ITALY

Topical Peer Review II

Fire Protection

National Assessment Report

2023

National Inspectorate
for nuclear safety
and radiation protection

Topical Peer Review II

Fire Protection

National Assessment Report

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This National Report has been prepared by the National Inspectorate for nuclear safety and radiation protection (ISIN), which carries out the functions of italian national competent regulatory Authority for nuclear safety and radiation protection, on the basis of its regulatory review of the self-assessments conducted by the involved national licensees.

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0. Preamble / Foreword

The present document constitutes the National Assessment Report ("NAR") of Italy prepared to participate in the Topical Peer Review 2023 ("TPR II") dedicated to Fire Protection in nuclear installations, according to the provisions established by the European Union's Nuclear Safety Directive 2014/87/EURATOM (NSD).

The document has been developed in accordance with the "*Technical Specification for the National Assessment Reports*" - June 2022, that defines the reference editorial structure and the main content of the NARS to facilitate an effective peer review. In particular, Annex 2 of the specification sets out in detail the contents of the NARs.

This NAR has been developed with the objective of describing the overall fire safety for the selected candidate installations listed in Chapter *1.1.2*, giving relevance to the application of the general fire safety programme, the strengths and weaknesses and the experience gained regarding fire safety activities.

From the resulting evaluations, improvement actions have been identified, where needed.

A key point to note is that the graded approach was applied in the assessments carried out and the resulting improvement actions to take into account the specificity of national installations.

1. General Information

1.1. Nuclear installation identification

This proposal of National list of "candidate installations" and "represented installations" for Italy has been prepared following the instructions provided in Section 0.03 - Scope of nuclear installations to be covered in the NAR of the TPR II Technical Specifications.

In particular, these steps have been followed:

1) identify all qualifying installations in the scope of TPR II (based upon NSD as indicated in Section 00.3, points 1&2 of TS). In this step, starting from the national installations falling under the scope of the NSD, the list of *qualifying installation* has been drawn, selecting installations according to the graded approach based on significant radiological risk criteria as reported in Section 00.3, Point 3 of TS;

2) conduct a national down-selection in order to identify the national list of "candidate installations "and "represented installations" (section 00.3, Point 4).

1.1.1. Qualifyng nuclear installations

As well-known Italy decided to abandon the peaceful exploitation of nuclear energy for electricity production many years ago, on the basis of two national referenda, which took place in 1987 and 2011. Commercial utilisation of nuclear power started in 1962 and within 1981 four nuclear power plants, namely the NPPs of Garigliano (BWR), Latina (Gas Graphite), Trino (PWR) and Caorso (BWR), and a LEU fuel fabrication installation (Fabbricazioni Nucleari S.p.A) had been commissioned. During that period an extensive R&D programme on the nuclear fuel cycle was developed with the operation of two experimental fuel cycle installations in the field of reprocessing, ITREC and EUREX plants, and a pilot MOX fuel fabrication facility (IPU).

The three NPPs of Latina, Trino and Caorso continued to be operated until 1987. The Garigliano NPP had already been shut down in 1978, for technical reasons. All other nuclear installations were also definitively shutdown. All these installations are currently at different stages of decommissioning.

In the nuclear programme several research reactors had been operated, some of which already decommissioned, some others definitely shutdown and under decommissioning (ISPRA -1 Reactor, ESSOR Reactor at JRC Centre of Ispra and L54 M Reactor in Milan. Four Research Reactors are still in operation TRIGA

RC 1 and TAPIRO at ENEA research Centre in Casaccia (RM), TRIGA MARK II at Pavia University and AGN 201 Costanza at Palermo University, which is however in permanent cold shutdown conditions.

Appendicies to the NAR contains a short description of each one of above listed installations and their current status.

On the basis of their characteristics and status, each individual installation has been evaluated in front of the graded approach criteria reported in the technical specifications, identifying the qualifying installations for the TPR II exercise and those that could be excluded. Results of Board Peer Review of National Selections have been also taken into account.

In particular,

1) For research reactors

- TRIGA RC 1, TAPIRO and TRIGA MARK II are considered as *Qualifying* installations
- AGN 201 Costanza is *Excluded* being a zero power reactor currently in permanent cold shutdown

2) For Dedicated spent fuel storage facilities, the spent fuel storage facilities (wet and dry) in ITREC plant and ESSOR Reactor, and the dry storage facility of OPEC 1 are considered as *Qualifying* installations. The Avogadro wet storage facility, initially *Excluded* because the fuel is expected to be removed in the near future to be transferred abroad for reprocessing, has been at the end considered on the bases of comments received by the Board.

3) For Facilities under decommissioning

- All NPPs (Garigliano, Trino, Caorso and Latina) are considered as Q*ualifying* installations;
- For FCFs, EUREX and ITREC are considered as *Qualifying* installations. Bosco Marengo Fuel Fabrication Plant is *Excluded* as all decommissioning activities are close to be completed with the transfer of all generated waste, treated and conditioned, to a dedicated storage facility on the site;
- For Research Reactors, Ispra 1 Reactor and ESSOR Reactor (Safe Store) are considered as *Qualifying* installations. L-54M Reactor is *Excluded* due to its very low original power (50 KW) and to the fact that spent fuel, relevant waste and radioactive sources have been removed from the site.

4) For Waste storage facilities

- All waste storage facilities on the sites of NPPs, but 2 out of 5 in Garigliano NPP, which have in store only conditioned waste, are considered as *Qualifying* installations;
- All waste storage facilities on the sites of FCFs, but 2 out of 6 in ITREC plant site, which for a large majority have in store conditioned waste, are considered as *Qualifying* installations.

1.1.2. National selection of installations for TPR II and justification

Based Upon the identified qualifying installations the following installations have been identified as candidate a represented for the conduct of the peer review.

Installation category	Candidate installations Reported in the NAR)	Represented installations
Nuclear power plant	NA	
Research reactor	Lena Triga Mark II Tapiro Fast neutron	RC-1 Triga Mark II
Fuel reprocessing facility	NA	
Fuel fabrication facility	NA	
Fuel enrichment facility	NA	
Dedicated spent fuel storage	In ITREC FCF under decommissioning site (Wet in operation and Dry under construction) In ESSOR reactor under decommissioning site (Wet and Dry, both into operation) Avogadro (Wet, into operation)	OPEC 1 (Dry Storage Facility)
Installations in Decommissioning	Latina NPP (Magnox Reactor) Trino NPP (PWR) EUREX FCF (Reprocessing) ESSOR - RR (now in Safe Store)	Caorso (NPP-BWR) Garigliano (NPP-BWR) ITREC (FCF - Reprocessing) IPU (FCF - Fabrication)
On-site radioactive waste storage	D1 – D2 (on Trino NPP site) E1, E2, E3 (on EUREX FCF site) OPEC2 (on IPU FCF site)	C1, C2, C3 (on Caorso NPP site) G1, G2, G3 (on Garigliano NPP site) L1, L2, L3 (on Latina NPP site) I1, I2, I3, I4 (on ITREC FCF site)
Total	17	19

The next paragraph shows the list of selected installations.

1.1.3. Key parameters per installation

The following table shows the key parameters of the selected Italian candidate installations.

Name **/NAR Code**	**Licensee/ Operator**	**Type of installation**	**Thermal and electrical net power**	**Year of operating licensee**	**Scheduled shutdown date**	**Year of end of operation**	**Year of authorization for decommissioning**	**Scheduled end of decommissioning operations date**
LENA Triga Mark II / A.I	University of Pavia	Reserch Reactor	250 kW	1965				
Tapiro Fast neutron / A.II	ENEA	Reserch Reactor	5 kW	1971				
ITREC-plant / B.I	SOGIN spa	Spent fuel storage (Wet and Dry)		1968				2035
ESSOR-B-plant / B.II	JRC Ispra	Spent fuel storage (Wet and Dry)		1968				
Avogadro AFR / B.III	DEPOSITO AVOGADRO SpA	Spent fuel storage (Wet)		2004				
Latina (NPP) / D.I	SOGIN spa	Decommissioning					2020	2043
Trino (NPP) / D.II	SOGIN spa	Decommissioning					2012	2035
ESSOR-D-C (RR) / D.III	JRC Ispra	Decommissioning					1987	
Eurex (FCF) / D.IV	SOGIN SpA	Decommissioning					2003	2037
D1+D2 (Trino) / C.I	SOGIN SpA	Waste Storage (in the NPP site)					2012	2035
E1 (EUREX) / C.II	SOGIN SpA	Waste Storage (in the facility site)					2003	2037
E2 (EUREX) / C.III	SOGIN SpA	Waste Storage					2003	2037
E3 (EUREX) / C.IV	SOGIN SpA	Waste Storage					2003	2037
Area 800 (Eurex) / C.V	SOGIN SpA	Waste Storage					2003	2037
OPEC2 (IPU) / C.VI	SOGIN SpA	Waste Storage					2011	2029

A – Research Reactor ; B – Dedicated Spent Fuel Storage ; C – Waste Storage Facility ; D – Installation Under Decommissionig

In the table, the "NAR Code" rows contain a code identifying the specific installation whose Self Assessment reports is given in *Annexes*.

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

The national competent regulatory authority, whose role in Italy is assigned to the *National Inspectorate for Nuclear Safety and Radiation Protection* ("ISIN") requested the licensees responsible fo the management of each of the identified candidate installations to conduct a self-assessment according to the TPR II Technical specifications.

A reference template, called "*Installation Assessment Report Content*", which was prepared and sent to the licensees, in order to facilitate the drafting of the self-assessment document related to their installations.

At the same time the purpose of this document is to standardise the information contained in all the Self-Assessments so that to facilitate thir systematic evaluation and the subsequente preparation of the NAR.

Once the Self-Assessments had been received from the licensees, ISIN carried out an initial analysis to assess whether the contents reported therein complied with the technical spefication. Following this initial analysis, ISIN sent comments and requested additional information where needed.

Once received the self-assessments in their final version carried out its own review and reserved the right to request further information from licensees.

The content of the self assessment presented by the licensees has therefore been used to prepare the NAR. To this purpose it has been complemented with the sections of competence of the Regulator for nuclear safety and radiation protection as indicated in the Technical Specifications.

Taking into account that NPPs and FCFs are no more into operation in Italy and they are therefore not to be discussed in the NAR, they are not included in the index of the report.

Based upon the above considerations the NAR standard content reported in the Technical Specifications has been adapted to the national situation as following:

- the different Group of installations discussed in the NAR are indicated with capitol letters as following:

    .A. Research reactors

    .B. Dedicated spent fuel storage facilities

    .C. Waste storage facilities on rhe sites

    .D. Facilities under decommissioning

- In Chapters 2 and 3, only the paragraphs related to the assessment and conclusion of the Regulator, respectively corresponding to point 2.1.7 and points 3.1.4, 3.5 and 3.6 of Technical Specifications ANNEX 2, are given;
- the results of the self-assessment conducted by the Licensees are reported for each installation Group, detailed for each individual installation, in the Annexes. They also include additional informations related toeach installation.

The other sections on Fire Safety Analyses, developed in accordance with the Techical Specification, can be found in the chapters on the relevant installations (*Annexes*).

1.2. National regulatory framework

The Italian legislative and regulatory framework in the field of nuclear safety and radiation protection is the result of an evolution of rules and regulations that began in the early 1960s and applies to all nuclear installations and activities, including Spent Fuel and Radioactive Waste management.

The regulatory framework defines the main principles related to nuclear safety and radiation protection and to applicable licensing procedures.

The regulatory system is made up of three types of rules of different legal force depending on their origin:

- legislation, that is Acts and Legislative Decrees, as well as governmental or ministerial decrees;
- technical guides;
- technical standards.

The national fire safety framework for nuclear installations is part of the broader national fire safety framework that deals with all installations and activities where there is a fire risk (nuclear and conventional installations).

In the national regulatory framework, the fire safety of nuclear installations is subject to a dual path of evaluation and verification:

- By the *Department of firefighters, public rescue and civil defense and the the National Fire and Rescue Service (CNVVF)* – from now called *"Fire Authority"*
- By the *National Inspectorate for Nuclear Safety and Radiation Protection (ISIN)*.

Department of firefighters, public rescue and civil defense and the The National Fire and Rescue Service (CNVVF)

Fire prevention is entrusted to the exclusive competence of the Ministry of the Interior, which carries out the relevant activities through the Department of firefighters, public rescue and civil defense and the the National Fire and Rescue Service ("CNVVF"). It is the function of preeminent public interest aimed at achieving, according to uniform application criteria throughout the national territory, the objectives of safety of human life, the safety of persons and the protection of property and the environment through the promotion, study, preparation and experimentation of standards, measures, precautions and methods of action aimed at preventing the outbreak of a fire and events connected to it or limiting its consequences.

It is carried out in every field characterised by exposure to fire risk and, due to its interdisciplinary relevance, also in the fields of safety in the workplaces, control of major-accident hazards associated with certain hazardous substances, energy, protection from ionizing radiation, construction products.

The fire prevention activities carried out by CNVVF include:

(a) the development of fire prevention regulations;

(b) the issuing of fire prevention certificates, acts of authorisation, technical approval, testing and certification, however named, attesting the conformity of civil, industrial, craft and commercial activities and constructions and of plants, products, equipment and the like with fire prevention regulations;

Considering the authorisation and approval aspects, fire prevention refers to DPR 151 and the fire prevention authorisation regulations, which have evolved in recent years with the aim of simplifying approval procedures.

In accordance with DPR 151, for Category C activities, i.e. those with a high risk, including nuclear installations, the legislation provides the procedure for obtaining the fire prevention certificate ("CPI") required for authorisation to operate the plant. This procedure requires the assessment of the project by the Department of firefighters ("CNVVF"), which must then carry out mandatory inspections that are essential for issuing the CPI.

National law also requires a periodic safety review, requiring a new assessment of fire risks and fire protection systems every five (5) years. The assessment is submitted again to the CNVVF in order to obtain the periodic renewal of the CPI.

In addition to the periodic renewal mentioned above, Italian law provides that the fire safety analysis must be reviewed when there are changes in the production process or in the organisation of work that are significant for the health and safety of workers, in relation to the development of technology, prevention or protection. For nuclear installations undergoing decommissioning, the "changes in production processes or in the organisation of work" means that fire risk assessments must be updated for each activity involving the dismantling of technological installations, modification of buildings and related work.

National Inspectorate for Nuclear Safety and Radiation Protection (ISIN)

As stated in the Legislative Decree n° 45/2014 - the ational Inspectorate for Nuclear Safety and Radiation Protection ("ISIN") is the Governmental body entrusted with the role of Competent Regulatory Authority, independent according to Directives 2009/71/EURATOM and 2011/71/EURATOM, responsible for the assessment and the inspection activities on nuclear installations, as well as for approving detailed designs or activities related to the construction of nuclear facilities, which are part of the general construction licence o decommissioning licence granted by the Ministry of Environment and Energy Security, or to the implementation of a plant modification.

ISIN has become operative on August 1st, 2018, and its regulatory functions were previously carried out by the Nuclear Department of the Institute for Environmental Protection and Research (ISPRA).

