ENSREG TPR-II

NATIONAL ASSESSMENT REPORT ON FIRE PROTECTION OF NUCLEAR INSTALLATIONS

TÜRKİYE - 2023

0. Preamble / Foreword

This report is prepared in accordance with the European Nuclear Safety Regulators Group (ENSREG) requirements for performing comprehensive risk and safety assessment in the light of the Fukushima accident.

Türkiye has currently no nuclear power plants in operation. Negotiations to build a NPP at Akkuyu site in Türkiye started with the Russian Federation in February 2010 and concluded with an Intergovernmental Agreement based on a Build-Own-Operate model. The Agreement was signed on May 12, 2010. Relying on the agreement, "Akkuyu Nuclear Power Plant Electricity Generation Joint-Stock Company (Akkuyu Project Company (APC), soon changed his title to Akkuyu Nuclear JSC), responsible for the construction, operation and decommissioning of 4 units Water-Water Energetic Reactor, VVER, of each to produce 1200 MW power, was established. The nuclear regulatory body of Türkiye, Turkish Atomic Energy Authority (TAEK), recognized APC as the owner (hereafter referred to as License) on February 7, 2011.

The Akkuyu Site on the Mediterranean coast was granted a site license for building a Nuclear Power Plant (NPP) in 1976. In 2011, this site was allocated to Licensee as specified in the Intergovernmental Agreement. Licensee started site investigations in Akkuyu for updating the site characteristics and parameters according to the national procedures laid out in the Decree on Licensing of Nuclear Installations [1]. Upon completion of updating the information on the characteristics and parameters of the site, Site Parameters Report is presented by the Licensee to TAEK. Site Parameters Report also includes the results of detailed site investigations performed at the NPP site and the precise values of the project parameters. On February 9, 2017 project parameters are approved by Turkish Atomic Energy Authority in accordance with the relevant articles of the Decree

On March 2, 2017, Licensee applied for construction license of Akkuyu NPP Unit 1. As the results of review and assessment of the application, limited work permit was given to Licensee for Akkuyu NPP Unit 1 at the 146th meeting of Atomic Energy Commission on October 19, 2017.

With the limiting work permit, the Licensee is allowed to proceed with the installation of structural foundations of reactor and environmental safety related buildings, facilities, and construction of other structures, systems and components in accordance with the Decree.

On April 2, 2018, construction license is granted for the Akkuyu NPP Unit 1 based on the application of the Licensee by the decision number 148/2 of the Atomic Energy Commission on March 30, 2018, in accordance with the Law on Turkish Atomic Energy Authority and related regulations.

According to the Decree on Licensing of Nuclear Installations, operation and construction licenses for nuclear facilities can be issued based on general and specific conditions. So, there are also general and specific conditions as integral part of the construction license of Akkuyu NPP Unit 1. The license conditions are mainly related to

the detailed design of the plant issues to be finalized during the operation license phase. The license conditions are being fulfilled by the Licensee and foreseen to be fully fulfilled before operation license. Therefore, some of the topics mentioned in this report will be detailed before operation phase of the plant.

On June 22, 2018, Licensee applied for construction license of Akkuyu NPP Unit 2. As the results of review and assessment of the application, limited work permit was given to Licensee for Akkuyu NPP Unit 2 at the 149th meeting of Atomic Energy Commission on November 30, 2018.

The Topical Peer Review Report of Türkiye, which included evaluations of the regulatory body, contains necessary information in conformity with the ENSREG Guidance for the content and format of National Reports.

1. General Information

1.1. Nuclear installations identification

Name: Akkuyu Nuclear Power Plant (under construction)

Akkuyu Nuclear Power Plant is one of nuclear power plants under construction of worldwide and the first nuclear power plant in Türkiye. The Akkuyu NPP site is located in southern Türkiye, on the shores of the Mediterranean Sea, in the Büyükeceli region, with a radius of approximately 3 kilometers. The main reasons for selection of the Akkuyu site are following; the plant should be located on a coast due to cooling water and land transportation suitability and the Mediterranean Sea coast is one of the safest regions due to earthquake risk and geopolitical advantages. Then, it will be operated Akkuyu Nuclear JSC. The first VVER-1200 reactor was installed at Novovoronezh II Unit 6 and Akkuyu NPP almost identical with Novovoronezh II Unit 6. There are four power units with VVER-1200 reactors type and V-509 reactor unit with a total capacity of 4800 MW (each unit produces 1200 MW). VVER is a thermal neutron reactor with pressurized water used both as coolant and moderator. Its design provides for a two-circuit steam generating system with four cooling loops, main circulation pump, pressurizer, relief and emergency valves on steam pipes, and accumulator tanks of the emergency core cooling system (ECCS).

After application for the first unit construction license to the regulatory body of Türkiye, first concrete poured for Unit 1 in 2018. Subsequently, the construction works of other units started respectively (Unit 2 in 2019, Unit 3 in 2020 and Unit 4 in 2021). The fresh nuclear fuel for unit 1 was delivered to the site in 2023. Therefore, with the arrival of fresh fuel, Akkuyu was officially recognized as a nuclear facility. The commissioning preparations for Akkuyu NPP Unit 1 are ongoing during preparation of this report.

Name: Istanbul Technical University (ITU) TRIGA MARK II Training and Research Reactor

- Licensee: Istanbul Technical University (ITU)
- Type of reactor: ITU TRIGA MARK II

Training and Research Reactor (ITU TRIGA) is a water-cooled, swimming pool type research reactor, which uses uranium/zirconium hydride fuel elements in a circular grid array. A ring of graphite, which serves to reflect neutrons back into the core, surrounds the reactor core. The core is situated near the bottom of a 6 meters deep water-filled tank, and a concrete biological shield, which acts as a radiation shield and structural support, surrounds the tank. The reactor is licensed by the former Nuclear Regulatory Authority, Turkish Atomic Energy Authority (TAEK) to operate at a maximum steady state power of 250 kW and can be pulsed up to a peak power of about 1000 MW.

1.1.1. Qualifying nuclear installations

There is only one for each type (NPP and RR) of installation so there is no need for qualification.

1.1.2. National selection of installations for TPR II and justification (brief summary of)

ITU TRIGA is the only operational research reactor in Türkiye. It was selected to ensure fire safety by applying the principles of graded approach and defense in depth, in accordance with the research reactor facility, the safety classes of the structure, system, and components (SSCs). This selection also contributes to the evaluation of fire safety and protection at the ITU TRIGA through international independent assessment, which is used for self-assessment for the facility management.

TENMAK owns a five MW Pool Type Reactor, TR2, in Istanbul campus of Nuclear Energy Research Institute. However, relocation of this campus in Cekmece, Istanbul is on the table for final decision, which will require decommissioning of the research reactor. That is why TR-2 research reactor is not selected within the scope of this report.

Other selected facility for NAR is Akkuyu NPP, which is the only nuclear facility and still under construction.

