European Nuclear Safety Regulators Group

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'Fire Protection'
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National Presentation of ROMANIA

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Nuclear installations addressed in the Romanian NAR					
Name	Licensee	Type of reactor / installation	Power output	Year of first operation	Scheduled shutdown
Cernavoda NPP Unit 1	National Company Nuclearelectrica (SNN)	Pressurized heavy-water reactor (PHWR) – CANDU 6	Design net capacity: 650 MW(e)	1996	N/A
Cernavoda NPP Unit 2	National Company Nuclearelectrica (SNN)	Pressurized heavy-water reactor (PHWR) – CANDU 6	Design net capacity: 650 MW(e)	2007	N/A
Cernavoda Intermediate Dry Spent Fuel Storage Facility (IDSFS)	National Company Nuclearelectrica (SNN)	Intermediate Dry Spent Fuel Storage Facility, naturally air-cooled	N/A	2003	N/A
Cernavoda Solid Radioactive Waste Interim Storage Facility	National Company Nuclearelectrica (SNN)	Solid Radioactive Waste Interim Storage Facility for medium and lowe level waste	N/A	1998	N/A
TRIGA research reactor	Institute for Nuclear Research (RATEN - ICN)	Dual core pool type TRIGA reactor	TRIGA SSR (Steady State Reactor) - 14 MW	1979	N/A
Nuclear Fuel Fabrication Plant	National Company Nuclearelectrica (SNN)	Natural uranium nuclear fuel fabrication plant	N/A	1983	N/A

TS 01.1 & 01.2

- CNCAN has specific regulations on fire protection for nuclear power plants – NSN-09 (Regulation on the protection of nuclear power plants against internal fires and explosions). This regulation is under revision to extend its scope to all types of nuclear installations.
- NSN-09 requirements on fire protection for NPPs cover:

- defence in depth
- fire protection program
- fire hazard analysis
- fire prevention
- fire detection, alarm and extinguishing
- limiting the spread and effects of fires
- separation
- ventilation
- radiological hazards in case of fire
- considerations regarding seismic qualification
- fire protection during construction and commissioning
- fire protection during operation
- organization of fire fighting intervention
- personnel training and qualification
- fire protection during decommissioning
- licensing basis documentation relevant for fire protection.

TS 01.1 & 01.2

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- Requirements on the protection against external fires are established in the regulation NSN-06 (Nuclear safety requirements on the protection of nuclear installations against external events of natural origin). This regulation applies to all nuclear installations and will be revised to extend its scope to cover also the protection against human induced external events.
- The fire protection of all types of nuclear installations has been addressed through the requirements in the regulation NMC-10 (Specific requirements for the quality management systems applied to the operation of nuclear installations), regulations on safety analyses and evaluations (NSN-24 - Regulation on deterministic nuclear safety analysis for nuclear installations ; NSN-08 – Regulation on probabilistic safety assessment for nuclear power plants) and guides on safety analysis reports (for NPPs, for research reactors and for nuclear fuel fabrication plants).

TS 01.1 & 01.2

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- The regulation NSN-07 (Nuclear safety requirements on the response to transients, accident management and on-site emergency preparedness and response for NPPs) includes provisions applicable for the response to all transients, accidents and emergencies, including events caused by fires and explosions and events that may have fires and explosions as a consequence.
- Starting with 2023, compliance with the applicable WENRA Reference Levels and the applicable IAEA Safety Standards is required, for all nuclear installations, by the provisions of NSN-22 - Regulation on the licensing of the nuclear installations (the regulation was initially issued 2019 and was supplemented in 2023).
- In addition to the specific nuclear regulations issued by CNCAN, all licensees implement also the provisions of the general national legislation on fire protection.