Any licence/authorization issued by the Ministry of Environment and Energy Security is based on the technical advice and specifications formulated by ISIN, which supervises, throughout its inspection activity, the compliance with the requirements established in the law, with the technical specifications issued in the authorization and with the conditions attached to specific approvals of documentation concerning the "Decommissioning project" that is divided into "*Detailed Projects*" or "*Operational Plans*".

The Detailed Project ("DP") refers to the creation of new installations, also through major interventions for the adaptation of existing structures and systems.

The Operational Plans ("OP") is the typical compliance documentation to be prepared for operations related to decommissioning (dismantling of parts of the installation, materials management, etc.).

ISIN inspectors are entitled by the law with the proper authority to request the licensee any information deemed necessary to ascertain compliance with legal requirements and licence conditions.

During the life of nuclear installations (both during construction and decommissioning) regulatory inspections on the sites are therefore regularly conducted. They are aimed at verifying compliance with rules established in the Legislative Decree. n. 101 of July 31, 2011 (“DL 101”) and with the technical specifications and conditions which are part of the licence or authorization.

ISIN is also the competent body for giving support to the Governmental rule-making function in the field of nuclear safety and radiation protection and it is also entitled to issue technical guides pertaining the different operational aspects of the regulatory process. ISIN is entrusted with functions and duties related to technical regulation, implementation of licensing procedures, technical assessments, control and surveillance of nuclear installations no longer in operation and in decommissioning, as well as of research reactors, of facilities and activities related to management of radioactive waste and spent fuel, of nuclear materials, of the passive physical protection of nuclear materials and facilities, of the use of ionizing radiation sources and of the transport of radioactive materials, issuing in this case, the certifications foreseen by the current legislation.

ISIN is entitled by law to require the licence holder to comply with the national safety requirements and with the terms of the licence either in the licensing process or in the inspection activity. In particular, any safety demonstration to be provided by applicants or by licence holders is independently assessed in the licensing process. For the major licenses, ISIN establishes *technical specifications or conditions* in the frame of its advice to the Licensing authority for authorizations, as well as in its approvals related to specific nuclear safety relate projects or operations.

Plant walk-down are also frequently performed by other ISIN professionals with the purpose of achieving data, information and other technically relevant elements to be evaluated with respect to technical regulations. Inspection activities may be ordinary (planned in advance for each technical area) or extraordinary.

Procedures for approval and control by the competent authorities

Fire safety approval procedures primarily concern the competent Fire Authority (CNVVF) and the ISIN in the role of Authority for nuclear safety aspects, which also covers fire safety.

The procedure to obtain fire authorization is:

- Submit to the Fire Authority (CNVVF) a basic design of the fire prevention and protection measures for the nuclear facility in order to identify the technical and management solutions aimed at achieving the primary objectives of fire prevention
- Obtain by the Fire Authority design approval
- Submit, at the end of construction, all the documents related to fire safety such as fire certificate of structure, conformity of the fire protection system, fire procedure, tests and controls
- On site inspection of the Fire Authority to verify the fire safety

Considering the way in which ISIN intervenes in the authorisation phase, the procedure adopted is that of issuing 'Prescriptions'.

The Prescriptions are provisions issued as integral parts of the Authorization Decree for the installation decommissioning (Italy's nuclear power plants are at this stage).

In particular, the *Licensee* (also commonly referred to as “Operator”) submits to ISIN for approval the Detailed Projects (DP) and/or Operational Plans (OP).

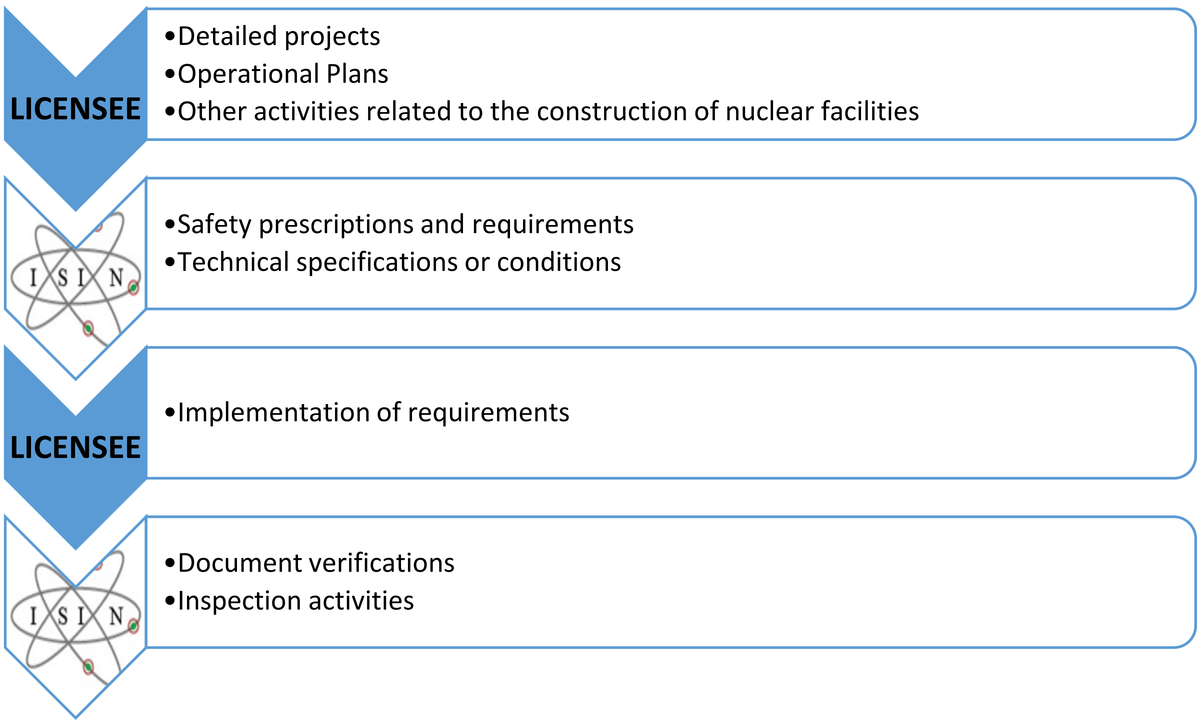
ISIN then begins the investigation phase in which it examines the documentation received, its completeness and content. In this phase, a person in charge of the procedure (a coordinator) is appointed who, in turn, is assisted by various officials appointed as "Technical Referees" who are experts in the various aspects of nuclear safety and radiation protection.

Usually there is the phase in which the technical referees, through the coordinator, interact with the operator by means of meetings and exchanges of technical communications in order to clarify all the necessary safety aspects.

Once the interlocutory phase is over, ISIN issues the Authorization Decree with any technical and management prescriptions.

The operator is obliged to implement the requirements of ISIN, which, in turn, will undertake verification and control actions on the documentation and inspections at the nuclear installation that is the subject of the application.

The diagram below shows the approval process involving the issuing of prescriptions by ISIN, and their subsequent verification.



1.2.1. National regulatory requirements and standards

Overview of the regulations adopted for the fire safety concept implemented in the installations

- DM 16 February 1982 (Amendments to the ministerial decree of 27 September 1965, concerning the determination of the activities subject to the fire prevention visits) activities n. 80, 64, 91
- DM 8 March 1985 (Directives on the most urgent and essential fire prevention measures for the purpose of issuing the provisional permit pursuant to law, 7 December 1984 n 818)
- DM 26 July 1965 n. 966
- DPR 29 July 1982 n. 577

Key regulatory requirements and guidance

- DM 26 march 1985 (Procedures and requirements for the authorization and registration of organisations and laboratories in the lists of Ministry of the Interior pursuant to the law of 7 December 1984, n. 818)

- DPR 1 august, 2011 n. 151 (Regulation simplifying the regulation of fire prevention procedures,…)
- DM 20 dicembre 2012 (Fire prevention technical regulation for active fire protection systems installed in activities subject to fire prevention controls)
- DM 3 August 2015 (Approval of fire prevention technical standards, pursuant to article 15 of the legislative decree 8 March 2006, n. 139), modified by DM 12 April 2019 and by DM 18 October 2019, Reg.(UE) n.305/2011
- DM 1 september 2021 (General criteria for the control and maintenance of systems, equipment and other fire safety systems, pursuant to article 46, paragraph 3, letter a), point 3, of the legislative decree 9 April 2008, n. 81
- DM 2 september 2021 (Criteria for the management of operational and emergency workplaces e characteristics of the specific fire prevention and protection service)
- DM 3 september 2021 (General criteria for the design, construction and operation of safety fire protection for workplaces, pursuant to article 46, paragraph 3, letter a), points 1 and 2, of the legislative decree 9 April 2008, n. 81

Note

"DPR" means a President of the Republic decree, through which in the Italian legal system, is a legal act issued by the President of the Italian Republic for the determination of administrative acts.

"DM" means a ministerial decree, through which both general and abstract rules and particular provisions can be laid down in the Italian legal system.

The main national legislative provision in the field of fire safety is the Ministerial Decree 10th March 1998, that, in its original versione, established a procedure to perform the Fire Risk Assessment. This procedure is aimed at the definition of the Fire Risk Level (Low, Medium, High), through:

- fire loads, ignition source and fire propagation risk individuation;
- individuation of the workers employed in the assessed areas;
- fire risk elimination or reduction;
- residual risk evaluation;
- adequacy of the existing fire protection systems and organization.

The decree also establishes provisions for aspects on:

- controls and maintenance of fire protection measures
- fire-fighting information and training
- planning of procedures to be implemented in the event of a fire
- content of training courses for fire prevention, firefighting and emergency management officers, in relation to the risk level of the activity

This decree has been amended and supplemented over the years and is still a reference for basic fire safety principles.

Furthermore, activities and facilities subject to the control of the *Department of firefighters, public rescue and civil defense and the the National Fire and Rescue Service (CNVVF) – Fire Authority* have been identified during the years, starting from the '60s in several ministerial decrees. The last updating occoured in 2011 when the Presidential Decree n. 151 of August 1, 2011 ("DPR 151") was issued, listing in its first annex a revised list of all the activities and facilities still valid nowadays. This list contains, for example, stores, malls, schools, car parking facilities, industrial buildings and many other fires risk activities including nuclear facility are subject to fire prevention inspection performed by the officers of the Italian National Fire Rescue and Service.

The DPR 151 established that the Fire Risk Level must be assigned considering also the specificity of certain work realities: for instance, the installations related to the peaceful use of the nuclear energy are distinctively identified as High Risk Level.

The DPR 151 also establishes that the operator af an activity or a facility has to submit the technical documentation related to the fire safety project, on which basis the fire authority can perform documental verifications and site visits, to ascertain the the compliance with technical requirements. At the end, a compliance certificate is granted with prescriptions, if needed.

The documentation to be submitted has been evolved during the years. The last updating has been introduced with the Ministerial Decree of 3 August 2015 (DM 8/15), which contains a new approach to the fire safety design of activities and facilities subject to the fire authority control. This DM 8/15 is commonly recognized among Italian fire officers and fire practitioners as the Fire Prevention Code (FPC). FPC was developed within the Italian Department of firefighters (CNVVF) safety engineers and fire practitioner experts aiming to simplify and rationalize the fire safety design of activities subjected to fire inspection.

The DM 3 August 2015 introduced a new engineering approach to fire safety, performance-based fire design. The application of the principles of fire safety engineering allows, similarly to other engineering disciplines, to define suitable solutions for achieving design goals by means of quantitative analysis. The designer defines the purpose of the project, then specifies the fire safety objectives he intends to guarantee and translates them into quantitative performance thresholds. He then identifies the design fire scenarios, the worst case fire scenario that can reasonably be expected to occur in the activity. Then, using analytical or numerical modelling tools, it describes or calculates the effects of the design fire scenarios in relation to the assumed design solution for the activity. If the effects thus calculated maintain an adequate margin of safety with respect to the previously established performance thresholds, then the design solution analysed is considered acceptable.

The performance design methodology consists of two phases:

a. first phase, preliminary analysis, in which the steps are formalised that lead to identifying the most representative conditions of the risk to which the activity is exposed and which are the performance thresholds to refer to in relation to the safety objectives to be pursued;
b. second phase, quantitative analysis in which, using calculation models, the quali-quantitative analysis of the effects of fire is carried out in relation to the objectives assumed, comparing the results obtained with the performance thresholds already identified and defining the project to be submitted for final approval.

With regard to nuclear installations, fire safety is also based on the specific legislation concerning nuclear installations and nuclear activities.

In particular, Dlgs 101/2020, which is the basic law that establish national general provisions for the peaceful use of nuclear energy, sets up the requirements that nuclear installations have to be authorized on the basis of a “safety report”, indicating, among others, the measures required for fire prevention and protection.

The same legislative decree refers also to the “*Technical Guides*” drawn up and published by ISIN developed on the basis of international standards and good technical practice in the field of nuclear safety and health protection.

Technical guides issued by ISIN are regulatory documents by which ISIN discloses best practices on operational and technical measures to implement legislative provisions in the field of nuclear safety and radiation protection, as well as project criteria. Compliance with Technical Guides is verified by the Competent Regulatory Authority during the licensing process based upon assessment and demonstrations provided by the operator. Some thirty Technical Guides have been issued on Safety and Radiation Protection matters ranging from procedural to detailed technical guidance.

In these technical guides, relevance is given to the measures provided for fire prevention and protection.
In particular, in the technical guides, considering the Italian specificity, the 'Fire Prevention and Protection Programme' is required for nuclear installation decommissioning, which must contain the Fire Risk Assessment guidelines for the definition of fire prevention and protection measures for each operation relevant to nuclear safety and radiation protection during decommissioning. It provides a framework for the administrative controls to be put in place for the achievement of fire safety objectives and identifies emergency management procedures.
The Technical Guide for radioactive waste and spent fuel storage facilities also prescribes that fire prevention and protection measures should be defined according to the storage facility's fire risk assessment and should be based on the general criteria of defence in depth, which provides for the adoption of fire prevention, control, detection and extinguishing measures. The same technical guide confirms the concept that fire protection systems must be designed in accordance with the applicable national regulations and international standards of good practice.

Moreover, conditions and technical specifications attached to the authorization of the nuclear installations establish specific requirements attaining the management of the fire risk and the maintenance and testing of fire protection provisions.

In addition, the existing wealth of international recommendations, such as IAEA (International Atomic Energy Agency) and ICRP (International Committee on Radiological Protection) publications, has been largely used in the Italian system.