1.1.3. Key parameters per installation

AKKUYU NPP

The major areas of the AKKUYU Nuclear Power Plant application is production of electricity from nuclear fresh fuel,

· The main characteristics of the AKKUYU NPP are as follows:

- Reactor thermal power (in nominal conditions) = 3300 MW
- Active electrical power (each unit) = 1200 MW
- Parameters of primary and secondary circuits:
- coolant pressure at the core outlet, MPa (abs.) 16.2
- coolant temperature at reactor inlet / outlet, 297.2 / 328.8
- reactor coolant flow, m3/h 87460
- steam pressure in steam generators, MPa (abs.) 7.0
- steam flow from each steam generator, t/h 1652
- feed water temperature, 225o
- Maximum fresh fuel enrichment for U-235, % = 4.95
- Spent fuel burn-up (average / maximum in unloaded fuel assemblies), MW×d/kgU = 49.4 / 54.3
- Refueling interval, months = 18
- Operation time of fuel in the reactor core (in steady state fuel cycle), years 4.5
- Number of fuel assemblies in the reactor core 163 163 10 Number of reactor control rod assemblies = 94

- Service lifetime of reactor facility equipment, years = 60
- Load (capacity) factor = 0.93
- Volume of ECCS hydraulic accumulators, m3:
- first stage = 200
- second stage = 960
- third stage = 720
- Capacity of passive heat removal system, MW 64 76.8
- Reactor containment structures:
- height (primary / secondary), m = 61.7 / 65.4
- inner diameter (primary / secondary), m = 44 / 50.8
- upper part wall thickness (primary / secondary), m = 1.2 / 0.5
- Aircraft crash impacts for reactor building, tons:
- design basis event = 20
- beyond design basis event = 400

Akkuyu NPP units use direct flow system of service (cooling) water supply with single circulation of Mediterranean Sea water as the ultimate heat sink. At a cooling water temperature of 25 ºC the cooling water flow to the turbine condensers of each unit of the NPP is about 254000 m3/h. Moderator H2O (as a coolant and moderator) The AKKUYU NPP facility was designed as a complex of various buildings, operationally connected (Fig.1). Additionally, four unit have been under construction at the same time.

ITU TRIGA MARK II

The ITU TRIGA has a number of different irradiation channels including a central irradiation channel, pneumatic transfer system, a thermal column, three beam ports, two sample holding (dummy) fuel elements for special in-core irradiations for experiments.

- Thermal and electrical net power: ITU TRIGA is authorized to operate the reactor at a steady-state power level up to a maximum of 250 kilowatts (thermal) and to pulse the reactor in accordance with the limitations in the Operational Limits and Conditions.
- Year of construction license (for reactors under construction): N/A
- Year of the operating license or first criticality (for operating reactors): The first criticality at 1979. The renewed operating license at 2006.
- Scheduled end of operation date (if any): There is no regulation in the national framework and management decision about scheduled end of operation date.

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

During the preparation of NAR, updated information was gathered from Licensees and completed by Regulatory comments.

1.2. National regulatory framework

Issued on May 5, 2023, Fire Protection of Nuclear Facilities is used in Turkiye for Nuclear Facilities. It has just been issued and recently started to be used because there was a need to establish a new regulation only dedicated to nuclear facilities. Previously used "Regulation on Fire Protection of Buildings" was issued in 2007 by Ministry of Environment, Urbanization and Climate Change had lots of inconsistencies, gaps and obstacles for licensing an NPP. Some major provisions are:

"*The fire cabins shall be present on every floor and not more than 30 meters far from each other in every section separated with fire walls.*"
"*At least, by means of capacity and numbers, half of the fire escape shall open directly to the outside.*"
"*Maximum three floors which are higher than the specified height shall be constructed as fire compartments in the non-residential buildings higher than 21.50 meters and…*"

These and other minor provisions would make it impossible to grant a license to any nuclear facility therefore these reasons were put forward in the mutual negotiations with Ministry of Environment, Urbanization and Climate Change and an exemption was requested for nuclear facilities.

Finally, this regulation was revised in 2018 authorizing NDK as containing the following provision:

"*Fire precautions to be applied in structures, buildings and facilities used by the Turkish Armed Forces and in training and exercise areas are determined by the Ministry of National Defense according to the characteristics of the structure, taking into account the provisions of this Regulation; Fire safety measures regarding nuclear facilities are determined by the Nuclear Regulatory Authority (NDK).*"

Upon this authorization, studies on preparing a regulation only for nuclear facilities have been accelerated. As a result of long negotiations, several technical visits to NPPs in Europe, and discussions with counterparts, the draft regulation was reduced in volume, cleared of technical details and the regulation "Fire Protection of Nuclear Facilities" issued in 2023 to specify only general lines.

By issuing the Regulation, the way to prepare guidelines and putting them into force is now open. These studies are now ongoing. Using the experience will be gained from the field by inspections and feedbacks, harmonizing them with international standards to Turkish specific circumstances, a series of national guidelines per licensing stage starting from commissioning are planned to be established.

1.2.1. National regulatory requirements and standards

NDK developed mostly technology neutral regulations by adopting IAEA requirements. Türkiye's rapid growth and Government's ambition to include nuclear energy in the energy mix led to a very aggressive schedule for the implementation of the

nuclear programme. Engaging with more than one different vendors for different projects raised difficulties to develop the regulatory basis. To be able to apply most recent requirements in the area of nuclear safety, NDK developed a licensing approach in parallel with the methods suggested in INSAG-26 document utilizing applicable IAEA, vendor country and third-party requirements to fill the gaps in current Turkish regulations.

1.2.2. Implementation/Application of international standards and guidance

The Regulation on Authorization of Nuclear Facilities defines the regulatory documents list, which consists of legislation of the Republic of Türkiye on radiation protection, safety, security and nuclear assurance, the requirements document of the International Atomic Energy Authority and the national and international standards that the Authority considers necessary to be complied with. The regulatory document list may also include regulatory documents of other countries or international organizations that have been recommended by the Licensee or deemed appropriate by the Authority.

2. Fire Safety Analyses

2.1. Nuclear power plants

The main fire safety analyses based on mostly deterministic approach with defense in depth but also probabilistic approach taken into account when fire safety analysis performed in AKKUYU NPP.

The experience of NPP operation predicts events where fires can lead to the occurrence of initial initiating events requiring the transition of the power unit to a safe state, as well as a large number of secondary consequences related to the failure of equipment necessary for shutdown and cooling of the unit.

This section presents the results of the deterministic (qualitative) analysis of the impact of NPP fires on the safety of Akkuyu NPP. Secondary consequences of fires affecting the operation of the unit, both due to the occurrence of initial accident events and due to dependent failures of safety system elements are described. More detailed qualitative and quantitative analyses of the impact of fires on NPP safety are carried out as part of the probabilistic fire safety analysis.

The scope of the analysis includes rooms with elements of technological, support and control safety systems (SS), equipment, power and control cables, chambers of the reactor control and protection system (RCS), chambers of the normal operating systems (NOS), rooms with malfunctions of elements, equipment or damage to cables that can lead to automatic operation of the unit shutdown systems or shutdown of the unit by the operator, and rooms with significant fire load (NE cables, oil).