TS 01.1 & 01.2

- Inspections on fire protection at nuclear installations are performed by CNCAN (National Commission for Nuclear Activities Control), for verifying compliance with CNCAN specific regulations and license conditions.
- Inspections on fire protection are also performed by the representatives of the Inspectorates for Emergency Situations, for verifying compliance with the provisions of the general national legislation on fire protection.
- Inspections by insurers are also performed at the nuclear power plant and the nuclear fuel fabrication plant.

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

- The following fire safety analyses have been performed for Cernavoda NPP Units 1 and 2:
  - Fire Hazard Analyses - FHA (deterministic) – last revisions in 2023;
  - Fire Safe Shutdown Analysis - FSSA (deterministic) – last revisions in 2020;
  - Fire Probabilistic Safety Assessment, as part of PSA Level 1 and Level 2 studies for Cernavoda NPP – Fire PSA (probabilistic) – last revisions in 2021.
- The scope of the above-mentioned fire safety analyses covers all the areas with systems, structures and components (SSC) important to nuclear safety (reactor buildings, nuclear services buildings, other nuclear buildings, balance of plant buildings) and all the different operational states (full-power operation and shutdown states). Detailed plant walk-downs have been performed for each of the fire safety analyses and for their updating.

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

Fire Hazard Analysis - FHA (deterministic)

- A single random fire is assumed at any time and location within the plant.
- The scenarios analyzed in the FHA are bounding scenarios, as the most conservative assumptions have been used with regard to the heat load density in the rooms / areas and to the extent of the damage cause by fires to the safety related SSC. The most penalizing scenarios are fire in cable spreading rooms and in the main control room and adjacent areas.
- No human actions are credited. Fire suppression systems are not credited.
- The simultaneous occurrence of a DBF (Design Basis Fire) with another design basis accident with a low probability of occurrence was not taken into account.
- Combinations of fire events and earthquake events have not been considered in the analysis, because the design of the plant is such that systems or components containing large quantities of flammable liquids or gases are seismically qualified or have been separated from essential safety related systems by a qualified barrier.

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

Fire Safe Shutdown Analysis – FSSA (deterministic):

- Demonstrates that the fire safe shutdown safety objectives are met: for any postulated Design Basis Fire (DBF), at least one group of systems remains available that can ensure safe shutdown of the plant and fulfillment of all the essential nuclear safety functions (control of reactivity, cooling of the nuclear fuel, containment of radioactivity and monitoring and control of the plant).
- The FSSA is limited to plant areas where fires have a potential impact on the SSCs required for fire safe shutdown functions.
- The FSSA also has conservative assumptions and postulates the bounding DBF for each fire compartment considering the fire characteristics, the plant response to the fire and the potential fire propagation to adjacent areas.
- No human actions are credited. Fire suppression systems are not credited.
- The simultaneous occurrence of a DBF with another design basis accident with a low probability of occurrence was not taken into account.

Fire safety analysis (FSA)
(cf TS 02.1)

NPP

Fire PSA (probabilistic):

- The analysis covers all plant operating states (POS) including hot, transition, and cold states, and includes the spent fuel bay.
- For Unit 1 of Cernavoda NPP, the contribution of internal fire events represents 74% of the core damage frequency (CDF). For Unit 2 of Cernavoda NPP, the updated results for internal events, fire and flood have been obtained through sensitivity analyses performed on Unit 1 results. The contribution of internal fire events represents 57% of the CDF.
- Dominant contributors to CDF from internal fires:
  - 27% from fires in Class II Motor Control Centers in the Service Building.
  - 14% from fires in the Reactor Building's cable spreading room.
  - 10% from control panel fires in the Main Control Room, leading to evacuation and requiring control from the Secondary Control Area.
- The dominant contributors are from fires in same rooms for Units 1 and 2.

Fire detection (cf TS 03.2.1)

NPP

- Fire detection is provided in all areas of the plant. The location, types and number of the detectors are based on the fire hazard analyses and take into account the importance of the systems and areas for the safety of the plant and of the personnel and also for production.
- The types of fire detectors installed include: optical smoke detectors, heat detectors, flame detectors, VESDA detectors.
- Fire alarm systems are designed, installed, and verified in accordance with the approved standards (Canadian and Romanian standards), including with regard to the type of fire alarm systems, performance levels and associated safety features.