International safety standards

- IAEA SSR3 Safety for Research reactors (points 19,32,61,79)
- IAEA Safety series No. 50-SG-D2 Fire protection in Nuclear Power Plants
- IAEA-TECDOC-778 Fire Hazard Analysis for WWER Nuclear Power Plants
- WENRA: Report Safety Reference Levels for Existing Research Reactors, November 2020.
- WENRA: Report Waste and Spent Fuel Storage Safety Reference Levels, Report of Working Group on Waste and Decommissioning (WGWD), Version 2.2, April 2014.
- WENRA WGWD: Report Decommissioning Safety Reference Levels - Version 2.2, 22 April 2015.
- DOE 5480.7A Fire Protection
- US NRC Regulatory Guide 1.191 – Fire Protection Program for Nuclear Power Plants During Decommissioning and Permanent Shutdown
- Eurocode 1 UNI EN 1991-2:2004. Part1-2 Action for fire resistant structures.
- ISO/TC 92/SC 4N 97
- ISO 23932:2009 FSE – General principles.
- ISO/TR 13387-1 FSE – Part 1: Application of fire performance concepts to design objectives.
- ISO/TS 16733 Fire safety engineering - Selection of design fire scenarios.
- ISO 16732-1 Fire safety engineering - Fire risk assessment.
- BS 9999 Code of practice for fire safety in the design, management and use of buildings, British Standards Institution (BSI)
- BS 7974:2001 Application of FSE principles to the design of buildings – Code of practice.
- BS PD 7974-0:2002 Application of FSE principles to the design of buildings – Part 0: Guide to design framework and FSE procedures.
- NFPA 101 Life Safety Code, National Fire Protection Association
- NFPA 551 Guide for the evaluation of fire risk assessment.
- NFPA 92 Standard for smoke control systems.
- NFPA 555 Guide on methods for ealuating potential for room flash over.
- NFPA 801 Standard for Fire Protection for Facilities Handling Radioactive Materials International Fire Code 2009, International Code Council
- UNI 9795 Automatic fire detection and fire alarm systems - Design, installation and operation
- UNI EN 1838 Lighting applications - Emergency lighting

Technical Guides

The main reference Technical Guides for the management of Radioactive Waste, issued by ISIN, in which fire safety aspects are included are:

- Technical Guide No. 30 (Safety and Radiation Protection Criteria for Radioactive Waste and Spent Fuel Storage Facilities) (2020).
- Technical Guide No. 31 (Safety and Radiation protection criteria for the nuclear installations Decommissioning) (2022).
- Technical Guide No. 32 (Safety and Radiation Protection Criteria for Near Surface Radioactive Waste Disposal Facilities) (2022)

Technical standards

- VVF Cert - Products approved and certified by the VVF
- SFPE Handbook for fire Protection Engineering
- SFPE Engineering Guide to Performance-Based Fire Protection (2007). 2nd edition.

Methods, data and analytical tools

- FMEA analysis for the evaluation of risks and improvement situations, SWOT analysis to highlight Strengths, Weaknesses, Opportunities of improvement, and Threats

1.2.2. Implementation/Application of international standards and guidance

Within the framework of Italian national regulations, as far as nuclear installations are concerned, fire protection in relation to the possible degradation of safety functions and the release of radioactivity into the environment is regulated within the technical guides (TGs) issued by Isin.

These TGs, also on the basis of international standards, lay down requirements for fire protection against fires involving radioactive waste stored at installations and the decommissioning operations themselves.

In the TGs, the reference abnormal and accidental events for safety analysis are considered in detail. In general, reference abnormal and accidental reference events for safety analysis are referred to within two main categories: internal (on-site) events and off-site events, the latter further subdivided into natural and man-made phenomena.

As far as fire safety is concerned, this is mainly in the area of internal events, i.e. those whose driving causes originate within the installation, whether related to problems with the installation's structures or to human error on the part of the installation personnel. Secondly, although not of less importance, fires caused by off-site events, i.e. those whose causes cannot be traced back to the installation's structures or personnel, must be considered.

For installations under decommissioning, TG 31 requires the licensee to submit a Fire Prevention and Protection Programme, which must contain guidelines for the Fire Risk Assessment ("VRI" according to the Italian acronym) and the definition of fire prevention and protection measures for each operation relevant to nuclear safety and radiation protection during decommissioning.

The topics contained in the VRI cover the identification of fire hazards, the description of environmental conditions, the assessment of fire risk and radiological hazards, and the identification of fire prevention and protection measures.

The programme also provides an outline of the administrative controls to be put in place for the achievement of fire safety objectives and identifies the modalities for both nuclear and conventional emergency management.

The above-mentioned analysis of accidental events, referred to as "Safety Analysis", assumes the fire risk analysis of the installation subject to decommissioning activities.

For waste storage facilities, reference must be made to TG 30 in which ample space is given to the contents of the fire risk assessment, specifically requiring the application of the general criterion of defence in depth, which requires the adoption of fire prevention, control, detection and extinguishing measures at different levels.

As part of the safety analyses, the radiological consequences of the worst case fire scenario that could develop in the storage facility must be assessed, considering the presence of permanent and temporary fire loads over the lifetime of the storage. The possible modes and mechanisms of radioactivity release in the event of a fire from any type of waste stored in the repository must be defined. Possible releases of toxic substances in the event of fire must also be assessed.
The application and implementations of international standards and technical guides are given in the sections on single installations whose self-assessments are given in *Annexes*.

It must be considered that there are very few operators in the Italian scenario. In particular, with the exception of the Research reactors (Type A installations) and the ESSOR-D-C and Avogadro AFR plants, the Installations under decommissioning (Type D installations) are operated by a single operator (SOGIN SPA), which therefore generally adopts the same approach to fire protection for all its plants, taking into account, however, the different activities carried out, their specific features and characteristics.

2. Fire Safety Analyses

This chapter reports details on the assessment and conclusion of the regulator, in accordance to technical specifications.

The other sections on Fire Safety Analyses, developed in accordance with the Techical Specification, are reported for each installation in the annexes.

2.1. Nuclear power plant (not applicable)

This session is **not applicable** for the Italian situation as there are no NPPs in operation.

A.2.2 Research reactors (RRs)

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

This paragraph describes the regulator's conclusions on fire safety analyses, considering the self assessment documents provided by the licensee of **research reactors** and the results of ISIN inspections and assessments as part of the regulatory oversight. The candidate reactors are the LENA Triga Mark II operated by the University of Pavia and the Tapiro reactor operated by ENEA. Tapiro reactor is currently not operating, in view of an improvement program to be implemented.

A.2.2.7.1 Overview of strengths and weaknesses identified by the regulator

For the **LENA Triga Mark II** research reactor ISIN identifies the following *strengths:*

1. limited source factor and fire loads;
2. conduction of regular tests and monitoring of the fire systems/fire-fighting organization with periodic drills and a strong collaboration between local fire brigade and operation centre firefighters.
3. policy, procedures, training programs to continuously improve the safety culture, both for management and employees.

and *weaknesses:*

1. Poor policy for turnover of retired employees: as a public institution the unavailability of new personnel can lead to a know-how loss;
2. need to acquire additional human resources;
3. need to have access to specialist personnel for evaluating and managing possible fire hazards within the internal reactor organization structure (specialists are with city firefighters for LENA and with ENEA operations centre);

For the **Tapiro** research reactor ISIN identifies the following *strength:*

1. limited source factor and fire loads;

and *weaknesses:*

1. A Fire Hazard Analysis (FHA) has been recently developed, in response to a request of ISIN. It is however to be complemented an assessment on the possible effects of a fire in front of the worst scenario, with demonstration of the capability of the final prevention and protection system to preserve key safety functions.

A.2.2.7.2 Lessons learned from inspection and assessment as part of the regulatory Oversight

For the LENA Triga Mark II research reactor. The last inspection with attention on fire safety aspects was performed on September 2023 as part of the regulatory Oversight with positive results considering documentation and field implementation.

For the Tapiro Fast neutron research reactor: the regulatory oversight conducted on the received documentation leads to the conclusion that fire safety aspects require a close monitoring. In relation to the improvement program to be implemented, additional technical demonstrations will be required in the near future and inspection conducted.

A.2.2.7.3 Conclusions drawn on the adequacy of the licensee's fire safety analyses

For the LENA Triga Mark II research reactor the deterministic fire safety analyses (Fire Hazard Analysis - FHA) is considered adequate and in compliance with the legislation in force. The FHA is also supported by a simplified probabilistic method for event combinations. A full probabilistic safety analyses is not foreseen.

For the Tapiro Fast neutron research reactor: a fire hazard analysis has been only recently conducted. It needs some additional analyses and demonstrations to be provided, that will be supervised by ISIN.

2.2. Fuel cycle facilities (not applicable)

This session is **not applicable** for the Italian situation as there are no Fuel cycle facilities in operation.

B.2.3. Dedicated spent fuel storage facilities

B.2.3.7. Regulator's assessment and conclusions on fire safety analyses

This paragraph describes the regulator's conclusions on fire safety analyses, considering the self assessment document provided by the operators on the facilities located on **ITREC-plant site** (wet and dry), on the two facilities located in the **ESSOR-B-plant site** (wet and dry) **and on the Avogadro spent fuel wet storage** based upon the results of ISIN inspections and assessments as part of the regulatory oversight.

B.2.3.7.1 Overview of strengths and weaknesses identified by the regulator

Spent fuel pool at ITREC site

Strenght
It is considered that, due to its age, the spent fuel stored in the pool is quite old and therefore there is no need for an active heat removal.

Weaknesses
The facility is quite old, and the fire safety system was designed according to fire hazard analysis based on an older approach. A plan is however under implementation to transfer spent fuel into a dry storage facility under construction. The implementation of this plan will ensure a substantial improvement in the safe management of spent fuel, also from a fire safety point of view.

Dry storage at ITREC site

Strenght
A new fire hazard analysis has been conducted as part of application documents submitted for construction approval, according to updated standards. The desing avails also of the strong capabilities and qualification of storage casks to withstand fires.

Weaknesses
No particular weaknesses are identified.

Spent fuel pool at ESSOR-B-plant site

Strenght
It is considered that, due to its age, the spent fuel stored in the pool is quite old and therefore there is no need for an active heat removal.

Weaknesses
The facility is quite old, and the fire safety system was designed according to fire hazard analysis based on an older approach. A plan is however under implementation to transfer spent fuel into the TSA dry storage facility. The implementation of this plan will ensure a substantial improvement in the safe management of spent fuel, also from a fire safety point of view.

Dry storage at ESSOR-B-plant site

Strenght
A new fire hazard analysis has been conducted as part of application documents submitted for construction approval, according to updated standards. The desing also avails of the location of the spent fuel structure into a hot cell, where a high level of prevention of fire can be achieved and containment structures are qualified also to fire.

Weaknesses
No particular weaknesses are identified.

Spent fuel pool at Avogadro plant site

Strenght

It is considered that, due to its age, the spent fuel stored in the pool is quite old. Even if the water pool cooling system is not redundant, there are large margin for decay heat removal performed by natural circulation.

Weaknesses

The facility is quite old, and the fire safety system was designed according to fire hazard analysis. The fire hazard analysis has been conducted following national legislation and is periodically updated. The resulting provisions have an old design. Due to the ageing of the installations, there is a plan to remove the spent fuel from the pool, to be sent abroad for reprocessing.

B.2.3.7.2 Lessons learned from inspection and assessment as part of the regulatory Oversight

For the **dedicated spent fuel storage plants** there are no particular Lessons learned to report. There were no fire events and no ISIN requirements as result of inspections and assessments as part of the regulatory Oversight. Documentation controls and verfications for the fire protection certificate updates, which is foreseen every 5 years, together with compliance with Fire Authority prescriptions have been successfully performed. In particular:

For the ITREC-plant dedicated spent fuel storage: An inspection with attention on fire safety aspects has been recently performed (July 2023) as part of the regulatory Oversight.

For ESSOR-B-plant dedicated spent fuel storage: The last inspection with attention on fire safety aspects was performed on October 2022 as part of the regulatory Oversight.

For Avogadro AFR dedicated spent fuel storage: The last inspection with attention on fire safety aspects was performed on September 2023 as part of the regulatory Oversight with positive results considering documentation and field implementation.

B.2.3.7.3 Conclusions drawn on the adequacy of the licensee´s fire safety analyses

For the dedicated spent fuel storage facilities, the fire safety analyses is considered adequate and in compliance with laws and regulations based on the a fire hazard analysis prescriptive approach. It is commensurate to the fire risk present in the facilities, according to the defence in depth principle and graded approach. Wet storage facilities (ITREC spent fuel, ESSOR pool and Avogadro storage facilities) are very old and for all of a program for spent fuel transfers is ongoing (for ITREC and ESSOR spent fuel into dry storage facilities and for Avogadro to be sent abroad for reprocessing). Particular attention is given to maintain and, if necessary strengthen preventive provision as well as to preserve efficiency and operability of existing fire safety systems.

Furthermore, it has to be considered that the residual heat of spent fuel still in storage in the pools is very low and also in the absence of the dedicated cooling systems the heat removal function can be assured by the evaporation of the water in the pool.

For the two dry storage facilities they are based on new designs (ESSOR TSA entered into operation in 2022; ITREC dry storage is under construction) and they avail of new fire protection systems and components.

For all the facilities, FHA demonstrates that any credible fire scenario doesn’t lead to an unacceptable radioactive release to the public and environment.

C.2.4. Waste storage facilities on the sites of nuclear installations

C.2.4.7. Regulator’s assessment and conclusions on fire safety analyses

The following regulator and assessment and conclusions refers to the fire safety analysis conducted for the following installation:

- D1 and D2 storage facilities at Trino NPP site.
- Building 2300, D2 and NPS/800 area at Eurex plant site.
- OPEC 2 waste storage facility.

C.2.4.7.1 Overview of strengths and weaknesses identified by the regulator

Strenghts

For all the assessed candidate installations listed above, no particular strengths have been identified for fire safety analysis.

Weaknesses

For the facilities D1 and D2 of Trino, Building 2300 of Eurex and Area 800 of Eurex a fire hazard analysis according to national legislation has been performed and regularly updated. The facilities are however quite old and the fire protection systems are obsolete. A plan to transfer waste into new storage facilities is ongoing. For liquid waste of Area 800 it will before imply their conditioning. The new facilities have an updated fire hazard analysis and new fire protection systems are realized, as for example in D2 facility of Eurex which started operation in 2020.

For the D2 and NPS liquid waste storage facilities of Eurex and for OPEC2 waste storage facilities, no weaknesses are identified.

For all the facilities, a detailed safety analysis of the radiological impact consequent to a fire has been conducted based on conservative assumptions to verify compliance with radiation protection objectives.

In particular, In the case of **2300 storage facility**, the fire scenario is the worst for the Saluggia site and it has been assumed as the main critical event in the impact Analysis for the Off-site Emergency Plan. For this purpose, the transfer of the radioactive waste from 2300 to D2 radioactive waste storage facility is ongoing.

The fire safety analyses developed for all the waste storage facility included in this TPR are developed according the legislation in force. They take into account the general characteristics of the facilities which influence the fire safety analysis (e.g. presence of non conditionated waste, evaluation of combustible materials, presence and type of compartements, presence or absence of active systems or components, identification of SSCs importants to safety, …) according to a graded approach and to the defence in depth principle.

Moreover, the fire safety analyses describe the absence of fire events to be reported or investigated (paragraph about *Lessons learned from events, reviews, fire safety related mission,…)* for almost of the described radioactive waste storage facilities.

C.2.4.7.2 Lessons learned from inspection and assessment as part of the regulatory Oversight

As result of Inspections and regulatory oversight conducted by ISIN on the candidate waste storage facilities, the conducted fire safety analysis for these installations is resulted in compliance with established safety requirements. Documentation controls and verfications for the fire protection certificate (*“Certificato Protezione Incendi” – CPI*) updates, which is foreseen every 5 years, together with compliance with Fire Authority prescriptions have been successfully performed.

C.2.4.7.3 Conclusions drawn on the adequacy of the licensee's fire safety analyses

It can be evaluated that the fire safety analyses for the radioactive storage facilities have been properly conducted and they are in compliance with the legislation in force.

