor building enclosure and consists of two independent subsystems. Both subsystems are connected to the external firewater supply.

Main components:

a) The firewater distributor of the first subsystem and the firewater distributor of the second subsystem are located in separate rooms. Each is connected to the external firewater supply from two directions via manual shut-off valves.
b) Distribution pipes from the firewater distributor to the individual fire sections. An electrical shut-off valve is installed at the beginning of each distribution pipe and a manual shut-off valve is installed at the bypass. The electrical shut-off valves and manual valves are located in the firewater distribution rooms.
c) The extinguishing strips are installed around the perimeter of the rooms, around the perimeter of the oil tanks, and are fitted with spray nozzles. The nozzles are directed so that the water will spray and cool not only the oil tanks but also the other equipment in the room.

Water Stable Sprinkling Extinguisher – Main Production Building

The water SSE is installed in el. distributor room of main production buildings and have basically the same components. The equipment is designed to sprinkle and cool 29 cable sections and 13 cable risers in the event of a fire and consists of two independent subsystems. The first subsystem protects the safety-critical cable sections located on the underground floor -5,2 m, the second subsystem protects the other cable sections located on the floor -5,2 m and all other cable sections and cable risers located on floors up to 21,0 m. Both subsystems are connected to the external fire water supply.

Main components:

a) The firewater distributor of the first subsystem is located in the turbine hall, the firewater distributor of the second subsystem is located in the el. distributor room.
b) Distribution pipes from the firewater distributor to the individual fire sections. A water filter is fitted at the end of each distribution pipe, before it is connected to the fire extinguishing strip, to catch any debris.
c) The extinguishing strips that are located in cable rooms between cable trays and in cable risers under the ceiling of the room.

Water SSE in the Auxiliary Building

The equipment is designed, in the event of a fire, to sprinkle and cool the 4 cable sections of the radioactive media cleaning stations. The equipment is connected to the external firewater supply.

Main components:

a) The firewater distributor is connected from two directions to the external fire water supply via manual shut-off valves.
b) Distribution pipes from the firewater distributor to the individual fire sections. The electrical shut-off valves and the manual valves are located in the same room as the firewater distributor.
c) The extinguishing strips, which are located in the cable spaces between the cable trays, are fitted with spray nozzles that are directed so that the water covers both the surface of the cables and the steel structures of the cable trays.

Water Stable Extinguishers of Transformers

The equipment is designed to extinguish fires arising on power output transformers, on self-consumption transformers (diversion transformers) and on transformers of reserve power supply. The equipment is designed so that intensive cooling of the transformer is ensured simultaneously with extinguishing.

Both extinguishers are connected to the external firewater supply and their main components are:

a) The fire water distributor is located on the -5.0 m floor in the turbine hall and is connected to the external fire water supply via a manual shut-off valve
b) Distribution pipes from the firewater distributor to the individual fire sections. Electrical valves are installed on the distribution pipes and manual valves are installed on the bypass pipes.
c) The distribution pipe ring of each transformer is connected to the respective distribution pipe. From the distribution ring there are riser pipes which are fitted with filters to catch any impurities. The ring is fitted with a drainage elbow and a drain valve.
d) Frame structure with extinguishing strips, which distribute firewater to the extinguishing nozzles. The structure is made of galvanized piping, the horizontal piping consists of extinguishing strips fitted with spray nozzles that create a water mist around the transformer, which extinguishes the fire and intensively cools the transformer.

Water Stable Extinguishers in Central Electrical Control Room

The equipment is designed to extinguish fires arising in the central electrical control room to protect the cable room. The device is connected to the external firewater supply.

Main components:

a) Fire water distributor, which is connected to the external fire water supply from two directions via manual shut-off valves. On the outlet side of the distributor, an electrical shut-off valve is installed, on its bypass pipe a manual shut-off valve is installed.
b) Distribution pipe from the fire water distributor to the fire section, on which water filters are installed, to catch any impurities, and drainage valves.
c) The extinguishing strips, which are located in the fire section between the cable trays and on which spray nozzles are mounted, which are directed so that the water covers both the surface of the cables and the steel structures of the cable trays.

Foam Semi-Stable Extinguishers in Diesel Generating Stations

The equipment is designed to extinguish fires arising in the buildings of diesel generating stations. This equipment does not have its own extinguishing agent tank or its own extinguishing agent pump and works in synergy with mobile firefighting equipment. It extinguishes on the basis of a foamed solution that quickly spreads over the surface of the burning liquid and has high cooling effects. The equipment designed to extinguish fires originating in a common diesel generator station consists of two independent subsystems:

- The first subsystem protects the diesel generator and its accessories.
- The second subsystem protects the room in which the diesel fuel tank and the engine oil tank are located.

The main components of both subsystems are:

a) A collector used to connect mobile firefighting equipment, which is located on the outside wall of the building. The individual connection points are marked with the necessary data so that no confusion can occur (name and number of the fire section, required fire water pressure, % of foaming agent admixture). A manual shut-off valve is installed behind the collector on the distribution pipe.
b) Distribution piping from the collector to the fire section. At the end of the distribution pipe, before its connection to the extinguishing strips, a filter is fitted to catch any dirt.
c) The extinguishing strips are installed around the perimeter of the diesel generator and its equipment, respectively around the perimeter of the diesel and oil tank and are fitted with spray nozzles, directed so that intensive cooling of the technological equipment threatened by fire is ensured simultaneously with extinguishing.

Foam Stable Extinguishers of above ground motor oil storage tanks

The equipment is designed to extinguish fires arising in any of the four tanks (V=1000 m^3) of the oil management and bottling plant. SE extinguishes on the basis of heavy extinguishing foam, its power and capacity is determined for extinguishing one tank fire

Main components:

a) Foam tank. SE has two independent foam tanks, each store 2000 litres of foam. Each tank is connected via manual shut-off valves to its own foam pressure regulator. During firefighting, either tank can be selected as the working one, the other tank then serves as a back-up.
b) The foam pressure regulators are each inserted into one branch of the fire water supply pipe. A manual shut-off valve is installed upstream of each pressure regulator and the two branches are connected to a common supply pipe, on which an electrical shut-off valve is installed and a manual shut-off valve is installed on the bypass. A water filter is fitted upstream of the electrical valve on the supply pipe to trap any impurities. The supply pipe is connected to the external firewater supply. After the foaming pressure regulators, the two branches of the firewater supply pipe are connected to a common extinguishing agent distributor.

c) The distributor is equipped with 12 manual shut-off valves, to which the respective distribution pipes conveying the extinguishing agent to the individual protected tanks are connected. In addition, a manifold with a shut-off valve is installed on the manifold for connection of mobile firefighting equipment and a shut-off valve with a coupling for connection of a fire hose enabling possible use of the SE also for manual extinguishing.
d) Distribution pipes from the distributor to the individual protected tanks. There are three manifolds to each protected tank, each manifold on a tank interfacing with a foaming set.

Two PS 4 type foaming sets and one PS 2 type foaming set are installed on each tank. The foam kits are connected to the flanges of the nozzles which direct the discharge of the extinguishing foam to the inner wall of the tank, along which the foam flows to the surface of the burning oil.

CO_2 gas Extinguishers

The equipment is installed:

- In the turbine halls - the design of both turbine halls is basically the same. The equipment protects 6 compartments of the turbine-generator oil management and the oil management of the turbine pumps.
- In el. distributor, room consists of two independent subsystems and each subsystem has its own CO_2 station.
- In the central electrical control room and protects 2 compartments of this building.

Gas Stable Extinguishers FM 200

The device protects 3 compartments of the Central Electrical Control Room building. The entire system is located on the 2nd floor. The FM 200 extinguishing agent is stored in steel flasks as a liquefied gas, compressed with nitrogen to 2.5 MPa and injected into the protected space in the form of steam.

Local Stable Extinguishing FIRESTOP

The purpose of the device is fire protection of important electrical el. distributors installed in the rooms of the reactor buildings.

The FIRESTOP system uses a hexafluor propane-based extinguishing agent (trade name FE 36) and starts automatically without the need for external energy sources. The system is equipped with detection tubes made of polymer plastic, which are led from the individual extinguishing agent containers to the interior of the electrical cabinets. In the event of a fire inside the electrical cabinet, the detection tube will burn through and release the extinguishing agent into the cabinet space. As a result of the drop in pressure of the extinguishing agent in the storage container, a pressure switch is subsequently activated, which sends an information signal to the EFD system to activate a stable extinguishing.

Manual Firefighting Systems

All the compartments and buildings of the NPP realization and equipment enable quick and effective fire-fighting intervention of FRSU in all fire sections.

Inside tapping points

Internal fire water supply

In each multi-storey building, and in some cases in single-storey buildings, an internal firewater supply is installed, which is connected to the external firewater supply. Type C (DN 52) or D (DN 25) hydrant systems are fitted as internal tapping points on the internal fire water supply systems, which are intended mainly for trained personnel for initial fire-fighting work before the arrival of the company's FRSU.

The internal firewater conduit, including hydrant systems, are permanently watered and pressurised to ensure an immediate continuous supply of firewater. In the rare case where hydrant systems cannot be reliably protected from freezing, there are installed on water-free piping, with the water supply shut-off to the water-free piping located in the nearest easily accessible frost-protected area.

All hydrant systems are located on internal emergency routes or in places easily accessible from internal emergency routes, and their positioning in the buildings ensures that at least one stream of water can be used to extinguish the fire at each point in the fire section where extinguishing is expected.

High pressure fire water distribution

In order to increase the efficiency of manual firefighting by FRSU, a high-pressure fire piping system is installed in the reactor and auxiliary buildings. The system allows extinguishing by means of high-pressure spray water, which has a very high cooling effect and which, in addition, together with the rapidly generated water vapour, creates an inert environment around the fire, thus quickly extinguishing the resulting fire at low fire water supply intensity.

Reactor building:

In each of the four protected emergency routes, in addition to the internal firewater supply, an internal high pressure fire water distribution system (pressure 2.2 MPa) is installed, which is fed from the firewater supply system. The internal high-pressure firewater distribution system is constructed in seismic resistance category 1a (piping and tapping points) and 1b (pumps and associated valves). All valves and piping are made of stainless steel class 17 (stainless steel). The piping is connected by welding, only at the connection points of the valves is the flange connection used. On each floor, in each of the four protected emergency routes, there is a tapping point on the pipework equipped with a manual shut-off valve, a spool with a minimum 60 m long high-pressure fire hose and a high-pressure adjustable nozzle.

The system is activated manually by remote operation from the pulse of any activated button installed at± 0.00 level in each of the four protected emergency routes and at +6.60 level in both protected emergency routes located on the southwest side of the building (accessible from the reactor control room). When the button is pressed, the pre-selected pump starts and if the piping is not pressurized to 1.8 MPa within 30 seconds, the backup pump starts automatically. The pressure pulse is scanned at the common discharge behind pumps. The shut-off buttons are installed together with the start buttons. The pump can be stop by any of the switched off buttons. The system can also be operated from the control box.

To check the pump operation, a contact manometer is installed at the control buttons for local pressure measurement. In the event that the back-up pump does not start within 30 seconds, the water supply to the high-pressure fire water supply can be ensured by connecting mobile firefighting equipment equipped with a high-pressure fire pump. A collector for the fire truck connection is installed at the entrance in the west corner of the building.

Auxiliary Building

In radioactive media cleaning stations unit in all floors of the north-western part of the building, in addition to the internal fire water supply, a system of non-watered high-pressure fire pipes (DN 65) is installed, which is fed in case of fire from mobile firefighting equipment equipped with a high-pressure fire pump. The system is primarily designed to increase the effectiveness of any fire-fighting intervention in the solid radioactive waste processing and storage areas located at +13.20.

All valves and piping are made of stainless steel class 17 (stainless steel). The piping is connected by welding, only at the connection points of the valves are flanges used. On each floor, one or two tapping points are fitted in the partially protected emergency route on the fire pipe, equipped with a manual shut-off valve, a spool with a minimum 60-metre long high-pressure fire hose and a high-pressure adjustable nozzle. A collector for the connection of fire equipment is installed on the north-west side of the building.

Fire water supply systems

Two different, independent firewater supply systems are implemented in NPP site. The first system is seismic resistant and provides for important areas in the reactor building, the second system is non- seismic resistant and provides for the entire NPP site.

Fire water supply system - seismic resistant

The system is designed to supply firewater to the stable extinguishing, sprinkling and cooling extinguishers to protect selected compartments of the reactor building that house safety system equipment and components. The system also supplies the internal high-pressure firewater distribution system for manual firefighting in the reactor building.

The entire system is designed as redundant with 3 x 100% backup and the individual branches are part of three redundant systems of stable water extinguishing, sprinkling and cooling. The system is classified as selected equipment safety class 3 and is designed in seismic resistance category 1b**.** Each redundant branch includes the following equipment:

1. Water source - the permanent fire water supply consists of a steel tank with a volume of 70 m^3, which is automatically replenished if necessary from the relevant redundant essential water system. In addition, the tank can also be replenished from a second fire water supply system, i.e. from an external fire water conduit fed from a fire water pumping station. The tanks of all three back-up systems are located in a room on floor + 33,6 m and have fire separation by distance.
2. Fire water pump - the supply of water from the tank to the stable extinguishing, sprinkling and cooling is provided by an electric pump type which parameters are sufficient to ensure the required water supply necessary for extinguishing and cooling of the largest extinguished and cooled section. The pump is connected to a category II electrical power supply. Each of the three pumps is electrically powered from an appropriate redundant secured power supply system. All three pumps are installed at +28.8m floor level and each pump is located in a separate fire section.
3. The water supply to the internal high-pressure fire water distribution system is provided by an electric pump type HAUKE TP 105 3C-55/15 with parameters sufficient for simultaneous extinguishing with two high-pressure hand extinguishing jets (the required output for 1 jet is 2.5 l/s). The water supply system to the high-pressure fire water distribution system is designed as redundant with 2 x 100% backup and its individual branches are assigned to the firewater supply systems. The pumps are connected to category III/II electrical power supply, supplied electrically from the 5th secured power supply system. Both pumps are installed at +28.8 m floor level and each pump is located in a separate fire section.
4. Measuring circuit and shut-off valves - the fire water supply system includes electrically operated shut-off valves and a measure system. The corresponding measuring circuit detects the water level in the tank and, when it drops to a low level, signals the automatic opening of the shut-off valve installed on the filling line of the relevant branch of the essential water system. When the tank has been refilled to a upper water level, the shut-off valve closes automatically or, if necessary, manual remote shut-off of the valve is possible from reactor or emergency control room. If the automatic mode of the refilling system fails and the water level drops to minimum, this condition is signalled as an alert to reactor operator, who ca manually remote control of this shut-off valve is possible.

In the event of a complete failure of the tank refilling system from the essential water system, it is important that the operator has the possibility to provide refilling of the tank from an alternative refilling system, i.e. from an external firewater supply pipeline fed from the firewater pumping station. The shut-off valve on the refilling line from this system is only opened manually remotely from the reactor or emergency control room. If the automatic mode of the refilling system fails and the water level drops to minimum, this condition and closes automatically when the tank is refilled to upper water level, or manually remotely by reactor operator.

Another component of the fire water supply system is the minimum bypass of fire pump system. Attached measuring circuit scan the water flow behind of the control valve at the fire pump output and, when the flow drops to Q = 40 m^3 /h, it signals the automatic opening of the shut-off valve installed on the bypass line with a delay of 10 sec. Manual remote control of this valve from reactor or emergency control room is also possible.

All of the above mentioned shut-off valves are connected to category II of electrical power supply and supplied from the respective redundant secured power supply system. Shutoff valves installed on the refilling lines are fire separated by distances, and shutoff valves installed on the bypass lines are located in separate fire sections together with the respective firewater pumps.

Fire water supply system – non-seismic resistant

The system is designed to supply firewater to the external fire water supply system, on which the underground and above ground fire hydrant systems are installed. The internal fire water supply systems of the individual NPP buildings and the stable foam and water extinguishing, sprinkling and cooling systems that are not supplied from the seismic-resistant fire water supply system are connected to it.

This system also serves as a backup water source to supplement the seismic resistant fire water supply system.

The following devices are part of the system:

1. The water source of fire water is the treated additional water of the NPP cooling system, which is automatically fed into the cooling circuit from two 15 000 m^3 storage reservoirs by gravity pipes DN 1000 through the suction sumps of the fire water pumping stations. This ensures the continuous replacement of firewater in the suction sumps and prevents its deterioration. Another option for refilling the fire sump is to refill it by means of an overflow from the cross channel between the cooling water circulation lines - the height of the overflow corresponds to the level in the suction channels of the pumps.
2. Each of the two firewater intake sumps is situated between two channels that supply water from the cooling towers to the respective cooling water pumping station and is connected to both channels by DN 300 openings that are closed by manually operated gate valves during normal operation. In the event of a failure in the water supply from the storage tanks, it is thus possible to provide a refilling firewater supply to the intake sump by opening the gate valves. The described solution ensures that the available fire water supply is practically inexhaustible.
3. The fire water pumping stations are 2 mutually independent and mutually backing up fire water pumping stations, which are situated in the cooling water and non-essential water pumping station buildings. Each firewater pumping station form a separate fire section. One of the firewater pumping stations is always designated as the operating station and the other as the standby station. The switches for the selection of the operating and reserve pumping station are located in the control rooms of the respective MPU and the selection of the operating station is made by mutual agreement between the two reactor operators and the signalling of the selected, i.e. operating, pumping station is always active on both control rooms.

In parallel, the following data are also signalled to the water control room:

- The water level in the cooling water supply channels,
- Water level in the fire water intake sump,
- Pressure in the fire water discharge pipe,
- Signalling the operation of the supplementary pumps.

Each firewater pumping station includes:

a) Firewater intake sump - the available volume of the fire water intake sump is 320 m^3 which ensures about 70 minutes of fire water supply for firefighting, sprinkling or cooling of the fire section with the highest required intensity of fire water supply even in case of failure of both systems of the intake sump refilling.

b) Fire pump - 2 electrically driven fire pumps with guaranteed parameters installed in each pumping station. The maximum pump output is 75 l per second at 0.8 MPa. Each pump is installed on a separate DN 300 pipe branch, the connection of both pipe collectors to the external fire water supply is made outside the pumping station building.

One of the fire pumps is always selected as the operating pump, the other as the reserve pump. The operating and standby pumps is selected in the reactor unit control rooms. The pump selected as operating is started automatically when the shut-off valve on any branch of the stable extinguishing, sprinkling or cooling system is opened or from the EFD signal from the fire section. The valve on the pump output line shall open and close automatically when the respective pump is started or shut down. The pump selected as standby pump is switched on automatically if the pump in service does not start within 5 sec, or if the service pump is running but the pump output pressure has dropped to 0,5 MPa, or if the service pump has been shut down.

Remote buttons from reactor unit control rooms can also activate the fire pumps manually. Switching off the pumps after the end of firefighting is only manual from the reactor unit control rooms. In cases where the required fire water supply intensity for firefighting is greater than the output of one pump (e.g. when extinguishing transformers), reactor operator has the option of manually starting the reserve pump remotely.

The following data are simultaneously signalled to the respective reactor unit control rooms:

- Switch on/off of the fire pump.
- Position of the shut-off valve on the fire pump output.
- Pressure and flow at the fire pump output.
- The level of fire water in the intake sump.
- Ambient temperature in the fire water pumping station.

Fire pumps, output shut-off valves and measuring circuits are connected to category III/II electrical power supply, electrically supplied from the 5th system of secured power supply. Each pump, including the shut-off valve, is supplied from a different electrical el. distributor, which are located in the relevant el. distributor room, in separate fire sections. The cable lines are routed in separate, fire separated cable channels up to the boundary of the fire water pumping station building, in the pumping station building the cabling to the individual fire pumps is routed in cable trays separated by distance. All cabling is in accordance with IEC 332.3 category A.

c) Refilling pump which is intended to feed up losses in the firewater supply network. Each firewater pumping station is equipped with 2 electrically driven pumps with guaranteed parameters. Each refilling pump is installed on a separate DN 300 pipe branch prior of the fire pump. One of the pumps is always selected as operating pump, the other as reserve pump. The selection of the service and reserve pumps is same as fire pumps.

The refilling pumps can also be operated remotely. When the fire pump starts, the operating refilling pump is automatically switched off and its restart is blocked for the duration of the fire pump operation.

Together with the respective compressor and wind fan, the refilling pump works as an automatic pressure station. Due to the possibility of different heights of the water levels in fans, both compressors are selected as operational. In automatic mode, the respective compressor is switched on when the pressure in the respective fan falls to 0.47 MPa and is automatically switched off when the pressure rises to 0.55 MPa or from the time relay after 20 minutes of operation.

The compressors can also be controlled remotely from reactor unit control room and also from the local control box on the relevant firewater station. When the fire pump starts, the working compressor in the automatic operating mode is automatically switched off and its re-start is blocked for the duration of the fire pump operation.

The following data are simultaneously signalled to the reactor units control rooms:

- Switching the refilling pump on and off.
- Position of the shut-off valve on the output of the refilling pump.
- Pressure at the discharge of the refilling pump
- Switch on/off of the compressor.
- Pressure and water level in the fan.

The refilling pumps are connected to category III of electrical power supply (non-secured). Each pump is supplied from a different electrical el. distributor in el. distributor room, in separate fire sections. The cable lines are routed in separate, fire separated cable channels up to the boundary of the firewater pumping station building. Inside the pumping station building the cabling to the individual pumps is routed in cable trays separated by distance. All cabling is in accordance with IEC 332.3 Cat. A.

d) Heating unit - 2 heating units are installed in each firewater pumping station, one of which is set as the 1st operating unit and the other as the 2nd operating unit. When the temperature rises, both operating units, including the fan, are switched off automatically. The reactor unit control rooms obtain simultaneously data on the fan operation of the heating unit.

External fire water supply

The external fire water piping is made of seamless steel pipes and is made as welded, the external fire water piping in the area of the SFS is made of PE pipe. The steel pipe is protected against corrosion by insulation, the welds are also additionally insulated. In sections where the pipe is difficult to repair or replace (pipe passage under power and pipeline channels, etc.), the resistance of the pipe to the effects of internal corrosion is increased by the use of steel pipes with reinforced wall thickness. There are 4 measuring points on the water supply line in the compartment of the chemical water treatment unit to measure the electrical potential. The measurements are used to assess the corrosive threat to the pipeline.

The pipeline is mostly saved in the ground at a depth of 1.8 to 2.2 m in a gravel-sand bed and backfilled. In the sections where the pipeline passes under railway sidings, power and pipeline channels and roads, the pipeline is saved in steel sleeves, which are also provided with asphalt corrosion protection and the faces of the sleeves are closed with rubber cuffs. In the areas around the MPU, the external fire water piping is saved in reinforced concrete seismic resistant channels together with the essential water piping. The external fire water main routes are designed to provide a fire water supply to simultaneously supply these buildings:

type of device	**consumption**
Stable extinguishers or peak demand cooling system	Q1 = 83 l/s
External fire hydrant systems (25% stable extinguishing)	Q2 = 21 l/s
Indoor tapping points (manual extinguishing inside buildings)	Q3 = 10 l/s
Total	Q = 114 l/s

The main lines (DN 300) leading from the fire water pumping stations, the lines laid in the areas around the MPU and the lines providing fire water supply to the southern and south-eastern part of the NPP site are designed for this flow. As the modifications have resulted in reduction of the maximum consumption from 83 l/s to 74 l/s, the water for the cooling of the DGS is supplied through a separate pipe, the DN 300 lines provide the largest firewater flow with a considerable margin. The other lines (DN 200, DN 150) provide the maximum required fire water supply for firefighting in buildings close to these routes.