Fire detection (cf TS 03.2.1)

NPP

- In the selection and installation of fire detectors and other field components of the fire alarm system, account has been taken of the environment in which the components are installed (e.g., in terms of radiation fields, electromagnetic field interference, humidity, temperature and air flow).
- Fire detection systems in the Reactor Building are designed to remain functional under high pressure containment test conditions.
- Fire alarm control and display panels are provided in both the MCR (or in its immediate vicinity) and in SCA (Secondary Control Area).
- The fire alarm system is installed to detect fire, to provide specific alarm signals (visual and auditive) to the control room operators (and retranslated to the on-site fire brigade), and to provide emergency signals to plant occupants.

Fire suppression (cf TS 03.2.2)

- The fire water system provides water for all fire categories from the classical and nuclear side for Units 1 and 2, through a common, ring network. The fire water system uses (filtered) water extracted from the Danube.
- The fire water pumping station that supplies water for the NPP units is located at Unit 0, outside Units 1 and 2, and consists of 9 electric pumps of different capacities and a high-capacity (reserve) diesel motor pump.
- Water is supplied from the external network to the external fire extinguishing systems (external hydrants, connections for powering the fire engines), but also to the fire extinguishing systems that serve the buildings belonging to units U0, U1, U2.
- Internal fire extinguishing systems consist of:
  - Automatic fire extinguishing systems;
  - Manual fire extinguishing systems.

Fire suppression (cf TS 03.2.2)

NPP

- Fire extinguishing systems with internal hydrants are provided in all major building with safety important SSCs. An exception is the Reactor Building of Unit 1, for which internal fire hydrants and piping will be installed during refurbishment.
- Fire extinguishing systems with sprayed water and automatic sprinkler systems are provided in plant areas and compartments where there is a substantial risk of fire.
- Fire extinguishing systems with INERGEN are used for computer rooms and other areas where water extinguishing systems are not suitable for use.
- For manual firefighting, a variety of extinguishers, fire hose cabinets, external hydrants and foam equipment are available throughout the plant.
- The response to extensive fires is provided by the Fire Brigade equipped with three fire trucks.

Compartmentation (cf TS 03.3.1)

NPP

- Fire barriers are provided as required by the approved standards and the fire safety analyses. Barriers are designed and installed to provide the required fire resistance rating and meet the licensing basis fire protection standards. Generally, the fire barriers have a fire resistance of 90 minutes to 3 hours.
- Inside the Reactor Building, separation of space into fire compartments cannot be achieved due to concerns for pressurization during accidents, i.e. the atmosphere inside the containment needs to be mixed in a large free volume to cope with events such as LLOCA (Large Loss of Coolant Accident) and MSLB (Main Steam Line Break) and prevent excessive pressure buildup. SSCs are separated by a combination of structural barriers, distance and local fire barriers around components and cables.
- Openings in required fire barriers for doors, hatches, windows, and ventilation ducts are protected with closures with a fire resistance rating not less than that for the barrier and installed in accordance with the approved standard.
- Electrical cable and mechanical penetrations in fire barriers are provided with firestops with a fire resistance rating not less than that for the barrier and installed in accordance with the approved fire protection standard.

Ventilation management (cf TS 03.3.2)

NPP

- Ventilation systems are provided for all buildings where safety-related SSC are located. The flow of the ventilation is such that air circulates from areas where there is no possibility of radioactive contamination towards areas where radioactive contamination could occur.
- Ventilation will stop in case of fire.
- The ventilation systems are provided with dampers that will close in case of fire to prevent fire spread.
- For the cases where filters are used in the ventilation systems, temperature detection and monitoring devices are installed, which also give a signal for the fire dampers to close.
- The fire dampers close when the temperature in the ventilation ducts reaches the temperature of 71^{o}C. The fire dampers have a fire resistance rating of 90 minutes.