They have been developed using a methodolody appropriate and commensurate to the fire risk present in the facilities, according to the defence in depth principle. The analyses often include the development of scenario of complete ignition of combustible materials in the storage facility, assuming no intervention of the suppression system, evaluating the consequences from the radiological point of view for the public and the environment. In the case that these consequences are not acceptable, the operator begins the licensing process for the modification of the storage facilities according to the TG n. 30 (e.g. **2300 storage facility in EUREX** plant and **D2 storage facility in Trino NPP**).

D.2.5. Facilities under decommissioning

D.2.5.7. Regulator's assessment and conclusions on fire safety analyses

The following regulator's assessment and conclusions refers to the fire safety analysis conducted for the following facilities under decommissioning or safe store:

- Trino NPP (under decommissiining).
- Latina (under decommissioning).
- ESSOR-D-C (pre-decommissioning/safe store).
- Eurex FCF (pre-decommissioning/safe store).

D.2.5.7.1 Overview of strengths and weaknesses identified by the regulator

Strengths

For all installations a fire hazard analysis has been conducted according to the national legislation.

For Trino NPP and Latina NPP, for which a decommissioning license has been already granted, all decommissioning operations relevant for nuclear safety and radiation protection, has to be assessed in front of a fire protection program with the development of a specific analysis, covering both the prevention measures and protection implemented measures (for example the adopted procedures for minimizing introduced fire loads, potential ignition sources and worplaces management, as well as assessment o radiological impact consequent to a fire).

A en example worth of mention, **In the case of Latina NPP**, beside the qualitative fire risk assessment, the licensee has performed in the fire safety analysis a quantitative analysis by using a specific calculation code to evaluate the fire loads and weighting factors associated to different scenarios analized which contributes to estimate the overall fire probability.

For ESSOR-D-C and Eurex FCF a fire hazard analysis has also been conducted according to the national legislation. For these installations, when pre-decommissioning activities are conducted, Operational Plans approved by the regulator has to be prepared, including a fire safety assessment of the involved operations.

Weaknesses

No particular weaknesses are identified.

D.2.5.7.2 Lessons learned from inspection and assessment as part of the regulatory Oversight

As result of Inspections (in the years 2022 and 2023) and the continuous regulatory oversight conducted by ISIN on the candidate waste storage facilities, the conducted fire safety analysis for these installations is resulted in compliance with established safety requirements. Documentation controls and verfications for the fire protection certificate (*"Certificato Protezione Incendi" – CPI*) updates, which is foreseen every 5 years, together with compliance with Fire Authority prescriptions have been successfully performed.

D.2.5.7.3 Conclusions drawn on the adequacy of the licensee´s fire safety analyses

For the four facilities under decommissioning the fire safety analyses, based on fire hazard analysis as methodology as required by the legislation, can be considered satisfactory and in compliance with legislative prescriptions and requirements. The fire hazard analysis is complemented with an assessment of potential radiological consequences associated to a fire event to demonstrate that they remain below the established radiation protection objectives.

3. Fire Protection Concept and its Implementation

This chapter reports details on the assessment and conclusion of the regulator, in accordance to technical specifications.

The other sections on Fire Concept and its implementation, developed in accordance with the Techical Specification, are reported for each installation in the annexes.

A.3.1 Fire Prevention – Research reactors (RRs)

This section reports the Regulator's assessment of the fire prevention measures for **Lena Triga Mark II** reactor and **Tapiro Fast neutron reactor.**

A.3.1.4. Regulator's assessment of the fire prevention

A.3.1.4.1. Overview of strengths and weaknesses in the fire prevention

Strenghts

No particular strengths in the fire prevention can be identified.

Weaknesses

For Tapiro Fast neutron reactor the fire hazard analysis has identified the need to improve the exisiting measures for fire prevention. There is therefore the need to improve existing procedures and personnel training.

A.3.1.4.2. Lessons learned from inspection and assessment on the fire prevention as part of its regulatory oversight

As far as the **Lena Triga Mark II** reactor is concerned, the fire risk assessment, in relation to the prevention measures, is the result of an ongoing study on the basis of new experiences related to the operation of the reactor and the possible impact on the ignition sources and fire loads and the maintenance of compliance requirements based on the upgrading of the systems and/or their ageing.

The dual control of fire prevention, both by ISIN and by the local fire brigade, has led to a continuous re-evaluation of prevention measures and systematic checks also by the operator, supported by an integrated management system.

For the **Tapiro Fast neutron reactor**, the licensee is in the process of of re-evaluating its fire prevention measures and a proposal will be submitted to the regulator.

A.3.5. Regulator's assessment of the fire protection concept and conclusions - Research reactors (RRs)

With regard to the **Lena Triga Mark II** reactor, it should be noted that it is equipped with the fire-protection systems envisaged in the fire hazard analysis, and in accordance with the applicable regulatory provisions, as reported in the authorisation documents.
These fire protection systems are adequate for the specific installation, correctly operated and maintained.
The regulator during its inspections and oversight activities, the following is verified:

- the actual presence of the extinguishing systems and their efficiency;
- the correct recording of periodic checks and maintenance work on the systems, equipment and other fire safety systems;
  the proper functioning of fire-fighting systems;
- the training, equipment and drills of fire-fighting personnel.

With regard to the **Tapiro Fast neutron reactor**, it should be noted that the installation is currently not in operation and the implemented fire protection concept is under revision as result of fire hazard analysis.

B.3.1 Fire Prevention – Dedicated Spent Fuel Storage Facilities

This section reports the Regulator's assessment of the fire prevention measures for the spent fuel wet and dry facilities at ITREC plant, at ESSOR-B plant and for the spent fuel pool of Avogadro.

B.3.1.4. Regulator's assessment of the fire prevention

B.3.1.4.1. Overview of strengths and weaknesses in the fire prevention

Strenghts

No particular strengths in the fire prevention can be identified.

Weaknesses

No particular weaknesses in the fire prevention can be identified.

B.3.1.4.2. Lessons learned from inspection and assessment on the fire prevention as part of its regulatory oversight

For spent fuel storage facilities (spent fuel wet and dry facilities at ITREC plant, at ESSOR-B plant and for the spent fuel pool of Avogadro), it is verified that procedures to ensure an adequate level of fire prevention are applied. In the case of ESSOR spent fuel a program to remove no more usable combustible cables is ongoing.

For dry storages, the presence in the different areas of fixed combustible materials is minimized by design. A continuous check of implemented measures is performed. In the case of fuel handling, in particular associated to transport operations, specific plants operations, also detailing the adopted fire prevention provisions, have to be presented by the licensee and approved by the Regulator.

For the facilities in question, the fire risk assessment, in relation to preventive measures, is the result of an ongoing study on the basis of changes due to new experiences related to changing fire loads and the maintenance of compliance requirements based on system upgrades and/or ageing. The dual control of fire prevention, both by ISIN and by the local fire brigade, has led to a continuous re-evaluation of prevention measures and systematic checks also by the operator, supported by an integrated management system.

B.3.5 Regulator's assessment of the fire protection concept and conclusions – Dedicated Spent Fuel Storage Facilities

The installations under consideration are equipped with the fire protection systems (detection active and passive protection) provided as resulting from for in the fire hazard analysis, and in accordance with the applicable regulatory provisions, as stated in the authorisation documents.

These fire protection systems are adequate for the specific installation, correctly operated and maintained. The regulator during its inspections and oversight activities, the following is verified:

- the actual presence of the extinguishing systems and their efficiency;
- the correct recording of periodic checks and maintenance work on the systems, equipment and other fire safety systems;
- the proper functioning of fire-fighting systems;
- the training, equipment and drills of fire-fighting personnel.

The following aspects can be highlighted for individual installations:

For ITREC wet spent fuel storage facility, in the transition phase before transferring the fuel into the new dry storage facility, the strenghtening of the fire detection function could be evaluated.

It is considered that for older spent fuel storage installations the need for some improvments concerning the interruptible power supply for detection and alarm systems should be verified. This function is generally ensured by the integrated battery system with which the fire alarm control panels are equipped. The signalling of cable connection faults is also implemented through the insulation control performed by a specific function of the fire control units. These control units, in turn, have the possibility of reporting such signals to the control room via the comulative fault signals.

For Avogadro and ESSOR spent fuel pool, in the transition phase before the removal of the fuel, in relation to the ageing of the detection and alarm systems, a general review should be conducted to verify the need for replacement.

With regard to ventilation systems, in old spent fuel wet storage facilities (ITREC, ESSOR-B and Avogadro), fire dumpers are not present. It has however to be considered that, for these facilities, the transfer of the spent fuel into new dry storage facilities, (ITREC and ESSOR) or abroad for reprocessing (Avogadro) is envisaged. In this perspective, the attention for the remaining time of operation, should be addressed to strengthen preventive and active fire protection capabilities.

C.3.1 Fire Prevention – Waste Storage Facilities

This section reports the Regulator’s assessment of the fire prevention measures for the waste storage facilities (D1 and D2 storage facilities at Trino NPP site, Building 2300, D2 and NPS/800 area at Eurex plant site, OPEC 2 waste storage facility.) on the installation sites.

C.3.1.4. Regulator’s assessment of the fire prevention

C.3.1.4.1. Overview of strengths and weaknesses in the fire prevention

Strenghts

No particular strengths in the fire prevention can be identified.

Weaknesses

No particular weaknesses in the fire prevention can be identified.

C.3.1.4.2. Lessons learned from inspection and assessment on the fire prevention as part of its regulatory oversight

It is found that strategies are adopted to mitigate fire risk through the application of the criterion of defence in depth by minimising fire loads, control of ignition sources and adequate fire compartmentation and detection systems. Moreover, for combustible waste, the facilities loading procedures are verified and optimized in relation to their internal distribution (so as to avoid any local concentration of combustible waste). In addition, conditioning programs are ongoing.

It is considered that an evaluation of the implemented prevention measures that is regulary conducted, according to the development of the fire regulations, the re-assessment during the submission of documentation for authorization/approval.

The double check on fire prevention carried out by both the regulator and the local fire brigade led to a continuous re-evaluation of the prevention measures and systematic checks also by the operator with punctual records of all interventions carried out on fire prevention and protection measures.

C.3.5. Regulator’s assessment of the fire protection concept and conclusions - Waste Storage facilities

In relation to **active fire protection**, suitable detection, alarm and extinguishing systems of different technologies are in place in the installations. These devices are provided as a result of the fire risk assessments of the individual installations.

All extinguishing systems are also subject to inspection and maintenance procedures as established in the technical prescriptions attached to the authorization.

The following aspects, specific for individual installations, can be highlighted.

In the case of OPEC2 storage facility, the type of stored waste is taken into account in the selection of the estinguishing system. In particular, due to the presence of waste contaminated with plutonium, the use of only CO2 estinguishers is envisaged.

New waste storage facilities, like the facility D2 of Eurex (into operation) and D2 of Trino (to be constructed), for which the fire suppression strategy is based on the use of hydrants, the water used to estinguish the fire, is collected in dedicated tanks by means of suitable drenage system realized in the floor of the facility. This in order to provide the control of any possible contamination released to the environment.

With regard to **passive fire protection**, in all installations adequate compartments and qualified barriers are installed. In new storage facilities, when the design envisages ventilation systems like D2 of Eurex, fire dumpers are installed.

With regard of **administrative and organisational fire protection issues**, the firefighting approach adopted in installations and also for waste storage facilities located in their sites, is based on the availability of internal firefighting resources, with the important contribution of the local fire brigade command. In this regard, specific training programs and drills are conducted, also to enhance coordination between the personnel of the installation and the external response team, as well as the knowledge of installation and the existing hazards

D.3.1 Fire Prevention – Installation under decommissioning

This section reports the Regulator's assessment of the fire prevention measures for the installations under decommissioning (Latina and Trino NPPs and EUREX FCF in pre-decommissioniing/safe storage).

D.3.1.4. Regulator's assessment of the fire prevention

D.3.1.4.1. Overview of strengths and weaknesses in the fire prevention

<u>Strenghts</u>

No particular strengths in the fire prevention can be identified.

<u>Weaknesses</u>

No particular weaknesses in the fire prevention can be identified.

D.3.1.4.2. Lessons learned from inspection and assessment on the fire prevention as part of its regulatory oversight

It is found that strategies are adopted to mitigate fire risk through the application of the criterion of defence in depth by minimising fire loads, control of ignition sources and adequate fire compartmentation and detection systems.

It is also considered that, an evaluation of the implemented prevention measures that is regulary conducted, according to the development of the fire regulations and the re-assessment during the submission of documentation for authorization/approval. In particular, for any decommissioning operation relevant to safety, a specific Plan of Operation has to be submitted by the licensee and approved by ISIN. The standard content of these plans must contain the demonstration of specific adopted preventive measures.

For the particular case of Latina Magnox NPP, the reactor core which represents a significant fire load, in isolated from the external environment by sealed plugs.

In some cases, like ESSOR FCF plant, a program to remove no more usable combustible cables is ongoing.

The double verification on fire prevention carried out by both the regulator and the local fire brigade led to a continuous re-evaluation of the prevention measures and systematic checks also by the operator with punctual records of all interventions carried out on fire prevention and protection measures.

D.3.5. Regulator's assessment of the fire protection concept and conclusions - Installation under decommissioning

All the installations equipped with fire protection systems (alarm and detection, active and passive protection) foreseen in the fire hazard analysis, and in accordance with the applicable regulatory provisions, as stated in the authorisation documents.

These systems are adequate for the specific installation, correctly operated and maintained.

During the Regulator's inspections and oversight activities, the following is verified:

- the actual presence of the Extinguishing Systems and their efficiency;
- the correct recording of periodic checks and maintenance operations on the systems, equipment and other fire safety systems;
- the proper functioning of fire-fighting systems;
  the training, equipment and drills of fire-fighting personnel.

For the **ESSOR D-C** and **EUREX** installations, it must be specified that the systems and components, although not in line with current technology, are continuously maintained to ensure their proper functioning.
For Trino and Latina NPPs, in view of relevant dismantling activities in area relevant for nuclear safety and radiation protection point of view, systems important for the conduction of the relevant operation (for example ventilation systems) have been refurbished, also taking into account fire safety requirements.

With regard of **administrative and organisational fire protection issues**, the firefighting approach is based on the availability of internal firefighting resources, with the important contribution of the local fire brigade command. In this regard, specific training programs and drills are conducted, also to enhance coordination between the personnel of the installation and the external response team, as well as the knowledge of installation and the existing hazards. The specific case of JRC Ispra site, characterized by an internal fire brigade structure, has to be positevly highlithed.

3.6. Conclusion on the adequacy of the fire protection and its implementation

With regard to ***fire prevention*** all the assessed candidate installations adopt proper measures to prevent fires to start (strict control of fire loads, ignition sources, appropriate management of workplaces), consisting of establishing procedures periodically verified.

For the Tapiro research reactor, a review and consequent updating of fire prevention measures is ongoing.

For spent fuel storage facilities (spent fuel wet and dry facilities at ITREC plant, at ESSOR-B plant and for the spent fuel pool of Avogadro), procedures to ensure an adequate level of fire prevention are applied. In the case of ESSOR spent fuel a program to remove no more usable combustible cables is ongoing.