The external fire water supply system is designed mainly as a looped water supply network, which ensures the supply of firewater to all important buildings of the NPP even in case of failure and shutdown of one of the lines. The network is designed in such a way that any line can be supplied by either of the two firewater pumping stations.

The shutdown of individual lines or branch lines is ensured by installing shut-off valves at the crossing points of the lines or at the places where branch lines are welded for supplying individual NPP buildings. Shut-off valves with a ground gate valve and a ground set are installed. A total of 28 prefabricated valve shafts are built at the crossing points of the lines, where shut-off valves are installed on the pipes of each line. This ensures the possibility of shutting down any line while maintaining the full operability of the remaining part of the water supply network.

Underground and above-ground fire hydrant systems DN 80 are installed on the individual lines at distances not exceeding 160 m for water extraction in case of fire. The hydrant systems are installed at the branch of the water supply lines and a shut-off gate is installed between the hydrant system and the line to ensure that in the event of a failure, the damaged hydrant system can be shut down without shutting off the entire line. Hydrant systems and gate valves that are installed outside of concrete or asphalt surfaces are placed in concrete rubble with gravel backfill.

Hydrant systems and gate valves are marked with red painted signs located on poles or walls of adjacent buildings and their covers are red painted.

In case of emergency, water for fire purposes can be taken from:

a) Drinking water supply line, which is also equipped with underground fire hydrant systems and whose parameters (pressure 0.35 MPa and flow rate 6.4 l/s) are usable for fire purposes.
b) Pools, or channels with cooling water – thus using firefighting equipment and material resources available to the FRSU organise long-distance transport of water to the fire site

Portable extinguishers

In all NPP construction buildings, the appropriate types of portable or mobile fire extinguishers are installed, which are intended mainly for trained workers, employees assigned to preventive fire patrols and for employees of the FRSU to provide rapid first firefighting intervention. Extinguishers are located in buildings according to the principles set out in ČSN 73 0804, ČSN 73 0802 and according to approved fire risk assessments. The type, number and location of fire extinguishers is determined for each building and are determined by the nature and size of the workplace located in the building and the nature of the combustible substances present in each workplace. Fire extinguishers are located in particular near the places where fires are likely to occur, at entrances to rooms and on internal emergency routes. In places where halon extinguishers were originally considered, halotron extinguishers are used, whose extinguishing effects are comparable and do not have negative consequences for the environment.

3.2.A.2.3. Management of harmful effects and consequential hazards

Systems for reducing secondary effects

Secondary effects of a fire include smoke, heat and toxic combustion products that spread from the original fire site to other areas not directly affected by the fire. Secondary effects of fire also include damage and dangers that may result from the reaction of the extinguishing agent used with the fire environment.

To reduce the secondary effects of fire, established systems and equipment ensure:

- The safe evacuation of persons from a burning or fire-threatened building.
- Conditions for effective intervention of FRSU in firefighting and rescue work.
- Controlled smoke ventilation during and after a fire.

Passive or active means are used to reduce these secondary effects.

Layout of buildings - emergency routes

The layout and spatial design of the individual buildings and installed technological equipment is such that redundant parts of the safety systems are separated from each other to prevent that fire affect nuclear safety activities. Means are provided to limit the consequences of a fire (assessed as a simple failure) and the general requirements for nuclear safety are met.

The design of the individual buildings included "technical fire protection reports" with emergency and intervention routes assessment. The design of emergency routes complies with the requirements of fire safety standards (ČSN 73 0802, ČSN 73 0804). Protected emergency routes, partially protected and unprotected emergency routes are established. The permissible limit lengths are not exceeded.

Ventilation systems

When designing ventilation systems from the point of view of fire safety, the procedure followed ČSN 73 0872. In addition, the principles of the decree on the requirements for the design of the ventilation system, in force at the time of the design of the systems, and the IAEA safety manual were applied for important buildings:

- Basic operational ventilation systems are used for ventilation of buildings in case of fire (except for ventilation of protected emergency routes).
- In cases where CČN 73 0872 is in conflict with nuclear safety requirements (e.g. it is necessary to create a permanent vacuum), alternative measures are implemented.
- The ventilation systems are designed to ensure the operation of redundant parts of the safety systems.
- Flammable air filters are designed in such a way that they cannot leak radioactive substances above the specified limits in the event of a fire. The environment in the ventilation pipes upstream and downstream of the filter is monitored by EFD; if a fire is detected, the filter is automatically separated from the rest of the ventilation system by closing the air dampers and the air is transferred to another filter. Due to the lack of oxygen, the fire is extinguished. Air dampers designed to prevent the spread of fire through the ventilation piping have a proven fire resistance by test or calculation.

Ventilation in the reactor and auxiliary plant buildings

The following principles were regarded in the fire safety of the ventilation systems:

- In the event of a fire, basic operational ventilation systems are used for ventilation of individual fire sections (except for ventilation of protected emergency routes - stairways).
- Fire dampers are installed in the places of penetrations of ventilation equipment (pipes, or other parts and elements) through fire-separating structures.
- In cases where the ventilation piping passes through a different fire section than the one ventilated by the ventilation system in question, dampers are installed or the piping is protected by fire insulation up to the next damper.
- No dampers are installed in ventilation systems of rooms for which a constant supply of air or even exhaust air is required, and protected tube is used when the tube passes through another fire section. E.g.: air-conditioning of reactor unit control room, ventilation of protected emergency routes, corridors on floors -4,20, ±0,00, +3,60, +6,60, +24,60.
- It is not expected that there will be a fire in the containment and the enclosure building at the same time. Precautions are taken to ensure that a fire cannot spread from the enclosure building to the containment and vice versa.
- Protected piping is not required for the supply system tubes, which filters outdoor air containing radioactive aerosols for the control room when necessary, and does not need to be used for fire sectioning for the following reasons:
    - The system is only operational when the outdoor air is contaminated with radioactive substances.
    - Pipeline routes are routed only through the enclosure building.
    - A fire in the containment enclosure will not increase the radioactivity around the unit.

KID automatic dampers

The KID dampers are used for air transfer between rooms and automatically maintain the pressure difference between the rooms connected by the dampers. The KID damper opens when the pressure difference between the connected rooms reaches a prescribed (set on the damper) value. The pressure difference is set by a weight on the damper. The KID damper closes automatically when the exhaust system is interrupted. The KID damper has a fire resistance of 90 minutes as proven by a test.

In cases where the air extraction from the box is switched off in the event of a fire, a damper is not connected to the KID damper located in the wall between the corridor and the box. From the corridors in which the oil pipes are routed, the EFD control the dampers in the adjacent boxes and in the event of a fire interrupt the air extraction, thereby closing the KID dampers.

Ventilation of protected emergency routes

In individual buildings, where required by ČSN 73 0804 or ČSN 73 0802, protected emergency routes are established for the safe evacuation of persons and, where appropriate, for fire-fighting intervention.

Type C protected emergency routes are provided in both reactor buildings and the auxiliary building - of the RA waste treatment unit. They are ventilated in accordance with EN 73 0804. A pressure gradient of 15-50 Pa is ensured between the staircase area and the halls, and 10-30 Pa between the halls and the other fire sections. The overpressure ventilation has an ensured power supply. The ventilation is activated by automatic smoke detectors of EFD. Another possibility to activate the ventilation is push-buttons from the protected emergency route.

Control of ventilation equipment and fire dampers in important buildings

- Electrical fire detection alarms located in rooms where circulating ventilation systems are used shut down (in the event of a fire detection) this ventilation equipment.
- In order to improve the conditions for manual fire-fighting in important buildings, in compartments with low fire loads, smoke is extracted during a fire for as long as possible by operating air ventilation systems. A thermal fuse controls the installed dampers and the position

of the leaf is signalled in the reactor control room. The possibility of such solution enable use of reduced flammability cables, which are halogen-free and have a reduced optical density of smoke.

- The fire dampers are controlled by automatic EFD alarms in the event that an oil fire could occur and thus smoke leakage to adjacent fire sections through the air channels.
- The KID dampers close when interrupted the exhaust from the box to which the damper supplies air.
- The automatic EFD alarms in the protected emergency route and from the staircase ventilation fan control dampers installed between the protected emergency route hall and other areas of the building by.

In addition to the requirements of ČSN 73 0872, the installation of fire dampers in the place of penetrations of ventilation equipment smaller than 0.04 m^2 has been specified in the following cases:

- Ventilation equipment penetrations through fire separation structures that separate the protected emergency route from adjacent spaces.
- Rooms with higher fire loads (pn>50 kg/m^2)
- In case of a risk of combustion release spreading into rooms where there are permanent workplaces.

Electrical equipment

Safety important electrical equipment is protected against the effects of fire (considered as a single failure) to not affect compliance with the general nuclear safety requirements.

The cable distribution systems are designed and implemented according to the coordination document "Principles for cabling solutions", which are based on ČSN and the requirements of IEEE and NUREG standards and have been approved by the state administration authorities.

Cable routes in which only cables complying with the test according to IEC 332.3 Cat. A are used are not considered as fire loads (within the meaning of ČSN 73 0804) if assessed no other fire loads in the compartment that could endanger these cable routes in the event of a fire.

The parallel installation of different divisions of cable routes of the secured power supply systems in compartments without separation by construction with fire resistance of at least 90 minutes is assessed and evaluated in detail in special documentation "engineering solutions", which demonstrate compliance with nuclear safety requirements including fire protection.

The transformers are designed and constructed according to ČSN 33 3240, including the corresponding fire protection structures and the provision of active fire protection systems (electrical fire alarm, fire extinguishing systems).

Easy access is provided to the cabinet el. distributors and cable connectors so that extinguishing can be performed. In cases when firefighting has to be performed under electrical voltage, the ČSN 34 3085 or methods laid down by the Ministry of the Interior shall be respected.

Explosion protection in connection with fire

Explosion protection for solids

No solids in significant quantities are present in the NPP buildings in the form, arrangement or use that could be the cause of an explosion. Individual small quantities can be used in chemical laboratories. Activities involving the use of these substances are subject to special working procedures, performed by qualified personnel and are not performed in areas where nuclear safety or radiation protection buildings are located.

Explosion protection for flammable liquids

Limited quantities of flammable liquids are stored and used in laboratories. The activities related to the use of flammable liquids are subject to identical procedures as solids.

Above-ground storage of flammable liquids is more than 400 m away from buildings containing safety systems and important radiation protection equipment. Storage tanks for diesel generator fuel are in underground buildings. The design of all storages and the activities performed are in accordance with ČSN 65 0201.

The critical flammable liquids (oil fuel, engine and turbine oil) used in process equipment are hazard classes III and IV. These flammable liquids do not form explosive mixtures under normal storage and operating conditions. All joints on the flammable liquid pipelines are made as tight (welded or in a "knockout, knuckle" design).

The turbine oil lines are routed in sheet metal channels. Even in the very unlikely event of a break (loss of integrity) of the pipe, the oil cloud would be confined to a small area within the channel. There is no nuclear safety or radiation protection equipment, the connected reactor building structure is of a pressure wave resistant design and equipment located in the reactor building cannot be damaged.

Each diesel generator serving one division of the secured power supply system is housed in a separate, structurally isolated, pressure wave resistant cell.

No nuclear safety or radiation protection equipment is located in the common diesel generator station, the follow-up cell structures are of a pressure wave design and the equipment located in the building cannot be damaged.

In the fuel oil management compartment are located underground and even a possible (unlikely) explosion will not cause damage to the equipment located in the diesel generator station or main production unit.

Pipelines that contain oil in normal operation are of seismic resistant design and are ensured against operational vibration. The quality of design, operation and maintenance (including appropriate in service inspections and revisions) ensure that there is no loss of integrity of these pipelines, no small leaks, and no subsequent oil cloud that could (if initiated simultaneously) cause an explosion.

Protection against explosion of flammable gases

The gas that could cause an explosion is primarily hydrogen. The hydrogen cools the internal equipment of the turbine-generator in the turbine hall. All measures prescribed for such piping are implemented, including ensuring the integrity of the piping, ventilation (including unsealed openings in the roof), monitoring of hazardous concentrations and the design of electrical equipment located in dangerous proximity to potential leaks. The construction of the connected reactor building is of a pressure wave design and the equipment located there cannot be damaged.

The hydrogen storage is in a separate open compartment, which is approximately 500 m from the buildings containing equipment important for nuclear safety. This distance is sufficient to ensure that safety and safety-related systems equipment is not compromised.

Hydrogen is produced in the primary circuit coolant and in the hermetic space in post-accident conditions. This solve installation of hydrogen recombining system. Hydrogen is also generated during battery charging and is vented through separate ventilation systems outside the buildings.

Pressure flasks

In some compartments, there are the necessary quantities of pressure flasks. Their quantity and weight limit the operating regulations. Technical and organisational measures are in place in connection with the operation of these compartments and the implementation of fire-fighting measures to prevent the possibility of a fire-related explosion of flasks.

3.2.A.2.4. Alternative/temporary provisions

Temporary measures to ensure the required fire safety are applied e.g. during shutdowns of fire safety equipment, repairs, modifications and maintenance. Temporary measures propose professionally qualified person in fire protection and subsequently submit it for approval to the Regional Fire Rescue Service of the Czech Republic, which assesses and approves the proposed measures or orders further measures that must be observed. Temporary measures include, for example: increasing the number of firefighters in shifts, increased inspection and patrolling activities or continuous surveillance of certain areas, increased number of portable fire extinguishers in the building, placement of firefighting monitors with prepared hose lines, etc.

3.2.A.3. Administrative and organisational fire protection issues

The company's Fire Rescue Service Unit

A professional unit of the company's FRSU is established at the NPP, which functions in a fire station located in the north-eastern part of the NPP site, at a distance of about 900 metres from the reactor buildings.

The FRSU has 79 employees who provide tasks in the field of prevention of firefighting as well as in the field of repressive activities. The FRSU is in organizational chart integrated into the Fire Protection and Emergency Preparedness Department. FRSU professionalism supervise the State Fire Supervision Authorities (Regional FSR).

Prevention of fire protection

The basic mission of the prevention is to design and promote the implementation of such fire safety measures so that during any activities in the lifetime of the NPP, the possibility of fire occurrence is eliminated with the maximum possible degree of probability, especially in buildings and compartments where safety systems and systems safety related are located.

The main task of the preventive activities is to carry out consistent checks on compliance with the established fire safety measures and to check compliance with the requirements of generally binding legal and technical regulations, the requirements of the internal procedures and documents of the Utility, applicable and valid to the Temelín NPP.

In fire hazardous activities where there is a high risk of fire, the Fire and Rescue Service provides fire assistance. Fire protection technicians, employees of the FRSU and preventive fire patrols perform preventive activities in NPP.

Fire protection repression

The basic mission of the NPP repression is to protect the systems and equipment ensuring nuclear safety, life and health of persons and property of the company in case of fires and to provide effective assistance in liquidation of accidents, natural disasters and emergencies occurring in the NPP site or in its vicinity.

The firefighters perform repressive activities in four shifts, each with 18 firefighters + 1 driver of the Rapid Medical Aid vehicle with 1 employee of the South Bohemian Regional Health Rescue Service.

The maximum time of arrival of the FRSU to the most important buildings of the nuclear power plant (MPU) is 4 minutes from the occurrence of a fire that is detected by EFD. The arrival time consists of:

- ✓ Detection of fire by EFD alarm - max. 1 minute
- ✓ Time for the FRSU to leave after the fire alarm - max. 2 minutes

- ✓ Time of driving of the FRSU - 1 minute

Commanders, engineers and special services technicians meet the qualification and competency requirements of the Fire Protection Act. In accordance with the requirements of the Fire Protection Act, all firefighters of the FRSU are graduates of the basic professional training, which they have completed in the educational facilities of the Ministry of the Interior of the Czech Republic.

Further periodic training of FRSU is performed according to training plans prepared for the respective training period. This training includes theoretical training, practical training and physical training. The number of firefighters and the material and technical equipment of the FRSU comply with the requirements of the approved design and the current legislative regulations.

The FRSU unit is equipped with the equipment and resources listed below:

Mobile firefighting equipment

Pcs	**Type**	**Name**
2	CAS 24	Tank car spraying machine, pump 2400 l/min
2	CAS 32	Tank car spraying machine, pump 3200 l/mi
1	KHA 32	Combined fire extinguishing vehicle, Tank car spraying machine, pump 3200 l/min Gas extinguishing car, extinguishing agent FE36
1	TA2/CH	Technical and anti-chemical car
1	PPLA	Anti-gas car
2	DA-12	Transport car
1	AP 44	Bronto F 44RLX automobile platform
1	VA	Command car
1	NA	Truck
1	NA	Truck - tipper with hydraulic arm
1	SA	Ambulance RLP
1	PHM	Truck with fuel
1	Excavator	Excavator loader Terex

3.2.A.3.1. Overview of firefighting strategies, administrative arrangements and assurance

Building structures and materials

The building materials used have a documented flammability according to ČSN 73 0862 or according to ČSN 73 0823 depending on the type of operation. The continuous inspection was performed throughout the construction period within the framework of the investor's technical supervision and author's supervision, as well as during the activities of the State Fire Inspectorate.

Bearing structures that ensure the stability of the building or its part, fire separating structures, fire sealing have documented fire resistance by a certificate from an authorized testing laboratory, expert opinion, or is proven by a standard value according to ČSN 73 0821. For selected structures, other fire technical characteristics are also documented, e.g. flame spread on the surface of building structures for floor coverings.

Technical and technological equipment

All cables that shall meet the test parameters of IEC 331 and IEC 332.3 Cat. A have a certificate of testing laboratory. All cable penetrations are certified for fire resistance of fire filling according to the test method approved by the Ministry of Interior, Main Administration of the Fire Protection Corps in 1992 (at present FRS CR).

The fire resistance of the pipe penetrations through the fire separating structures prove a certificate according to the approved test methodology from 1995.

Electric fire detection system, Stable extinguishing equipment

The EFD and SE systems and its individual components have been assessed by the Directorate of the Fire Rescue Service in accordance with the fire protection regulations and approved for use in the Czech Republic. Before commissioning, the entire system was comprehensively tested.

Portable extinguishers

Each type of portable extinguisher used has approval for use in the Czech Republic in accordance with fire protection regulations.

Ventilation systems of protected emergency routes

The ventilation system for individual protected emergency routes is designed and implemented according to the requirements of ČSN 73 0804, including an alternative source of electrical power. The fire dampers and fire insulation of the piping have a fire resistance test report.

3.2.A.3.2. Firefighting capabilities, responsibilities, organization and documentation onsite and offsite

Qualification requirements for fire protection posts

Function name	**Qualification requirement**
Licensing Specialist - fire protection	University degree in the field of fire protection Technical university + professional competence according to the Fire Protection Act
FRSU Commander	University degree in fire protection or university degree + professional competence (course in tactical and strategic management + professional competence according to the Fire Protection Act)
Fire protection technician	High school + professional competence according to the Fire Protection Act
Operations Officer	High school + tactical management course
FRSU Shift Commander	High school + tactical management course + professional competence according to the Fire Protection Act
FRSU Squad Leader	High school + tactical management course
Firefighter - engineer	High school + mechanical engineering course
Firefighter - chemist	High school + chemical service course
Firefighter - liaison	High school + course of connection service
Firefighter	High school + initial professional training

Training and preparation of NPP employees on fire protection

In accordance with the requirements of the Fire Protection Act, fire protection training is organized for all nuclear power plant personnel on the following dates:

a) Training of employees on fire protection:
   - Training shall be provided on entry of the person to employment and whenever there is a change in the employee's workplace or job classification, if such changes also result in changes to the facts that were the subject of the previous fire protection training,
   - Training is repeated 1 x per year.

b) Training of managers on fire protection:
   - Training is performed when senior staff at all levels of management enter to their posts,
   - Training is repeated 1 x every 2 years.

c) Fire protection training provided for employees of contractors performing activities at Temelín NPP.

d) A "professional training" - is organized for employees assigned to the FRSU (professional firefighters) and for employees assigned to preventive fire patrols.

The management system documentation of the Temelín NPP includes the organization, scope and content of training of NPP employees and contractors' employees on fire safety and the organization, scope and content of training of employees assigned to preventive fire watches.

There are 358 fire points located in the buildings throughout the NPP area, where the fire protection documentation is located: fire alarm orders and the graphical and textual part of the fire evacuation plan of the building.

All fire protection documentation is located in the nuclear power plant archives.

3.2.A.3.3. Specific provisions

In the NPP design, all risk factors were already taken into account in the siting phase, including fire risk not only inside but also in the vicinity of the buildings. Analyses and exercises performed since the start of operation have shown that the measures taken are sufficient, in line with the current situation and no special provisions are needed. Graphical diagrams of the fire-fighting documentation have been drawn up for the important buildings, with access, boarding and emergency routes marked.

3.2.B. Active fire protection of the Dukovany NPP

3.2.B.1. Fire detection and alarm provisions

The detection and reporting of fire in all the Dukovany NPP buildings is ensured by the electrical fire detection system (EFD). The EFD system is a set of fire detectors, exchangers, interconnecting cabling and additional equipment, the purpose of which is to signal acoustic, optical and graphical information the location of a fire or the start of fire extinguishing systems. In addition to this activity, the EFD system continuously monitors the function of its own critical components and immediately signals their possible failure.

The control of the fire dampers and ventilation units (ventilation system) is a further link. Ventilation systems in SSE-protected areas are activated by the automatic start-up function of the SSE.

3.2.B.1.1. Design approach

The EFD system is designed according to Czech normative regulations, especially ČSN 342710, ČSN 730875, EN 54, Decree No. 246/2001 Coll. and related standards and according to the technical conditions of the equipment manufacturer.

The types of fire detectors are designed and realized depending on the parameters of the products formed during heating, carbonization, ignition or combustion of the materials present in the respective protected area.

When selecting the type of fire detectors and determining their placement in the protected area, the environment of the protected area is also considered, e.g. radiation, humidity, temperature, air flow, etc. A fire alarm signalled by an EFD is unambiguous, clearly recognizable and not interchangeable with any other warning signal.

Historically, the EFD in the Dukovany NPP is divided into five parts: in individual reactor buildings and in outdoor buildings, including external cable channels. The operator of the EFD is always at the individual reactor unit control room. The operator of the FRSU controls EFD of the outdoor buildings and channels and has the possibility to control all the EFD in the Dukovany NPP site using of the superior extension system.

After the completion of construction and the start of operation of the Dukovany NPP, the TESLA Liberec EFD system was used in all buildings. The EFD system was gradually replaced as the support of individual systems and manufacturers finished.

In the middle of the 1990s, the action "Improvement of the EFD system at the Dukovany NPP" has started. Within the framework of this modification, the TESLA Liberec EFD was dismantled in MPU I. and II. In predetermined compartments, the so-called "critical points", the TESLA Liberec EFD was present together with the new EFD. The new systems used the CERBERUS ninth series equipment for fire detection. The company headquarter was in Switzerland and later became part of SIEMENS.

The original system in the units and on the outside buildings has been completely replaced by the new Esser FlexES Control EFD system. The exchangers, detectors and some cabling were replaced. A new unified extension system “TVRZ” was installed for all buildings. In parallel, stable extinguishing was installed in diesel generator station (DGS) 1-12, aerosol stable extinguishing was built on each cell in the fuel oil and oil storage tanks compartment, spray extinguishing was installed in the oil and fuel management compartment of the DG. The method of provisioning and extent of the EFD system were retained. The following modifications were made to some of the buildings:

- Linear detectors in el. distributor rooms replacement by a suction system.
- Automatic fire detectors (intake system) added in the rooms of the emergency cooling system of the core.
- Automatic fire detectors (intake system) added in the generator covers.
- Additional automatic fire detectors in selected compartments.