The main objective of the deterministic analysis of the impact of fire on NPP safety is to assess the adequacy of decisions made in the design, including layout solutions, fire protection measures, systems and facilities required for safe shutdown.

The following basic design solutions have been taken into account during the fire safety analysis:

- Physical and functional separation of equipment.
- Provision of protective measures for facilities:
- Effective use of passive systems
- Categorization of initiating events from 1 to 5

Category 1 includes initiating events (IEs) with transient processes without leakage from the primary circuit that lead to reactor shutdown and require automatic activation of safety systems (SS), i.e. activation of the reactor emergency protection system (REPS) and other SS that perform heat removal from the reactor plant through the secondary circuit: emergency cooling and steam generator systems (EPS), passive heat removal systems (PHRS);

Category 2 includes ICs with primary circuit leaks through the KD UPS. This requires shutting down the IC reactor, maintaining the primary circuit coolant reserve and

performing heat removal functions through the secondary circuit. The emergency and programmed primary coolant cooling, containment pool cooling (CAPR) system, and the emergency high-pressure injection system perform the first function. The second function is performed through the second circuit using normal heat removal systems (SNOT) or emergency heat removal systems (ATS or SPOT).

Category 3 includes ICs that require unplanned shutdown of the power unit using standard tools for equipment repairs or replacement of SB and SNE cables.

Category 4 includes false alarms of the SAZ leading to reactor shutdown and requiring the performance of heat removal functions from the unit through the second circuit using normal heat removal (SNOT) or emergency heat removal (ETR or ETS) systems;

Category 5 includes ICs in category 1 above where the SB channel(s) are faulty leading to automatic shutdown of the reactor and requiring automatic activation of SAZ, ETS or SPOT.

The deterministic analysis is based on a systematic assessment of the consequences of fires in each of the fire zones in terms of their impact on NPP safety. Fire zones are rooms (groups of rooms) completely isolated by fire barriers with the required fire resistance. When performing deterministic analysis, all fire zones are divided into the following groups:

- Fire zones in which a fire with fire-induced failures in a separate channel of the safety systems leads to an initiating event
- Fire zones where a fire leads to an initiating event without fire-induced failures in the safety systems
- Fire zones where the fire does not result in an initiating event but where failures in safety systems are possible
- Fire zones where the fire does not affect safety-critical systems.

2.1.2. Key assumptions and methodologies

Fire points analyzed in the Akkuyu NPP project are;

- Safety systems (SS) rooms
- Reactor control and protection system (RCS) facilities
- Inside the primary containment vessel (PCV)
- In the inter-core space (ICS)
- In the turbine hall
- In diesel generator buildings
- In block control panel (BCP) or standby control panel (RCP) rooms
- In systems of normal operation (NO) facilities

In the basic analysis of deterministic analysis of passive fire protection of redundant fire-sensitive systems (elements) important for safety, where safe shutdown and cooling

of the reactor unit is ensured, it was concluded that the solutions implemented in the project, including the use of the passive heat removal system (PHRS) without dependent failures due to fires, provide deep protection against the impact of fires on the safety of Akkuyu NPP.

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

The Akkuyu NPP fire safety system includes organizational and technical measures such as fire prevention systems and fire protection systems.

The design level of fire safety is ensured by fulfillment of general safety criteria in all modes of operation (construction, operation, and protection periods) and in case of accidents;

- Ensuring safe shutdown in design modes, normal operation, in case of violation of normal operating conditions and in case of design accidents
- Minimizing radioactive releases to the environment in case of fire and ensuring that the releases do not exceed the limits set by regulations
- Ensuring the safety of personnel in case of fire
- Minimization of economic and material damage caused by fire

2.1.4. Main results / dominant events (licensee´s experience)

Akkuyu NPP is the first experience for Akkuyu Nuclear JSC so there is not a licensee experience so far.

2.1.5. Periodic review and management of changes

Akkuyu NPP is still under construction so this header is not applicable.

2.1.6. Licensee's experience of fire safety analyses

Akkuyu NPP is the first experience for Akkuyu Nuclear JSC so there is not a licensee experience so far.

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

From the Regulatory point of view, this report is evaluated consistent especially considering facility's licensing stage. As part of regulatory oversight at the construction site, conducted inspections cover only fire brigade station. This on site fire brigade is considered the main strength for the facility with their highly trained staff.

On the other hand, fire safety unit of NPP is asked to prepare a comprehensive fire safety program covering all the aspects of fire safety on the site including design considerations and active & passive measures will be taken amongst the site.

2.2. Research reactors

Due to the fact thermal power of the ITU TRIGA below to the 1000 kW, it is considered not to have any significant additional risk. Therefore, engineering assessment and expert opinion will be the main methodology of the analysis. These are two of the main methodologies that will be used to perform the fire hazard analysis for the ITU TRIGA reactor.

Engineering assessment involves the use of engineering principles to identify and assess the fire hazards in the reactor. Expert opinion involves the input of experts in fire safety to help identify and assess the fire hazards in the ITU TRIGA. The analysis will be also discussing the limitations of the engineering assessment and expert opinion methodologies. These methodologies are not perfect, and there is always some uncertainty involved in predicting the likelihood of a fire occurring. The analysis will be also discussing how these limitations can be addressed. Among the factor discussed in fire hazard analysis, will also include sequential disaster approach for the seismic risk of Istanbul where is located in the heart of North Anatolian Fault Zone.

2.2.2. Key assumptions and methodologies

The main fire safety objective for ITU TRIGA is to prevent fires from occurring for ensuring the safety of personnel, public and protect the environment, and prevent potential radiological consequences.

It also includes

- Limiting the damage caused by a fire,
- Protecting the reactor core from fire damage,
- Maintaining continuity of operations.

In line with the new Regulation (Fire Protection of Nuclear Facilities), the fire hazard analysis for ITU TRIGA will be consistent for comprehensive and systematic approach to identifying and assessing the most possible and specific fire hazards in the reactor with the different operational states such as steady state, pulsing and other states, which are described in the Safety Analysis Report. The Safety Analysis Report and its appendix also includes primary fire safety analysis for reactor core and other SSCs. The fire hazard analysis will also be discussing the limitations of the methodologies used and how these limitations can be addressed.