In relation to *waste storage facilities*, programs to condition combustible wastes are in place with the aim to reduce the contaminated fire loads.

Furthermore, procedures to optimize the distribution of combustible waste insiede storage facilities are applied.

For installations under decommissioning, detailed regulatory oversight is conucted on relevant dismantling and material treatment operations, which includes assessment of adopted fire prevention measures.

For the particular case of Latina Magnox NPP, the reactor core which represents a significant fire load, in isolated from the external environment by sealed plugs.

Fire detection and fire alarm devices are implemented on the installations on the basis on the results of fire hazard analysis. For the Tapiro reactor a revision of the needed devices is ongoing.

For ITREC wet spent fuel storage facility, in the transition phase before transferring the fuel into the new dry storage facility, the strenghtening of the fire detection function could be evaluated.

It is considered that some improvments could be implemented by equipping detection and alarms with a non interruptible power supply. This function is generally ensured by the integrated battery system with which the fire alarm control panels are equipped. The signalling of cable connection faults is also implemented through the insulation control performed by a specific function of the fire control units. These control units, in turn, have the possibility of reporting such signals to the control room via the comulative fault signals.

One aspect worth to be highlighted concerns the ageing of the fire detection and alarm systems. In installations **Lena Triga Mark II (RR)** and **Avogadro AFR** these systems are quite old or at least not up-to-date from a technological point of view and a general review is necessary as also required by an updated technical standard on the subject (UNI 11224).

In relation to **active fire protection**, suitable extinguishing systems of different technologies (hydrants, mobile estinguishers) are in place in the installations. These devices are provided as a result of the fire risk assessments of the individual installations. However, it should be noted that for the **Tapiro (RR)**, which is currently not into operation, the main weaknesses concern the not full implementation of the fire prevention and protection systems on the basis of the risk analysis just developed.

In general, outside the buildings there is a loop network of fire water distribution and a system of hydrants (internal standpipes) so that there is adequate coverage of all areas of the plant. There is also a system of internal hydrants, where water is not a source of damage.

Also for research reactors the same measures are provided outside (external loop), while inside, where the use of water is not allowed, suitable manual extinguishing systems are adopted.

In the case of OPEC2 storage facility, where waste contaminated with plutonium is stored, the use of only CO2 estinguishers is envisaged.

New waste storage facilities, like the facility D2 of Eurex (into operation) and D2 of Trino (to be constructed), for which the fire suppression strategy is based on the use of hydrants, the water used to estinguish the fire, is collected in dedicated tanks by means of suitable drenage system realized in the floor of the facility. This in order to provide the control of any possible contamination realesed to the environment.

All extinguishing systems are also subject to inspection and maintenance procedures as established in the technical prescriptions attached to the authorization.

To ensure the operation of fire protection measures, in particular fire barriers, fire detection and alarm systems, fire extinguishing systems, appropriate procedures are implemented through planned maintenance plans, the actions of which must be recorded in the fire records. They include visual examinations, inspections, maintenance.

With regard of **administrative and organisational fire protection issues**, the firefighting approach is based on the availability of internal firefighting resources, with the important contribution of the local fire brigade command. In this regard, specific training programs and drills are conducted, also to enhance coordination between the personnel of the installation and the external response team, as well as the knowledge of installation and the existing hazards. The specific case of JRC Ispra site, characterized by an internal fire brigade structure, has to be positevly highlithed.

In the specific case of LENA Triga Mark II (RR), the retirement of several emplyees is generating the issue of temporary shortage of skilled internal staff.

One critical aspect seems for Tapiro (RR) has also highlighted the lack of skills, training, and safety procedures which has to be addressed in the future.

For the research reactors, some improvements in procedures established in relation to emergency situations should be implemented in order to define the different responsibilities involving the site personnel.

Regarding **passive fire protection**, the use of a fire compartment approach and the use of barriers, is systematically adopted for the buildings of nuclear facilities. The fire resistance of the fire barriers of the compartment shall be conservatively determined on the basis of the fire load and shall be reported in the fire risk analysis.

In the considered **research reactors**, the building area containing the SSCs important for safety has adequate fire resistance adopted in accordance with the results of the fire hazard analysis.

With regard to ventilation systems, where present, they must be equipped with fire dumpers. In old spent fuel wet storage facilities (ITREC, ESSOR-B and Avogadro), they are not present. It has however to be considered that, for these facilities, the transfer of the spent fuel into new dry storage facilities, (ITREC and ESSOR) or abroad for reprocessing (Avogadro) is envisaged. In this perspective, the attention is addressed to strengthen preventive and active fire protection capabilities.

4. Overall Assessment and General Conclusions

The NAR has reported the assessment on fire protection related to the following types of installation:

- Research Reactors (Triga LENA Mark II, Tapiro Fast Reactor).
- Dedicated spend fuel facilities (ITREC wet and dry, ESSOR-B wet and dry, Avogadro).
- Waste storage facilities on nuclear installation sites (D1 and D2 waste storage facilities at Trino NPP, Building 2300, D2 and NPS/area 800 for liquid waste,).
- Installations under decommissioning (Latina Magnox reactor NPP, Trino PWR NPP, ESSOR research reactor in safe store/pre-decommissioning, Eurex reprocessing facility in safe store/pre-decommissioning).

The NAR is based on the self assessment conducted by the licensee and the evaluation performed by the regulator.

Fire protection of nuclear installations in Italy is regulated by the general legislative framework of fire protection, whose implementation is under the control of the national Fire Authority, as well as by specific requirements established in the legislation related to the safe peaceful use of nuclear energy, conditions and technical prescriptions attached to the authorization and technical guides issued by the Regulator (ISIN). The implementation of the defense in depth principle and the development of fire hazard analysis are a basic requirement.

Applicable WENRA SRLs are reflected into the ISIN technical guides, for example TG n. 30 on safety criteria of spent fuel and waste storage and TG n. 31 on safety criteria on decommissioning activities.

It is considered that the compliance with above listed legislative and regulatory provisions, is also in line with WENRA SRLs, that are applied according to the graded approach.

From the analysis of the self-assessments and the results of the regulator inspections and oversight conducted by the regulator, it is considered that licensees diligently apply the national regulations and international standards considering the specificity of their installations. They are evidently aware of the fire risk and the need to limit it, by applying the defense in depth principle with the objective to protect workers, the population and the environment. This in particular in relation to the possible releases of radionuclides resulting from a fire.

In accordance with national regulations, licensees adopt internal procedures to ensure the implementation of fire prevention measures and for the control and maintenance of fire detection, active and passive protection systems. All controls and inspections on fire prevention systems, carried out with the periodicity established by the regulations and surveillance procedures adopted for each installation, are recorded in fire registers as prescribed by the applicable regulations. These registers are also subject to inspection by the competent authorities.

In general, it can also be said that licensees are aware of the weaknesses of their fire prevention and protection system and the situations that need to be remedied.

As a result of the assessments carried out on all installations, the following can be considered.

A **Fire Hazard analysis** in line with the national legislation has been conducted for all the installations.
The *two research rectors (LENA Triga Mark II and TAPIRO Fast neutron)* share the common characteristic of a limited source factor and fire load compared to bigger nuclear installations.
Common weaknesses are to be found in the fire-fighting personnel for different reasons.
For the LENA reactor, we have a shortage due to personnel who have not yet been reintegrated following retirements (poor policy for turnover of retired employees).
This aspect is compensated for by a good safety culture of internal staff and strict collaboration with the fire brigade.

For the Tapiro reactor, the assessment has shown some deficiencies in staff training, in particular in the use of fire-fighting equipment.

For *spent fuel storage facilities*, the Fire Hazard Analysis is commensurate with the fire risk present in the facilities, according to the principle of defence in depth and graded approach. It demonstrates that any credible fire scenario does not lead to an unacceptable radioactive release to the public and the environment. In this regard, it should be pointed out that the residual heat of the spent fuel still stored in the pools is very low and that, even if there are no redundant cooling systems, in the event of their failure, the heat removal function can be provided by the evaporation of the water in the pool.
Moreover, all the wet storage facilities (ITREC, ESSOR, Avogadro) are quite old and for reasons related to their ageing, the removal of the spent fuel is planned in the near future. In particular, the spent fuel in ITREC will be transferred to dry storage facility under construction, while the spent fuel in the ESSOR will be transferred into a dry storage facility (TSA) into operation. The spent fuel of Avogadro is planned to be transferred abroad for reprocessing. This will substantially improve the same management of the spent fuel, including the aspects associated to fire safety. In the meantime, the current exisiting fire protection provision will be properly maintained.

Fire safety analyses developed for all *waste storage facilities* are well developed in accordance with current legislation and are sufficiently detailed. They shall take into account the general characteristics of the installations which influence the fire safety analysis, the state of the waste contained (conditioned or not), the presence and type of compartments, the presence or absence of active systems or components, identification of SSCs important for safety, ...) always according to a graded approach and the principle of defense in depth.

Some *waste storage facilities* are quite old and in these cases the transfer of the stored waste into new facilities (for example from Building 2300 of Eurex into the new D2 storage facility on the site), or a refurbishment project is ongoing (e.g. for D2 storage facility at Trino NPP). Also in this case the fire safety will be improved as the new facilities are built according to updated standards and equipped with new components.

When necessary, in the EUREX plant’s 2300 and D2 radioactive waste storages, the licensee studied the accident scenario of complete combustion of the fuel material contained in the packages and assessed the source term and the environmental consequences in terms of dose to the population and to the workers involved in the restoration operations and in terms of soil contamination. Also in the case of deposit 2300, the fire scenario is the worst for the site of Saluggia and has been taken as the main critical event in the impact analysis for the off-site emergency.

Some waste storages facilities are in a phase of renewal (such as Trino D2 and Eurex 2300), with the implementation of new systems and equipments, even including firefighting systems. However, in installations where obsolete detection and alarm system are installed with maintenance difficult to be implemented due to out of production, the replacement with a new system should be considered.

For *installations under decommissioning* (NPP Trino e Latina, ESSOR-D-C and EUREX FCF) a complete fire hazard analysis has been conducted and periodically updated, also following the progressive evolution of the plant configuration during the period of operation during decommissioning.

For any operation connected to decommissioning and relevant for nuclear safety, dedicated Operational Plans containing al the necessary safety demonstrations, including the assessment of the fire safety provisions in place, have to be developed by the licensee and approved by the regulator.

Where needed, as in the case of Latina NPP, in addition to the qualitative assessment of fire risk, the licensee carried out a quantitative analysis using a specific calculation code to assess the fire loads and weighting factors associated with the different scenarios analysed that help to estimate the overall probability of fire.

The fire hazard analysis conducted is, for any installation, complemented with a safety evaluation aimed at veryfing the potential radiological impact to the population in case of a radioactive release generated consequent to a severe fire reference scenario.

Fire detection and fire alarm devices are implemented on the installations on the basis on the results of fire hazard analysis. For the Tapiro reactor a revision of the needed devices is ongoing. For ITREC wet spent fuel storage facility, in the transition phase before transferring the fuel into the new dry storage facility, the strenghtening of the fire detection function could be evaluated.

One aspect worth to be highlighted concerns the ageing of the fire detection and alarm systems (for example **Lena Triga Mark II (RR)** and **Avogadro AFR**).

In relation to active fire protection, suitable **extinguishing systems of different technologies (hydrants, mobile estinguishers)** are in place in the installations. These devices are provided as a result of the fire risk assessments of the individual installations. However, it should be noted that for the **Tapiro (RR)**, which is currently not into operation, the main weaknesses concern the not full implementation of the fire prevention and protection systems on the basis of the risk analysis just developed.

It is the case to highlight that for new waste storage facilities, like the facility D2 of Eurex (into operation) and D2 of Trino (to be constructed), for which the fire suppression strategy is based on the use of hydrants, the water used to estinguish the fire, is collected in dedicated tanks by means of suitable drenage system realized in the floor of the facility. This in order to provide the control of any possible contamination realesed to the environment.

With regard of **administrative and organisational fire protection issues**, the firefighting approach is based on the availability of internal firefighting resources, with the important contribution of the local fire brigade command. In this regard, specific training programs and drills are conducted, also to enhance coordination between the personnel of the installation and the external response team, as well as the knowledge of installation and the existing hazards. The specific case of JRC Ispra site, characterized by an internal fire brigade structure, has to be positevly highlithed.

In the specific case of research reactors, concerns have been raised on the availability of skilled human resources and on the need of developing further addional training. The Tapiro RR deserves special attention as it requires a plan to adapt prevention and protection measures to ensure its safety before the authorization to operate.

Regarding **passive fire protection**, the use of a fire compartment approach and the use of barriers, is systematically adopted for the buildings of nuclear facilities. The fire resistance of the fire barriers of the compartment shall be conservatively determined on the basis of the fire load and shall be reported in the fire risk analysis.

In old spent fuel wet storage facilities (ITREC, ESSOR-B and Avogadro), they are not present. It has however to be considered that, for these facilities, the transfer of the spent fuel into new dry storage facilities, (ITREC and ESSOR) or abroad for reprocessing (Avogadro) is envisaged. In this perspective, the attention has to be addressed to strengthen preventive and active fire protection capabilities.

5. References to the NAR

- Council directive 2014/87/EURATOM of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations;
- Report Topical Peer Review 2023 Fire Protection Technical Specification for the National Assessment Reports;
- HLG-r(2022-49)_646 ToR ENSREG - Terms of reference for the topical peer review process on fire protection, 16 June 2022;
- WENRA: Report Safety Reference Levels for Existing Research Reactors, November 2020;
- WENRA: Report Waste and Spent Fuel Storage Safety Reference Levels, Report of Working Group on Waste and Decommissioning (WGWD), Version 2.2, April 2014;
- WENRA WGWD: Report Decommissioning Safety Reference Levels - Version 2.2, 22 April 2015.
- Self-assessments developed by licensees

Annexes

A. RESEARCH REACTORS

A.I - LENA

A.I.1 General information

A.I.1.1 Nuclear installations identification

- Name: TRIGA MARK II
- Licensee: University of Pavia

The TRIGA Mark II installed at the Laboratory of Applied Nuclear Energy (L.E.N.A.) of the University of Pavia. LENA is an "Interdepartmental Service Laboratory" of the University of Pavia which manages, in addition of the TRIGA reactor, also a IBA CYCLONE® 18/9 cyclotron to produce radioisotopes. The Laboratory is also equipped with other radiation sources, such as an industrial RX irradiator, a Co-60 irradiator and laboratories for the manipulation of radioactive materials produced by neutron activation. LENA is part of the Nuclear Pole of the University, which includes the Radiochemistry area with a medium-activity laboratories (NAA), a sub-critical assembly, SM1 complex, that consists of 206 fuel elements divided into ingots (5 for each element) for a total of about 2000 kg of natural uranium. The neutron injecting source is a Pu-Be source with an intensity equal to 7×10^6 s^{-1}. It also belongs to this area, the Environmental Monitoring Laboratory, equipped dedicated to gamma, LSC and alpha measurements.