3.2.B.1.2. Types, main characteristics and performance expectation

Main components of the ESSER EFD system

EFD Esser FlexES Control is a modular system consisting of individual components that ensure the detection of a fire, the transmission of a fire signal, the evaluation of the signal, the announcement of a fire alarm, and possibly the control of other fire protection systems. The modularity of the system allows, in case of subsequent requirements, to extend the capabilities of individual EFD exchangers by relatively simple hardware intervention.

Fire detectors

Approximately 10,000 fire detectors of the following types are installed at the Dukovany NPP:

a. Optical-smoke detector reacts to visible smoke. It is the most widely used type of automatic fire detector.
b. Thermal detector, usually in a combined version, in which the detector reacts both to a temperature rise above the set limit and to a temperature increase in time (gradient) faster than the set value.

c. Linear (active lighting): the transmitter of the detector sends out an optical beam, which the receiver (which can be located up to 100 metres from the transmitter) evaluates according to the intensity of the smoke obscuration.

b) Distributed Temperature Sensing (DTS) equipment consisting of a control unit and a fibre optic detection cable. Honeywell-Esser Company declares the set as a linear thermal combination detector. The device detects the exceeding of a set temperature limit and/or a temperature rise gradient with an accurate assessment of the fire location.

a. O2T multisensory detector with two integrated optical smoke sensors with different detection angles and an additional temperature evaluation sensor. The detector is suitable for the detection of smouldering and open fires. By comparing the signals of the smoke sensors, the detector can minimise the risk of false alarms caused by e.g. water vapour or dust.

c) Flame detectors respond to flame emission in a specific part of the IR spectrum. These detectors are equipped with three IR sensors to minimise the risk of false alarms. Flame detectors are currently installed in the DGS engine room where flame burning and rapid spread of flammable liquid fires can be expected. The detectors are mounted near the ceiling in a corner of the DGS engine room so that the IR sensors scan the diesel generator technology. The flame detectors are used in combination with the O2T multi-sensor detectors there.

d) The Air Sampling/Smoke Detection (ASD) system consists of a control unit and an intake piping. It is used where for various reasons it is not appropriate to use conventional point detectors. The system continuously samples air from the monitored areas using a fan. The air sample is fed through the intake pipe into the measuring chamber to the smoke detector.

e) Push-button manual fire detectors, usually with direct operation (type A), which is a detector in which the transition to the alarm state is automatic, without the need for further manual intervention after the fragile element has been broken or displaced. In a few cases, indirectly operated (type B), which is a detector where the transition of the functional element to the alarm state requires independent manual operation of the functional element by the user after the fragile element has been broken or displaced.

Point fire detectors are installed in mounting sockets that are connected to the fire lines. The fire lines connected to the EFD exchanger are realized as circular with a return line, which ensures the signal supply from the fire detector to the EFD exchanger even in the event of mechanical damage or interruption of the fire line.

Addressable fire lines are in place in the NPP buildings. For each addressable fire detector, its position on the line is recognized by the exchanger, which means that the EFD exchanger can accurately recognize the specific detector that indicates a fire or a fault, thus determining the exact location of the fire. ESSER detectors have their unique address embedded in the detector's memory and the detector is always recognised regardless of its position on the line.

In the Dukovany NPP, detectors are grouped into groups - detector groups as reported in the documentation. The assignment of detectors to groups makes a program (in the EFD exchanger software) and does not depend on which line or in what position they are installed on the line. Groups are formed by room or by fire section preferably. Each fire detector has identification number tag located in close proximity to it. The number is the logical address of the detector in the EFD system.

In cases where the EFD controls a stable extinguishing or sprinkler system, the unintentional activation of which is undesirable, the fire detectors are installed in the relevant space as follows:

a) In the compartments protected by the water SSE, the logic of 2 out of "x" is used - to release the extinguishing medium it is necessary that 2 detectors in the given space have been activated.

b) In the compartments protected by halon stable extinguishing system with used extinguishing agent HALON 1301 (or by gas stable extinguishing system with extinguishing agent FK-5-1-12) the 2 out of 2 logic is also used, the detectors are on two collective lines and to release the extinguishing agent at least one detector on each line must be activated.

c) In the compartments protected by the KD 200 stable extinguishing system, the 2 out of 18 logic is used. That means 18 detectors on one line and in order to release the extinguishing agent it is necessary that any two detectors on the line are activated, and an external input must be present on both detectors at the same time to activate the detectors.

d) In the compartments protected by the aerosol and spray system, the logic 2 of x is implemented, to release the extinguishing medium it is necessary that 2 detectors in the compartment are activated.

e) The SE can also be started manually by buttons, no logic is programmed, the start-up process is immediately activated. The SE can be manually activated from the relevant unit control room or from the location where the electrical valve is controlled. If the electrical valve is not working, the manual valve can be opened by pressing the button "Start of fire pumps."

ESSER EFD exchangers

EFD exchangers are the basic construction unit of the EFD system and their basic function is optical and acoustic signalling of detected fire. Each EFD exchanger also performs self-diagnostic functions and in the event of a fault on the fire detector, fire line, exchanger or electrical supply, this condition is optically and acoustically signalled with simultaneous display of the fault code on the exchanger display.

In the event of a failure or power supply failure, the EFD exchanger is automatically powered from an independent source - a battery. The battery capacity ensures emergency power supply for a maximum of 24 hours, depending on the capacity drop during the lifetime of the battery and on the operating modes of the exchanger during emergency operation.

All EFD exchangers installed in the NPP are organized into decentralized groups and are connected to the EFD extension system (TVRZ) by converters:

- Four Essernet groups - one Essernet group on each reactor unit.
- Six Essernet groups - exchangers for outdoor buildings: auxiliary boiler room, service building, FRSU building, administrative building, radiation testing laboratory Moravský Krumlov, pumping station of the Jihlava river.
- One Metanet group - two exchangers redundantly used for remote control of the eight above mentioned Essernet groups (except for remote exchangers in Moravský Krumlov and Jihlava basin) from the operational centre of FRSU.

Groups of exchangers for aerosol and spray stable extinguishers control at DGS 1-12 are organized in the Essernet 4 network (7 exchangers per DG of reactor unit) and operate in automatic mode.

The FX18 exchangers at each reactor unit are connected to a separate Essernet network. This network includes only the exchangers on the respective unit. Similarly, the outdoor building exchangers are grouped into several separate Essernet networks according to their spatial location.

Two FX18 exchangers are located on each main production unit (MPU) in a 19" rack mountable design, with 8 detector lines connected to each. The exchangers are located at the interface between the operational and non-operational parts of the control room, with the front panels of the exchangers facing the operational part of the control room. There are also FX 18 exchangers for the SE and 8010 and RP1r exchangers located in the unit. There are 2 FlexEs Control exchangers located on the FRSU as part of the Metanet network. These exchangers display all information from all FlexEs Control exchangers located on the individual Essernet networks. From these exchangers it is also possible to control all FlexEs Control exchangers.

Direct display of information and control of decentralised exchangers is possible both locally on the panel of the respective exchanger, and from the exchangers at the fire station and the extended EFD system.

EFD extended system

The extension system at the FRSU station is the centre of the EFD system of the entire Dukovany NPP. The EFD exchangers on the NPP site form a decentralised system of fire exchangers connected in a ring in the extension network by fibre optic cables with Ethernet network. The transmission is fully redundant in case of a failure at one point of the ring connection. The active network elements used automatically adapt to the new configuration.

The extension system used is the computer system "TVRZ" of SKS Blansko Company, which is a local monitoring system with the possibility of controlling the EFD exchangers. The extension computer system TVRZ on the console monitor or synoptic board provides computer processed text or graphic output information precisely determining the area in which the fire is detected, activated loops and fire detectors. In addition, this system also allows the processing and display of intervention texts containing other relevant information. The control terminals of the extension system are located at the FRSU operations centre and at all control rooms. The possible non-operability of the extension system will not cause the EFD exchangers inoperability. The whole system has redundant control via control, signalling terminals at the FRSU Station, the exchanger for the SE of the outdoor transformers has a terminal at the respective control room. All exchangers can also be controlled directly from its location. The most important signalling (fire and failure) is signalled to the relevant operational part of the control room by separate secondary optical and acoustic elements.

TVRZ system description

It is a complete automatic safety and control system based on a exchanger (data server). The architecture of the operator part is solved by a client-server system. The server is used for calculations, data collection and exchange at the lowest level, including local visualisation. The visualization system uses progressive software technologies to create an application user environment. The basis of the graphical environment is a SQL database that maintains all the data, tables and codebooks needed to run the extension program with links to connected systems. The control can be either manual (performed manually by the operator) or automatic, where integrated algorithms are used to provide partial or fully automatic operation. The visualization also provides the possibility of analysing the event recording, where different filters can be used (quick finding of critical time, event, operator identification) or printing the data.

The main menu of the TVRZ system contains

- Event Solution contains a list of events, e.g. alarms, that require action. The events are sorted down in the list according to their importance and are presented in different colours according to type, so that the most critical messages can be easily identified.
- Event list filters. Only events with certain attributes or criteria are selected using the filter. This feature allows operators to display only certain types of events, for example by category or by discipline.
- Building Browsing allows to move through the different levels of the building and control all configured points in the TVRZ system. The navigation is done through a clear view of the hierarchical building tree and on optional graphics or maps. This method provides an easy way to locate individual compartment of the building to execute individual commands. These include turning groups on and off (disconnecting and connecting them), switching any data point to maintenance mode, and switching sections to "test" mode.
- Browse the archive: Provides access to a record of every event that has occurred, including details such as how and when the event was solved and the name of the operator who did processed event. With this utility, reports are easily generated and data is more easily retrieved for the purpose of evaluating system and operator performance.

External cable channels

For the protection of cable channels by the Distributed Temperature Sensing (DTS) system, 5 control units (DTS controllers) are designed, located at 3 stations as shown in Table below. In this case, it is a two-stage EFD – the control unit of the DTS system is connected to the main EFD exchanger via a line as a linear heat detector.

DTS controller layout

Group **B**	FRSU building	2x DTS
Group **C**	Auxiliary boiler room	1x DTS
Group **D**	Service building II	2x DTS

Graphical interface of the extension:

Displays (graphic - synoptic boards) as part of the extension:

The video wall with a 3x3 LED 46" frameless monitors replaced original synoptic board in the FRSU Operations Centre. The wall shows the entire NPP site and symbolically also buildings outside the main site. It visually indicates in which building the fire originated.

Video walls made of 4x55" LED monitors replace the original synoptic boards in the unit control rooms. The video walls are located in the original frame of the synoptic boards. They display floor plans of all MPU floors and visually indicate in which room and/or compartment the fire originated.

A printer that prints out detected fires including the relevant intervention texts is an additional part of the TVRZ system.

3.2.B.1.3. Alternative/temporary provisions

Temporary measures to ensure the required fire safety are applied e.g. during shutdowns of fire safety equipment, repairs, modifications and maintenance. Temporary measures propose professionally qualified person in fire protection and subsequently submit it for approval to the Regional Fire Rescue Service of the Czech Republic, which assesses and approves the proposed measures or orders further measures that must be observed. Temporary measures include, for example: increasing the number of firefighters in shifts, increased inspection and patrolling activities or continuous surveillance of certain areas, increased number of portable fire extinguishers in the building, placement of firefighting monitors with prepared hose lines, etc.

3.2.B.2. Fire suppression provisions

3.2.B.2.1. Design approach

The purpose of a stable extinguishing system is to quickly extinguish any fire that occurs in the area protected by the SE system or semi-stable extinguishing system. The purpose of the stable sprinkling and cooling extinguishers (SSE) is, in the event of a fire, sprinkling and cooling the compartment, building and technological structures and equipment located in the protected compartment, thus protecting them from the thermal effects of the fire, and at the same time to sprinkle and cool the combustible materials located there and protected by the SSE, thus preventing the spread of the fire.

The type of extinguisher was selected according to:

a) Conditions specified in generally binding regulations (fire protection regulations, technical standards).
b) Instructions and statements of the ministry of the interior authorities (individual assessment of fire protection means), opinions of the state fire supervision.
c) The manufacturer's technical conditions.

The actual technical design respected:

a) The flammable substances (type, quantity, method of storage and arrangement, fire technical characteristics, reaction to extinguishing agents) and according to international recommendations,
b) The time between system start-up and the start of its operation.
c) The effect of the extinguishing agent on equipment, in particular equipment important for the reactor safe shutdown.
d) Possible consequences for the operator.

All equipment and components used to activate and control the relevant extinguishing system or sprinkling and cooling system shall be located in a different fire section from that protected by that system. This requirement does not apply to components that are directly used for extinguishing or sprinkling (fire extinguishing strips and nozzles) and EFD components that give the impulse to activate the system (automatic fire detectors including associated wiring).

During automatic and manual start of SE or SSE to any fire section, the ventilation system is automatically shut down from the EFD pulse, which has a direct link to the respective fire section, at the same time. All doors of rooms protected by the SE or SSE are marked with a blue and white (in the case of water systems) or yellow and white (in the case of gas systems) sign with the word "Stable Extinguishing System".

Stable extinguishing systems and sprinkling and cooling systems are designed according to Czech normative regulations and methodologies approved by the Ministry of the Interior. The systems installed in the NPP site are water stable extinguishing system, water sprinkling and cooling system, CO_2 gas stable extinguishing system, FM 200 gas stable extinguishing system, aerosol stable extinguishing system and FK 5-1-12 gas stable extinguishing system.

3.2.B.2.2. Types, main characteristics and performance expectations

Water Stable Sprinkling Extinguishers

The system is designed to sprinkle and cool important cable spaces and important cable risers. Main components of the SSE

- Fire water distributor, electrical control valves, supply pipes, fire pumps, suction sumps and connection channels of cooling towers as a source of fire water /raw water/.
- Distribution pipes from the firewater distributor to the individual fire sections. From the firewater distributor there is one branch pipe for each fire section, on which a shut-off electrical valve and a manual bypass valve are installed. Behind the shut-off valves there is a branch pipe for the respective fire section,
- Extinguishing strips, which are located in the cable rooms between the cable trays through the overhead distribution and in the cable risers under the ceiling of the room. The extinguishing strips are fitted with shower nozzles. The nozzles are directed so that water covers both the surface of the cables and the steel structures of the cable trays and cable grates.

The control electrical valves of the SSE of the fire sections of the hermetic zone are supplied from 0.4 kV secondary el. distributors of the 1st category of secured power supply and the others from 0.4 kV secondary el. distributors.

The SSE starts automatically when the EFD detectors of two fire loops of the respective fire section are activated. The EFD control unit signals "FIRE" and at the same time transmits an impulse to open the electrical valves of the respective fire section and start the fire pumps. The sprinkling can be terminated by manually closing the electrical control valve remotely or from its location. The sprinkling time is expected to be approximately 10 minutes. However, the operation of the SSE can be extended, interrupted or restarted at any time manually: from the control room non-operating section or manually from the local control box. If necessary, the restart by bypass valve and manual start of the fire pumps using the "start fire pumps" button is possible.

Water SE

The WSE is designed to extinguish fires arising on power output transformers, self-consumption transformers (tap transformers) and transformers of reserve power supply. The WSE is designed so that intensive cooling of the transformer is ensured simultaneously with extinguishing. Furthermore, the equipment is designed to extinguish fires in the oil tanks of individual turbogenerator and in the oil tanks of electrical pumps. WSE protects the outdoor transformers 300 MVA, 40 MVA and 32 MVA.

The WSE is connected to the external firewater supply and its main components are:

- Fire water distributor, which is located in the Turbine hall on the -5.5 m floor and is connected to the external firewater supply via manual shut-off valves.
- Distribution pipes from the firewater distributor to individual fire sections /transformers/. Electrical valves are installed on the distribution pipes and manual valves are installed on their circuits.
- The distribution ring of each transformer is connected to the respective distribution pipe. From the distribution ring there are riser pipes which are fitted with filters to catch any impurities. The ring is fitted with a drainage valve, which is used to flush the supply pipe and the ring.
- Frame structure with fire extinguishing strips, which is used to distribute firewater to the extinguishing nozzles. The structure is made of galvanized piping; the horizontal piping consists of fire extinguishing strips fitted with spray nozzles V 70, MH 50, L 40. The nozzles create a water mist around the transformer, which extinguishes the fire and intensively cools the transformer. The frame structure /cage/ is divided into sections so that in the event of damage to part of the frame structure, the efficiency of the other intact sections is not reduced.

The SE control valves are supplied from 0.4 kV secondary el. distributors. The equipment is started by opening the electrical valve on the respective distributor. In case of impossibility to start the device by the electric valve, it is possible to start the device by manual valve installed on the bypass of the electric valve. Methods of starting a stable extinguishing device:

- Automatically from flame detectors (selection 2 out of 2) implemented on all reactor units.
- Manually remotely from the control room or manually from local control boxes located at the control valves on the respective distributor or by pushbutton detector located on the turbine hall wall near the transformers.

With automatic operation of the flame detectors of AT and AU system transformers (1 pre-alarm sensor, 2 alarm sensors), when 2 detectors are activated, the fire water pumps start and the timing of 5 minutes to start extinguishing begins. After 5 minutes have elapsed and automatic confirmation of the no-voltage condition in the control room, the extinguishing process starts on the transformers - opening of the respective valves. On BT system transformers, the extinguishing process starts immediately (no confirmation of voltage-free status is needed) and there is no waiting time. The information about the activation of the detectors goes to the control room of the respective unit and to the operation centre of the NPP FRSU.

In automatic operation, extinguishing of one transformer can be started, other transformers are blocked to ensure sufficient pressure in the fire line. If 2 or more transformers are required to be extinguished, the valves must be opened manually (allow for the possibility of insufficient pressure in the fire piping).

The extinguishing process is completed by closing the electrical valves on the respective distributor. The estimated time of extinguishing is 20 minutes. However, the extinguishing can be extended or interrupted at any time manually remotely from the control room or manually from the local control boxes located at the control valves on the distributor. If necessary, extinguishing can be restarted at any time manually from the control room or manually from the local control boxes located at the control valves on the distributor. Shutting down of the fire pump is done by the operator from the control room only after the fire has been finally extinguished as verified by the fire department.

If any control electrical valve SSE, SE on the distribution pipe is opened, the opening of other electrical valves SSE, SE on the distribution pipes of the respective reactor unit connected to the external firewater supply is automatically blocked.

In case of the need to start extinguishing or sprinkling and cooling in another fire section (in case of a fire on more important equipment), it is possible to start another fire section manually from the local control box. In the non-operational part of the control room, the following information is indicated on the panels:

- "open-closed" status of electrical shut-off valves on distribution pipes,
- "dry pipe filled" - water pressure in distribution pipes,
- "deblock"- signalling the control of the valve from the local control box,
- "SSE blockage" - indicates that one SSE, SE valve is open and the other one cannot be started.

Spray extinguishing systems

The system is designed to extinguish fires in the DGS building to protect the diesel generator engine room sump. For the purpose of extinguishing the oil and fuel oil management of the DG, a piping control distributor with a control valve station is installed for each DG, located inside the DGS building, which is connected to the pressurized water of the fire distribution system of the building.

Starting of the control valve station is done on the basis of EFD alarm or activation by the yellow start button and then the alarm is announced in the fire section - the acoustic-optical signalling is activated in the fire section and before the entrance to the DG. After a time delay (60 s) the solenoid valve is activated and the respective control valve station is opened and then the pressure switch is activated (by pressure water flow) and the signal about starting the extinguishing is activated to the respective exchanger. Furthermore, the alarm bell (located on the outside of the building) is activated. The firewater at the required pressure is routed through the stainless steel pipe to the MicroDrop fire nozzles. There, it is sprayed onto a water mist that cools the area to be extinguished, creating an inert atmosphere that prevents air income and thus extinguishing the fire. At the 60 s time delay, it is possible to delay extinguishing by pressing the blue interlock button, which will reset the solenoid valve activation countdown on the exchanger back to 60 s. The spray system start and interlock buttons are located at +0.0 m.

For activating, the logic of activating 2 out of all functional detectors in the protected area or pressing the activate button applies. The ventilation system is automatically switched off, the acoustic siren and the visual signal are activated. Information about the activating of the spraying is signalled to the FRSU operations centre and reactor control room. The fire pumps are started. A timing of 60s is activated, after which time the valve is opened and the acoustic alarm is activated. During the countdown period, the blue interlock button can be pressed to delay extinguishing.

After the extinguishing operation is completed, the exchanger shall be set to standby according to the valve control station operating instructions and the 8010 exchanger operating instructions. The system shall be set to standby by the service organisation as instructed by operator of system.

CO_2 Gas Stable extinguishing systems

The equipment is designed to extinguish fires in the Central Oil Management in the turbine hall. The gas station is located in a separate building outside the turbine hall. In 160 steel flasks (80 standby + 80 backup, each with a capacity of 30 kg of extinguishing agent), the necessary CO_2 supply for the protected areas is stored there. The steel flasks are assembled into batteries. Each of the batteries is stored on a decay scale which automatically checks the weight of the extinguishing agent inside and signals this in the event of a 10% drop. The batteries are piped to a single piping distributor.

Distribution pipes are led from the distributor to the respective fire sections. In the protected areas, the distribution pipes fit into fire extinguishing strips which are routed under the ceiling around the perimeter of the protected area. The extinguishing strips are fitted with 1/2" or 3/4" nozzles which are angled at 45° and directed into the protected space.

The system is activated in the event of a fire by one of the following methods:

- Semi-automatically by activate buttons installed on the signal box near the door on emergency routes from protected areas
- Semi-automatically by activate buttons installed on the signal box located at the FRSU operations centre and at the reactor control room or by manual manipulation in the CO_2 station.

The control, signalling and monitoring centre of the entire system is the SE exchanger, which is located in the CO_2 Station. The SE exchanger, after receiving a activate pulse, first provides an acoustic warning signal in the protected compartment and after a time delay of 25 sec ensures the release of extinguishing agent into the protected compartment. The time of filling the protected compartment with carbon dioxide is up to 120 sec. When extinguishing a fire with the help of SE, the FRSU is provided for the possible extinguishing of burning materials. Simultaneously with the start of the SE, the ventilation equipment is automatically switched off in the respective protected compartment and the damper is closed.

The device is powered via 2 rectifiers that enable automatic activation of power back up (the rectifiers are powered from the technological and light el. distributor) with DC current of 24 V and from a maintenance-free gel battery located in the CO_2 station. The battery is permanently recharged and its capacity is 100 Ah. The capacity of the battery ensures a minimum of 24 hours of operation of the device in the event of an interruption of the recharging current supply.

The signal board located above the door at both doors to the COH signals the release of CO_2 into the COH room by illuminating the "CO_2 RELEASED" board.

Stable halon extinguishing system

Stable halon extinguishing system (hereinafter referred to as SHEKD 200) is designed to ensure fire safety on the MCP board. The operational safety systems are essential for ensuring nuclear safety of Dukovany NPP. There is one SHEKD-200 exchanger on each reactor unit and it protects the engine compartments of the MCP. The SHEKD-200 system consists of two mutually integrated parts:

- Part I&C - exchanger (detection, start-up, blocking, setting of downstream ventilation systems), SE exchanger is type ESS-RP1r (control of SHEKD 200n other rooms). The extinguishing agent is FM 200 (CF3CHFCF3),
- The machine part - battery FM200 (flasks battery or separate flasks) - consists of one or more pressure flask with a head enabling the supply of the piping with extinguishing agent. The flasks are filled with FM200 gas and pressurised with nitrogen to an operating pressure of 2.5 MPa. The FM200 flasks are filled to: 12.5 kg, 169.5 kg, and the total amount of FM200 gas in the engine compartment of each reactor unit is 1 395 kg.