Ventilation management (cf TS 03.3.2)

NPP

- Modifications to the installation / resizing of the inspection viewports were developed and implemented to facilitate access to the fire dampers on the ventilation systems.
- There are currently no inaccessible fire dampers on the ventilation system. The fire dampers have a semiannual or at least annual maintenance program.
- The fire dampers located on the ventilation ducting have a preventive maintenance program that includes the following activities, performed annually:
  - visual checks of the inside of the fire damper (cleanliness, integrity, no blockages)
  - fuse status check
  - actuate the flap in the closed or open position to confirm its operation
  - identified deficiencies are remedied.

Conclusion

TS 01.3 and TS 04

NPP

- Several design improvements have been identified based on the PSRs and based on the review of the latest standards, as well as from benchmarking activities and use of operating experience. As described in the national report, many design improvements have been already implemented or are in progress.
- Since the publication of the report, the replacement of the fire detection system for the nuclear island of Unit1 has been completed in the planned outage in 2024.
- Several additional improvements in the area of fire protection are planned for implementation during the refurbishment of Unit 1, to ensure alignment with the modern fire protection standards.

Conclusion

TS 01.3 and TS 04

NPP

- Strengths include:
  - periodic update of the fire safety analyses; effective use of external reviews and benchmarks to improve fire protection;
  - self-assessment for compliance with the latest applicable IAEA Safety Standards and industrial standards in the area of fire protection;
  - continuous improvement of the fire protection design measures, through plant modifications.
- Some weaknesses have been identified in the fire hazard analyses as regards compliance with the latest standards A gap analysis has been performed and the FHA and the FSSA will need to be updated.

Fire safety analysis (FSA)
(cf TS 02.2)

RR

- For the TRIGA Research Reactor in Pitesti, Deterministic fire safety analyses were performed in 2013, in accordance with the IAEA guidelines for evaluation of Fire Hazard analyses for NPPs (IAEA Safety Series No. 50-P-9) and a general national regulation applicable to all types of industrial construction (P-118).
- Based on thermal loads density, the fire safety analysis determined the values of the duration of the fire event with maximum consequences and the maximum temperature that could be reached in the control rooms. These values were established using the methodology based on standard ISO curves. Thermal loads density analysis showed that the greatest values are in the vicinity of the technical archive. Otherwise, thermal load values are not important for the construction strength or reactor operation, if the measures for firefighting and confinement are respected.

Fire safety analysis (FSA)
(cf TS 02.2)

RR

- The FHAs are based on the following assumptions:
  - Considering the occurrence of a single random fire at any time in any area in the research reactor facilities;
  - The simultaneous occurrence of a fire with a LOCA (Loss of Cooling Accident) event or with another design basis accident with a low probability of occurrence was not taken into account;
  - Minor fires that may occur in the area of safety related equipment will be extinguished with portable extinguishers.
- Fire events have been considered for all major safety-related SSCs of the research reactor, including a fire affecting the experimental devices.

Fire safety analysis (FSA)
(cf TS 02.2)

RR

- Only qualitative conservative engineering judgements were made about the possible consequences of fires occurring in areas where safety-related SSCs are located. It was concluded that none of the fire events could impair the capability for safe shutdown of the research reactor and for the fulfillment of the essential nuclear safety functions.
- The recommendations from the fire hazard analysis performed in 2013 have been used to improve the fire protection for the research reactor.
- The fire hazard analysis performed in 2013 has not been revised and updated.
- No probabilistic fire safety analyses have been performed for the research reactor.