The TRIGA (Training Research and Isotopes-production General Atomics) Mark II is a pool-type reactor cooled and partly moderated by light water, with the fuel consisting of a uniform mixture of uranium and zirconium hydride, which provides a negative prompt temperature coefficient. The TRIGA Mark II reactor is licensed for operating at 250 kW power in steady state. The reactor core is shaped as a right cylinder and contains 90 slots, distributed over 5 concentric rings; they can contain either fuel elements, graphite (dummy) elements, control rods or in-core irradiation channels. The fuel consists of a uniform mixture of uranium (8% wt., enriched 19.95% wt. in ^{235}U), zirconium (91% wt.) and hydrogen (1% wt.). These elements are solid cylinders, assembled with top and bottom graphite reflectors and an aluminium alloy or stainless-steel cladding. Core reactivity is governed by three control rods, named Shim, Regulating and Transient; the first two contain boron carbide, while the latter is filled with boron enriched graphite. A 30 cm thick radial graphite reflector surrounds the core while the axial reflector is provided by two graphite cylinders located at the ends of the fuel element itself (inside the cladding)

The different installations are operated with different licensees. The owner/licensee for all the installations is the Rector of the University of Pavia.

The Cyclotron and TRIGA reactor share the power supply cabin, personnel, fire officers and emergency plan. SM1 complex has a different power supply cabin and partially shares personnel, fire officers and emergency plan.

Off-site emergency plan is responsibility of the civil Prefecture with evaluation of technical aspects by ISIN. Moreover, the city fire brigade participates to the annual drill and share resources for the reactor emergency plan.

The TRIGA facility is in the University of Pavia scientific campus surrounded by Chemistry, pharmacy and physics departments. Several hundred students use University's buildings and activities involves use of prototype and inflammable substances.

Key parameters

- Type of reactor: (TRIGA Mark II)
- Year of the operating licence or first criticality (1965)
- Thermal power (research reactors) (250 kW stationary state – 250 MW pulsed)
- Scheduled end of operation date (if any) (license extended each five years)

A.I.1.2 National regulatory framework

As per §1.2

A.I.1.3 Improvements in fire safety as a result of experience feedback

An Integrated Management System (IMS) has been established in order to continually improve the protection against internal hazards. An action plan is annually defined based on results obtained by the assessment that involves fire loads, modification, new requirement implementation, inspections, testing and maintenance reports. The resulting program is split in two categories: ordinary and extraordinary interventions defined at each revision. Since 2014, following a request of the competent regulatory authority, an assessment of the implementation of the IAEA Code of conduct on the safety of research reactors, which requires a periodic assessment of safety issues, including Fire hazards, has been performed.

All personnel involved in reactor activities are trained for the risks and informed on responsibilities. Each new activity must be submitted for approval to the reactor management with description, procedures and risk assessment. An annual report is sent to the regulatory body and each five years the licence is extended after the evaluation of the five years relation on the reactor condition. Each year a report is sent to university administration.

A.I.1.4 Defence in depth principle and its application

The application of defence in depth is detailed in the document "L.E.N.A. FIRE-FIGHTING SYSTEMS AND PROCEDURES." with objectives, systems and procedures implemented at LENA. It provides an overview of the different areas in which the L.E.N.A. facility is divided, of the detection and protection devices available in each area, as well as of the procedures and methods of prevention, mitigation, and effective intervention in the event of an event characterised by the presence of a fire. The document provides also useful information on the fire prevention system and on the active and passive defences available in the laboratory, as well as on the methodologies and intervention precautions to be adopted to limit damage to people, environment and equipment in the event of fire, as well as to prevent any radiological risks to personnel inside the laboratory, and to those outside the building. In accordance with the laws that regulate the management procedures of a nuclear reactor, precise management responsibilities and precise intervention rules have been defined for accidental events deriving from a possible fire.

The first level of defence in depth foresees the minimization and segregation of fixed and transient combustibles lowering the fire loads. Particular attention is applied in these procedures to evaluate modification of fire loads and ignition sources. As a second level of defence in depth, LENA building has an alarm system certified to detect and activate fire brigade and active manual fire extinguisher systems in place. The third level of defence in depth foresees that the different areas and facilities are compartmented, and the ventilation systems are separated. When the ventilation system is in common, a shutter is installed.

In addition, to prevent fires from starting, procedures are implemented to control and minimise the amount of combustibles and the potential ignition sources. New project and maintenance activities are authorised following dedicated procedures that consider also the evaluation of fire hazards.

As a quick response, the fire detection systems and alarms have an announcement of the location of a fire to the control room and entrance building to guide emergency personnel. LENA personnel are trained as firefighters and city fire brigades are involved in the emergency plan and participate in emergency drills. Adequacy is reassessed each five years and certificated. The system has non-interruptible emergency power supplies and failures of the cable connections are reported to the control room. In order to ensure the operability of the fire protection measures, procedures are established and implemented. Each 6 months systems are tested by an authorised company and a report is inserted in a proper register. They shall include examination, inspection, maintenance and testing of fire barriers, fire detection, alarm features and extinguishing systems. Suitable fire extinguishing features are in place according to the fire hazard assessment. The fire water distribution network for fire hydrants outside buildings (four, one each building side) provide adequate coverage of all facility areas. Mobile manual extinguishing systems are installed.

Fire protection measures, procedures shall be established considering the capability of SSCs important to preserving their safety functions.

Fire compartment approach is implemented between adjacent installations. The fire resistance rating of the fire barriers of the fire compartment between cyclotron and TRIGA installation is sufficiently high so that the total combustion of the fire load in the compartment can occur without breaching the barriers.

SSCs important to safety are protected by additional active systems and prevention stresses lowering fire loads in accordance with the results of the fire hazard analysis.

Reactor buildings are subdivided into fire cells, providing a balance between passive and active means, as justified by fire hazard analysis. Radioactive materials that could cause radioactive releases in case of fire are kept, as procedures, in dedicated areas of the reactor buildings and in cabinets that contain to minimise such releases.

Procedures are implemented to minimise the impact of fire events and personnel are trained and informed. Automatic system act on the ventilation system when nuclear emergency alarm is activated.)

A.I.2 Fire Safety Analyses

A.I.2.1 Fire Safety Analyses for LENA Research reactor

A.I.2.1.1. Types and scope of the fire safety analyses

A Deterministic fire safety analyses (Fire Hazard Analysis - FHA) is developed and applied with a graded approach using also a simplified probabilistic method for event combinations. The the fire safety objective is to limit damage to people as a direct effect of fire. Being a nuclear installation a key fire safety objective is also to limit damage to SSCs and relate equipment so as to prevent radiological risks to personnel, the population and the environment. The scope of the analysis is the Prevention and mitigation on internal and external hazards: fire in controlled zone, fire in surveilled zone, fire in solid waste temporary deposit, fire in free area, fire outside the reactor building and outside the site, evaluation of fire during working hours and non-working hours. A further evaluation considers credible combinations of individual events)

The two different operational states are: working hours (reactor in operation) and non-working hours (reactor in shutdown).

The scenarios analysed and the technical elements used to justify that they are the most relevant (bounding scenarios) are:

- fire in a controlled zone: fire may affect areas of temporary storage of radioactive materials (radioactive waste or other material). Combustion of material containing radioactive substances can generate dust, aerosols, vapours or gases themselves containing radioactivity, thus generating or increasing the risk of exposure and contamination, even internally (by inhalation).
- fire in surveilled zone: Risk of fire spread.
- fire in solid waste temporary deposit: In this case there would be a risk of exposure and external and internal contamination of the personnel in charge of the intervention due to the formation of gases and vapors containing radioactive substances.
- fire in free area: Risk of fire spread.
- fire outside the reactor building and outside the site: Risk of fire spread.
- fire during working hours and non-working hours: Considerations based on inventory variations (reactor in operation or not) and considerations on the different crowding and presence of personnel).

The following additional external events are considered as combined events or as initial event of an internal hazards:

- earthquake of maximum magnitude for Pavia, which is classified seismic zone 3/4 (Italian classification 1 to 4), characterised by a maximum horizontal acceleration Ag = 0.078g on rigid and flat ground and a probability of being overcome of 10% in 50 years;
- flood event in Pavia for the Po and Ticino rivers, evaluated of little relevance on the basis of the document "Geological and hydrogeological report of the Laboratory of Applied Nuclear Energy of the University of Pavia" of 15 January 2015, based on hydrometric observations compared to the floods observed in the last 200 years (21 flood events from the year 1800);
- possible vulnerability of the LENA building due to adverse weather conditions: exceptional rainfall, strong winds and tornadoes, lightning, landslides or collapses of adjacent buildings, local flooding that can cause prolonged power cuts or flooding inside the 'building;
- fire in proximity of LENA building.

A.I.2.1.2. Key assumptions and methodologies

- assumptions and methodologies applied to perform the analysis:
    - guidance used: IAEA SSG-10, IAEA SSR-3, ISO 9001/2015 and 31000/2010)
    - identification of the safety functions and related SSCs to be protected against fire

SSC screening and prioritising method;

The categorization of structures, systems and components was realised through a detailed analysis of systems.

SSC
Pool structure and vessel
Core Structure
Reflector
Shielding
Beam Tubes
Liner
Fuel assemblies and storage in reactor pool
Primar
Biological shield
Ventilation: emergency
Control Console (LOG channel, SCRAM loops)
Cabling (control console internals and interconnections)
Shielding

Consequences of any fire on systems and equipment relevant for safety (SSCs)

For the analysis of the consequences deriving from fires involving essential parts of the safety and control equipment of the reactor at LENA it is necessary to remember some essential characteristics:

The regulation of the TRIGA neutron flux is made by three control rods, two in boron carbide (Shim and Regulating) and one in boron adsorbed on graphite (Transient).

The Shim and Regulating control rods are coupled to the respective movement mechanism by means of an electromagnet. The de-energization of that magnet causes the rods fall by gravity into the core. The Transient bar is supported by compressed air and falls by gravity to the core upon opening, due to power failure, of the compressed air valve itself. All in one time not exceeding 0.5 sec.

The reporting of the reactor power is given by:

A logarithmic channel working right up to the source level (fission counter chamber)

An extended field linear channel (compensated ionisation chamber)

A safety channel (non-compensated ionisation chamber)

Assuming that in any area of the building a fire develops accidentally, it can:

determine the manual shutdown of the reactor ("scram") on the autonomous decision of the operator who, assessing the importance and evolution of the fire itself, it acts by complying with safety procedures;

The worst case scenario, fire event involves SSCs such as:

The console power supply, emergency generator included.

The power supply and/or signalling cables (console instrumentation included).

The supply line of the electromagnets supporting the control rods (motor units and compressed air valve on the reactor deck and in the console)

The electric power supply cables, signalling cables of the stacked sensors and of the electromagnet line and the compressed air valve of the control bars.

In any case, the lack of power to the console causes the reactor scram.

In general, in any fire event, at any point of the building and whatever the causes and the structures involved are, the reactor automatically shuts down.)

- consideration of the research reactor locations where permanent or transient combustible material is present, rules and justifications used to consider the absence of fire in specific situations, (Rules and justifications used to consider the absence of fire in specific situations are describe in the Fire hazard assessment that is based on the analysis relating to fire loads, nature and quantity of radioactive materials stored that could be involved in a fire event. These informations are presented to the fire department for approval with LENA fire-fighting systems and procedures description, which include compartmentation such as cyclotron facility, RX irradiator room, NADIR experiment area)
- consideration of on-site or off-site fire brigades, (The reactor personnel are trained with theoretical lessons and fire fighting exercises both in general conditions and with specific exercises at the facility. Coordination withtakes place with periodic meetings and joint emergency drill)
- general description of how uncertainties are considered, (Uncertainties are discussed in the design phase within the safety committee)

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

Systems involved and countermeasures in place are identified for each area and a simplified extract is reproduced in following table.

Reactor Area	Consequence	Countermeasures
Control Room	Involvement of Safety Related Systems	Redundancy of systems, possibility of reading the instrumentation remotely, fire-fighting systems (detection and extinguishing), limited fire load and

		periodic maintenance and replacement of equipment
Radiochemistry laboratory (flammable liquids)	Possible involvement of irradiated radioactive materials under processing and flooding or damage of monitoring systems following the use of extinguishing device	Limited use of flammable solvents, storage procedures in special fireproof cabinets and fire prevention systems (detection and extinguishing)
Microbiology area	Possible involvement of irradiated radioactive material with associated biological risk under processing	Limited use of flammable solvents, storage procedures in special fireproof cabinets and fire prevention systems (detection and extinguishing). Specific procedures for biological hazards
Service area main electrical panels	Total or partial loss of the electricity supply	Auxiliary power supply for safety related systems, fire prevention systems (detection and extinguishing) and verification, maintenance and replacement of electrical components subject to aging
Waste storage room	Possible involvement of irradiated radioactive materials. Flooding or damage of nuclear waste barrel	Limitation of the flammable load and periodic maintenance and replacement of equipment
Mechanical workshop	Flooding or damage following the use of extinguishing device	Evaluation of specific processes and updating of work equipment
Hydraulic circuits	Flooding or damage following the use of extinguishing device	Limitation of the flammable load and periodic maintenance and replacement of equipment
Offices	Flooding or damage following the use of extinguishing device	Limitation of the flammable load and periodic maintenance and replacement of equipment
Local air treatment unit (external)	Possible cause of fire spread to reactor building	Periodic maintenance and replacement of equipment
Electric cabin (external)	Total or partial loss of the electricity supply	Auxiliary power supply for safety related systems, fire prevention systems (detection and extinguishing) and verification, maintenance and replacement of electrical components subject to aging
Nearby University Departments	Possible cause of fire spread to reactor building	fire prevention systems (detection and extinguishing) and verification, maintenance and replacement of electrical components subject to aging
Reactor hall (experimental setups)	Heavily dependent on the experience in place	Experiences subject to specific evaluation and approval in consideration of the materials used (flammability, toxicity, radioactivity)

The performed assessment considers records of events that have happened, near miss events or non-conformities in maintenance procedures and irradiation procedures. Each of these events can be contemporary with the reference event and procedures also provide for the combined management of the two events. Reactor personnel are trained for a first response and an annual fire drill is held in collaboration with the fire department.)

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

Following the method mentioned above the results of risk analysis are highlighted in the table below that shows the combination for concurrent events and associates a criticality value of 3 to the design event.

Probability, severity	Flood 1	External fire 1	Internal fire 1	Adverse weather condition 2	Earthquake 2
Reactivity 1	1	1	1	2	2
Power Supplier failure 1	1	1	1	2	2
Tank failure 1	1	1	1	2	2
Leakage 2	2	2	2	4	4
Design event 3	3	3	3	6	6

Taking in to account all the fire fighting systems (passive and active, procedures e.g..) the results of risk analysis is that in-equivocally in the face of/the fire event in any point of the building it has origin and whatever the causes and the structures involved, the reactor stop automatically in state of arrest for the simultaneous release of the three control rods. However, the staff and the procedures adopted are implemented considering the LENA as high-risk level. This is due because the centre it is an University Building, compared as a school buildfding that has specific requirements for the fire fighting and fire prevention.

Working hypothesis for the consequences

The potential effect of loss of confinement of the LENA reactor building in fire situations, in conjunction with the design event (value 6) is considered to be the reference event. In particular, the building abatement factors, adhesion to the walls of the Tank / Reactor Room and the abatement of HEPA filters + activated carbon of the emergency ejector will not be considered for the purpose of the evaluation of the effect in terms of dispersion in the environment of radionuclides. The extreme hypothesis is the building damage concurrently with the design event (tank emptying and element leakage).