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

The focus of the new Regulation is regard to the “Fire Safety Program” for the facility. This program should be consisting of:

1) Application of fire safety "Defense in Depth" approach and its' justification;
   a) Prevention measures fire from starting,
   b) Detection and extinguish quickly,
   c) Prevention spread.
2) Methodologies (deterministic etc.) and its selection justification for fire hazard analysis, and the periodic updating of the analysis,
3) The organizational chart of fire safety management for fire prevention, fire protection, firefighting and mitigatory measures,
4) Definition of the facility and the other stakeholder organization(s) and responsibilities of the fire safety person, the facility firefighting team, and the local firefighting team, and the methods of assignment and the minimum qualifications for these personnel,
5) Analysis of the facility and local firefighting capabilities,
6) The procedures should to be followed during fires specific to different types of fires and with the different operational states, approved and new experiments in the reactors,
7) The management of modifications and changes on the fire safety, in line with the ITU TRIGA safety modification methodology,
8) Procedures containing administrative measures that limit the inventory of flammable materials and potential ignition sources in certain areas of the facility in order to keep the likelihood of fires at a minimum level, for the impact of plant control of combustible materials and ignition source,
9) Periodic, internal and external and/or after event inspections, testing and maintenance of fire protection systems, for appropriate inspection, maintenance and testing of all fire protection measures (passive and active, including manual firefighting equipment)
10) Methodologies for table-top and/or full-scale exercises,
11) Training program for the facility personnel and local fire brigade personnel,
12) Integration of management system activities relating to fire safety and fitting fire safety objectives in line with the safety policy of the ITU TRIGA, for to ensure that fire safety is one of integral part of the overall safety culture and management framework.
13) Integration of "Fire Safety Program" and its appendix that are affected Periodic Safety Reviews (PSR) of ITU TRIGA.
14) Review and updating emergency response procedures in the event of a fire, including the role of the incident command team, communication procedures, and coordination with external authorities on emergency or disaster managements.

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

There is no direct experience related to deterministic or probabilistic fire safety analysis as required by the new regulations. However, there is limited experience in conducting safety analyses during the construction phase, operational, and ageing management process and occupational health and safety analysis regulation within the facility.

2.2.5. Periodic review and management of changes

In line with the draft version of Regulation on Fire Safety in Nuclear Facilities, "Fire Safety Protocol between ITU and the Istanbul Metropolitan Municipality" was signed by representatives' of ITU Rectorate and Istanbul Metropolitan Municipality in January, 2023 before to the Regulation come into force.

The purpose of this protocol is to determine the roles of the actors in a network to be created to prevent and effectively prevent fires that may occur in the ITU TRIGA MARK II Training and Research Reactor facility and the nuclear and radioactive materials located in this facility, to prevent fires from endangering nuclear safety and prevent radiological consequences, to organize the fire protection organization of the facility, to provide training and exercises to the relevant persons, and to provide direct response during a fire. The protocol defines responsibilities of the ITU and Istanbul Metropolitan Municipality in terms of fire safety. Under this protocol, ITU will prepare fire protection program to submit for approval by NDK.

For operational feedback at the facility level; under the "Fire Safety Protocol" between the ITU and the Istanbul Metropolitan Municipality is defined specific arrangement for stakeholder communication and feedback experience with the facility and Istanbul Fire Department. This arrangement is allowed to sharing operational feedback to the local and municipality level firefighter organization and the other relevant stakeholders. This feedback process is also required for the facility's fire protection program, which will be approved by NDK.

2.2.6. Licensee's experience of fire safety analyses

Before to the Regulation on Fire Safety in Nuclear Facilities is to be in force, in line with the previous "Regulation on Fire Protection of Buildings" and international fire safety standards, the fire consultant conducted the fire hazard analysis of all areas of the ITU TRIGA facility and determined the requirements to identify the potential fire hazards and the necessary fire protection measures. The consultant also examined the Energy Institute building in this direction and informed to facility management both during this process and afterwards in 2022. The system is also designed to comply with the relevant Turkish and International Standards, which are TS EN 15004-1 and TS ISO 14520. These standards provide requirements for the design, installation, and maintenance of fire protection systems.

The reasons and legal provisions for the installation of a fire protection system in a facility that contains radioactive materials in accordance with the sub-articles of "Regulation on Fire Protection of Buildings";

- Article 17, which states, "The design includes measures to prevent fire and explosion, especially in auxiliary systems containing radioactive materials, and is supported by protective systems."

- Article 98 and the 2nd sub-article, which states that "In volumes where the extinguishing effect of water is not considered sufficient or where substances that can react with water are located, stored and produced, a suitable type of extinguishing system is installed."
- Article 141, which states that "If there is a use that requires additional exits or the rearrangement of escape stairs in the building, it is obligatory for the building owner or the owners of the flats to have additional exits or escape stairs built for the whole building, considering the whole building."
- Article 148, which states that "The followings shall be complied with for the number and width of escape routes and escape stairs in existing buildings."
- Article 151, which states that "The followings shall be complied with for the location and arrangement of escape stair wells in existing buildings." and the provisions specified in the sub-articles.

Article 157, which states that "The doors of escape stairs in existing buildings must be at least 60 minutes fire resistant and smoke-tight if the building height is less than 30.50 m, and at least 90 minutes fire resistant and smoke-tight in buildings 30.50 m and above. The width of escape route doors must not be less than 70 cm and the height must not be less than 190 cm."

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

In line with the new regulation on Fire Safety in Nuclear Facilities, changes to the facility over its lifetime should be reflected in the fire hazard analysis. The fire hazard analysis should be reviewed and updated following any plant modification that could affect fire safety, periodically that is also specified by NDK.

3. Fire Protection Concept and Its Implementation

3.1. Fire prevention

AKKUYU NPP

In general, fire prevention concept is carried out as follows in

- Preventing the creation of a flammable environment;
- Preventing ignition sources in a flammable environment.

In order to prevent the creation of a flammable environment, the project foresees the restriction of the use of flammable substances and materials.

Non-combustible materials (firestop chemicals) are mainly used in the construction of infill openings, wall, ceiling and floor coverings as well as roof insulation, transportation and packaging containers. Non-combustible materials are also used for heat and sound insulation, sealing of cable and pipeline penetrations, ventilation ducts, etc. To reduce the fire hazard of combustible materials, if they are used in building structures, they are coated with fire retardant compounds.

The fire hazard of electrical cables is reduced by using fire resistant and flame retardant cables. Lubrication, control and cooling systems are also designed to use mainly non-flammable and non-flammable materials.

Process equipment and pipelines containing flammable media are isolated from ignition sources by making them hermetically sealed and earthquake resistant. If it is not possible to seal equipment containing flammable gases, the rooms in which they are located are equipped with a system to maintain the gas concentration in that room at a level below the lower concentration limit.

Gas-containing equipment is equipped with automatic emergency shutdown and (or) gas venting (displacement) systems. To prevent the generation of ignition sources in the combustible environment, the project uses machines, mechanisms, equipment and devices that do not generate ignition sources during their operation. Electrical equipment corresponds to fire hazard and explosive zones, explosive mixture group and category in accordance with the requirements of the Rules for Electrical Installation (PUE). Technological processes and equipment meet the requirements of electrical internal safety. Buildings, structures and equipment are equipped with lightning protection devices. The heating temperature of the surfaces of machines, mechanisms, equipment, devices that may come into contact with combustible media is lower than the auto-ignition temperature of this medium.