Fire detection (cf TS 03.2.1)

- In 1996, a "Fire risk analysis for the TRIGA ICN Pitesti reactor building" was performed. Based on this analysis, the fire detection and signaling system for the reactor building was developed, with the following components installed:
  - fire detection and warning panel;
  - addressable optical smoke detectors;
  - manual fire warning buttons;
  - 4 sound warning units.
- In 2012, supplementary addressable optical smoke detectors and two manual fire alarm buttons were installed in the buildings of the Diesel plant, the 6 kV electrical station, the 0.4kV station and the secondary circuit pump station.
- These detectors and buttons are connected to the fire detection and warning panel, located in the hall at the main entrance to the reactor building.

Fire detection (cf TS 03.2.1)

RR

- In 2014, as a result of the findings of the INSARR 2013 peer review mission recommendations, the following components were additionally installed in the fire alarm system:
  - an analog optical smoke detector in the reactor hall;
  - the smoke sampling component for the ventilation piping, in the reactor hall;
  - a hydrogen detector, in the battery room; meantime, the old batteries were replaced with gel type batteries.
- These detectors are also connected to the fire detection and warning panel, located in the hall at the main entrance to the reactor building.

Fire suppression (cf TS 03.2.2)

RR

- The installations and systems, devices and devices for preventing and extinguishing fires that are in the building include:
  - internal hydrants;
  - external hydrants;
  - portable fire extinguishers - Foam Spray, ABC powder, Carbon dioxide.
- The reactor building is provided with a fixed installation for extinguishing fires, with hydrants. The water supply for the hydrant system in the reactor building is made with potable water from the well area and with industrial water from the pretreatment station in the nearby town.
- All the consumers in the reactor building as well as the internal/external hydrants are connected to the internal network of the research institute, being fed from buffer tanks. The flows and pressures of potable and fire water at the feeding points are ensured by the pumps from the external network of the reactor building. In laboratories, fire hydrants are provided.
- Mobile equipment (portable fire extinguishers, etc.) has been provided for extinguishing fires according to the national regulations.

Compartmentation (cf TS 03.3.1)

RR

- The initial fire protection arrangements for the research reactor did not follow a strict fire compartment approach, therefore the fire cell approach has been used in the subsequent improvements of the fire protection design features.
- Prevention of fire spreading has been performed by the fireproofing (placing layers upon layers of materials over an object or area to give it high resistance to heat and flame).
- The building resistance structure is made up of prefabricated reinforced concrete elements, plain concrete and reinforced concrete.
- The cable passages through the floors and walls at the entrance to the panels, cabinets and cells were sealed with protective pipes, metal tubes and seals to avoid the spread of possible fires. Also, where the free length of the route exceeds 25 m, fireproof separations (fireproof plugs) have been provided.

Ventilation management (cf TS 03.3.2)

RR

- The design of the ventilation/air conditioning systems for the technological areas of the research reactor is based on the following principles:
  - grouping of rooms according to radiological zoning;
  - ensuring the circulation of air, within the same ventilation system, from the rooms with a lower risk of contamination to the rooms with a higher risk of contamination by ensuring the negative pressure in the rooms, depending on the nuclear zoning, thus avoiding the leakage of contaminated air from rooms to outside;
  - ensuring air evacuation through active charcoal filters in the event of an accident in the reactor hall;
  - ensuring the automatic switching of the ventilation system of the reactor hall from normal mode to emergency mode;
  - ensuring the automatic switching from the equipment in operation to the spare equipment, in case of failure of the equipment in operation;
  - the adoption of open circuit schemes in order to avoid the recirculation of contaminated air.

Ventilation management (cf TS 03.3.2)

RR

- The following technological requirements were also implemented:
  - ensuring optimal temperature and humidity in the reactor hall;
  - removal of excess heat from technological equipment, in order to ensure the operating conditions of technological installations and equipment
- Thus, ventilation schemes were adopted for:
  - the reactor hall, the irradiation capsule room, the heat exchanger room;
  - the radioactive waste storage circuit.
- The ventilation installation attains negative pressure in:
  - reactor hall;
  - neutron experiments;
  - neutronography laboratory;
  - irradiation capsule room;
  - heat exchanger room.
- The ventilation system is a support system, safety-related.