The extinguishing agent SHEKD-200 is FM 200 (chemical composition CF3CHFCF3). The extinguishing agent is placed in flasks and pressurized with nitrogen to the prescribed pressure. The quantity of extinguishing agent for the respective room is determined from a program calculation according to the volume of the room to be extinguished. The gas concentration in any room protected by FM 200 shall not exceed 7,6 % of the extinguishing agent concentration by volume. FM 200 is heavier than air. The extinguishing agent is contained in the flasks which make up the flask battery. At the top of the flask there is a head on which is located a solenoid valve (actuating device), connecting hoses which connect the individual flasks in the battery, a control contact manometer and flexible pressure hoses connecting the flasks of the battery to the piping distributor. A pipe is led from the pipe distributor through the wall (bulkhead) into the extinguishing room. There, the pipe is branched at the ceiling of the room according to the shape of the room into so-called pipe rails, which are fitted with gas nozzles. The clearance, the shape of the piping, the number and shape of the gas nozzles and the quantity of flasks (quantity of extinguishing medium) are determined by computer calculation according to the volume of the extinguished room.

Start-up of SHEKD-200 on board MCP is performed via Esser 8010 and FX18 exchangers, which are located on control room. Start-up of the system in the engine rooms of the MCP is handled by a separate EFD line designed only for controlling the stable extinguishers, which is connected to the existing EFD system. 18 detectors are installed for the activating of this system.

The SHEKD 200 activated signal is output to the reactor control room, the FRSU Operations Centre and is visible before entering the protected room on the optical and acoustic signalling.

It is possible to put it into the idle state after releasing the operator with the key by pressing the reverse setting button. If gas has been released, the contact gauge must be brought to rest and the halon flasks must be replaced. The halon exchanger cannot be brought to a resting state remotely. The timing is used to allow evacuation from the room and is set to 30 s. The FM 200 STOP button (blue) is used to block the extinguishing. If the door to the MCP board is open, extinguishing is blocked. The maximum time for releasing the extinguishing agent into the extinguished room is 10 s.

After releasing the extinguishing agent into the extinguished compartment, it is necessary to ensure the closure (gas-tightness) of the extinguished space and wait for the arrival of the FRSU. The decision to ventilate the area after the intervention will be made by the intervention commander after inspection of the area.

Gas Stable Extinguishing

The gas SE (hereafter referred to as GSE) is designed to ensure high fire safety in selected areas of the floors at +9.6 m of all reactor units. These SE are of fundamental importance for ensuring the nuclear safety of Dukovany NPP. A total of 12 GSE fire extinguishing units are located at each reactor unit.

Replacement of the halon extinguishing with FK-5-1-12 gas-fired stable extinguishers was completed in July 2023.

The Gas Stable Extinguishing (GSE) consists of two mutually integrated parts:

1. Part I&C - exchanger (detection, start-up, blocking, setting of downstream ventilation systems)
2. The machine part - the battery of flasks of the new Novec 1230 fire extinguishing agent consists of one or more cylindrical flasks with a head enabling the supply of the pipeline with the extinguishing agent. The extinguishing agent flasks are pressurised with nitrogen to an operating pressure of 4.2 MPa (42 bar), the flasks for the control room counter are pressurised to 2.5MPa (25 bar). The flasks are filled depending on the volume to be protected and the result of a hydraulic calculation.

The GSE exchanger is type ESS-RP1r. The first extinguishing agent container in the battery is equipped with an electric activator and a manual activate. Each additional flask is fitted with a pneumatic activate which will be activated by the pressure from the pilot flask when the system is activated. A visual inspection gauge on the container continuously monitors the flask and provides a visual indication of pressure loss in the event of a pressure drop. In the event of a fault indication, the operator is required to check the indicators- of all gauges of the respective flask battery and further troubleshoot with the GSE manager.

The RP1r exchangers start-up the GSE and are used to control the gas stable extinguishing system. They are located on the access road to the guarded area. They are equipped with acoustic and optical signalling above the door and an outlet for controlling the ventilation dampers and a solenoid valve for releasing the extinguishing gas. If a fire occurs in this room, the first reporting loop indicates an

“Warning” (pre-alarm). If the second loop is also activated, the exchanger initiates a timing cycle during which time an audible signal sounds in the room and the optical signalling above the door indicates by flashing the possibility of gas discharge, the ventilation dampers are closed. After the timing period, the fire extinguishing gas is released into the room and the exchanger reports “Alarm”.

A pressure switch is located in the main activation pipe above the extinguishing flasks, which detects the release of the extinguishing agent and transmits this signal to the exchanger.

The exchanger is equipped with a manual button for manual extinguishing start. The FK-5-1-12 extinguishers exchangers are connected by input/output modules to the system of FlexES Control exchangers. The electrical control and delay devices (ECD) can be operated directly from the panel on the front of the exchanger - always and fully at the level of unskilled and skilled operators. As principal rule, the unlocking of a fully inhibited extinguishing or inhibited extinguishing from automatic detectors must be done at the control levels at which the inhibition was made. Full stop of detectors, i.e. a state where no fire is reported, can only be done directly at the exchanger.

The timing serve to allow evacuation from the room and is set to 60 s. During this time, the release of the extinguishing agent can be reversed (stopped) using the blue button. Before releasing the extinguishing agent into the extinguished room, it is necessary to ensure that the extinguished room is sealed (gas-tight) and then wait for the arrival of the FRSU. The decision to ventilate the area after the intervention will be made by the intervention commander after inspection of the area.

It is possible to put it into the idle state after crew release using the key, by pressing the reverse setting button. If gas has been released, flask replacement must be arranged. If a manual button has been used, this must be put into standby and call EFD dispatch. The GSE exchanger cannot be put into standby remotely. The GSE start signal is displayed in the control room and is visible before entering the protected room on the visual and acoustic signalisation.

Stable aerosol extinguishing system

The equipment is designed to extinguish operational oil fuel tank and oil storage tank fires in the DGS building. It is also installed in protected sections of cable channels to increase their fire safety. The system consisting of the aerosol stable extinguishers (ASE) is part of the overall fire protection system. The extinguishing aerosol concentration in the respective fire sections is designed to extinguish all flames within 30 s after the extinguishing agent discharge is complete. At the same time, the aerosol concentration will prevent repeated ignition of the fire for at least 10 minutes after the extinguishing agent release. After the activation of the generator of the respective fire section, the SE using aerosol agent no longer functions and the aerosol generators and the burner must be replaced. The timing for aerosol discharge is 180s.

Aerosol as a fire extinguishing medium, suppresses the basic chain reactions of the chemical combustion branching processes. The oxygen concentration in the protected compartment does not change when the generator starts. In the event of a fire, the aerosol is emitted by the aerosol generators - together with a small amount of bearing inert gases - into the compartment to be extinguished after initiation of ECD ESSER 8010. The aerosol stable extinguishers itself (type AGS-8/3) are small cylindrical sheet metal non-pressurised containers with aerosol outlets, installed using steel brackets on the walls directly in the protected room. The generators are positioned so, as to prevent the aerosol stream hit the building structures and materials or possible openings in the surrounding structure of the protected compartment.

In the case of the DGS, each protected compartment of the oil tank room has its own ECD to provide control of the ASE system. In the compartment of selected DG, a superior EFD exchanger is installed from which an addressable Esserbus ring line with functional integrity is routed to the individual oil tank rooms. The individual ECD are also connected to the EFD exchanger via an Esserbus ring line. The timing for aerosol discharge is 60s.

In the event of a fire in the cable compartment, the EFD signalling functions and activates a "pre-alarm" condition. Then the system waits for the response of the next detector point. Pre-alarm activities (signal from one detector EFD):

- Start of signalization on the SW extension (reactor control room, FRSU Operational Centre).
- Signalling at the exchanger in the non-operational part of the control room (in case of signalling in the hermetic zone).
- Activation of acoustic and light signalling inside/outside the FS.
- Closing of the respective fire dampers (checking the closing status).

Alarm activities (signal from another fire line of the EFD system):

- Starting the signalling on the SW extension (reactor control room, FRSU Operational Centre).
- Signalling at the exchanger in the non-operational part of the control room (in case of signalling in the hermetic zone).
- Activation of acoustic and light signalling inside and outside the FS.
- Door closure check.
- Closure of fire dampers check.
- Initialization of aerosol generators.
- Locking of the SE of adjacent fire sections (automatic switching to remote manual mode in case of a fire).

Each of the fire sections is controlled by a separate autonomous exchanger located in the storey corridor.

In case one EFD loop signals, when the SE is in automatic mode, the relevant ASE section exchanger is activated (instruction to close the damper, start the internal signalling in the fire section) - the system waits for the evaluation of the next detector. The FRSU operator or secondary circuit operator restarts the EFD exchanger and restarts the parent SE exchanger.

In case 2 EFD loops signal in one section, and the SE control mode is automatic, the SE exchanger is activated and the ASE is started (starting external signalling, starting aerosol generators, blocking of adjacent sections with the ASE system). After the generator is fired, the system is inoperative until recovery. Recovery must be performed within 32 hours after activation of the ASE. Possible entry into the affected section without protective equipment is after aerosol sedimentation after 24 hours. After about 1 hour after activation of the SE, the FRSU or the secondary circuit operator shall restart the EFD of the adjacent fire sections with the ASE system.

The ASE activation signalling is output to reactor control room, the FRSU Operational Centre and is visible before entering the protected room on optical and acoustic signalling.

Manual firefighting systems

All compartments and building structures of the NPP are designed and equipped to enable quick and effective fire-fighting intervention of FRSU in all fire sections.

Fire water supply systems

The fire water supply system is designed to feed the external firewater supply system with underground and overhead fire hydrants, to which the internal fire water supply systems of the individual NPP buildings and the stable water extinguishing and sprinkling systems are connected. The two independent pumping stations can fed entire system. The fire water system and its hydrants form the most accessible fire protection system of the Dukovany NPP. This design system complies with ČSN 73 6639 and ČSN 73 0873.

The fire water supply system at the Dukovany NPP is designed for:

- Ensuring a permanent sufficient supply of fire water (system of sources, storage tanks, fire water distribution systems and internal and external hydrants) for fire-fighting intervention of operational personnel and FRSU.
- Extinguishing of the external transformers of the NPP (SE water),
- Extinguishing and cooling during fires in the cable compartments of the Dukovany NPP (water SSE),
- Prevention, localization, minimization of fires and their consequences.

The source of fire water is the central pumping stations (CPS) of the units, which are located in the cooling towers, i.e. the cooling circuits of the NPP. The water supply in the fire pump intake sumps, cooling tower interconnecting channels and cooling towers available for fire pumps is 56 386 m^3. This quantity is independent of other water sources. In the case of continuous recharge of water to the CPS, which is possible by gravity feed from the gravity reservoir, the water supply is limited by the amount of water in the reservoir. An operational raw water pumping station at the Mohelno dam buffer reservoir is assumed.

About mentioned amount of water available for the fire pumps is limited by the blockage from the minimum level at the fire pump intake. In extreme case, if the water intake to the fire pump intake sumps were blocked (cooling circuit refilling), it is possible to block or reposition the minimum level at the fire pump intake downwards by 2 m, thereby increasing the independent water supply in the fire pump sumps to three times, which is 169 158 m^3.

Fire and supplementary water pumps are also installed in these buildings. Each fire water pump station contains a total of 4 vertical fire water pumps, with 2 pumps in each half of the cooling water intake building. There is only one operating pump at any time and the other is a standby pump.

Fire pumps start from:

1. Impulse to open the SSE valve.
2. Fire buttons.
3. Impulse extinguishing of transformers.
4. Start buttons from the exchanger on the CSC.

There are four pumps per MPU, divided into two pairs. Anyone of pair of pumps is set to work and the other to standby. When pulsed to start the fire pumps, the pump called to work is switched on, i.e. two pumps (one from each system) start. In the event of a misconfiguration of the keys from the operation option, as many pumps as the key has in the "Work" position will start. The standby pumps only start from the failure of the working pump, but only within one system. A drop in line pressure is not included in the automatic function.

Each MPU has its own SSE that are not interconnected in any way. The impulse to start the fire pumps from the 1st and 2nd reactor units comes to the fire pumps located on the 1st CPS and the impulse to start the fire pumps from the 3rd and 4th reactor units comes to the fire pumps located on the 2nd CPS.

The doubling of the pumps is necessary for the possibility of shutting down (dewatering) one half of the pumps' suction sumps during gradual commissioning, shutdown, maintenance, repair, etc.

Another pumping station that pumps cooling water into the firewater network is the replenishing water pumping station. The replenishing pumps provide water for non-fire small utilitarian water tapping from the fire network such as flushing and washing floors, sprinkling greenery, roads, etc. The replenishing water station is equipped with 6 vertical pumps. There are 3 pumps in each half of the canal. The number of simultaneously operated pumps is 1 - 3.

The start of the replenishing pumps in automatic mode is initialized in the pressure drop, depending on the selected sequence and the output water pressure of the pumps. The second pump selected in the second sequence starts after 2 minutes and the third pump after 4 minutes if the pressure is still less than 0.35 MPa. The selection of the starting order is made by keys on the panel shaft of the respective CPC. Packet switch SD14 determines the selection of the sequence and switch SD13 sets the pumps to operating mode or standby. The fire pumps can be started directly from the control room of the CS, remotely from the reactor control room or from the panel at the pump.

In addition, the following start conditions must be met:

- Open flap behind the fan.
- The level in the first or second sump is greater than minimum.
- No fire pump shall be running.

The pumps are switched off from the MAX pressure in the reverse order to that set by the SD14 key, i.e. the last pump started at a pressure greater than 0.48 MPa switches off immediately, the second after 2 min and the first after 4 min. Then the pumps are switched off:

- By switching on the fire pump.
- Level drop to "min" (less than 4 m).
- When the valve on the pump outlet is closed.
- When the flap behind the fan is closed.

The reason for doubling the number of pumps is the same as for the fire pumps, i.e. the possibility of shutting down one half of the suction sump. Since the start of the fire pumps is always initiated from the appliances of the respective units to the pumps of the respective CPS, the firewater supply system of the Dukovany NPP is divided into two independent parts. The division of the respective water lines is made between the MPU I and II in the valve shafts of the external firewater line and in the piping channel.

The fire distribution system is mainly made with plastic pipelines stored in the ground and in piping channels. The distribution is performed around the entire NPP with backbones distributions in the middle of the plant site in a north-south direction and on the north and south sides of the plant in a west-east direction. There are fire hydrants on the distribution system, either above ground or underground. The hydrants are conveniently located around the plant site and their positioning is suitable for the FRSU in case of refilling of mobile firefighting equipment. Branches are made from the fire distribution system to the individual buildings to which the internal wall-mounted fire hydrants are connected. This distribution system feed also the water distribution system of the SE and SSE.

In each multi-storey building, and in some cases in single-storey buildings, an internal firewater supply is installed, which is connected to the external firewater supply. Type C hydrant systems (DN 52 or DN 25) are installed as internal tapping points on the internal fire water supply systems, which are intended mainly for initial fire-fighting before the arrival of the FRSU.

The internal fire water distribution systems, including hydrant systems, are permanently watered and pressurised to ensure an immediate continuous supply of fire water. In the rare case where hydrant systems cannot be reliably protected from freezing, hydrants are installed on unwater piping, with the water seal to the unwater piping located in the nearest easily accessible frost-protected area.

All hydrant systems are located on internal emergency routes or in places easily accessible from internal emergency routes, and their positioning in the buildings ensures that at least one stream of water can be used to extinguish at each point in the fire section where extinguishing is expected. The equipment of the installed hydrant systems (insulated fire hoses, shut-off hoses, fixed-form hoses) allows their effective operation by one person.

Portable extinguishers

In all NPP buildings, the appropriate types of portable or mobile extinguishers are installed, which are intended mainly for trained workers, employees assigned to preventive fire patrols and for the employees of the company's FRSU to perform rapid first firefighting intervention. Fire extinguishers are placed in buildings according to the principles set out in ČSN 73 0804, ČSN 73 0802 and according to approved fire risk assessments. The type, number and location of fire extinguishers shall be determined for each building and shall be determined by the nature and size of the operations located in the building and the nature of the combustible substances present in each workplace. Fire extinguishers shall be located in particular near the places where fires are likely to occur, at entrances to rooms and on internal emergency routes.

Halotron extinguishers whose extinguishing effects are comparable and have no negative consequences for the environment, are used in places where halon extinguishers were originally considered.

3.2.B.2.3. Management of harmful effects and consequential hazards

Systems for reducing secondary effects

Secondary effects of a fire include smoke, heat and toxic combustion products that spread from the original fire location to other compartments not directly affected by the fire. Secondary effects of fire also include damage and hazards that may result from the reaction of the extinguishing agent used with the fire environment. Passive or active means are used to reduce these secondary effects.

To reduce the secondary effects of fire, established systems and equipment ensure:

- The safe evacuation of persons from a burning or fire-threatened building.
- Conditions for effective intervention of FRSU in firefighting and rescue work.
- Controlled smoke ventilation during and after a fire.

Layout of buildings - emergency routes

The layout and spatial design of the individual buildings and installed technological equipment is such that redundant parts of the safety systems are separated from each other so that a fire cannot affect the performance of nuclear safety related activities. Means are provided to limit the consequences of a fire assessed as a single failure and the general requirements for nuclear safety are met.

The design of the individual buildings included technical fire protection reports which include emergency and intervention routes assessment. The design of emergency routes complies with the requirements of fire safety standards (ČSN 73 0802, ČSN 73 0804). Protected emergency routes, partially protected and unprotected emergency routes are established. The permissible limit lengths are not exceeded.

Ventilation systems

When designing ventilation systems regarding fire safety, the design respect requirements of ČSN 73 0872. In addition, the following principles were applied for important buildings:

- Basic operational ventilation systems are used for ventilation of buildings in case of fire (except for staircase ventilation).
- In cases where CSN 73 0872 does not comply with nuclear safety requirements (e.g. it is necessary to create a constant vacuum), alternative measures are implemented.

The ventilation systems are designed to ensure the operation of redundant parts of the safety systems, the fresh air intake is located to prevent the intake of combustion products from other fire sections or buildings.

COLT fire dampers

They are installed in the ceiling of the turbine hall and are intended to dissipate any heat generated by the fire so that the heat generated by the fire will be dissipated outside the building and will not endanger the steel supporting structures of the turbine hall. Another purpose of these dampers is to "clean" the intervention area after the firefighters' intervention from the smoke products of combustion.

Ventilation of protected emergency routes

In individual buildings, where required by ČSN 73 0804 or ČSN 73 0802, protected emergency routes are established for the safe evacuation of persons and for ensuring fire intervention. Type A protected emergency routes are provided in the reactor building and the service buildings. They are ventilated in accordance with EN 73 0802.

Fire damper control

In order to improve the conditions for manual firefighting, smoke is extracted for as long as possible during a fire by means of operational ventilation systems. Therefore, the dampers are controlled by a thermal fuse for automatic closure (e.g. cable channels, control room, etc.). KID dampers close when the exhaust from the box to which the damper is supplying air is interrupted.

Circulating ventilation systems are mostly stopped manually in the event of a fire from the room in which they are installed and a fire has been detected. The operation of COLT dampers is manual (packet marked switches on the emergency and emergency routes).

Electrical equipment

Safety important electrical equipment shall be protected from the effects of fire so that the general design requirements for nuclear safety are met.

The cable distribution systems are designed and implemented according to the coordination document "Principles for cabling solutions", which are based on ČSN and the requirements of IEEE standards and NUREG and have been approved by the state administration authorities.

Cable routes in which only cables complying with the test according to IEC 332.3 Cat. A are used are not considered as fire loads (within the meaning of EN 73 0804) if there is no other fire load in assessed compartment that could endanger these cable routes in the event of a fire.

The parallel installation of different divisions of cable routes of the secured power supply systems in compartments without separation by construction with fire resistance of at least 90 minutes is assessed and evaluated in detail in special documentation "engineering solutions", which demonstrate compliance with nuclear safety requirements including fire protection.

The transformers are designed and constructed according to ČSN 33 3240, including the corresponding fire protection structures and the provision of active fire protection systems (electrical fire alarm, fire extinguishing systems).

Easy access is provided to the cabinet el. distributors and cable connectors so that extinguishing can be performed. In cases when firefighting has to be performed under electrical voltage, the ČSN 34 3085 or methods laid down by the Ministry of the Interior shall be respected.

Explosion protection in connection with fire

Measures are in place to prevent a situation where nuclear safety could be compromised as a result of a fire-related explosion.

Protection against explosion of solids

There are no solids in large quantities in the NPP buildings, which by their form, arrangement or use may cause an explosion. Individual small quantities may be used in chemical laboratories. Activities involving the use of such substances are subject to special working procedures, are performed by qualified personnel and are not performed in areas where nuclear safety or radiation protection equipment is located.

Explosion protection for flammable liquids

Among liquid combustibles, oil fuel (as fuel for diesel generators) and oil are mainly used for lubrication and cooling of machinery and equipment. All joints on the flammable liquid distribution lines are made as tight joints (welded or in the form of a "kink, knuckle"). The reactor building structures have a pressure wave design and cannot be jeopardised by explosion.

The oil pipelines in the reactor building containing oil during normal operation are secured against operational vibration. The quality of design, operation and maintenance (including appropriate in-service inspections and revisions) ensure that there is no loss of integrity of these lines, no small leaks, no subsequent oil cloud which could (if initiated simultaneously) cause an explosion.

Protection against explosion of flammable gases

Hydrogen is a potential hazard associated with the explosion of flammable gases in NPP buildings. Hydrogen is used to cool the internal equipment of the turbine-generator in the turbine hall. All the measures prescribed for such piping are implemented, including ensuring the integrity of the piping and venting. The hydrogen storage is in a separate open building, which is approximately 300 m from the buildings containing equipment important for nuclear safety. This distance is sufficient to ensure that safety systems equipment is not compromised.

Pressure flasks

In some areas there are the necessary quantities of flasks. Their quantity and weight are limited by the operating regulations. Technical and organisational measures are in place in connection with the operation of these compartments and the implementation of fire-fighting intervention to prevent the possibility of a fire-related explosion of flasks.

3.2.B.2.4. Alternative/temporary provisions

Temporary measures to ensure the required fire safety are applied e.g. during shutdowns of fire safety equipment, repairs, modifications and maintenance. Temporary measures propose professionally qualified person in fire protection and subsequently submit it for approval to the Regional Fire Rescue Service of the Czech Republic, which assesses and approves the proposed measures or orders further measures that must be observed. Temporary measures include, for example: increasing the number of firefighters in shifts, increased inspection and patrolling activities or continuous surveillance of certain areas, increased number of portable fire extinguishers in the building, placement of firefighting monitors with prepared hose lines, etc.

3.2.B.3. Administrative and organisational fire protection issues

The company's FRSU

A professional unit of the company's Fire Rescue Service (FRSU) is established, which is located in a fire station in NPP site, at a distance of about 100 metres from the MPU. The FRSU has 70 employees who provide tasks in the field of both prevention and repressive activities. The FRSU unit is integrated in the Fire Protection and Emergency Preparedness Department. In terms of professional performance of the FRSU, it is methodically controlled by the Fire Rescue Service of the Vysočina Region.