All other events, and in particular the following incidents, have lower consequences:

- Dropping of heavy loads during core maintenance (reactor in cold shutdown for a week) with mechanical damage to 1, 3, 10 up to 30 fuel elements with the presence of cooling water (5m water head).
- uncontrolled insertion of reactivity with the reactor operating at full power, an event described in the LENA licensing documents.
- emptying of the Tank without damaging the fuel elements, an event described in the LENA licensing documents.
- accident during the transfer of a fuel element from the Tank to the dry storage pits, an event described in the “LENA licensing documents.)

A.I.2.1.5. Periodic review and management of changes

A.I.2.1.5.1. Overview of actions

An integrated management system has been established in order to continually improve the protection against internal hazards with a continuous revision of SSCs. The system is periodically reviewed by the management considering last normative requirements (the implementation of DM 2 september 2021 is ongoing). An action plan is defined based on results obtained by the assessment. The resulting program is split in two categories: ordinary and extraordinary actions defined at each revision. For example, the registration of 'near misses' and non-conformities that may be precursor to an initiating event and therefore should be analysed.

A.I.2.1.5.2 Implementation status of modifications/changes

The most risk significant research reactor modifications were: refurbishment of ventilation system and power supply and the cyclotron installation. It is ongoing an evaluation of the fire detection and alarm system ageing. Assessments are reported to the safety committeeand submitted for approval to the regulatory body.

To facilitate prompt firefighting, the following four zones are defined with a dedicated alarm circuit:

- Reactor hall and rooms of first level
- offices and rooms entrance level
- Laboratories first floor
- Control room

The fire assessment evaluates fire loads, impacts on SSCs and active and passive defence to mitigate consequences in each of the four zones.

In the service area outside the building there are the temporary waste deposit, the emergency generator group and the thermal heater plant. A fire extinguisher is located in each of these points and each is equipped with a smoke detector. The fire load of the solid waste room of 14 m2 is given by the contents of the bins stowed in it and can be estimated at a total of 600 kg of equivalent wood.

Qualitative assessments of the fire load are evaluated for each zone for the purposes of nuclear safety. The fire load is of modest importance because, whatever the nature of the fire and in any point of the building it developed, the reactor automatically and immediately is brought to arrest condition.

In consideration of the type of reactor and facilities and the application of the graded approach it is not planned to use the PSA methodology.

A.I.2.1.6 Licensee's experience of fire safety analyses

The University has a dedicated department for the fire hazard analysis.

A.I.2.1.6.1. Overview of strengths and weaknesses identified

STRENGTHS +	WEAKNESSES –
• The centre has a limited source factor, related in particular to bigger and more powerful nuclear installations. Moreover, using low-activity sources is an intrinsic safety condition referred to as the related resulting hazards. • The strong collaboration with city firefighters results in the availability of skilled external help in the evaluation and management of possible fire hazard situations. • The adoption of policy, procedures and training programs to continuously improve the safety culture, both for management and employees.	• The lack of internal specialist personnel for evaluating and managing possible fire hazard situations. • As a public institution, the management of turnover of retired employees, because usually, the availability of new personnel is subsequent to the retirement process and can lead to a know-how loss. • The complete implementation of international standards due to the availability of resources and the size of the centre. In this case, the use of a graded approach may be challenging.

A.I.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

LENA Laboratory hosted OMARR, INSARR and IRRUR peer review IAEA mission in the last ten years and no relevant threats or weakness were reported on fire hazards.

A.I.3 Fire Protection Concept and Its Implementation

A.I.3.1 Fire prevention

A.I.3.1.1. Design considerations and prevention means

A general overview of the process in the installation´s design for minimizing the likelihood of fire is described in chapter A.I.2.1.5.2, moreover, in order to prevent fires, procedures are in place, each activity at the laboratory shall be authorised by the management. Requests include, in addition to the description of the activities to be carried out, also a risk analysis and list of materials used, including any fire, flammable or ignition loads. Specific procedures are in place to assess the safety impact of new experiences and changes to existing ones. The assessment process is described in the reactor documents relating to the design phase of the new facility which describes the steps to be taken, the information flows and the identification of the responsible in charge and the bodies to which to submit the approval according to the impact on the safety of the reactor. The assessment includes a revaluation of the impact of the new installation on the severity or probability of the effects. The fire load, detection systems, extinguish systems available in various areas are evalauted.

The scheduled preventive maintenance interventions on both, the detection and the extinguishing systems, guarantee the perfect efficiency of all the fire-fighting systems supplied to the LENA. These interventions are made internally and with authorised companies. In compliance with the provisions of the "requirement for the operation" of the TRIGA Mark II, the maintenance plan of the fire protection system is carried out every six months. The plan adopts a "Test procedures - checklist" document which sets out the procedures to guarantee the correct maintenance on the fire-fighting systems.

The document, with relative certification by the contractor, constitutes evidence of correct maintenance, providing a basis for planning, scheduling, and the execution of planned maintenance. As far as the reactor safety operation is concerned, most of the Preventive Maintenance (PM) activities, along with their scheduling times, are mandatory since they are determined by Organization’s legal requirements for the reactor operation. PM includes, for example: test, adjusting, lubricating, cleaning, and replacing components.

Time intensive PM, such as bearing/seal replacement or Instrumentation & Control system calibration, would typically be scheduled for regular reactor shutdown periods.

A.I.3.1.2. Overview of arrangements for management and control of fire loads and ignition sources

One of the processes that can impact the evaluation of ignition sources and fire loads is the operation of the reactor for the irradiation of materials and products as part of experiments. The irradiation process (i.e. both for standard irradiations and non-routine experiments), is designed accomplishing the facility Operating Limiting Conditions (OLCs) and also evaluation the following items as input elements:

- all statutory and regulatory requirements applicable to the operation of a nuclear installation (i.e. OLCs) and to the management of radioactive materials;
- historical information, including records, from previous operational experience and experiments at the reactor;
- functional requirements, e.g. physics and control of nuclear installations, as well as requirements for facilities and equipment that can influence the quality of operation or irradiation;
- specific procedures established for the implementation of activities;
- the competence required by personnel assigned for specific activities within the operation or irradiation process;
- implicit requirements;
- user requirements, depending on the different kinds of users;
- available resources;
- quality objectives of the process or activity under consideration.

All requirements are periodically reviewed in order to verify the adequacy, completeness, absence of ambiguity and conflict.

The outputs of the realisation process are procedures, work instructions and any other documentation which illustrates the management and operating methods used by personnel for the conduct of activities. The outputs of the design include or refer to, if appropriate, the following elements:

- Information for the supply of goods and services, if required;
- Criteria and specifications for compliance with the process and products;
- Safety features of the processes;
- Specifications for the storage and delivery of irradiated products.

The verification of design is then performed to ensure that the specifications have been met and transposed into the outputs of the design. It consists of checking the completeness and accuracy of data and the achievement of expected results. Design review is implemented at appropriate stages (previously determined and scheduled based on the complexity of the project). It allows assessment of whether the results meet the design input requirements and identification of any shortcomings and necessary actions (i.e. design changes). The review is performed with the participation of the functions involved in planning and development (e.g. through, safety committee, group meetings, etc.) and the Director (e.g. in an management review).

At the end of the verification and review phases, the project validation is carried out in order to determine compliance with requirements. The experiment validation is performed on the first irradiation or experiment or is based on historical data if available.

The project validation is intended to confirm that:

- The designed experiment satisfies the needs and requirements identified in the design phase.
- The realisation process works in accordance with the newly implemented procedures.
- Assigned resources (personnel and equipment) are adequate, appropriate and actually available.

- Information provided to the user is complete and comprehensive.
- The designed process can effectively meet the requirements, achieve the quality objectives and planned results.

If design changes are proposed and evaluated before the phases of verification, validation and final review, they are considered and handled in these phases. If changes are introduced after these steps, it is necessary to begin again with verification, review and validation before the delivery of the new service is implemented.

The design activities are kept up to date through the drafting of meeting reports, through the gradual completion of the monitoring design development form and through the issue of procedures and/or their review.

For standard irradiations the above described activities are carried out once in the design stage, then periodically assessed and reviewed. For non standard experiments, the iter results the same, but developed on a case-by-case basis.

The following table summarises the main documents (and their applicable requirement) that are taken into account during all the phases of design, implementation, and realisation of experiments:

<table>
<tr><th>Standard category</th><th colspan="2">Examples (not exhaustive)</th></tr>
<tr><td>International directives and regulations</td><td colspan="2">● Code of Conduct on the Safety of Research Reactors , Resolution GOV/OR.1088,IAEA, Vienna,(2004).
● Treaty on the non-proliferation of nuclear weapons, INFCIRC/140, IAEA, Vienna (1970).
● The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, International IAEA, Vienna, 1980.</td></tr>
<tr><td>Statutory and regulatory National (Italian) standards</td><td colspan="2">● Framework Act on the Peaceful Uses of Nuclear Energy (No. 1860 of 31 December 1962)
● Regulation for the recognition of technical operation of nuclear installations (Presidential Decree No. 1450/1972)
● Implementation of Directive Euratom 96/29 on health protection of the public and workers against the risks of ionizing radiation
● DgL.S 101/2020</td></tr>
<tr><td rowspan="2">Specific standards for the RR Organization (issued by national Regulatory Body or Ministries)</td><td colspan="2">● Operation Licence of the TRIGA Mark II reactor</td></tr>
<tr><td>● TRIGA Mark II reactor Operating Rules
● TRIGA Mark II reactor Management Rules
● TRIGA Mark II reactor Operational requirements</td><td>OLCs</td></tr>
<tr><td>Not legal requirements, but to be used as guidelines</td><td colspan="2">IAEA Safety Standards for Research Reactors, as:
● Safety of Research Reactors, IAEA Safety Standards Series No. SSR-3, IAEA, 2016;
● Leadership and Management for Safety, IAEA Safety Standards Series No GSR Part 2, IAEA, 2016;</td></tr>
</table>

	• Application of the Management System for Facilities and Activities, IAEA Safety Standards Series No GS-G-3.1, IAEA, 2006; • IAEA Safety Standards Series No. GS-G-3.5: The Management System for Nuclear Installations, 2009; • Implementation of a Management System for Operating Organizations of Research Reactors, IAEA Safety Report Series No 75, IAEA, 2013; • Operational Limits and Conditions and Operating Procedures for Research Reactors, IAEA Safety Standards Series No. NS-G-4.4, IAEA, 2008; • IAEA Safety Standards Series No. SSG-10: Ageing Management for Research Reactors, 2010; • Use of a Graded Approach in the Application of the Safety Requirements for Research Reactors, IAEA Safety Standards Series No. SSG 22, IAEA, 2012; • IAEA Safety Standards Series No. SSG-24: Safety in the Utilization and Modification for Research Reactors, 2012; • Instrumentation and Control System and Software Important to Safety for Research Reactors, IAEA Safety Standards Series No. SSG-37, IAEA, 2015;
Standard defined by the Organization	• Internal procedures and instructions • ISO Standards (Quality management systems - Fundamentals and vocabulary - ISO 9000:2015; Quality management systems, Requirements - ISO 9001:2015; General requirements for the competence of testing and calibration laboratories - ISO 17025:2018; Measurement management systems - Requirements for measurement processes and measuring equipment - ISO 10012:2004, Guidelines for auditing management systems – ISO 19011:2018 etc.) • Internal University regulations • Preventive measures for the fire protection of the TRIGA MK II • Periodic attestation of conformity for the fire protection by national fire fighter department • Internal procedures for the fire emergency • Internal procedures for the evaluation of the efficiency of the fire-fighting systems • Systems and procedures for the fire fighting systems at LENA

Activities are authorised which do not lead to a variation in the fire risk following the verification of combustible, flammable materials or sources of ignition introduced into the laboratory premises.

In consideration of the type of reactor and facilities, oxygen (reduction of oxygen concentration, inert gas atmosphere, etc.) is considered as a low risk profile and the related systems are not installed.

A.I.3.1.3 Licensee's experience of the implementation of the fire prevention

A.I.3.1.3.1. Overview of strengths and weaknesses

As noticed before, LENA has a limited source factor, related in particular to bigger and more powerful nuclear installations, as highlighted in the table below.

STRENGTHS +	WEAKNESSES –
• The centre has a limited source factor, related in particular to bigger and more powerful nuclear installations. Moreover, using low-activity sources is an intrinsic safety condition referred to as the related resulting hazards. • The strong collaboration with city firefighters results in the availability of skilled external help in the evaluation and management of possible fire hazard situations. • The adoption of policy, procedures and training programs to continuously improve the safety culture, both for management and employees.	• The lack of internal specialist personnel for evaluating and managing possible fire hazard situations. • As a public institution, the management of turnover of retired employees, because usually, the availability of new personnel is subsequent to the retirement process and can lead to a know-how loss. • The complete implementation of international standards due to the availability of resources and the size of the centre. In this case, the use of a graded approach is challenging

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

The use of the reactor, from 1965s to today, has undergone continuous changes with new applications, experiences, users and purposes. Continuous re-evaluation, supported by an integrated management system and a management ageing system, is necessary. In the case of Fire hazard assessment, have been studied how new experiences can modify the assessed fire loads or how a system can lose compliance with the requirements set in the assessment over time. For this reason, procedures for maintenance and replacement plan are in place and new experiences are evaluated, limited if possible or managed with the necessary re-evaluations and corrective action such as an updated fire hazard assessment. LENA Laboratory hosted OMARR, INSARR and IRRUR peer review IAEA mission in the last ten years and no relevant threats or weakness were reported on fire hazards

A.I.3.1.3.3. Overview of actions and implementation status

At present, an internal assessment, done with support of external experts, has the results that the fire alarm system is being revised in accordance with current legislation and is ongoing the renew of all fire detection devices

A.I.3.2 Active fire protection

A.I.3.2.1 Fire detection and alarm

A.I.3.2.1.1. Design approach

The control unit, installed in the Control Room, has the task of processing the signals coming from the various automatic and manual sensors placed in the building.

In the "maintenance checklist and procedures" document, are defined specifications needed to be able to carry out a more selective investigation in the event that a fire breaks out in the building.

The control unit has been divided into thirteen areas as follows:

1. Area 1 central heating
2. Area 2 electrical switchboard room
3. Area 3 workshop
4. Area 4 radioactive waste storage
5. Area 5 physics laboratories mezzanine floor
6. Area 6 main switch
7. Area 7 offices on the mezzanine floor
8. Area 8 radiochemistry laboratory first floor
9. Area 9 control room
10. Area 10 Office space
11. Area 11 ventilation supply system
12. Area 12 reactor room
13. Area 13 ventilation return system

When one or more sensors are triggered, or one of the manual buttons is activated, the control unit performs the following operations:

- provides an indication of all the zones involved in the alarm by turning on the red LEDs on the control unit in the control room and simultaneously on the synoptic panel located in the atrium of the building. The synoptic panel is also equipped with a flashing light activated automatically by the control unit;
- only for zones: 2, 3, 5, 7, 8, 9, 12 the control unit activates an optical-acoustic panel;
- activates a siren located in the reactor room also equipped with a red flashing light;
- activates a telephone alarm which sends the "fire alarm" message to:
    - staff available for the guardianship;
    - available health physics officer;
    - Radio protectionist;
    - Director LENA.
- In the event of a mains power failure, buffer batteries ensure the operation of the fire-fighting system during the time required for the generator set to switch on (approximately 10 seconds).)