The active fire prevention process at Akkuyu NPP facilities is mainly carried out as follows:

- Limiting the use of flammable materials and substances in the design, construction and operation of NPPs,

- Use of non-combustible and/or flame retardant materials, including cable products,

- taking into account and controlling the presence of materials that may cause negative secondary consequences as a result of fire;

- Ensuring safe gas concentration in NPP facilities and equipment against explosion and fire by using ventilation systems;

-Observance of safety rules for hydrogen production by water electrolysis during hydrogen production;

- Ensuring high tightness of systems containing flammable and combustible liquids and gases, protection of these systems from destruction by external influences and control of their system status;

- Protection against external and internal potentially fire hazardous events (lightning protection, short circuit protection, etc.);

- Application of explosion-proof types of equipment;

- Layout and volume planning solutions for fire containment within the fire zone;

- Development of appropriate arrangement solutions of fire barriers in buildings and structures; All electrical equipment (including lighting fixtures and electrical installation products) is selected taking into account environmental conditions, including classes of fire and explosion hazardous areas; in explosion hazardous areas, appropriate equipment with explosion protection level, type of protection, groups and temperature classes is used. Electrical equipment located in fire hazard areas is selected with a degree of protection not lower than IP54. Electrical equipment located in electrical rooms has a degree of protection not lower than IP31. Electrical equipment located in production rooms where it may be contaminated with radioactive materials is selected with a degree of protection not lower than IP54.

ITU TRIGA MARK-II RR

The Safety Analysis Report and its appendix is also included primary fire safety analysis for reactor core and other SSCs.

In line with the former and current version of "Regulation on Fire Protection of Buildings" and international fire safety standards at, construction and operation years, this document includes the main fire safety objectives which it is possible to significantly reduce the risk of fires occurring in the ITU TRIGA and to minimize the consequences of any fires which minimize the risk of fire initiation during operating, service, and maintenance of the facility.

3.1.1. Design considerations and prevention means

The Safety Analysis Report and its appendix also include primary fire safety analysis for reactor core and other SSCs.
In line with the former and current version of "Regulation on Fire Protection of Buildings" and international fire safety standards at, construction and operation years, this document includes the main fire safety objectives which it is possible to significantly reduce the risk of fires occurring in the ITU TRIGA and to minimize the consequences of any fires which minimize the risk of fire initiation during operating, service, and maintenance of the facility. The reactor core and other SSCs are typically constructed from non-combustible materials, such as metal, concrete, or glass, to replace any combustible materials.

3.1.2. Overview of arrangements for management and control of fire load and ignition sources

One of the most important procedures to prevent fires at ITU TRIGA is the control and minimization of combustible materials and ignition sources. The reactor core and other SSCs (Structures, Systems, and Components) are typically constructed from non-combustible materials, such as metal, concrete, or glass, to replace any combustible materials. Additionally, strict control measures are in place to limit the presence of combustible materials within the reactor hall and the control room. Procedures have been established to control the delivery, storage, handling, transport, and usage of combustible solids, liquids, and gases in accordance with reactor experiments and other facility activities. To further enhance fire prevention precautions, specific zones have been created to cater to specific needs, particularly for the neutron activation analysis and the gamma counting laboratories. For instance, flammable liquids and chemicals, such as solvents, acids, or base materials, are not permanently stored within the reactor area. Instead, there is a dedicated storage room located outside the reactor facility.

Ignition sources are controlled by using safety procedures, such as keeping open flames away from combustible materials, using electrical equipment in a safe manner, and welding machine only in designated area in the reactor hall. However, limit of temporary wiring uses should be established through administrative procedure. By each sample to be irradiated in the ITU TRIGA requires evaluation by radiation protection officer before irradiation approval.

In addition, there are effective housekeeping (daily and on duties cleaning etc.) procedure to reduce the presence of flammable materials (such as package, paper, disposable gloves etc.) in and around the reactor area. Smoking in Türkiye is banned in government offices, such as university, there is established strict smoking policies and designated smoking (including e-cigarette) areas not only reactor hall but also any places where is no allowance smoking in the Istanbul Technical University excluding designated open areas.

There is only one specific method for identifying combustible materials within the facility, and it is based on expert guidance from the Istanbul Fire Department.

3.1.3 Licensee's experience of the implementation of the fire prevention

As part of the protocol with the Istanbul Fire Department, ITU TRIGA holds the responsibility to review the fire protection plan and draw upon its technical and organizational experience in collaboration with stakeholders. This experience reviewing process will be implemented on an annual basis. The process is also including chapter on experience subchapter with the Istanbul Fire Department review on implementation measures of the ITU TRIGA and also other related activities.

3.1.3.1. Overview of strengths and weaknesses

ITU TRIGA has several strengths;

- ITU TRIGA Reactor is low-power inherently safe reactor for nuclear safety aspects and its consequences,
- ITU TRIGA has protocol with Istanbul Fire Department,
- ITU TRIGA Management accepted to participate EU TPR II international mission to gain objective review and suggestions which are coming from international aspects and best practices other similar users for the fire safety status of the facility,
- ITU TRIGA Management has awareness and responsibility on the fire safety.

ITU TRIGA has also several weaknesses;

- Perception on there is no fire risk
- ITU TRUGA Reactor and its SSC's are getting older and particularly on the upgrading, the system related to fire safety on the construction design and materials, for adapting new requirements on fire safety.
- ITU TRIGA operational organization deals with also other legal requirements,
- Lack of personnel and economic resources.

3.1.3.2. Lessons learned from events, reviews fire safety related missions, etc.

There is no any fire event and fire safety related international mission at the reactor. However, review and stakeholder communication process is also included lessons learned from Fire Department experience related to chemical facility and/or critical infrastructure.

3.1.3.3. Overview of actions and implementation status

In accordance with the new regulation (Fire Protection of Nuclear Facilities), ITU TRIGA has to require and submit an action plan for the fire safety program by the end of November 2023. This step is first and necessary to ensure that ITU TRIGA's fire safety analysis aligns with the regulatory requirements and standards established by NDK.

Also in accordance with the new regulation, after several discussions the licensee has prepared fire safety program for Akkuyu NPP, and about to submit it alongside with the documents of commissioning license application.

Upon finalizing the pre assessment of this document, site inspections are planned to be initiated. Using the outputs of these inspections, important information will be gained. Conducted inspections cover only fire brigade building and personnel so far, which is considered licensee's main strength on the site.

3.2. Active fire protection

AKKUYU NPP

Active fire protection systems are comprehensively used in Akkuyu NPP.

The fire protection monitoring and control system (FPMS) is designed for;

Automatic earliest detection of fire in buildings with the appearance of smoke on emergency evacuation routes or fire hazard;

Detection of the fire point at the points of permanent duty personnel and providing information about the presence of fire with its transfer to the fire brigade;

Automatic and remote control of technological equipment of fire extinguishing systems (fine spray water, water, gas) at the facilities provided by the project and signaling of location transfer information;

Control of process equipment operating parameters and generation of information about the extinguishing process; Control and management of smoke exhaust systems and creation of air pressure in stairwells; Control and management of fire dampers;

Generation of fire signals to the technical means of the control center for shutting down ventilation systems;

Automatic activation of the notification and evacuation control system in case of fire;

Automatic control of circuits and diagnostics of their technical means, including fire detectors.