For the activities of FRSU Dukovany NPP, an alarm plan of unit has been prepared, which includes the predetermination of the FRSU within the alarm stages at the NPP, which are called by the FRS Vysočina Region. THE FRSU intervention is based of the scope of the possible event and according to the requirements of the commander of the intervention on site.

Prevention of fire protection

The basic mission of the prevention is to design and promote the implementation of such fire safety measures so that during any activities in the lifetime of the NPP, the possibility of fire occurrence is eliminated with the maximum possible degree of probability, especially in buildings and compartments where safety systems and systems safety related are located.

The main task of the preventive activities is to carry out consistent checks on compliance with the established fire safety measures and to check compliance with the requirements of generally binding legal and technical regulations, the requirements of the internal procedures and documents of the Utility, applicable and valid to the Temelín NPP.

In fire hazardous activities where there is a high risk of fire, the Fire and Rescue Service provides fire assistance. Fire protection technicians, employees of the FRSU and preventive fire patrols perform preventive activities in NPP.

OP repression

The basic mission of the NPP repression is to protect the systems and equipment ensuring nuclear safety, life and health of persons and property of the company in case of fires and to provide effective assistance in liquidation of accidents, natural disasters and emergencies occurring in the NPP site or in its vicinity.

When providing rescue work during emergencies, the activities of the FRSU unit are coordinated by the NPP shift engineer and the ČEZ-the Dukovany NPP emergency staff. The 70 firefighters perform repressive activities in four shifts, each with 12 firefighters on the day shift and 11 firefighters on the night shift divided into 3 fire teams.

The maximum time of arrival of the FRSU to the most important buildings of the nuclear power plant (MPU) is 4 minutes from the occurrence of a fire that is detected by EFD. The arrival time consists of:

- ✓ Detection of fire by EFD alarm - max. 1 minute
- ✓ Time for the FRSU to leave after the fire alarm - max. 2 minutes
- ✓ Time of driving of the FRSU - 1 minute

Commanders, engineers and special services technicians meet the qualification and competency requirements of the Fire Protection Act.

In accordance with the requirements of the Fire Protection Act, all firefighters of the FRSU are graduates of the basic professional training, which they have completed in the educational facilities of the Ministry of the Interior of the Czech Republic.

Further periodic training of FRSU is performed according to training plans prepared for the respective training period. This training includes theoretical training, practical training and physical training.

The number of firefighters and the material and technical equipment of the company's fire Rescue Service correspond to the requirements of the approved design and current legislation. The fire Rescue Service unit is equipped with the equipment and resources listed below:

Mobile firefighting equipment

PCS	Type	Name
1	KHA 30	Combination extinguishing vehicle with high pressure water pump, pure extinguishing system FE 36 and the CAFS system
1	CAS 30 MB	Tanker truck sprayer, pump 3 000 $l.min.^{-1}$
1	CAS 30 Scania	Tanker truck sprayer, pump 3 000 $l.min.^{-1}$

PCS	Type	Name
1	RZA	Rapid intervention car
1	TA-L	Technical car designed for work on water + climbing activity
1	TACH	Technical chemical car
1	AP 44	Fire Forklift Platform
1	VEA RANGER	Command car
1	NA	Truck with hydraulic arm
1	AC PHM	Fuel tanker (petrol + diesel)
1	Digger	Tractor-bagger
1	HA 60	Hose wagon
1	PLHA	CO2 gas fire extinguisher
1	PCS	Trailer refuelling station

3.2.B.3.1. Overview of firefighting strategies, administrative arrangements and assurance

Building structures and materials

The building materials used have a documented flammability according to ČSN 73 0862 or according to ČSN 73 0823 depending on the type of operation. The continuous inspection was performed throughout the construction period within the framework of the investor's technical supervision and author's supervision, as well as during the activities of the State Fire Inspectorate.

Bearing structures that ensure the stability of the building or its part, fire separating structures, fire sealing have documented fire resistance by a certificate from an authorized testing laboratory, expert opinion, or is proven by a standard value according to ČSN 73 0821. For selected structures, other fire technical characteristics are also documented, e.g. flame spread on the surface of building structures for floor coverings.

Technical and technological equipment

All cables that shall meet the test parameters of IEC 331 and IEC 332.3 Cat. A have a certificate of testing laboratory. All cable penetrations are certified for fire resistance of fire filling according to the test method approved by the Ministry of Interior, Main Administration of the Fire Protection Corps in 1992 (at present FRS CR).

The fire resistance of the pipe penetrations through the fire separating structures prove a certificate according to the approved test methodology from 1995.

Electric fire detection system, Stable extinguishing equipment

The EFD and SE systems and its individual components have been assessed by the Directorate of the Fire Rescue Service in accordance with the fire protection regulations and approved for use in the Czech Republic. Before commissioning, the entire system was comprehensively tested.

Portable extinguishers

Each type of portable extinguisher used has approval for use in the Czech Republic in accordance with fire protection regulations.

Ventilation systems of protected emergency routes

The ventilation system for individual protected emergency routes is designed and implemented according to the requirements of ČSN 73 0804, including an alternative source of electrical power. The fire dampers and fire insulation of the piping have a fire resistance test report.

3.2.B.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and off site

Qualification requirements for fire protection posts

Function name	**Qualification requirement**
Licensing Specialist - fire protection	University degree in the field of fire protection Technical university + professional competence according to the Fire Protection Act
FRSU Commander	University degree in fire protection or university degree + professional competence (course in tactical and strategic management + professional competence according to the Fire Protection Act)
Fire protection technician	High school + professional competence according to the Fire Protection Act
Operations Officer	High school + tactical management course
FRSU Shift Commander	High school + tactical management course + professional competence according to the Fire Protection Act
FRSU Squad Leader	High school + tactical management course
Firefighter - engineer	High school + mechanical engineering course
Firefighter - chemist	High school + chemical service course
Firefighter - liaison	High school + course of connection service
Firefighter	High school + initial professional training

Training and training of NPP employees on fire protection

In accordance with the requirements of the Fire Protection Act, fire protection training is organized for all nuclear power plant personnel on the following dates:

e) Training of employees on fire protection:
- Training shall be provided on entry of the person to employment and whenever there is a change in the employee's workplace or job classification, if such changes also result in changes to the facts that were the subject of the previous fire protection training,
- Training is repeated 1 x per year.

f) Training of managers on fire protection:
- Training is performed when senior staff at all levels of management enter to their posts,
- Training is repeated 1 x every 2 years.

g) Fire protection training provided for employees of contractors performing activities at Dukovany NPP.

h) A "professional training" - is organized for employees assigned to the FRSU (professional firefighters) and for employees assigned to preventive fire patrols.

The management system documentation of the Dukovany NPP includes the organization, scope and content of training of NPP employees and contractors' employees on fire safety and the organization, scope and content of training of employees assigned to preventive fire watches.

Fire protection documentation is prepared in 2 copies. One is stored so that it is accessible to the employees to whom it relates - typically fire alarm directives and workplace fire regulations. Copies are stored in such a way that in the event of a fire, compliance with the obligations set out in the Act can be demonstrated, usually with competent persons and managers.

3.2.B.3.3. Special provisions

In the NPP design, all risk factors were already taken into account in the siting phase, including fire risk not only inside but also in the vicinity of the buildings. Analyses and exercises performed since the start of operation have shown that the measures taken are sufficient, in line with the current situation and no special provisions are needed. Graphical diagrams of the fire-fighting documentation have been drawn up for the important buildings, with access, boarding and emergency routes marked.

3.2.C. Active fire protection of LVR-15

3.2.C.1. Fire detection and alarm provisions

An electronic fire detection system (EFD) is installed in the LVR-15 reactor building to detect fire. It was reconstructed in 2016. The alarm and system failure are automatically signalled acoustically and optically to the existing ZETTLER EXPERT MZX exchanger located in the fire alarm room of the FRSU of the NRI Řež and in the security command room in the reactor building. An optical and acoustic sensor is connected to the reactor operator's room to inform the shift of a fire in the building. By enquiring at the security command room, they will find out where the fire is.

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.

The exchanger (informative) is located in the security room of the building.

3.2.C.1.1. Design approach

The Zettler Expert EFD exchanger is a powerful electrical fire alarm system with MZX technology at its heart. As MZX technology 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.

With the introduction of the plug-in (slot) expansion card mechanism, EFD exchangers can be adapted to the specific requirements of the application and the protected area. If the protected area changes or expands, the system can be easily expanded and adapted to the new requirements.

The exchanger is specifically designed to provide increased capacity for circular lines. The ability to share lines offers even greater flexibility in system design and reduced installation costs. The system provides detailed status information, guarantees a rapid response to all system events, combines ease of use with high performance, and delivers lifetime cost savings to end users through innovation.

3.2.C.1.2. Types, main characteristics and performance requirements

Zettler EFD exchanger

The robust exchanger protocol of the ZETTLER EXPERT is capable of operating even in the most demanding conditions. In the event of a system upgrade, existing cabling can be used, significantly reducing system replacement complications. Sufficient power is available on the wiring to meet the growing demand for optical alarm signalling in addition to the traditional acoustic signalling. Specific situations, such as the spatial layout of a building or the number of alarms, often limit the capacity of the ring line used and can lead to its maximum capacity not being used and the need for additional hardware. In order to optimise the use of the ring line capacity, the system offers a system solution. Each addressable ring line can be connected as one high power (HP) or two power shared (SP) lines. This gives the system designer the freedom to allocate all available power and 250 addresses to the HP ring line, or share resources between the two SP lines. With this optimization, a significantly lower total installed system cost can be achieved.

EFD optical and thermal detectors 850 P and 850 H

With the ability to detect a wide range of fires, from flame burning to smouldering fires, the combined optical and thermal multi-sensor detector is the preferred choice for many applications. It offers a range of approved modes and sensitivities that can be dynamically selected based on specific environmental conditions.

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.

3.2.C.1.3. Alternative/temporary measures

3.2.C.2. Fire suppression provisions

To extinguish the fire, it is assumed that there will be cooperation with the municipality's FRSU and, if necessary, other external emergency intervention - the cooperation of the units is part of regular exercises. The prerequisite for intervention is coordination with the reactor command room and following the emergency regulations for the operator (shutdown, initiation of reactor cooling and minimization of leakages to the surroundings) and the actual procedures of the FRSU in firefighting.

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).

3.2.C.2.1. Design approach

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 definition of the location of the resources is part of the construction documentation and operational response cards, all of which are controlled according to the standards.

Water sources, fire extinguishing agents and fire safety equipment are:

- Portable extinguishers (powder and snow),
- Internal hydrant systems C52,
- Electrical fire alarm system - EFD exchanger with permanent service is located in the fire station of the FRSU,
- Emergency lighting,
- 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 building is equipped with ventilation system and retrofitted with fire dampers. The active ventilation section may be a source of contamination - all parts of it, especially at the time of intervention, may be contaminated with aerosol. Respiration equipment is always absolutely necessary.

In the event of a radiation incident associated with fire, the ventilation system is equipped with nine fire dampers - in the supply systems in the space behind the fan, in the extraction systems in the basement of the ventilation machinery hall behind the supply to the building. The damper upstream of the fan and the other upstream of the iodine filter are operated only in emergencies. The dampers close automatically when the inlet media temperature reaches 680 °C.

The Vltava River is used as the main source of firewater in the area. There is a paved pumping station connected to the paved site roads. This source is used in priority, both for its capacity and permanent availability, but also for safety reasons. In the event of an emergency, the water supply lines in the site may be disconnected from service or operate at reduced flow or pressure conditions. An ancillary source is the aforementioned underground hydrants - marked with a vertical "H" on the site. The system is not equipped with automated fire suppression systems.

3.2.C.2.2. Types, main characteristics and operating requirements

To determine the most complex fire variants:

Reactor hall fire - 6 streams of C used for extinguishing, 1 x CAS for water supply to hose line, total water supply 14.000 litres, number of firefighters 44.

Fire in the control room with spreading to the laboratories - 10 streams of C used for extinguishing, 2 x CAS for water supply to the hose line, total water supply 120.000 litres, number of firefighters 68.

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 with a possible volume of 3x65 m^3.

3.2.C.2.3. Management of harmful effects and consequential hazards

Due to the nature of the LVR-15 workplace, there is an increased risk of exposure and contamination during fire intervention - information from operations personnel on the latest status of the equipment is required when the FRSU arrive on site. For this purpose, operating personnel and accessible personnel are defined for non-operating hours. In case of possible non-receipt of this operational information, the FRSU personnel are equipped with their own detection equipment.

In the event of a necessary intervention by an external FSU upon arrival at the site, the unit must wait for information about the radiation situation at the site and perform its own dosimetry measurements and dose evaluation throughout the intervention. The first contact is at the gatehouse with the security guard - contact to the company FRSU, which has the right of priority command for the due to its knowledge of the site, the buildings, has the necessary equipment for the intervening firefighters with protective equipment (respiration equipment).

Regime measures for entry into the hazardous zone apply throughout the intervention (use of dosimeters, registration of persons, dosimetry control). The number of intervening firefighters is limited to the minimum necessary, compliance with radiation protection principles (distance from the source, minimum irradiation time, use of shielding) is required, the need for decontamination (deactivation) of intervening firefighters according to the internal emergency plan of the site. The integrated rescue group on site perform possible decontamination - a special risk is posed by the flood out of the building with water and the subsequent surface contamination outside the building.

3.2.C.2.4. Alternative/temporary provisions

3.2.C.3. Administrative and organisational fire protection issues

Company FRSU

Nuclear Research Institute Řež PLC is the founder of the FRSU. The unit provides all entities in the site on the basis of contracts between the founder and individual operators of activities.

Minimum is 1+3 shifts, continuous duty in 12-hour shifts. Unit departure time is maximum 2 minutes from alarm, arrival time to LVR-15 is 1 minute.

The operation of the fire alarm room is provided by a security agency (an external contracted company) for 24 hours a day.

Technical equipment

- CAS 20/4000/240 - Scania, CAFS (air-foamed dry foam equipment primarily for fire fighting in controlled zones, etc.), submersible pump
- CAS 10/1000 L1 Iveco Daily - special vehicle for water and powder (1000 l water+250 kg powder)
- TA 2 VW LT 35 - special vehicle for decontamination (mobile decontamination unit
- Outboard extinguisher 4x30 CO2
- Means of chemical service
- IDP Pluto 300-13 pieces - maintenance, filling and checks provided in chemical technology own workshop
- Anti-chemical protective suits AlphaTec Light CV - 4 pcs
- Intervention Dosimeter UltraRadiac - Plus
- RKP-1-2 surface contamination monitor
- Radiometer DC-3A-72
- Mobile decontamination unit
- Means of communication service
- Mobile phones

In the event of a radiation emergency, a system of accessibility of competent personnel is set up at several levels within Nuclear Research Institute Řež a.s:

- Dosimetry Group.
- Integrated Response Groups - for accidents involving the transport of ionising radiation sources.

3.2.C.3.1. Overview of firefighting strategies, administrative arrangements and assurance

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. A ground floor stand-alone building in the hillside is used as a ventilation centre.

1st floor - in the front four-storey part there are dressing rooms, workshop of spare power supply and workshop of hot air units. The reactor hall is basically the "reactor bottom" with hot cells.

2nd floor - in the front four-storey part there are mechanical workshops, a welding corner in a separate room, a large distribution and accumulator room and common administrative buildings. Behind the four-storey part there is a hall part with a reactor vessel and a reinforced concrete annex with a radioactive waste storage (pools with water).

3rd - 4th floor - in the front four-storey part there are offices and laboratories (mostly of physical type, with occasional radioactive substances in designated places). There is also a reactor control room and a reactor water loop control room.

Building structures

The building is made of brick. Vertical load-bearing structures in the hall part are made as a steel skeleton, in the laboratory part from bricks. The ceilings above all floors are reinforced concrete. The main staircases are reinforced concrete; the internal service staircases are steel. The roofing of the hall is prefabricated slabs and cast foam concrete, the roofing is bituminous.

Evacuation of persons

During reactor outage morning shift of up to 30 people from 6 am to 3 pm work on weekdays. During the campaign (reactor operation), 6 persons remain there permanently (24 hours per day in the control room). Evacuation takes place through unprotected emergency routes and via stairways - partially protected emergency routes with pressure ventilation.

Fire sections

The building is only partially divided. The following fire sections are gradually being created:

FS 1 - reactor hall with expeditionary centre,
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).

Separately fire separated is the building of small residue (after reconstruction), the storage and ventilation centre (structurally separated building + fire separated ventilation system).

Portable extinguishers

In all Research Centre construction buildings, appropriate types of portable or mobile fire extinguishers are installed, which are intended mainly for trained workers, employees assigned to preventive fire patrols and for employees of the company's FRSU to perform rapid first firefighting intervention. Fire extinguishers are located in buildings according to the principles set out in ČSN 73 0804, ČSN 73 0802 and according to approved fire risk assessments. The type, number and location of fire extinguishers shall be determined for each building and shall be determined by the nature and size of the workplace in the building and the nature of the combustible substances present in. Fire extinguishers shall be located in particular near the places where fires are likely to occur, at entrances to rooms and on internal emergency routes.

Main switches and closures

The main electrical switch is located on the second floor in the distribution room. The distribution room is a separate room separated by fire partitions on cable routes and fire-resistant doors. Shutting down the electrical power will not cause secondary damage or cause a fire, explosion or radiation leak from the reactor.

The main water tap is located at the first floor. Gas is not introduced to the building.

3.2.C.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

Qualification requirements for fire protection posts

Function name	Qualification requirement
Fire protection Group Leader	University education in the field of fire protection, or higher education + professional competence according to the Fire Protection Act

Function name	Qualification requirement
FRSU Commander	High school + professional competence (course tactical-strategic management + professional competence according the Fire Protection Act)
Fire protection technician	High school + professional competence according to the Fire Protection Act
FRSU Shift Commander	High school + tactical management course + professional competence according to the Fire Protection Act
Firefighter - engineer	High school + NOV, mechanical engineering course
Firefighter - chemist	High school + NOV, chemical service course
Firefighter - communicator	High school + NOV, course of communication service
Firefighter - technician	High school + NOV, technical services course
Firefighter	SŠ + NOV (entry professional training)

Training and professional training of Research Centre employees on fire protection

Fire protection training is organized for all Research Centre employees in accordance with the requirements of the Fire Protection Act on the following dates:

a) Training of employees on fire protection:

- Training shall be provided on entry of the person to employment and whenever there is a change in the employee's workplace or job classification, if such changes also result in changes to the facts that were the subject of the previous fire protection training,
- Training is repeated 1 x per year.

b) Training of managers on fire protection:

- Training is performed when senior staff at all levels of management enter to their posts,
- Training is repeated 1 x every 2 years.

c) Fire protection training provided for employees of contractors performing activities at site of the Research Centre.

d) A "professional training" - is organized for employees assigned to the FRSU (professional firefighters) and for employees assigned to preventive fire patrols.

The management and working documentation of the Research Centre includes the organisation, scope and content of training of employees and contractors' employees on fire safety and the organisation, scope and content of training of employees assigned to preventive fire patrols.

3.2.D. Active fire protection SFS

3.2.D.1. Fire detection and alarm provisions

The SFS building is equipped with an electrical fire alarm 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.

The SFS building is not equipped with a stable extinguishing system. In the SFS building, technical measures are implemented to ensure fire intervention by fire protection units in accordance with ČSN, which allow effective fire intervention conducted through the interior of the building.

The SFS compartments are designed and equipped so that it is possible to perform a quick and effective intervention of FRSU. It is not possible to conduct effective fire-fighting intervention from the outside of the building in the SFS, and therefore, in accordance with the ČSN, 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.

The fire water supply system is designed according to ČSN 73 0804, ČSN 730873 and related standards. Wall hydrants are located in the building and the corresponding types of portable or mobile fire extinguishers are installed.

3.2.D.2. Fire suppression provision

A professional unit of the company's FRSU is established at the NPP and is located in the fire station building. Its employees provide tasks arising from the Fire Protection Act as amended, both in the field of fire prevention, firefighting and rescue work. The material and technical equipment of the FRSU is sufficient and does not need to be supplemented in connection with the operation of the SFS. The existing operational documentation is supplemented by requirements related to the specific conditions of the activities performed in the SFS.

3.3. Passive fire protection

3.3.A. Passive fire protection at the Temelín NPP

3.3.A.1. Prevention of fire spread (barriers)

3.3.A.1.1. Design approach

Fire separating structures

Fire-separating structures are building structures preventing the spread of fire outside the fire section, capable of resisting the effects of a fire for a specified period without failure of their function. Fire separating structures are:

- Fire walls,
- Fire ceilings,
- Fire closures - fire doors, fire hatches, fire dampers and fire penetration seals,
- Perimeter construction.

For each fire section, the fire safety level was determined according to the methodology, based on which the lowest fire resistance of the individual types of fire-separating structures bounding the respective fire section was determined. In cases where a fire separating structure separates fire sections with different fire safety ratings, the required lowest fire resistance is determined according to the fire section with the higher fire safety rating, i.e. the fire section with the higher fire risk.

In the case of fire ceilings and fire hatches, their lowest fire resistance is determined by the fire section below the fire ceiling.

Fire walls, fire ceilings

Fire walls and fire ceilings in all NPP buildings are of non-combustible design, their actual fire resistance meets the requirements of ČSN. The actual fire resistance values of the individual structures range from 15 to more than 240 minutes.

All structures used in the buildings of the Soviet design zone were assessed. The actual fire resistance values were determined according to ČSN 730821 or by attestations or expert evaluation. In some cases, where the fire resistance values determined in this way did not meet the requirements of the ČSN, fire-resistant coatings, plastering or cladding increased the fire resistance of that structure.

Fire doors, fire hatches

The actual design and fire resistance of fire doors and fire hatches in NPP buildings meet the requirements of the ČSN. The fire resistance of individual closures ranges from 15 to 90 minutes. The closures leading to the protected emergency routes are of type PB or EI (preventing the spread of heat); the other closures are of type fire protection or EW (limiting the spread of heat).

In a few cases, fire closures of type fire protection, in accordance with ČSN, are also installed in protected emergency routes, but only if they separate the protected emergency route from the fire section or area without fire risk. Fire doors in protected emergency routes shall be fitted with an automatic closing mechanism (except in the case of hermetic doors).

The original doors and hatches, including hermetic closures, installed in the buildings of the "Soviet Design Zone" were assessed by the "Expertise Centre for Fire Safety in Buildings" to determine the types and fire resistance of the different types of closures and, where necessary, modifications to increase the fire resistance of the existing doors and hatches were proposed. In most cases, this involved the addition of thermal insulation, the application of Flammoplast SP-A fire-resistant coating to the closures, structural modifications to the doorframes and door leaves, or the replacement of entire door leaves.

Fire dampers

A fire damper is a fire stop in an air channel that closes because of an impulse (e.g. mechanical, thermal, electrical) and thus prevents the spread of flames, heat and combustion products through the channel. The fire dampers installed in important buildings are equipped with a limit switch and the position of the damper leaf is signalled to the control room and to the fire alarm station of the FRSU.

Fire seals, grommet sealing

All cable penetrations through fire-separating structures, including cable penetrations through fire partitions, are sealed with fire penetration seals. The fire penetration seals used in the NPP comply with the requirements of ČSN and the approved test methodology.