Conclusion

TS 01.3 and TS 04

RR

- Significant improvements have been implemented for the fire protection of the research reactor, in the period 2013-2014, based on the recommendations from an IAEA peer review.
- No strengths have been identified.
- The fact the fire hazard analysis performed in 2013 has not been revised and updated is identified as a weakness.

Fire safety analysis (FSA)
(cf TS 02.3)

Fuel fabrication facilities

- The licensee for the Nuclear Fuel Fabrication Plant in Pitesti elaborated, in 2012, the study "Identification, Evaluation and Control of Fire Risks – Nuclear Fuel Manufacturing Plant". The aim of this study was to identify the possible causes of fire, to estimate the probabilities of fire occurrence, to evaluate the inventory of combustible material and sources of fire initiation, to assess the potential consequences of fire and to control fire risks.
- The Integrated Safety Analysis (ISA) of the Final Safety Analysis Report, includes all relevant hazards, including fire hazards, which could result in unacceptable consequences for the installation, workers, population and the environment.
- The fire risk analysis involved the fire hazard identification, fire risk assessment (frequency and probability of a fire occurrence, fire development, probability of failure for fire protection systems) and quantifying the consequences of fires (fire protection engineering calculations).

Fire safety analysis (FSA)
(cf TS 02.3)

Fuel fabrication facilities

- The maximum credible accident analyzed is the occurrence of an earthquake-type event, causing the rupture of the hydrogen supply pipe of the sintering furnaces, leading to the initiation of its explosion. The inoperability of the hydrogen detection system supports the production of the explosion. The scenario involves the initiation of a fire, generated by the rupture of the methane gas pipe coincident with the occurrence of an electrical short circuit. Conservative assumptions have been used in the analysis.
- The results of the analysis for the maximum credible accident show that the maximum value of the total effective dose equivalent (TEDE) for workers is 8.17 mSv at 10 m from the source term, at 1 m/s wind speed, B atmospheric stability class, sunny/cloudy day and wet deposition in the first 24 h from event.
- The maximum value of TEDE at UPZ, for a person from the population, calculated for 30 days from the beginning of the emission, is 0.49 mSv, below the maxim value of dose provided in Annex 4 from NSN-24 regulation for class 2 events (Design Basis Accidents) and even below class 1 events (Anticipated Operational Occurrences).

Fire detection

- Plant spaces are equipped with fire detection and alarm systems that include smoke detectors, fire alarm buttons and sirens, located throughout the buildings, connected to a main alarm panel, permanently monitored, indicating the exact location of the fire to facilitate the coordination of the evacuation process.
- Fire detection, signaling and alarming systems include: Intelligent Addressable Control Panel equipment, fire detectors (optical smoke detectors, combined smoke/temperature detectors, aspiration smoke detectors, linear smoke detectors), manual alarm triggers, acoustic alarm devices, optical alarm signaling devices, input/output modules.
- Detection systems of explosive gas accumulations (hydrogen, methane gas) are also provided in technological areas that use such gases, respectively: control and signaling equipment, hydrogen detectors and methane gas detectors.

Fire suppression

- Fire suppression provisions consist in fixed systems (e.g. Argon fire extinguishing system ensures fire protection of the Zy-4 compacting machine and an automatic Inergen Fire Suppression System protects the server room), portable fire extinguishers, indoor and outdoor hydrants, pipeline networks, water tank to provide water to fire fighter use.
- Interior fire hydrants ensure the protection of each point; the fire hydrants are equipped with three-position hoses and pipes for water discharge.
- An annular network of firewater with seven external hydrants ensures the external extinguishing of building fires. An annular network of firewater with five external hydrants ensures the external extinguishing of fires at the General Warehouse of Goods / Materials.
- Two tanks for drinking water supply, domestic water and firewater, with a capacity of 500 m3 each, provide firewater storage.
- Periodic maintenance of fire extinguishing equipment, carried out by specialized external contractors, prevent breakdowns and ensure safety and reliability of the fire suppression provisions, in accordance with the requirements provided by the national legislation in force.