ITU TRIGA MARK-II RR

- The fire detection system consists of smoke detectors in the reactor hall, the control room, and other auxiliary laboratories, personnel rooms, etc. The system also includes alarm panels with audible and visual alarms.
- The fire suppression system in the control room is an FM-200 system. This system suppresses fires by reducing oxygen levels or interfering with the combustion process. The system also includes an alarm panel with audible and visual alarms.
- Firefighting Equipment: Foam-based and dry chemical fire extinguishers, fire hoses, are considered active fire protection equipment.

- Emergency Lighting and Signage for ensure that escape routes are well-lit and clearly marked to the reactor and control room safe evacuation during a fire emergency.

3.2.1. Fire detection and alarm provisions

AKKUYU NPP

The fire detection system is part of the fire safety control system and is designed for automatic early detection of fire in fire hazardous premises and the appearance of smoke in evacuation routes.

The fire detection system is installed in all buildings, structures and installations in accordance with SP 5.13130.2009, with the exception of buildings of category B4 and D, buildings with wet processes, ventilation rooms (not serving buildings of categories A and B) and stairwells. In addition, a fire detection system must be installed in all listed buildings of categories A, B, B1-B4.

Automatic fire alarm systems ensure that the personnel on duty are informed about the detection of malfunctions of communication lines and technical means of the fire alarm system.

Fire alarm systems provide light and sound signals when a fire occurs in the fire alarm controller, notification devices (scoreboards) in the room of the staff on duty.

A "Caution" signal is generated when a fire detector is activated. In case of fire and at least two fire detectors are activated in the area, a "Fire" signal is generated and control commands are given.

One fire alarm loop is installed in the rooms of normal working systems, two fire alarm loops connected to two controllers are installed in the rooms of security systems. Thus, the occurrence of fire in the rooms of the security system is monitored by two sets of technical means and at least four detectors.

As a rule, addressable analog fire detectors are used as an automatic fire detection system:

- Smoke (optical) or combined (smoke- and heat-responsive) fire detectors (cable rooms, computer rooms, switchgear rooms, control panels, administrative rooms, etc.)
- Thermal fire detectors (in rooms with high levels of differentials, oil, diesel fuel, petroleum products, etc.);
- Differential fire detectors with intrinsically safe design (for rooms where explosive materials are placed);
- Linear fire detectors - for rooms with high ceilings;
- Manual fire detectors on escape routes, where they can be operated;
- Smoke detectors resistant to airflows for installation in the supply air ducts of control panels;
-Thermo-cables are used in cable rooms of the hermetic zone.

The principle of operation of smoke (optical) fire detectors is based on the emission of light LED in the smoke chamber of the detector and its reflection photodiode. If smoke particles appear in the room, part of the light is reflected from them and falls on the photodiode, the level of the electrical signal at the output increases and the presence of smoke is detected.

ITU TRIGA MARK-II RR

In accordance with regulations, there is a fire detection and alarm system with 46 sensors and 3 conventional fire alarm buttons. The system can rapidly detect smoke or fire in the ITU TRIGA. However, it is not directly connected to the reactor control console and cannot automatically shut down the console. The system is visually and audibly monitored by three different security points on a 24/7 basis with supported emergency power supply. This system was established in 2016. The service provider checks the operability of the fire detection and alarm system at least three times a year, with inspection, maintenance, and testing of the fire detection sensors and buttons. In addition, another fire detection and alarm system covers all rooms, labs, and other areas in the Energy Institute. This system will be put into operation with all functions in October 2023.

After a fire hazard analysis with the support of the Fire Department, in line with the Fire Safety Protocol between ITU and the Istanbul Metropolitan Municipality, a new fire detection and alarm system will be planned for the laboratory. This could involve setting up a new system or upgrading the existing system with appropriate adaptations.

3.2.2. Fire suppression provisions

AKKUYU NPP

At Akkuyu NPP, pulverized or fine atomized water (water mist / fine spray system) is used as extinguishing agent for cable structures, power transformers, facilities and equipment containing flammable liquids.

Among all fire extinguishing agents, water mist has the widest application in fire extinguishing installations. NPPs traditionally use water drip units, which have proven to be effective and reliable. These units are also envisaged in the Akkuyu NPP project.

The Akkuyu NPP project envisages sprinkler-type water installations in the cartridge filter chambers of the block desalination unit (hereinafter BWU) and in the filter hall of chemical water treatment systems.

Automatic gas fire extinguishing units are used for fire protection of buildings with electronic and electrical equipment.

Dry pipe automatic water fire extinguishing units are designed for the following systems:

- For fire extinguishing of cable rooms of normal working systems,
- Fire extinguishing of buildings with oil-filled equipment,
- Extinguishing transformers in the substation,

These installations are used where there is no danger of flooding and there are no water drainage problems.

In the Akkuyu NPP project, automatic fire extinguishing sprinkler systems are implemented in the UMX building in the rooms with cartridge filters and in the filter hall of chemical water treatment systems, as well as in the 00UKX, 00USV, 00UYC buildings.

The system of automatic fine spray water units is designed for fire protection of normal working rooms and security systems in the main buildings of Akkuyu NPP, where the application of traditional drainage systems causes flooding of rooms and difficulties with water drainage.

Automatic gas fire extinguishing units (AGFU) are designed to detect and extinguish fire, these systems are used in:

- In switchboard rooms;
- In rooms with electronic and electrical equipment;
- In rooms with electronic and electrical equipment where personnel are constantly present;
- In the double-decked spaces of the above-mentioned rooms where electrical cables are located;
- In the rooms of backup diesel power plants (PDPP).

In permanently staffed facilities, gas fire extinguishing units are operated in manual start mode to prevent false triggering.

In the project, FK-5-1-12 is used as a gas extinguishing agent for main buildings and structures.

According to manufacturer data FK-5-1-12:

- Environmentally safe,
- Zero ozone has destructive potential,
- It has low toxicity and is safe for both the environment and humans.

ITU TRIGA MARK-II RR

In line with the "Regulation on Fire Protection of Buildings" and international fire safety standards; there are fixed, mobile, automated, and manual extinguishing systems are be installed at the reactor building with graded approach firefighting strategy for each area of the reactor area identified as important to safety such as proximity of control console, SSCs, access and exit routes, and other locations important to safety, etc. These systems also provide adequate coverage of areas of the research reactor

relevant to safety. However, it is not justified by the fire hazard analysis for these systems.

- Two fire hose cabinet (manual-fixed),
- Eleven dry chemical powder extinguishers (manual-mobile),
- Three CO2 extinguisher (manual-mobile),
- One FM-200 Fire Suppression System (fixed- automated).

There is no loop for fire hydrant outside building and the internal standpipes of the ITU TRIGA relevant to safety. The service provider checks the operability at least three times a year, with inspection, maintenance, refilling and testing of the extinguishing systems.