3.3.A.1.2. Description of fire section and cell design and key features

Fire sections

All construction buildings, where required by normative regulations and safety instructions, are divided into smaller fire-resistant units - fire sections. Their purpose is to contain the fire within the fire section and prevent its spread outside the fire section. Individual buildings have been divided into fire sections to ensure that:

a) Fire separation of compartments in which redundant equipment and components of safety and nuclear safety related systems are located (if such a solution is technically feasible).
b) Fire separation of compartments that are exhaustively listed in Czech normative regulations:

- Protected emergency routes,
- Shafts and turbine halls of evacuation and fire lifts,
- Elevator, installation and cable shafts, cable rooms, cable channels,
- Ventilation engine rooms, except those serving only a single fire section,
- Control and computer centres with a surface area greater than 100 m^2,
- Electrical distribution rooms with an area greater than 100 m^2, transformer chambers,
- Compartments and operations that must form separate fire sections according to the relevant standards (especially according to ČSN 65 0201).

c) Easy and safe emergency escape of persons from each fire section.
d) Fast and effective intervention of fire units.
e) Separation of high fire risk operations or operations with a higher probability of fire occurrence and spread from other operations.
f) Limitation of the number of penetrations in fire separating structures.
g) Possibility of exhausting combustion products outside the building.
h) Limiting the extent of damage.

The prevention of fire spread between individual fire sections is ensured by consistent delimitation of each fire section by fire-separating structures.

3.3.A.1.3. Performance assurance through lifetime

Fire protection activities are subject to integrated management system. The basic objective of quality assurance in the field of fire protection is to ensure that all systems and equipment of the fire protection system operate reliably, safely, economically and in an environmentally friendly manner and that all employees of the Temelín NPP at all levels of management work in such a way as to ensure a high level of fire protection.

Fire protection programme

The fire protection programme for the period of construction, physical start-up, power start-up, test operation and operation of the the Temelín NPP is elaborated in the operating procedures and in the management and documentation system of the NPP. The fire protection programme elaborates the requirements of national legislative and normative documents as well as the recommendations of IAEA and WANO safety guides.

The fire protection programme addresses in particular:

- Responsibilities and powers of the Temelín NPP employees in the area of fire protection.
- The tasks of the Fire Protection and Emergency Preparation, which is responsible for fire protection management at the Temelín NPP, and the tasks of the FRSU in the area of fire prevention and fire repression.
- Training and professional training of the Temelín NPP employees in the field of fire protection and professional training of FRSU employees.
- Types and scope of fire protection documentation and responsibilities for its preparation and maintenance.

The fire protection documentation includes especially:

- Fire alarm orders setting out the procedure and duties of staff in the event of a fire being detected.
- Fire-fighting documentation containing fire-fighting plans. Fire-fighting documentation is prepared for each NPP building.

Professionally qualified persons within the meaning of the Fire Protection Act perform the preparation of fire risk assessments, training of employees assigned to preventive fire watches and training of managers on fire protection.

Revisions and inspections of fire protection systems

All fire protection systems are subject to regular periodic checks and inspections. The method and scope of ensuring the management, operation and maintenance of fire protection systems is incorporated in the relevant operating procedures or in documents of internal management system.

Persons who are qualified and competent shall only perform inspections and checks.

3.3.A.2. Ventilation systems

The following principles were followed in addressing the fire safety of the ventilation systems in the reactor and auxiliary buildings:

- In the event of a fire, basic operational ventilation systems are used for ventilation of individual fire sections (except for ventilation of protected emergency routes - stairways).
- Fire dampers (PK) are installed in the places of penetrations of ventilation equipment (pipes, or other parts and elements) through fire-separating structures.
- In cases where the ventilation piping passes through a different FS than the one ventilated by the ventilation system in question, dampers are installed or the piping is protected by fire insulation up to the next damper.
- No dampers are installed on the channel of ventilation systems of rooms for which a constant supply of air or even exhaust air is required, and protected channel is used when the channel passes through another fire section. E.g.: air-conditioning of the control room, ventilation of protected emergency routes, corridors on floors -4,20, ±0,00, +3,60, +6,60, +24,60.
- It is not expected that there will be a fire in the containment and the extension building at the same time. Precautions are taken to ensure that a fire cannot spread from the extension building to the containment and vice versa.

For the pipe routes of the supply system, which, if necessary, filters outdoor air containing radioactive aerosols for the reactor control room, protected pipes are not required and do not need damper to be used for fire separation for the following reasons:

- The system is only operational when the outdoor air is contaminated with radioactive substances.
- Pipeline routes are routed only through the building.
- A fire in the containment will not increase the radioactivity around the unit building.

KID automatic dampers

The KID dampers are used for air transfer between rooms and automatically maintain the pressure difference between the rooms connected by the dampers. The KID damper opens when the pressure difference between the connected rooms reaches a prescribed (set on the damper) value. The pressure difference is set by a weight on the damper. The KID damper closes automatically when the exhaust system is interrupted. The KID damper has a fire resistance of 90 minutes as proven by a test.

In cases where the air extraction from the box is switched off in the event of a fire, no damper is connected to the KID damper in the wall between the corridor and the box.

From the corridors in which the oil pipes are routed, automatic electric fire detectors control the damper in the adjacent boxes and in the event of a fire interrupt the air extraction, thus closing the KID dampers.

Ventilation of protected emergency routes

In individual buildings, where required by ČSN 73 0804 or ČSN 73 0802, protected emergency routes are established for the safe evacuation of persons and, where appropriate, for fire-fighting intervention.

In the reactor buildings and the auxiliary building - the radioactive waste treatment stations, protected emergency routes are ventilated in accordance with ČSN 73 0804. A pressure gradient of 15-50 Pa is ensured between the stairwell area and the halls, and 10-30 Pa between the halls and other fire sections. The overpressure ventilation has an ensured power supply. The ventilation is activated by automatic electrical fire smoke-detectors. Another possibility to activate the ventilation is by push buttons from the protected emergency route.

In addition to the requirements of ČSN 73 0872, the installation of fire dampers in the place of penetrations of ventilation equipment smaller than 0.04 m^2 has been specified in the following cases:

- Ventilation equipment penetrations through fire separation structures that separate the protected emergency routes from adjacent spaces.
- Rooms with higher fire loads (pn>50 kg/ m^2).
- When there may be a risk of combustion fumes spreading into rooms where there are permanent workplaces.

3.3.A.2.1. Ventilation system design: separation and insulation requirements

Ventilation systems

When designing ventilation systems from the point of view of fire safety, the procedure was followed according to ČSN 73 0872. In addition, the principles of the Decree on Nuclear Facility Design and IAEA Recommendation 50-SG-D2 were applied for important buildings:

- Basic operational ventilation systems are used for ventilation of buildings in case of fire (except for ventilation of protected emergency routes).
- In cases where CSN 73 0872 is in conflict with nuclear safety requirements (e.g. it is necessary to create a constant vacuum), alternative measures are implemented.
- The ventilation systems are designed to ensure the operation of redundant parts of the safety systems.
- Flammable air filters are designed in such a way that they cannot leak radioactive substances above the specified limits in the event of a fire. The environment in the channel upstream and downstream of the filter is monitored by EFD. If a fire is detected, the filter is automatically separated from the rest of the channel by closing the air dampers and the air is transferred to another filter. Due to the lack of oxygen, the fire is extinguished. Air dampers designed to prevent the spread of fire through the channel shall have a proven fire resistance by test or calculation.

Fire dampers

One of the following methods prevent the spread of fire through the air channels in NPP buildings:

a) Fire dampers are installed at the boundaries of the fire sections, i.e. at the points of penetrations of the air channels through the fire-separation structure. The dampers close the thermal fuse when the critical temperature is reached. In selected areas, the pulse of the electric fire alarm also closes them. Part of the dampers are designed so that when a temperature of 130 to 150 °C is applied, the fire damper blade is "baked" - sealed in the pipe to prevent the spread of smoke. All fire dampers can also be operated manually from its site.
The fire resistance of the fire dampers installed in the power plant buildings is 90 minutes, the fire resistance of the fast-acting dampers installed at the boundary of the containment is 120 minutes,

and the fire resistance of the KID automatic pressure relief dampers installed in some areas of the "Soviet design zone" buildings is 90 minutes.

b) Fire insulation was used to protect the air channel in accordance with ČSN 73 0872 in cases where it was not possible or appropriate to install fire dampers, (e.g.: the location of the channel does not allow the installation of a fire damper, it was not possible to place the damper directly in the fire separation structure, in cases where the channel must remain open at all times). The fire resistance of the fire insulation ranges from 30 to 90 minutes.

Fire separation seals, grommet sealing

The fire resistance of the penetration seals installed in critical areas is 90 minutes, although the CSN does not require a fire resistance of more than 60 minutes for penetration seals.

Penetrations of pipeline routes through fire-dividing structures are fire-sealed with fire resistance complying with the requirements of ČSN. The fire resistance of the sealing of pipe penetrations in important spaces is 90 minutes and the sealing construction is designed to allow pipes dilatation. The fire resistance of hermetic grommets installed at the boundary of the containment is 90 minutes.

In places where the level of flammable liquid can reach the level of the piping penetrations (e.g. emergency sumps of technological equipment), materials resistant to both the chemical effects of the liquid and the hydrostatic pressure of the leaking liquid column are used to seal the penetrations.

3.3.A.2.2. Performance and management requirements under fire conditions

Control of ventilation equipment and fire dampers in important buildings

- Electrical fire alarm detectors located in rooms where circulating ventilation systems are used will shut down (if a fire is detected) these ventilation units.
- In order to improve the conditions for manual fire-fighting in important buildings, in areas with low fire loads, smoke is extracted during a fire for as long as possible by means of operating air ventilation systems. A thermal fuse controls the installed dampers and the position of the leaf is signalled in the unit control room (damper type B). This solution is made possible by the use of reduced flammability cables, which are halogen-free and have a reduced optical density of smoke.
- The PKs are controlled by automatic electric fire alarm detectors (PK type D) in case of an oil fire and thus smoking of the adjacent fire sections through the ventilation channels.
- The KID dampers close when the exhaust from the box to which the damper supplies air is interrupted.
- In cases where dampers are installed between the hall of the protected emergency route and other areas of the building, the dampers are controlled by the automatic detectors of the EFD in the protected emergency route and from the staircase fire ventilation fan.

3.3.B. Passive fire protection of the Dukovany NPP

3.3.B.1. Prevention of fire spread (barriers)

3.3.B.1.1. Design approach

Fire separating structures

Fire-separating structures are building structures preventing the spread of fire outside the fire section, capable of resisting the effects of a fire for a specified period without failure of their function. Fire separating structures are:

- Fire walls,
- Fire ceilings,
- Fire closures - fire doors, fire hatches, fire dampers and fire penetration seals,
- Perimeter construction.

For each fire section, the fire safety level was determined according to the methodology, based on which the lowest fire resistance of the individual types of fire-separating structures bounding the respective fire section was determined. In cases where a fire separating structure separates fire sections with different fire safety ratings, the required lowest fire resistance is determined according to the fire section with the higher fire safety rating, i.e. the fire section with the higher fire risk.

In the case of fire ceilings and fire hatches, their lowest fire resistance is determined by the fire section below the fire ceiling.

Fire walls, fire ceilings

Firewalls and fire ceilings in all NPP buildings are of non-combustible design; their actual fire resistance meets the requirements of ČSN. The actual fire resistance values of the individual structures range from 15 to more than 240 minutes.

All structures used in the buildings of the so-called Soviet design zone were assessed. The actual fire resistance values were determined according to ČSN 730821t by attestations or expert evaluation. In some cases, where the fire resistance values determined in this way did not meet the requirements of the CSN, fire-resistant coatings, plastering or cladding increased the fire resistance of the structure concerned.

Fire doors, fire hatches

The actual design and fire resistance of fire doors and fire hatches in NPP buildings meet the requirements of the ČSN. The fire resistance of individual closures ranges from 15 to 90 minutes. The closures leading to the protected emergency routes are self-closing and smoke-tight, the other closures are heat-spread limiting and possibly supplemented with a self-closer.

In a few cases, fire dampers to limit heat spread are also installed in protected emergency routes - but only if they separate the protected emergency route from the fire section or area without fire risk. Fire doors in protected emergency routes shall be fitted with an automatic closing mechanism (except in the case of hermetic doors).

Fire dampers

A fire damper is a fire stop in an air channel that closes on the basis of an impulse (e.g. mechanical, thermal, electrical) and thus prevents the spread of flames, heat and combustion products through the channel.

In order to improve the conditions for manual fire-fighting, smoke is extracted for as long as possible during a fire by means of operating air ventilation systems. Therefore, the dampers are controlled by a thermal fuse for automatic closure (e.g. cable channels, control room, etc.). KID dampers close when the exhaust from the box to which the damper is supplying air is interrupted.

Circulating ventilation systems are mostly stopped manually in the event of a fire from the room in which they are installed and a fire has been detected.

Fire seals, grommet sealing

All cable penetrations through fire-separating structures, including cable penetrations through fire partitions, are sealed with fire penetration seals. The fire penetration seals used in the NPP comply with the requirements of ČSN and the approved test methodology from 1992.

3.3.B.1.2. Description of fire section and cell design and key features

Fire sections

All construction buildings, where required by normative regulations and safety instructions, are divided into smaller fire-resistant units - fire sections. Their purpose is to contain the fire within the fire section and prevent its spread outside the fire section. Individual buildings have been divided into fire sections to ensure that:

a) Fire separation of compartments in which redundant equipment and components of safety and nuclear safety related systems are located (if such a solution is technically feasible).
b) Fire separation of compartments that are exhaustively listed in Czech normative regulations:
    - Protected emergency routes,
    - Shafts and turbine halls of evacuation and fire lifts,
    - Elevator, installation and cable shafts, cable rooms, cable channels,
    - Ventilation engine rooms, except those serving only a single fire section,
    - Control and computer centres with a surface area greater than 100 m^2,
    - Electrical distribution rooms with an area greater than 100 m^2, transformer chambers,
    - Compartments and operations that must form separate fire sections according to the relevant standards (especially according to ČSN 65 0201).
c) Easy and safe emergency escape of persons from each fire section.
d) Fast and effective intervention of fire units.
e) Separation of high fire risk operations or operations with a higher probability of fire occurrence and spread from other operations.
f) Limitation of the number of penetrations in fire separating structures.
g) Possibility of exhausting combustion products outside the building.
h) Limiting the extent of damage.

The prevention of fire spread between individual fire sections is ensured by consistent delimitation of each fire section by fire-separating structures.

3.3.B.1.3. Performance assurance through lifetime

Fire protection activities are subject to integrated management system. The basic objective of quality assurance in the field of fire protection is to ensure that all systems and equipment of the fire protection system operate reliably, safely, economically and in an environmentally friendly manner and that all employees of the Temelín NPP at all levels of management work in such a way as to ensure a high level of fire protection.

Fire protection programme

The fire protection programme for the period of construction, physical start-up, power start-up, test operation and operation of the Dukovany NPP is elaborated in the operating procedures and in the management and documentation system of the NPP. The fire protection programme elaborates the requirements of national legislative and normative documents as well as the recommendations of IAEA and WANO safety guides.

The fire protection programme addresses in particular:

- Responsibilities and powers of the Temelín NPP employees in the area of fire protection.
    - The tasks of the Fire Protection and Emergency Preparation, which is responsible for fire protection management at the Temelín NPP, and the tasks of the FRSU in the area of fire prevention and fire repression.

- Training and professional training of the Temelín NPP employees in the field of fire protection and professional training of FRSU employees.
- Types and scope of fire protection documentation and responsibilities for its preparation and maintenance.

The fire protection documentation includes especially:

- Fire alarm orders setting out the procedure and duties of staff in the event of a fire being detected.
- Fire-fighting documentation containing fire-fighting plans. Fire-fighting documentation is prepared for each NPP building.

Professionally qualified persons within the meaning of the Fire Protection Act perform the preparation of fire risk assessments, training of employees assigned to preventive fire watches and training of managers on fire protection.

Revisions and inspections of fire protection systems

All fire protection systems are subject to regular periodic checks and inspections. The method and scope of ensuring the management, operation and maintenance of fire protection systems is incorporated in the relevant operating procedures or in documents of internal management system.

Persons who are qualified and competent shall only perform inspections and checks.

3.3.B.2. Ventilation systems

The designing of the ventilation systems from the fire safety point of view followed ČSN 73 0872 and principles based on the previously valid Decree No. 195/1999 Coll. and IAEA 50-SG-D2:

- Basic operational ventilation systems are used for ventilation of buildings in case of fire (except for staircase ventilation).
- In cases where ČSN 73 0872 does not comply with nuclear safety requirements (e.g. it is necessary to create a constant vacuum), alternative measures are implemented.
- The ventilation systems are designed to ensure the operation of redundant parts of the safety systems.
- The fresh air intake is positioned to prevent the intake of combustion products from other fire sections or buildings.

COLT fire dampers

They are installed in the ceiling of the turbine hall and their purpose is to dissipate any heat generated by the fire. Their main purpose is that the heat generated by the fire will be dissipated outside the building and will not endanger the steel supporting structures of the turbine hall. Another consequence of the operation of these dampers is the "cleaning" of the firefighters' intervention area from the smoke products of combustion.

Ventilation of protected emergency routes

In individual buildings, where required by ČSN 73 0804 or ČSN 73 0802, protected emergency routes are established for the safe evacuation of persons and for fire-fighting intervention. In the reactor building and auxiliary building, protected emergency routes are ventilated in accordance with ČSN 73 0802.

3.3.B.2.1. Ventilation system design: separation and insulation requirements

Ventilation systems

When designing ventilation systems from the point of view of fire safety, the procedure was followed according to ČSN 73 0872. In addition, the following principles were applied for important buildings, based on Decree No 195/1999 Coll., in force at the time of the design of the systems, and the recommendations of IAEA 50-SG-D2:

- Basic operational ventilation systems are used for ventilation of buildings in case of fire (except for ventilation of protected emergency routes).
- In cases where ČSN 73 0872 is in conflict with nuclear safety requirements (e.g. it is necessary to create a permanent vacuum), alternative measures are implemented.
- The ventilation systems are designed to ensure the operation of redundant parts of the safety systems.
- Flammable air filters are designed in such a way that they cannot leak radioactive substances above the specified limits in the event of a fire. The environment in the channel upstream and downstream of the filter is monitored by EFD. If a fire is detected, the filter is automatically separated from the rest of the channel by closing the air dampers and the air is transferred to another filter. Due to the lack of oxygen, the fire is extinguished. Air dampers designed to prevent the spread of fire through the channel shall have a proven fire resistance by test or calculation.

Fire dampers

A fire damper is a fire stop in an air channel that closes on the basis of an impulse (e.g. mechanical, thermal, electrical) and thus prevents the spread of flames, heat and combustion products through the channel.

a) Fire dampers are installed at the boundaries of the fire sections, i.e. at the points of penetrations of the air channels through the fire-separation structure. The dampers close the thermal fuse when the critical temperature is reached. In selected areas, the pulse of the electric fire alarm also closes them. Part of the dampers are designed so that when a temperature of 130 to 150 °C is applied, the fire damper blade is "baked" - sealed in the pipe to prevent the spread of smoke. All fire dampers can also be operated manually from its site.
b) In cases where it was not possible or appropriate to install fire dampers, a fire protection structure (cladding or insulation) was used to protect the air channel along the entire length of the air channel in the fire section in accordance with EN 73 0872 (e.g.: the location of the channel does not allow the installation of a fire damper or it was not possible to install a damper directly in the fire protection structure or in cases where the channel must remain open at all times). The fire resistance of the fire section structure was determined according to the fire safety rating of the fire section and ranges from 30 to 90 minutes.

COLT ventilation dampers are operated manually (packet marked switches on emergency and intervention routes).

Fire seals, grommet sealing

The fire resistance of the penetration seals installed in critical areas is 90 minutes, although the CSN does not require a fire resistance of more than 60 minutes for penetration seals.

Penetrations of pipeline routes through fire-dividing structures are fire-sealed with fire resistance complying with the requirements of ČSN. The fire resistance of the sealing of pipe penetrations in important spaces is 90 minutes and the sealing construction is designed to allow pipes dilatation. The fire resistance of hermetic grommets installed at the boundary of the containment is 90 minutes.

In places where the level of flammable liquid can reach the level of the piping penetrations (e.g. emergency sumps of technological equipment), materials resistant to both the chemical effects of the liquid and the hydrostatic pressure of the leaking liquid column are used to seal the penetrations.

3.3.B.2.2. Performance and management requirements under fire conditions

Control of ventilation equipment and fire dampers in important buildings

- Electrical fire alarm detectors located in rooms where circulating ventilation systems are used will shut down (if a fire is detected) these ventilation units.
- In order to improve the conditions for manual fire-fighting in important buildings, in areas with low fire loads, smoke is extracted during a fire for as long as possible by means of operating air ventilation systems. A thermal fuse controls the installed dampers and the position of the leaf is signalled in the unit control room (damper type B). This solution is made possible by the use of reduced flammability cables, which are halogen-free and have a reduced optical density of smoke.
- The PKs are controlled by automatic electric fire alarm detectors (PK type D) in case of an oil fire and thus smoking of the adjacent fire sections through the ventilation channels.
- The KID dampers close when the exhaust from the box to which the damper supplies air is interrupted.
- In cases where dampers are installed between the hall of the protected emergency route and other areas of the building, the dampers are controlled by the automatic detectors of the EFD in the protected emergency route and from the staircase fire ventilation fan.

3.3.C. Passive fire protection of LVR-15

3.3.C.1. Prevention of fire spread (barriers)

3.3.C.1.1. Design approach

The building is made of brick with masonry or reinforced concrete or bricks made. Vertical load-bearing structures in the hall part is a steel skeleton, in the laboratory part bricks structure. Partitions are reinforced concrete or brick. The main staircases connecting all floors are reinforced concrete monolithic, internal are just for service. Internal doors are wooden, in some places additionally replaced by fire-stopping ones. The building has a non-combustible structural system.

3.3.C.1.2. Description of fire section and cell design and key features

The originally undivided reactor building is being divided into fire sections subsequently during use; the division is not complete and finished. 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, etc. The two staircases on both sides of the building, which form ventilated, partially protected emergency routes, are properly fire-proofed. The following fire sections are gradually being created:

Fire section 1 - reactor hall with dispatch centre, section 2 - reactor operator room, section 3 - fuel storage room, section 4 - diesel generator, section 5 - battery rooms - accumulator rooms, section 6 - individual floors with laboratories, section 7 - staircases on both sides of the building (partially protected emergency routes).

After reconstruction, the small residue building is separated by fire; the storage and ventilation centre (structurally separated building + fire separated air conditioning) is also a separate FS.

3.3.C.1.3. Fire protection assurance through lifetime

The following requirements are met throughout the operation:

a) Determined the organisation of fire protection security with regard to the fire risks of the activities performed.
b) Established and demonstrated comply with the fire safety conditions of the activities, technological processes and equipment operated, if the conditions for the operation of activities and the maintenance and repair of equipment are not stipulated by special legislation.
c) Ensured maintenance, inspection and repair of technical and technological equipment within the time limits specified by the fire safety conditions or the equipment manufacturer,
d) Established, from the point of view of fire safety, requirements for the professional qualifications of persons responsible for the operation, inspection, maintenance and repair of technical and technological equipment, unless this is provided for by special legal regulations, and to ensure that work which could lead to fire is performed only by persons with the appropriate qualifications.
e) Availability the fire-technical characteristics of substances and materials manufactured, used, processed or stored necessary to determine preventive measures to protect the life and health of persons and property.
f) Ensured compliance with the prohibition of burning of vegetation; when burning flammable substances in the open, establish measures against the occurrence and spread of fire.
g) Provided once a year evacuation exercises for fire protection (Řež, Plzeň).

3.3.C.2. Ventilation systems

Heating of the laboratory part of the building is solved by central heating with hot water (70 - 80°C) with forced circulation. The heating elements are cast iron elements. The heating water is supplied from the central boiler room, its temperature is regulated by mixing with the return water from the heating elements. The hot water is piped to the men's locker room, where heat metering is installed, and is distributed to the central heating system, the hot water heat exchanger, the supply air heaters and the hot air heaters in the annex, the loop fan space, and the storage room.