Compartmentation (cf TS 03.3.1)

Fire protection is implemented through the following measures:

- Separation of areas where non-radioactive hazardous materials are stored from process areas;
- Minimizing the thermal load in the individual rooms;
- The maximum fire load allowed was determined on the basis of fire walls resistance, fire loads (types and quantities), rooms / compartment area, ignition sources and related SSCs in order to keep fire risk as low as reasonably possible;
- Choice of materials for structures and partitioning walls, for penetrations and cables associated with structures, systems and components important for nuclear safety in accordance with the functional criteria and fire- resistance assessments;
- Partitioning of buildings and isolation of the ventilation ducts, in order to prevent the fire propagation;
- Limitation the number of possible sources of ignition, such as open flames, or electric sparks.

Ventilation management (cf TS 03.3.2)

- The ventilation system consists of ventilation units and the piping system. The rooms where the ventilation units are located are made of fire-resistant walls and doors. The pipes of the ventilation system pass through the fire-resistant walls, 90 minutes fire-resistant, air-dampers are provided, triggered by fuses with a trigger temperature of 73° C (for example: Hall IV, Chemical Analysis Laboratory).
- A remote shutdown system of the ventilation system ensures the remote shutdown of the ventilation system in case of fire in the plant. The remote shutdown system ensures the shutdown of the ventilation system in case of fire, if it cannot be done from the local control panel (as a result of smoke/fire) or when rapid shutdown is required to avoid the spread of smoke and fire.

Conclusion

TS 01.3 and TS 04

Fuel fabrication facilities

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- Significant improvements have been implemented for the fire protection of the nuclear fuel fabrication plant based on the recommendations from an IAEA peer review mission (SEDO) conducted in 2011.
- No strengths have been identified.
- The fact the fire risk analysis performed in 2012 has not been revised and updated was identified as a weakness.
- The licensee has initiated the development, in the period 2023-2024, of a Fire Hazard Analysis, using the applicable requirements provided in CNCAN regulations for NPPs and in accordance with IAEA SSR-4 requirements.

Fire safety analysis (FSA)
(cf TS 02.3)

Spent fuel storage

- The licensee for Cernavoda NPP has evaluated the external hazards that could affect the dry spent fuel storage facility, including fires and explosions occurring at other installations on site (e.g. fuel storage facilities, industrial gases storage facilities) and off-site. It was concluded that the credible external hazards cannot initiate a fire or explosion that could affect the spent fuel storage facility.
- A fire hazard analysis has not been performed for the spent fuel storage facility.
- A conservative deterministic analysis has been performed for an event involving an aircraft crash on the dry spent fuel storage, for the purpose of emergency planning and preparedness. Various types of aircraft were assumed to crash accidentally on the dry spent fuel storage, irrespective of the very low probability of such events.
- With very conservative assumptions applied in the analysis of the radiological consequences, it was determined that aircraft crash would trigger the activation of the off-site emergency response plan. With less conservative assumptions, it was determined that the estimated doses would exceed the dose limits for normal operation, but would not require significant off-site protective measures.

Active fire protection

Fire detection & Fire suppression (cf TS 03.2.1-2)

Spent fuel storage

- Passive fire protection is ensured by the design of the facility. All the materials used in the construction of the dry spent fuel storage facility are not combustible.
- Natural ventilation has been considered sufficient for this facility, based on design and operational specific aspects, therefore there is no engineered ventilation system installed.
- Fire detection provisions have not been considered necessary for the dry spent fuel storage facility. Fire detectors are installed only in the administrative building in the vicinity of the dry spent fuel storage. Alarm buttons are installed in the administrative building and alarms are displayed in the Main Control Room of the Unit 1 of the NPP.
- No automatic fire suppression systems are installed the dry spent fuel storage facility for the storage modules.