3.2.3. Administrative and organizational fire protection issues

AKKUYU NPP

1. Fire Safety Department.

The Fire Safety Service of the Company is organized to carry out control and supervisory fire prevention measures, fire prevention works, fire extinguishing and accident elimination at the industrial site, buildings and structures of Akkuyu NPP.

The Fire Safety Service is an independent structural subdivision of the Company and reports to the First Deputy General Director - NPP under Construction Director.

The abbreviated name of the structural subdivision is FSS.

The FSS is established, reorganized or dissolved by order of the Company.

It is headed by the Service Director, who is appointed and dismissed by the decision of the Managing Director of the Company.

The main objectives of the Fire Safety Service are as follows:

1.1 Realization of the Company's technical policy in terms of development and implementation of fire safety measures ensuring reduction of fire (ignition) risks at Akkuyu NPP facilities.
1.2 Organizing the development and implementation of a set of measures in the field of fire safety aimed at minimization of fire (ignition) risks at all stages of the life cycle of Akkuyu NPP and effective extinguishing of them in case of their occurrence.
1.3 Develop and implement a set of measures in the field of fire safety aimed at timely detection and extinguishing of fires, safe shutdown of reactor units, and evacuation of people and prevention of situations that may cause significant economic damage in case of fire at the Akkuyu NPP facilities.
1.4 To organize the development and implementation of a set of measures aimed at reducing damage caused by the impact of fire at the Akkuyu NPP facilities.
1.5 Provision of NPP fire protection organization and operational support,

1.6 Carrying out fire inspection and other control and inspection functions to ensure fire safety and fire prevention work.
1.7 Interaction with the supervisory bodies and emergency services of the Republic of Turkiye on fire safety issues.

AKKUYU NPP Fire Brigade Unit

One of the structural subdivisions of the Fire Safety Department is the Fire Department (FD). The FD is established, reorganized or liquidated by order of the Company.

It is headed by the Chief of the Fire Department, who is appointed and dismissed by the decision of the General Manager of the Company or other authorized person.

The main objectives of the Fire Department are as follows:

- Ensuring the organization of extinguishing of fires at the Akkuyu NPP facilities and conducting emergency rescue operations related to them,
- Establishment of a set of measures aimed at ensuring the readiness of fire-fighting equipment and means to extinguish fires at all stages of the life cycle of Akkuyu NPP and organization of their implementation.
- Establishment and organization of implementation of measures to ensure technically correct operation of specialized fire-fighting machinery and equipment,
- Planning and organizing the purchase of special firefighting equipment, supplies and spare parts.
- Carry out the audit of the services provided by the Fire Brigade Unit at different locations, and implement the necessary measures to eliminate the identified nonconformities.
- Organize the development of operational and service documentation related to fire fighting at Akkuyu NPP facilities.
- Organize round-the-clock reception and processing of reports on fires at Akkuyu NPP and beyond.
- Establishing and ensuring the implementation of a set of preventive and operational measures aimed at minimizing the risk of fire outbreaks,
- Establishment and implementation of fire safety measures aimed at timely detection and extinguishing of fires, safe shutdown of reactor units, evacuation of people and prevention of situations that could cause significant economic damage in case of fire at Akkuyu NPP facilities,
- Ensuring that the level of education and training of firefighters of the Fire Department complies with the requirements of the regulatory documents of the Republic of Türkiye and the Local Normative Regulations of the Company.

Fire Safety Unit

The Fire Safety Unit is a structural subdivision of the Fire Safety Department of the Company and reports to the Fire Safety Unit Chief.

The abbreviated name of the Department is Fire Safety Department (FSD).

The Fire Safety Department is established, reorganized and dissolved by order of the Company.

The FSD is headed by the Unit Manager, who is appointed and dismissed by the decision of the General Manager of the Company.

The main objectives of the SPSD are as follows:

- Implementation of the Company's technical policy in terms of development and implementation of fire protection measures at Akkuyu NPP facilities,
- In the field of fire safety, ensuring the organization of the development and implementation of measures aimed at minimizing fire risks and ensuring effective extinguishing in case of fire at the facilities of Akkuyu NPP at all stages of its life cycle,
- Establish and implement fire safety measures aimed at timely detection and extinguishing of fires, safe shutdown of reactor units, and evacuation of people and prevention of situations that may cause significant economic damage in case of fire at Akkuyu NPP facilities.
- To organize the development and implementation of measures aimed at reducing damage caused by fire impact at Akkuyu NPP facilities.

Firefighting capacities and numbers at AKKUYU NPP:

The Fire Station includes the following structures:

- 10 car administrative and social fire brigade building (01UYP);
- Separately located fire brigade garage for 4 fire trucks;
- Foam material storage;
- 1 vehicle fuel station;
- 2 car fire station (90VXA);
- 2 car fire station (00UYA);
- 50-m3 capacity underground water tank.
- Training and sports areas include the following:
- outdoor running track with fire brigade training tower;
- heat and smoke training room;
- basketball and volleyball court;
- fire lane (outdoor area) for psychological training of firefighters;
- simulator for extinguishing electrical installations with voltage up to 10 kV
- FSS management - 1 person;
- Fire Department - 130 people;

- Engineering and technical staff - 38 people.
- According to the project, the number of fire trucks is 16:
- Vehicles:
- Fire Truck 7 units.
- Pump and hose fire truck 2 pcs.
- Foam extinguishing fire truck 1 unit.
- Total: 10 units.

ITU TRIGA MARK-II RR

ITU TRIGA should prepare and submit a Fire Safety Program in line with the new regulation, and implement a program specific to the facility, for aiming at ensuring, maintaining and monitoring fire safety at the facility, through a team of competent personnel.

The fire safety program of ITU TRIGA should be revised using graded approach that considers the type of low risk facility and the fire classes of the structures;

- To conducting a fire hazard analysis with the expert opinion and engineering approach methodologies. The methodology on fire hazard analysis to ensure that their fire safety measures are adequate and demonstrate that the fire protection measures in place are capable of preventing or controlling a fire and protecting people and property from harm (it is covered and justified by legal agreement with the Fire Safety Protocol between ITU and the Istanbul Metropolitan Municipality);
- To explaining the duties and responsibilities of the personnel or unit responsible for fire safety and the fire response team, the methods of assignment, and the minimum qualifications and quantities of this personnel and the organizational chart of fire fighting in line with the hazard analysis and its requirements (it is covered and justified by legal agreement with the Fire Safety Protocol between ITU and the Istanbul Metropolitan Municipality);
- Procedures which are including communication and intervention flow charts, to be followed during fires specific to different types of fires or different operating conditions (it is covered and justified by legal agreement with the Fire Safety Protocol between ITU and the Istanbul Metropolitan Municipality);
- Procedures containing administrative measures that restrict the inventory of flammable materials and potential ignition sources in certain areas of the facility, aimed at keeping the likelihood of fires at a minimum level (it is being prepared);
- Procedures on the regular inspection, testing, maintenance and repair of fire protection systems (it is being revised in line with the regulation) ;
- Information on access and escape routes and on the use of firefighting signs;
- Procedure on training, exercise and drills (it is covered and justified by legal agreement with the Fire Safety Protocol between ITU and the Istanbul Metropolitan Municipality);

3.3. Passive fire protection

AKKUYU NPP

In accordance with the concept of defense in depth, fire protection is usually achieved through the high quality and reliability of SSCs (systems and components), the environmental adequacy of those SSCs (systems and components), the application of the principles of redundancy and diversity, and the provision of physical separation, segregation and appropriate barriers and other defense approaches.