To heat the reactor building, the air is heated by an electric heater, if necessary. The heater is capable of increasing the air temperature by up to 15 °C and is used in winter.

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 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.

3.3.C.2.1. Ventilation system design: separation and insulation provisions

The ventilation system of the LVR-15 reactor belongs to the selected equipment of the reactor. The main functions of the LVR-15 reactor process ventilation include:

- 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 principle of negative pressure ventilation meets the above requirements. 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. There is ventilation in the reactor hall to provide the required air exchange. The exhaust is compensated by fresh air supply through supply systems with possible preheating. The pump room ventilation is interchangeable, with air being extracted from the upper zone of the room and the extraction being compensated by the supply of air from the corridor by pressure relief valves regulated to maintain a specified negative pressure. 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 centre and parts of the systems located inside the ventilation centre 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.

3.3.C.2.2. Requirements for operation and control under fire conditions

Reactor shutdown in case of fire

The fission chain reaction in the LVR-15 reactor is controlled. In case of any power loss (including burned-out wiring, fire in electrical distributor, etc.), there is always an automatic (self-acting) drop (run down) of the control rods into the core. The self-activity is due to rods held by electromagnets, which cause the rods to fall by their own weight whenever power is lost. The retraction of the rods stops the fission chain reaction. If operator discover a fire, the reactor is shut down manually by an emergency button on the console in the reactor operator's room. If the operator's room is not permissible, this can also be done by an emergency button in the operator's rooms of loops or probes, or by shutting down any electrical power system in the distribution room. In the event of a fire, the reactor will always be safely shut down and remain shut down.

Remaining heat removal after reactor shutdown in case of fire

The removal of residual heat after reactor shutdown ensured operation of one emergency pump and one operating pump and the emergency power supply system. If there is no failure of the reactor power supply from the external network, cooling is also ensured by operating pumps. The pumps are located in the pump room, the emergency power systems are located in the distribution room and battery rooms, and the emergency power supplies are located separately. The interconnecting cables to the pumps run from the distribution room through a niche to the ground floor and through a cable channel in the ground floor corridor to the hot cells, where they pass through the wall to the pump house. A fire in any of these spaces can disable the cooling function for the prescribed 30 minutes. The fire affects the removal of residual heat, but there will be no release of radioactive substances to the surrounding area or danger to reactor operators.

Fire consequence prevention

The reactor vessel is located on the reactor hall in a massive approx. 1.5 thick heavy concrete shielding. During operation, an 80 cm thick cast iron lid covers it. The vessel is made of 15 mm thick stainless steel and is filled with water. The ionisation chambers and control rods from the reactor protection and control system and the experimental equipment are suspended on the upper floor of the vessel. Of the combustible materials, only cables are present in the upper part of the vessel. Possible sources of fire are very low power electrical drives, electrical heating in the experimental equipment - probes and water loops, and hot feed pipes to the water loops. The piping carries water at a temperature of approximately 300 °C, and the piping is provided with thermal insulation so thick that the temperature at the surface of the insulation is 45 °C. The layout of the equipment in the upper part of the vessel is such that, even in the event of a short circuit and ignition in any part of the equipment, the spread of fire to such an extent as to affect the function of the vessel is excluded. The spread of fire to other equipment under the lid is also unlikely. Fire sealing of the cable penetrations prevent fire transmission through the cables into the cable tray.

The exhaust ventilation ventilates space under the reactor lid. The air channel passes through the concrete shielding and underground to the ventilation centre. A fire damper is fitted at the entrance to the ventilation centre. This prevents the spread of fire to the ventilation centre. In the event of a fire in the reactor hall outside the vessel shielding, its spread to the area under the vessel lid prevents the layout, concrete shielding and sealing of cable penetrations.

3.3.D. Passive fire protection SFS

3.3.D.1. Prevention of fire spread (barriers)

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.

3.3.D.2. Ventilation systems

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) and the reception area, divided into controlled area and outside controlled area (where the staff presence is permanent but periodic), is mechanically ventilated (forced).

3.4. Experience of the permit holder with the implementation of the fire protection concept

The Temelín NPP, the Dukovany NPP and SFS

All three nuclear installation - Temelín NPP, the Dukovany NPP and SFS - operates company ČEZ, PLC Within its organizational structure the Fire protection and emergency preparedness department supervise the fire safety of them. The method and scope of ensuring the management, operation and maintenance of fire protection systems is incorporated in the relevant operating procedures and in the integrated management system of documentation of ČEZ, PLC The nuclear power plants have professional company's Fire Rescue Service Units (FRSU), which are located in the fire station building in respective NPP. Its employees provide tasks arising from the Fire Protection Act, both in the field of fire prevention, firefighting and rescue work in all facilities in the site of the NPP.

The fire protection concept at the Dukovany NPP and the Temelín NPP creates conditions and assumptions based on the characteristics of the operation so that any fire occurring on the NPP site or in the SFS could not cause a reduction in the level of compliance with the general requirements for nuclear safety, radiation protection and fire protection.

The operation of the Unit of company's FRS is part of the Alarm Plan of the region where the NPP is located. Any changes in the determination of the area of intervention of Regional Fire rescue Service outside the nuclear power plant site are discussed in cooperation with the head of the fire protection of the NPP.

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The fire protection concept is part of the overall risk management and risk prevention system of the company, as well as defined as a special process in the management system program with a designated guarantor and at the same time as one of the qualification criteria for the nuclear facility design area itself.

Thanks to the presence of the Fire Rescue Service Unit directly on the site of Nuclear Research Institute Řež PLC, the requirements in the area of fire law are fully implemented, both in the company's central procedures and directly in the procedures for operation and management of the emergency response at LVR-15. A prerequisite for intervention is coordination with the reactor operator's room and following the emergency regulations for operators (shutdown, initiation of reactor cool-down and minimisation of leakage to the surroundings) and the fire-fighting procedures of the fire-fighting units themselves.

3.5. Regulator´s assessment of the fire protection concept and conclusions

The fire protection system in the Czech Republic has long been conceptual and sufficiently robust. Standards have been issued which cover both the need for fire risk assessment and the need for firefighting equipment and resources for firefighting. Nuclear installations in the Czech Republic are fully compliant with the requirements of the applicable legislation and accept its provisions as the basic standard on which some other safety measures are based for present time.

3.6. Conclusions on the adequacy of the fire protection concept and its implementation

All permit holders for nuclear installation operation have the fire prevention system well elaborated and recorded in their internal management documentation system. Operators observe in their operating procedures both the requirements of the fire protection regulations and the requirements of nuclear law, including the recommendations set out in the SÚJB NSG No. BN_JB_3.5 "Protection against internal fires". All operators take due account of international good practice recommendations which go beyond Czech legislation and standards.

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 of not only state administration has been taking place throughout the Czech Republic. In this regard, a change made by 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. At ČEZ, PLC, the digitisation process is implemented in all areas of management, including the system of remediation and event prevention.

4. Overall evaluation and conclusions

The basic concept of fire protection in the Czech Republic has such a long history and continuity (the Fire Protection Act has been in force since 1985) that during this time, amendments have eliminated explicitly weak points. The requirement for some form of deterministic analysis has always been a part of this concept and, regardless of its designation, its content is identical to the requirements of nuclear law, the anchoring of which in the legal system in the former Czechoslovakia began with the first "atomic act" - the issuance of Act No. 28/1984 Coll., on State Supervision of Nuclear Safety of Nuclear Installations. Currently, there is an obligation to prepare a Fire Safety Solution, which is, however, linked to the permitting procedure for new buildings or changes to existing buildings, and Fire Fighting Documentation, which is used for the activity being performed. The Fire Fighting Documentation is part of the operating documentation. 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).

While the Fire Protection Act is still in force and continuously amended, the Atomic Act of 1984 has been completely revised twice (in 1997 and in 2016). The current Atomic Act No. 263/2016 Coll. takes full account of the latest requirements of the European legal framework and internationally recognised good practice. It obliges all permit holders to ensure the prevention of fires and explosions, their detection, elimination and dissolution, their safety impact reduction, and to provide for a nuclear facility that is not a nuclear research facility a unit of the company's Fire Rescue Service from the start of its construction, in accordance with the Fire Protection Act. The Research Centre in Nuclear Research Institute Řež a. s also fulfils the last provision - company´s FRSU presence in the site.

The decree on the requirements for the design of a nuclear power plant also requires that the prevention, resistance and protection of the nuclear installation against the effects of fire, explosion or combustion products on the nuclear installation shall be ensured, and a fire risk assessment must be prepared for all construction buildings. The Atomic Act anchors the requirement to perform probabilistic safety assessment (PSA), specified in detail in Decree No 162/2017 Coll., and the associated monitoring and risk assessment within the scope of Periodic Safety Review (PSR).

The Defence in Depth application is fully implemented in fire safety approach. 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. The modernization steps to improve the fire protection is continuously controlled and planned.

The competencies of the Fire Rescue Service of the Czech Republic (FRS CR) in the field of nuclear and radiation safety are integrated in the Atomic Act in FRS CR participation in monitoring the radiation situation, monitoring of routes and sites and establishing conditions for fire protection of nuclear installations. The Fire Rescue Service of the Czech Republic performs, within the scope of its competence, in the event of a radiation incident or emergency, provide the information of the affected population on measures to protect the population and prepares an off-site emergency plan.

The activities of the Fire Rescue Service Units during a radiation accident generally solves the Combat Order in separate methodological sheets. It is always necessary to notify the State Office for Nuclear Safety via the National Operating Information Centre on any radiation emergency.

Communication with the SÚJB Emergency Response Centre is performed in accordance with the contract concluded between the Ministry of the Interior-General Directorate of the Fire Rescue Service of the Czech Republic and the SÚJB.

Both competent regulatory bodies of the Czech Republic have similarly elaborate systems of legislative and administrative activities as well as their own inspection activities. In this respect, Regulators systematically monitor holders of permit for nuclear installation operation, irrespective of the operator. The Fire Rescue Service of the Czech Republic checks on compliance with fire regulations at a randomly selected nuclear power plant building. Any findings from the inspection are rectified as soon as possible. The Dukovany NPP and the Temelín NPP FRSU shall provide the Fire and Rescue Service of the Czech Republic with documents on the findings elimination and the Fire and Rescue Service of the Czech Republic shall subsequently issue a decision on the result of the inspection.

The SÚJB has included in its basic inspection plan regular inspections of the operation and maintenance of selected fire safety and ventilation systems. In 2023, an inspection of the fire protection process is newly included in the annual inspection plan. Within its competence, the SÚJB assesses design changes related to fire protection of nuclear installations and, in the case of modifications requiring SÚJB permit, the fire risk is included in the assessment. The periodic safety review must assess the compliance of the design with current legislation and recognised good practice at 10-year intervals and include, among other things, a reassessment of the fire risk.

As mentioned, the SÚJB assess modifications and changes of the nuclear installation design. The assessment focus on all systems of the installation design including fire protection systems. In case of negative finding, the SÚJB inform relevant authority. SÚJB fulfilled this possibility in case of the delay in implementation of replacing extinguishing systems with halon in the Dukovany NPP. The issue is currently subject to the Czech environmental authority’s assessment following the SÚJB application, as the change in extinguishing agent was forced by the implementation of measures to protect the ozone layer.

Detailed evaluation of fire systems is part of the process of ageing management and monitoring of the reliability and performance capability of the components of the safety systems. The results of this process are summarised in reports that demonstrate the ability of NPP to meet safety objectives by the permit holder. These reports are included in the annexes in the case of an application for further operating permit (LTO). The conclusions of the process are then presented in the Operational Safety Analysis Report.

5. REFERENCE

LIST OF ABBREVIATIONS

ASD	Air Sampling Detection
ASFE	Aerosol Stable Fire Extinguisher
CCF	Common Cause Failure
CCW	Circulating Cooling Water
CDF	Core Damage Fequency
CR	Control Room
ČVUT	Czech Technical University In Prague
DG	Dieselgenerator
DGS	Dieselgenerator Station
DiD	Defence In Depth
DTS	Distributed Temperature Sensing
EFD	Electrical Fire Detector
FC	Fire Compartment
FDF	Fuel Damage Frequency
FFS	Fresh Fuel Storage
FJFI ČVUT	Czech Technical Univesity, Faculty Of Nuclear And Physics Engineering
FPO	Fire Prevention Officer
FRS CR	Fire Rescue Service of the Czech Republic
FRSU	Fire Rescue Service Unit
FS	Fire Section
FSD	Fire Safety Device
GFE	Gas Fire Extinguisher
I&C	Instrumentation And Control System
IAEA 50-SG-D2	Safety Guide No. 50-SG-D2 (Rev. 1), Fire Protection In Nuclear Power Plants
IEC	The International Electrotechnical Commission
INPO	Institute Of Nuclear Power Operations
IRS	Incident Reporting System
ISFS	Interim Spent Fuel Storage
KID	Automatic Pressurized Fire Damper
LERF	Large Early Release Frequency
LTO	Long Term Operation
MPU	Main Production Unit
NAR	National Assessment Report
NPP	Nuclear Power Plant
OC	Operating Center
OSS	Operating Safety Systems
PFP	Preventing Fire Patrol
POS	Plant Operating State
PQP	Professionally Qualified Person
QP	Qualified Person
RA	Radioactive
RC Řež	Research Center In Řež
NRI Řež	Nuclear Research Institute Řež

RID	Règlement Concernant Le Transport International Ferroviaire Des Marchandises Dangereuses
RR	Research Reactor
RU	Reactor Unit
RW	Radioactive Waste
RWR	Radioactive Waste Repository
SE	Stable Extinguisher
SF	Spent Fuel
SFE	Spray Fire Extinguisher
SFS	Spent Fuel Storage
SS	Safety System
SSE	Stable Sprinkling Extinguisher
SÚJB	State Office For Nuclear Safety
TG	Turbogenerator
VDS	Videodetection System
VS	Ventilation System
WANO	World Association Of Nuclear Operators
WEC	Westinghouse Company
WENRA	Western European Nuclear Regulators Association

Decrees, related legislation and standards in the Czech Republic

Decrees

[1] Decree No. 329/2017 Coll. on the Requirements for the Nuclear Installation Design

[2] [Decree No. 162/2017 Coll. on the Requirements for Safety Assessment under the Atomic Act

[3] Decree No. 21/2017 Coll., on Assuring Nuclear Safety of Nuclear Installations

[4] Decree No. 358/2016 Coll. on the Requirements for Quality Assurance and Technical Safety and Assessment and Verification Of Conformity of Selected Equipment

[5] Decree No. 378/2016 Coll. on Siting of Nuclear Installations

[6] Decree No. 408/2016 Coll. on the Management System Requirements

[7] Decree No. 246/2001 Coll., on the Determination of Fire Safety Conditions and The Performance of State Fire Supervision (Decree on fire prevention)

[8] Decree No. 247/2001 Coll., on the Organisation and Activities of Fire Protection Units

[9] Decree No. 35/2007 Coll., on the Technical Conditions of Fire-Fighting Equipment

[10] Decree No. 23/2008 Coll., on the Technical Conditions of Fire Protection Of Buildings

[11] Decree No. 281/2001 Coll., implementing Section 9(3)(a) of Act No. 240/2000 Coll., on Crisis Management and on Amendments to Certain Acts (Crisis Act)

[12] Decree No. 328/2001 Coll., on Certain Details of the Integrated Rescue System

[13] Decree No. 380/2002 Coll., on the Preparation and Implementation of Population Protection Tasks

[14] Decree No. 498/2000 Coll., on Planning and Implementation of Economic Measures for Crisis Situations

[15] Decree No. 202/1999 Coll., on Determination Technical Conditions for Fire Doors, Smoke-Proof Doors and Smoke-Proof Fire Doors

[16] Decree No. 87/2000 Coll., on Determination Fire Safety Conditions for Welding and Heating of Bitumen in Fusible Vessels

[17] Decree No. 69/2014 Coll., on the Technical Conditions of Fire Protection Equipment

[18] Decree No. 34/2016 Coll., on Cleaning, Inspection and Revision of the Flue Pipe

[19] Decree No. 460/2021 Coll., on the Categorization of Buildings in Terms of Fire Safety and Protection of the Population

Government Regulation

[20] Government Regulation No. 172/2001 Coll., on the Implementation of the Fire Protection Act

[21] Government Regulation No. 462/2000 Coll., Implementing Section 27(8) and Section 28(5) of Act No. 240/2000 Coll., on Crisis Management and on Amendments to Certain Acts (Crisis Act)

[22] Government Regulation No. 352/2003 Coll., on the Assessment of The Medical Fitness of Employees of Fire Rescue Units of Companies and Members of Units of Voluntary Fire Rescue Services of Municipalities or Companies.

Overview of technical standards valid in the Czech Republic

[23] ČSN 73 0802 Fire safety in buildings (hereinafter referred to as "FSB") - Non-operational buildings

[24] ČSN 73 0804 FSB -Operational buildings

[25] CSN 73 0810 FSB -Common Provisions

[26] ČSN 73 0818 FSB -Obsession of the building by persons

[27] ČSN 73 0821 ed. 2 FSB - Fire performance of building structures; Part 5 Classes of reaction to fire according to Section 6

[28] ČSN 73 0822 Fire performance - Flame spread over the surface of building materials; Part 12 Design of stable extinguishing systems according to Section 21
[29] CSN 73 0831 FSB -Gathering spaces
[30] ČSN 73 0834 FSB -Changes to buildings
[31] CSN 73 0845 FSB -Warehouses
[32] ČSN 73 0848 FSB - Cable distribution
[33] ČSN 73 0863 Fire performance of materials - Determination of flame spread over the surface of building materials
[34] ČSN 73 0865 FSB - Assessment of dripping of materials from ceilings and roofs
[35] ČSN 73 0872 FSB -Protection of buildings against the spread of fire by ventilation equipment; Part 10 Determination of requirements in terms of flammability and combustibility according to § 17, § 18 and § 19
[36] ČSN 73 0873 FSB -Fire water supply
[37] ČSN 73 0875 FSB - Determination of conditions for the design of electrical fire alarm systems within a fire safety solution
[38] ČSN 65 0201 Flammable liquids - Operation, storage and handling areas
[39] ČSN 34 2710 Electrical fire detection systems - Design, installation, use, operation, inspection, servicing and maintenance; Part 2 Determination of fire risk and division of the building into fire sections according to Sections 3 to 5, Sections 10 to 14 and Annex 2
[40] ČSN 65 0201 Flammable liquids - Operation, storage and handling areas
[41] EN 1991-1-2 Eurocode 1: Loads on structures - Part 1, clause 1-2: General loads - Loads on structures subjected to the effects of fire; Part 4 Determination of the fire resistance of building structures according to Section 5, Section 9 and Section 14
[42] EN 13 501-1 +A1 Fire classification of construction products and structures of buildings - Part 1: Classification according to reaction to fire test results; roof sheathing according to Section 7
[43] EN 13 501-2 +A1 Fire classification of construction products and structures of buildings - Part 2: Classification according to fire resistance test results except for ventilation equipment
[44] EN 13 501-3 +A1 Fire classification of construction products and structures of buildings - Part 3: Classification according to fire resistance test results of products and components of common service installations: fire resistant pipes and fire dampers
[45] EN 13 501-5 +A1 Fire classification of construction products and structures of buildings - Part 5: Classification according to test results of roofs exposed to external fire; Part 7 Determination of requirements for chimneys according to Section 8
[46] ČSN 06 1008 Fire safety of thermal installations; Part 9 Determination of requirements for ventilation equipment according to Section 9
[47] EN 12845 +A2 Stable fighting systems - Sprinkler systems - Design, installation and maintenance; Part 13 Determination of requirements for structures with flammable liquids - Section 22 and Annex 7
[48] EN 3-7 +A1 Portable fire extinguishers - Part 7: Characteristics, extinguishing performance requirements and test methods
[49] EN 3-10 Portable fire extinguishers - Part 10: Provisions for the assessment of conformity of portable fire extinguishers according to EN 3-7
[50] EN 2 Fire classes
[51] EN 1127-1 Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concept and methodology
[52] EN 60079-10-1 Explosive atmospheres - Part 10-1: Determination of hazardous areas - Explosive gaseous atmospheres

International documents

[1] WENRA: Report Safety Reference Levels for Existing Reactors Revision 2020, 17th February 2021.

[2] WENRA: Report Safety Reference Levels for Existing Research Reactors, November 2020.

[3] WENRA: Report Waste and Spent Fuel Storage Safety Reference Levels, Report of Working Group on Waste and Decommissioning (WGWD), Version 2.2, April 2014.

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[5] WENRA WGWD: Report Decommissioning Safety Reference Levels - Version 2.2, 22 April 2015.

[6] Ad-hoc TPR II WG Report to WENRA - TPR II Technical Specification 21 June 2022/ Page 42

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[15] Safety of Research Reactors, Specific Safety Requirements, IAEA Safety Standard Series No. SSR-3, Vienna, Austria, 2016.

[16] Safety of Nuclear Fuel Cycle Facilities, Specific Safety Requirements, IAEA Safety Standard Series No. SSR-4, Vienna, Austria, 2017.

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[18] Operating Experience Feedback for Nuclear Installations, Specific Safety Guide, IAEA Safety Standards Series No. SSG-50, Vienna, Austria, 2018.

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APPENDICES

ČEZ, PLC, documents related to fire protection

[1] ČEZ_PP_0435 Fire protection of NPP, rev. 01, 2022

[2] ČEZ_ME_0919 Monitoring of Performance and Condition of Technological Systems and Equipment in NPP

[3] ČEZ_PP_0205 Operating Experience Feedback

[4] ČEZ_ME_072 Investigation of Severity 1, 2, 3 events and non-conformities

[5] MANAGER'S GUIDE the Temelín NPP Fire and Rescue Service Annual Plan of Inspection Activities the Temelín NPP Fire Rescue Service 2023

[6] COLLECTIVE. DÚP 369 Fire protection solutions in the Soviet design zone: fire protection technical report. Energoprojekt Prague, 1994.