Conclusion

TS 01.3 and TS 04

Spent fuel storage

- The licensee has performed only conservative deterministic analyses of a fire scenario affecting the dry spent fuel storage facility, and submitted it to CNCAN as part of the licensing basis documentation (safety analysis report).
- CNCAN has accepted the safety analyses performed for this facility and no significant issues have been identified from the regulatory review and inspection activities.
- There have been no improvements and updates since the NAR production.
- No strengths and weaknesses have been identified for the fire protection of the dry spent fuel storage facility.

Fire safety analysis (FSA)
(cf TS 02.4)

Waste

- The licensee has evaluated the external hazards that could affect the Cernavoda Solid Radioactive Waste Interim Storage Facility, including fires and explosions occurring at other installations on site and off-site. It was concluded that external hazards cannot initiate a fire or explosion that could affect the radioactive waste storage facility.
- A fire hazard analysis has not been performed for the storage facility, but a deterministic analysis of a postulated fire has been included in the safety analysis report, as the maximum credible accident for this facility.
- The radiological impact of a postulated fire was analyzed in a conservative manner for the storage of radioactive waste packed in barrels. It was assumed that the storage is filled to the maximum capacity and that 25% of combustible waste burns. Although it was assumed that the fire detection and alarm system is functional and that the firefighters reacted to the alarm signal, it was conservatively assumed that the duration of the fire will be of 6 hours.
- With conservative assumptions applied in the analysis of the radiological consequences of such an event, it was determined that the off-site impact is minor.

Fire detection and fire suppression (cf TS 03.2.1/TS 03.2.2)

Waste

The fire protection measures implemented for the Cernavoda Solid Radioactive Waste Interim Storage Facility are:

- passive protection measures, namely the protection of the metal structure of the storage, with a layer of intumescent paint, which ensures a minimum limit of fire resistance for 30 minutes;
- installation of a fire detection and alarm system, consisting of 15 detectors, placed above the barrel stack and an alarm circuit connected to the Main Control Room of the Unit 1 of the NPP; also, alarm buttons and sirens are installed in the storage facility;
- a ring of external hydrants for fire water;
- fire fighting equipment, including portable fire extinguishers.

- The most important measure to prevent an extensive fire is the containerization of waste in fire resistant closed metal barrels with lids and gaskets.
- Prevention of fire spreading is ensured through the use of fire resistant barrels for the storage of the radioactive waste and through the protection of the metal structure of the storage with a layer of intumescent paint.
- No fire compartments are necessary
- Natural ventilation has been considered sufficient for this facility, based on design and operational specific aspects, therefore there is no engineered ventilation system installed.

Conclusion

TS 01.3 and TS 04

Waste

- The licensee has performed only conservative deterministic analyses of a fire scenario affecting the Solid Radioactive Waste Interim Storage Facility, and submitted it to CNCAN as part of the licensing basis documentation (safety analysis report).
- CNCAN has accepted the safety analyses performed for this facility and no significant issues have been identified from the regulatory review and inspection activities. However, a more systematic and realistic analysis of the internal fire hazards will be required when the revised regulation on fire protection for all nuclear installations will be issued and come into force.
- There have been no improvements and updates since the NAR production.
- No strengths and weaknesses have been identified for the fire protection of the dry spent fuel storage facility.

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General conclusions:

- The performance of the licensees in the area of fire protection has been found adequate.
- Several opportunities for improvement have been identified, which will be included in the national action plan.
- Opportunities for improvement of the licensed installations and activities include the revision of fire safety analyses and design upgrades.
- Improvements to the regulatory requirements and oversight processes have been also identified and will be included in the national action plan.
- One of the actions identified is already in progress and relates to the revision of the nuclear safety regulations on fire protection, to adequately cover all nuclear installations and to include more detailed provisions on fire safety analyses and design provisions.