3.3.1. Prevention of fire spreading (barriers)

The Akkuyu NPP project applies the principle of fire localization, which assumes that the fire resistance of surrounding structures located in the fire zone ensures the localization of the fire until the fire load is completely removed (without taking into account the effect of fire extinguishing agents on the fire). Furthermore, the possibility of fire spread to other fire zones through fire ventilation systems, cable and pipeline crossings, common drainage systems, interconnected power grid and other common communication lines is prevented.

Fire prevention is performed through the use of ventilation systems to ensure explosion and fire safe concentration of gases contained in NPP equipment and facilities.

To ensure personnel safety, the project includes smoke-free stairwells and elevator shafts, as well as smoke ventilation systems for smoke evacuation from corridors during a fire.
The fire protection system of fire zones includes, among other things, technical equipment and appurtenances of fire zone boundaries, i.e. their structures surrounding the fire zone boundaries (walls, ceilings), including doors, hatches, ventilation valves, communication gaps.

Fire dampers installed at fire zone boundaries, in addition to the electrical actuator, a repeated thermal and mechanical actuator.

ITU TRIGA MARK-II RR

This requirement has not yet been applied or analyzed technically in the ITU TRIGA.

3.3.2. Ventilation systems

AKKUYU NPP

In the reactor compartment design of the Akkuyu NPP, the mirror layout is implemented, which ensures symmetrical arrangement of the chambers of different

channels of the safety system, separated from each other by a fire-resistant wall of not less than REI 150 (150 minutes). There are no exposed connections through gaps, cable, ventilation, pipeline and other passages through this wall.

Structural fire protection of cable boxes, ducts and other equipment of fire zones is accepted with a fire resistance limit not less than REI 90. At the same time, the supporting structures of the boxes have a fire resistance limit not lower than R 90.

Taking into account the layout of the NPP industrial site adopted by the Project, the layout is similar to the reference NPP-2 (RPPP buildings, pumping stations buildings, backup control panel building), where the buildings containing the safety systems are spatially separated from each other by significant distances, and in the reactor compartment building, symmetrical arrangement of different safety system channels and rooms separated from each other by a fire protection wall is implemented.

In addition, the rooms are equipped with self-closing, airtight doors with a fire resistance limit of not less than 90 minutes and fire-retardant dampers of ventilation systems. Cable, pipe and ventilation passages are designed to prevent the ingress of air from other rooms and the transfer of toxic products of combustion to neighboring rooms.

All rooms of the main NPP buildings containing safety-critical equipment and cables are insulated with fire-resistant barriers. These barriers include walls and floors of building structures, passageways and active localization elements (doors equipped with self-closing mechanisms, fire-retardant dampers in ventilation ducts). The fire resistance of the enclosing elements separating different ducts is more than 1.5 hours.

In this way, it ensures serviceability under the thermal influence of fire in all conditions of successful isolation of emergency rooms (without taking into account the active fire extinguishing systems in them) and in many cases - regardless of the isolation of these rooms and without taking into account the fire extinguishing systems in them.

Fire zoning eliminates the possibility of fire spreading from one fire zone to other fire zones not only through surrounding structures, but also through common ventilation, drainage systems and other communication links.

The fire protection monitoring and control system ensures the generation of fire signals for the shutdown of ventilation systems.

Fire ventilation is part of the technical tools of the Fire Protection Control and Management System (FPMS).

The following technical tools of the Fire Protection Control and Management System are provided for each NPP power unit:

- Control and management of stairwell air supply and smoke exhaust system, smoke ventilation systems;
- Control and management of fire retardant dampers and smoke exhaust dampers;
- control actions on the control and management means of normal operation ventilation systems;

- Provides the function of signaling to close the safety ventilation system.

To ensure the safe evacuation of people in case of fire, a smoke ventilation system in stairwells and shafts is also included in the project.

ITU TRIGA MARK-II RR

This requirement has not yet been applied or analyzed technically in the ITU TRIGA. This requirement should be assessed with together service provider, contractor and Fire Istanbul Fire Department.

3.4. Licensee's experience of the implementation of the fire protection concept

The licensee JSC Akkuyu Nuclear is a subsidiary of Rosatom State Corporation. When implementing the fire protection concept, the experience of Rosenergoatom Concern, a member of the Electric Power Division of the Rosatom State Corporation, the largest generation company in Russia and the 2nd largest in the world in terms of nuclear generation capacity, was taken into account. A total of 37 power units operate at 11 NPPs in Russia.

Russian NPPs are operated in a reliable and safe manner, as confirmed by the results of regular inspections by both independent authorities (Rostekhnadzor) and international organizations (World Association of Nuclear Operators (WANO), etc.). Since 1998, not a single safety violation classified above Level 1 on the INES International Scale has been recorded at Russian NPPs

Currently, OSART (Operational Safety Review Team) missions of the International Atomic Energy Agency (IAEA) have not been conducted at Akkuyu NPP. A number of activities are being carried out to prepare for the IAEA Pre-OSART expert mission.

The general designer of Akkuyu NPP is JSC Atomenergoproekt, a joint design institute that designs nuclear power plants in Russia and abroad. Over the entire history of its existence or with their participation, Atomenergoproekt specialists have developed about 120 designs of power units of nuclear power plants with various types of reactors. The company has developed designs for most NPPs in Russia, Eastern Europe and the Commonwealth of Independent States.

Atomenergoproekt is the overall designer of Bushehr NPP in Iran, Kudankulam NPP in India and Akkuyu NPP in Turkiye. When implementing the fire protection concept at Akkuyu NPP, JSC Atomenergoproekt took into account its many years of experience in NPP design and construction.

There is no fire event or fire safety related international mission at the ITU TRIGA Reactor. However, before enforcing new regulations in line with the "Regulation on Fire Protection of Buildings" review and stakeholder communication process, lessons learned experience coming from Fire Department experience related to chemical facility and/or critical infrastructure fire cases are also included.

3.5. Regulator's assessment of the fire protection concept and conclusions

From a regulatory point of view, given fire protection concept above seems quite adequate keeping in mind that NPP is still under construction and Licensee is establishing regulatory documents before commissioning. On the other hand, TRIGA RR has low thermal power and when to use a graded approach here; awareness level is considerably high amongst the staff.

3.6. Conclusions on the adequacy of the fire protection concept and its implementation

For the assessment of implementation, there has been no clear opportunity to conduct fire walk downs on any of sites.

4. Overall Assessment and General Conclusions

We are on the verge of initiating too much works alongside the sites and it is too early to approach a final idea.

5. References to the NAR

There is not any reference used while preparing this report.