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SCHEMATIC FIGURES OF NUCLEAR INSTALLATIONS REPORTED IN TPR II

A. Temelín NPP

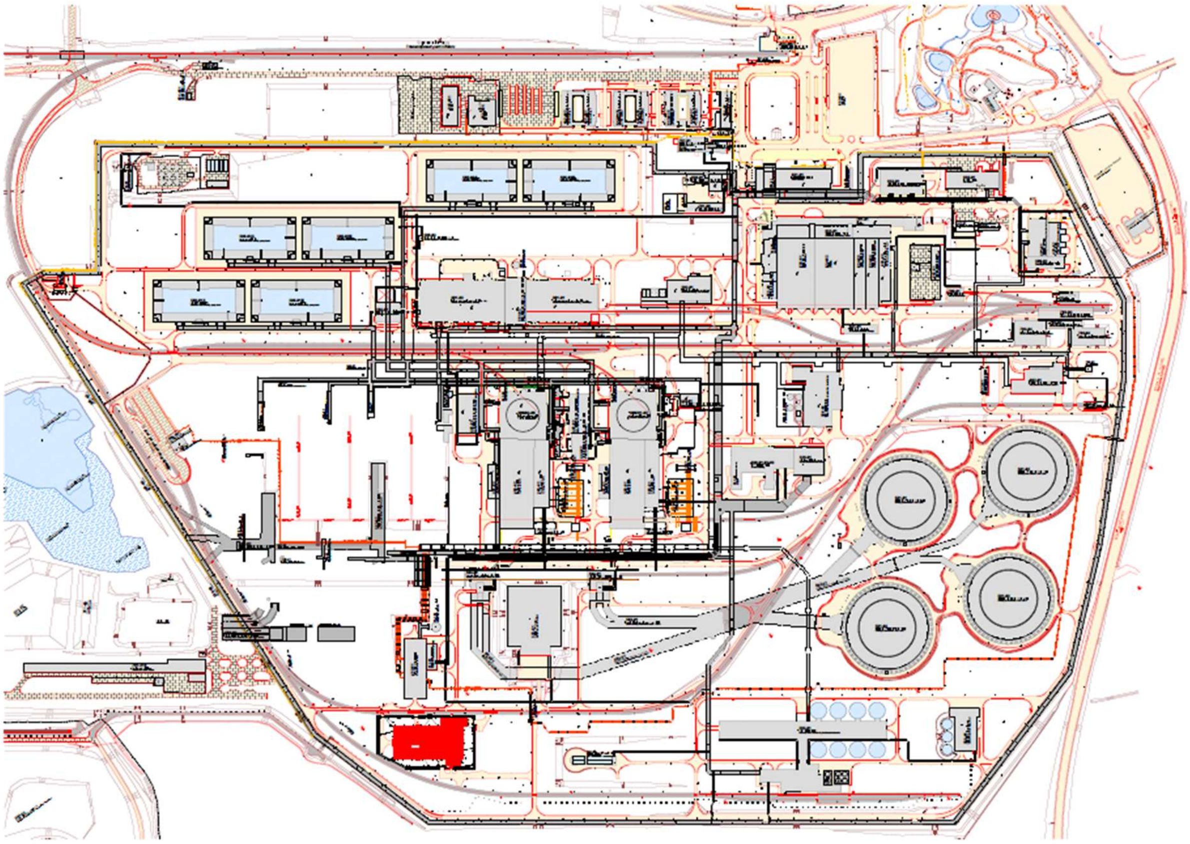

Fig. A1 NPP Buildings scheme in Temelín Site

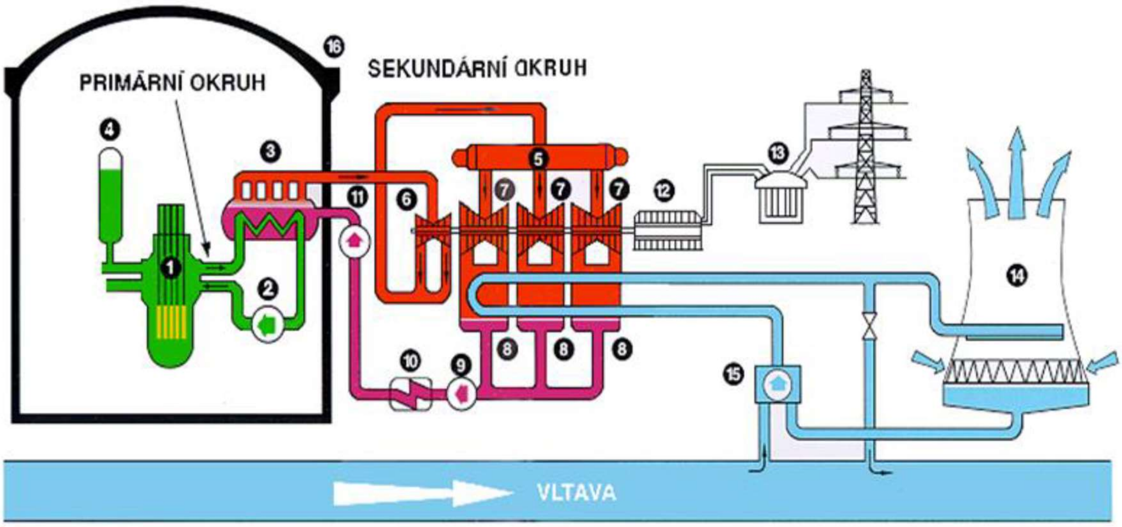

Fig. A2 General Layout of the Temelín NPP Reactor Unit

Legend: 1 – reactor, 2 – main circulation pumps, 3 – steam generator, 4 – pressurizer, 6 – HP turbine, 7 – LP turbine, 11 – feed water pump, 12 – generator, 13 – transformer, 14 – cooling tower, 15 – circulation cooling water pumping station, 16 – containment

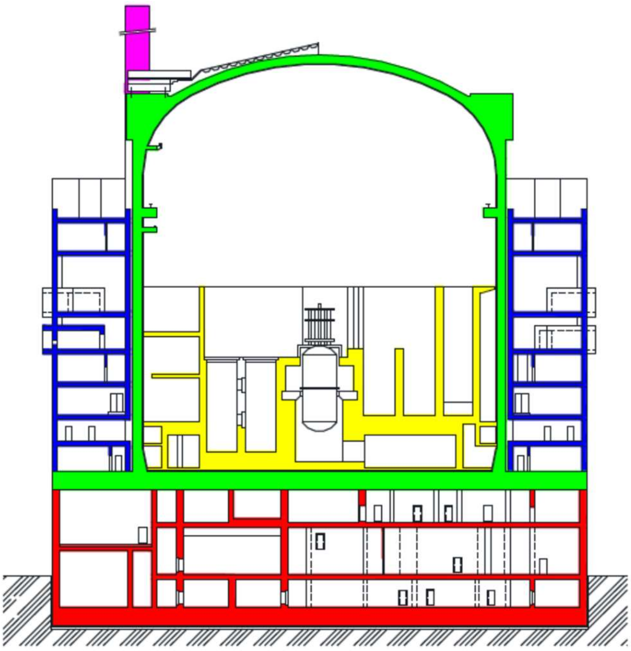

Fig. A3 Layout of the reactor building of the Temelín NPP

Basement, containment, hermetic compartment, enclosure, ventilation stack

B. Dukovany NPP

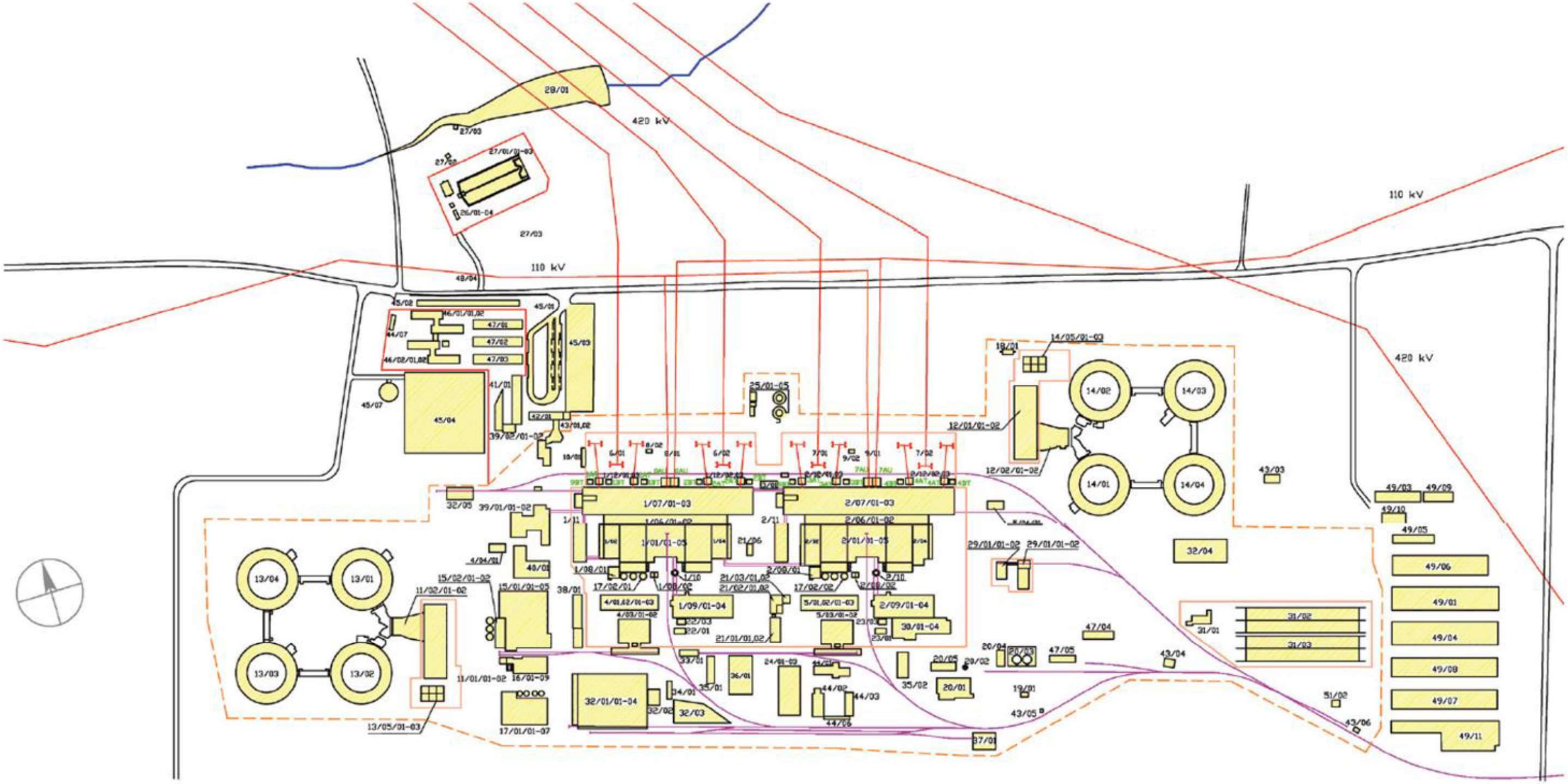

Fig. B1 General Layout of the Dukovany NPP site

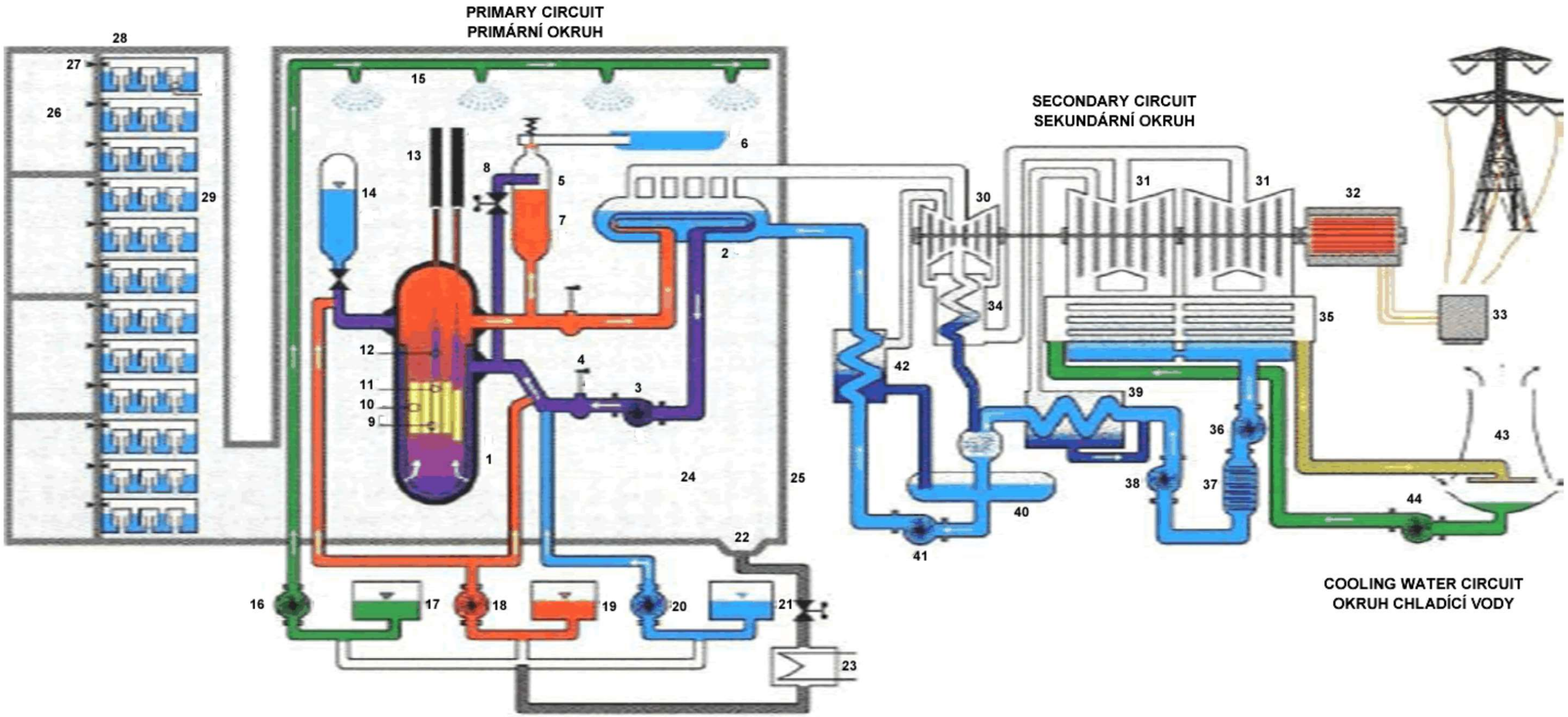

Fig. B2 General Layout of the Dukovany NPP Reactor Unit

Legend:

1 – reactor, 2 – steam generator, 3 – main circulation pump, 4 – main isolation valve, 5 - pressurizer, 9 ÷ 12 – core, 14 – hydroaccumulator, 15 – spray system, 16, 17 – spray system, 18, 19 – low-pressure safety injection system, 20, 21 – high-pressure safety injection system, 22 – suction from the hermetic zone, 23 – spray system cooler, 24, 25 – confainment, 26, 27, 28, 29 –bubbler tower, 30 – high-pressure part of the turbine, 31 – lowpressure part of the turbine, 32 – electric generator, 33 – transformer, 40 – feed water tank, 41 – auxiliary feed water pump, 42 – high-pressure regeneration, 43 – cooling tower for circulation water, 44 – water pumps

C. Research Reactor LVR-15

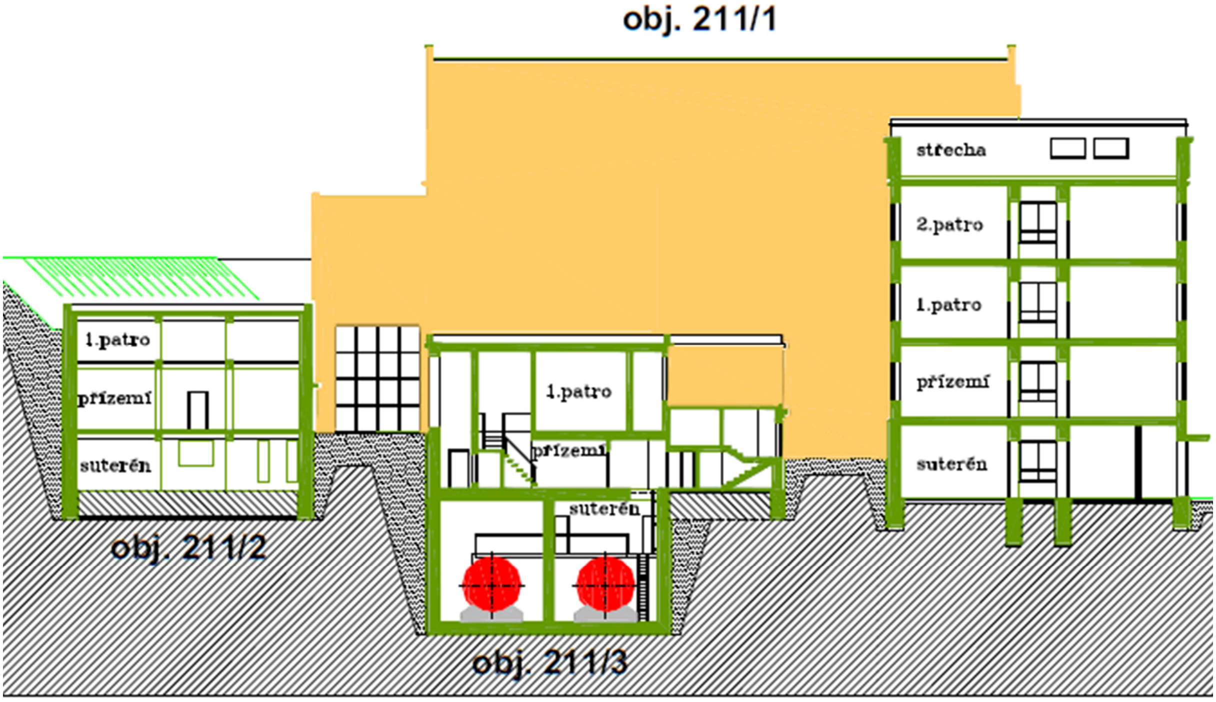

Fig.C1 Layout of LVR-15 Reactor Building

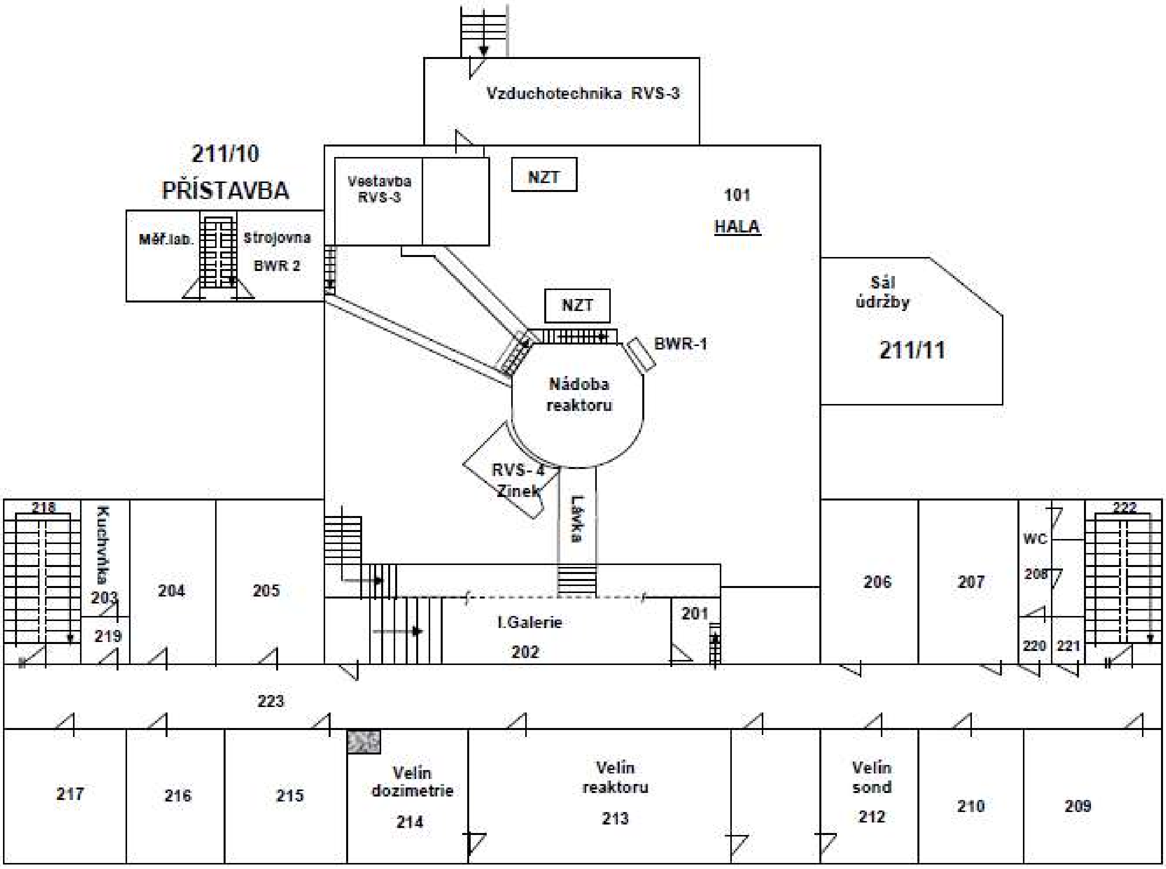

Fig. C2 LVR-15 reactor hall

Přístavba	Annex building
Měř. Lab.	Measuring/testing laboratory
Strojovna	Machinery hall
Vestavba	Internals
Vzduchotechnika	Ventilation
Hala	Hall
Nádoba reaktoru	Reactor vessel
Kuchyňka	Kitchen
Galerie	Gallery
Lávka	Footbridge
Sál údržby	Maintenance hall
Velín dozimetrie	Dosimetry control room
Velín reaktoru	Operators control room
Velín sond	Probe control room

D. Spent Fuel Storages in the Sites of NPP

Fig. D 4 Spent fuel storage Temelín NPP

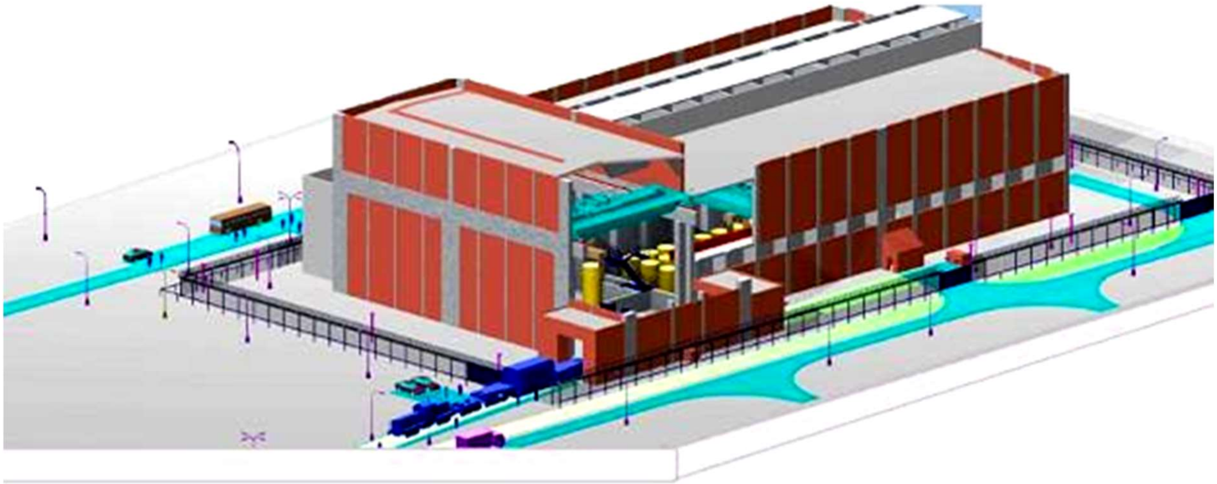

Fig. D 2 Spent Fuel Storage Dukovany NPP

Fig. D 3 Interim Spent Fuel Storage Dukovany NPP

SF Storage Hall

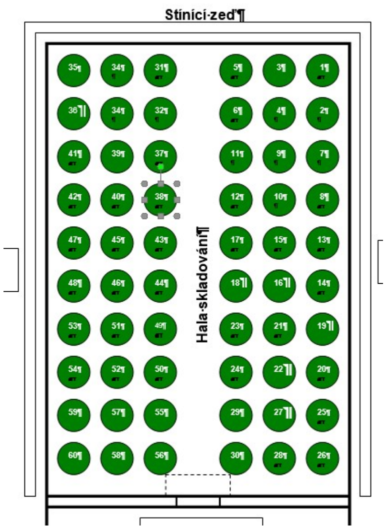

Fig. D 4Transport and Storage Package CASTOR

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