The system is equipped with an auto check and reports faults requesting intervention. Normal operating conditions do not include ambients where the system is subjected to particular conditions.

A.I.3.2.1.2. Types, main characteristics and performance expectations

Fire detection systems in adjacent compartments are complete separated with different centreline and different alarm systems. Each system includes optical smoke detectors and sensors and thermosensitive cables.

A.I.3.2.1.3. Alternative/temporary provisions

When there are requirements for fire detection to be disabled, these are treated as non-conformities. In our case an evaluation of non conformities means that there is always a complete evaluation of any impact on safety, responsibilities, corrective or preventive actions foreseen and the final authorization of the reactor director.

A.I.3.2.2 Fire suppression

A.I.3.2.2.1. Design approach

The approach applied in the selection, design and location of fire extinguishing systems is aimed at the protection of the environment, population and workers. To ensure its effectiveness, each independent room is equipped with adequate sensors according to UNI and mobile fire protection means are provided so that each room containing auxiliary systems is equipped with a fire extinguisher. Moreover, the choice of SSC is based on the results of the Fire Safety Analysis (FSA). The FSA has determined the choice of fire extinguishing equipment and systems for the different parts and buildings of the Site.

The water distribution system is sufficient to reach every part of the facility. Some well-defined areas do not provide for the use of water as an extinguishing medium which is mostly considered as a safeguard of the building. In any foreseen case the use of water is supervised by the reactor manager who works jointly with the city fire brigade for any fire fighting actions.

There are no specific active fire protection areas for the experiments. Each experiment set up must comply with the same safety requirements for activities in the laboratory.

A.I.3.2.2.2. Types, main characteristics and performance expectations

Fire system anomalies are considered in the analysis. In particular, since there are no active automatic systems, activations due to human error are considered. As an effect, in addition to material damage, it is on the possibility of spreading contamination and damage to the SSCs. In order to prevent such occurrences, specific training and periodic exercises are envisaged.

Manual systems are preferred to fixed systems due to the variable source factor (radioactive materials) at the facility depending on the scheduling of the activities. The possibility of access is always guaranteed, even through the use of breathing apparatus supplied to reactor personnel and the city's fire brigade. All personnel are trained in its use.

The fire load, the detection systems, the means of protection available in the various areas of the plant are evaluated, zone by zone.

A.I.3.2.2.3. Management of harmful effects and consequential hazards

Harmful effects of an involuntary operation are taken into account and the reliability of the system is guaranteed, with specific training, personnel information, exercises and with a system of recording and notification of events.

A.I.3.2.2.4. Alternative/temporary provisions

When a fire protection system isn't in operation, there is always a complete evaluation of any impact on safety and responsibilities. Corrective or preventive measures are authorised by the reactor director. When it is not possible to promptly restore the foreseen conditions, the reactor is kept in shut down condition.

A.I.3.2.3 Administrative and organisational fire protection issues

A.I.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

To ensure the operability of the fire proctections measures, LENA centre has a contract with an authorized external company that provide maintenance and preventive checks as needed and almost every six months, moreover a control list with OLC'S and timing of maintenance in the document Fire Fighting procedure at LENA, approved by city fire brigades). The head of the mechanical maintenance service is the internal reference for these aspects and manage the correct recording procedure to ensure traceability of what happened, moreover ensure the highlightining of non conformities and their preventive or corrective actions.

A.I.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

Written procedures are listed in the document: "Fire emergency intervention procedures within the perimeter of the LENA", external events are considered as a pre-alarm situation. All internal employees are trained, in a theoretical and a practical way, for the fire-fighting emergency situation and annually an emergency drill is made in cooperation with city fire brigades)

In the document cited in point A.I.3.2.2, and in the organization chart are clearly defined responsibilities and duties, all these documents are maintained and reviewed complying with the IMS in place.

The emergency plan defines materials and human resources for the emergency, for the on-site and off-site fire-fightining. This document is developed from the Relevant Events Risk Assesment.

The coordination is guarantee with periodic meetings between emergency personnel and external fire-fighters)

It is ensured that the firefighting resources are familiar with the hazards of the plant with the annual emergency drill)

There are procedures in which are listed, authorities and responsibilities, resources (material and human resources), timing and frequency for training and maintenance etc. Internal recording and check lists, are signed and managed by the head of the mechanical maintenance service and reviewed by the top management and the quality assurance team of the plant.

A.I.3.2.3.3. Specific provisions, e.g. loss of access

Externally there are four hydrants and a hose with corresponding lance. Moreover, the personnel of the emergency teams of the reactor have access to equipment for intervention in support of the firefighters with fireproof clothing and self-contained breathing apparatus. Such personnel are also adequately trained. This, to prevent loss of access even in the reference event.

The internal personnel is adequately trained for the use of each fire fighting equipment like, extinguisher ($CO2$, powder, foam), hose and self-contained breathing apparatus.

Alternative routes for emergency situation are also present in the site.

A.I.3.3 Passive fire protection

A.I.3.3.1 Prevention of fire spreading (barriers)

A.I.3.3.1.1. Design approach

Different areas inside the building (see para. A.I.2.1.3.) are defined in accordance with the FHA and the defence in depth principles (as per para. A.I.1.4).

A.I.3.3.1.2. Description of fire compartments and/or cells design and key features

On-site there are documents for the evaluation of fire compartments, in which are listed all the technical specifications)

It is ensured that the expected fire resistance and stability ratings are fulfilled since for all the equipments there are certifications of materials used.

The adoption of fire-resistant building materials prevents or delays the spreading of fire, smoke and contamination between adjacent fire compartments / cells (HVAC systems, combustible free areas, use of self-fire extinguishing and/or fire-resistant components, connecting doors and materials

A.I.3.3.1.3. Performance assurance through lifetime

With periodical testing and the re-evaluation during the annual management review access routes for firefighting are assessed and maintained. Moreover all these aspects are considered in the Ageing Management Plan of the centre.

The process for justification that the fire barriers remain efficient under temporary and permanent evolution of the fire loads, operations increasing fire load and/or ignition sources (maintenance, modifications, etc.) are considered in the authorizing process to establish that fire loads and ignition source are not modified, and the fire barrier remain efficient.

The reactor is still in operation, and it is not planned a short time the stop of the activities.

A.I.3.3.2 Ventilation systems

A.I.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The LENA research reactor is considered as a low risk profile. Neverthelles, the installations are physically divided. Each installation is equipped with its dedicated ventilation system. In the reactor building there is only one compartment that is divisible with shutters in the ventilation system.

A.I.3.3.2.2. Performance and management requirements under fire conditions

Main areas of the reactor building are separate compartments each with separate ventilation and fire fighting systems.

Moreover, there are fire barriers as e.g. fire doors and specific procedures for the fire loads management.

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

The University has a dedicated department for the fire hazard analysis that is supporting the LENA Laboratory. LENA hosted OMARR, INSARR and IRRUR peer review IAEA mission in the last ten years and no relevant threats or weakness were reported on fire hazards.

A.II - TAPIRO

A.II.1 General information

A.II.1.1 Nuclear installations identification

- Name: TAPIRO
- Licensee: ENEA

The RSV TAPIRO nuclear reactor is a fast neutrons source, and its design is based on the Argonne Fast Source Reactor - Idaho Falls. The reactor's name comes from the Italian acronym Reattore Sorgente Veloce TAratura PIla Rapida potenza 0 (Fast source reactor - Fast Pile Calibration at 0 Power). RSV TAPIRO was built in the sixties and its first criticality was in April 1971. The RSV TAPIRO reactor can operate at the maximum power of 5 kW, and the neutron flux at the center of the core at full power is about $4 \cdot 10^{12}$ $n \cdot cm^{-1} \cdot s^{-1}$. The reactor core is a cylinder made of highly enriched metallic uranium (weight 98.5% U; 1.5% Mo) enclosed in a stainless-steel cladding. The core is split into two parts, the first one is fixed and takes up 2/3 of the total volume, whereas the second one is movable. The core refuelling is not contemplated due to the low value of the fuel burn-up. The cylindrical core is surrounded by a cylindrical reflector made of copper, with a thickness of about 30 cm and a height of 72 cm. The reflector is housed in a steel sheath surrounded by a biological shield made of borate concrete of about 1.3 m. The reactivity is controlled by the movement of 5 control rods and a safety plug composed of the movable core and reflector. The heat is removed by a flow of Helium and a Helium-Freon heat exchanger. Many irradiation channels crossing the reflector are used for the neutron irradiation experiences. The main channels on the horizontal plane are two radial channels, a diametral channel, and a tangential channel.

The RSV TAPIRO operates with a licence granted by the Italian "Ministero dell'Industria del Commercio e dell'Artigianato" (Ministry of Industry, Trade and Craft) to ENEA on November 29th 1985 (D.M. VII-225) and is renewed every 5 years. The last renewal was granted in December 2022. In the same site of RSV TAPIRO is located also the TRIGA RC-1 research reactor. Both are operated by ENEA.

An electrical substation, with an uninterruptible power inverter group, supply both the RSV TAPIRO and TRIGA-RC1 research reactors and allow the safe operation of the research reactors in the event of an external electrical power failure. In addition, some auxiliary electrical generators furnish the electrical power to the entire Casaccia Research Center with a delay of about one minute. Both the power inverter group and the electrical generators are subjected to periodic checks according to a test procedure agreed upon with the Management of the plant.

A round-the-clock fire brigade (a little brigade composed by ENEA fire specialist) operates in the Casaccia Center (hereafter referred as SPI) intervening, for the relevant actions, in the whole area of the Center. The most sensitive buildings of the Center, like the TRIGA RC-1 and RSV TAPIRO research reactors, are constantly connected with the SPI operations center that can be automatically activated in case of fire or "nuclear" alarm signals coming from those installations.

The maintenance of the fire alarm systems of the reactors is performed by an external company that is also responsible for the periodic checks on them.

The on-site defence unit, composed of security guards, performs constant monitoring of the nuclear installations and manages the accesses to the Center. The physical protection systems of the facilities are connected with the defence unit station and maintained by a common external company.

Other common resources are the radioprotection technicians team and the doctors and nurses first aid that operates in the Casaccia centre during working time and is activated, when needed, by the reactors staff.

The common shared resources and the installations teams are involved in the drills that take place every year in the Casaccia Center. The most significant outcomes of the drills are recorded and constitute the bases for the improvements of the fighting capabilities of a potential accident involving the nuclear installations including the fire-fighting.

The qualification of RSV TAPIRO reactor is performed by periodic monitoring and testing of items important to safety. The monitoring includes visual inspections and the measurement of parameters that indicate the physical state of the equipment. Procedures for periodic surveillance of the equipment are implemented and periodically updated. The results of the surveillance are recorded and summarized in a document that is written every five years for the license renewal. The last license renewal was granted in December 2022 by the Italian Ministry of Ecological Transition.

The nuclear installations located in the Casaccia research Center are listed in following table with the principal key parameters.

Name	Reactor type	Power	First criticality	Status
RSV TAPIRO (Italian acronym: Reattore Sorgente Veloce TAratura PIla Rapida potenza 0)	Fast	5 kW	April 4th 1971	In operation
TRIGA RC1	Thermal	1 MW	July 1969	In operation

A.II.1.2 National regulatory framework

As per §1.2

A.II.1.3 Improvements in fire safety as a result of experience feedback

Fire safety is constantly improved for reducing the likelihood of internal fires or the propagation of an external fire inside the nuclear installation. The measures taken into consideration during the improvement process arise from several factors, such as a fire event on the installation or in a similar installation and the following lesson learned, the defects or possible improvements coming from the maintenance and testing operations on the fire detectors and extinguisher systems, the prescriptions or observations made in the inspections. In the RSV TAPIRO reactor, for example, after the fire events occurred in August 1978 the fire system was enhanced with the installation of an automatic extinguisher system, and the electronic devices were equipped with a protection system.

A.II.1.4 Defence in depth principle and its application

This paragraph contains the elements and concepts of fire protection identified in the RSV TAPIRO facility afferent to the three levels of defence indicated in the TPRII Fire Protection Technical Specification for the National Assessment Reports - Sez.03

- <u>Fire Prevention</u>
  Preventing fire ignition is the first level of defence in depth with respect to fire safety. The adoption of measures that can minimize the probability of internal fires mainly involve the analysis of fire load, the analysis of possible ignition sources, and finally the oxygen concentration in the various areas of the plant. These measures are outlined in the following paragraphs:

  - A.II.2.1.3 Fire phenomenal analyses
  - A.II.3.1 Fire prevention
  - A.II.3.1.2 Overview of arrangements for management and control of fire loads and sources

- <u>Active Fire Protection</u>

  The second level of defence in depth refers to nuclear fire safety and consists of detecting and extinguishing fires that develop. All of these measures are referred to in the term active fire protection.

  Typically, these measures are identified in fire detection systems, suppression, and administrative and organizational aspects regarding firefighting.

  These measures are outlined in the following paragraphs:

  - A.II.3.2 Active fire protection
  - A.II.3.2.1 Fire detection and alarm
  - A.II.3.2.1.1 Design approach
  - A.II.3.2.1.2 Types, main characteristics and performance expectations
  - A.II.3.2.2 Fire suppression

- <u>Passive Fire Protection</u>

  In the third level of defence, the impossibility of intervention is assumed, both of the firefighting teams and the proper functioning of the firefighting systems. All those measures are then evaluated to keep the facility safe in order to limit as much as possible the release of radioactive material involved or released in the fire.

  These measures are outlined in the following paragraphs:

- A.II.3.3.1 Prevention of fire spreading (barriers)
- A.II.3.3.1.1 Design approach

A.II.2 Fire Safety Analyses

A.II.2.1 Fire Safety Analyses for Research reactor

A.II.2.1.1. Types and scope of the fire safety analyses

RSV TAPIRO, due to its inherent design features, is classified as a research reactor with a low risk profile. The RSV TAPIRO emergency plan classifies the fire hazard as an initial event (named conventionally PIE). The combination of events is not considered in the assessment for the fire protection, but is included in different scenarios and plant procedures applied to an emergency. Emergency drills, without a PSA evaluation can consider the combination of fire with others PIEs related to nuclear safety, namely reactivity accident, during reactor operation. The objective is to perform evaluations on the SPI and reactor staff response to radiological or nuclear event including a fire event during the operation and in case of temporary or extended shutdown.

A FHA has never been performed for the facility, but rather in 1998, an engineering assessment, by means of calculations having as parameters the volumes, type of risk (using general categories) and the presence of hidden volumes (for example, false floor), has been performed due to the modernization of the automatic fire detection and suppression system located in the vital areas of the facility: the control room of the reactor, the atrium hosting all the electrical cables serving the reactor hall and the room hosting main electrical panel of all the facility, including the reactor. All the implementations entrusted on the valid (at the time) laws and regulations.

A.II.2.1.2. Key assumptions and methodologies

There is not any validate FHA, but some fundamental information to be considered in the assessments is that there is no spent fuel storage in the RSV TAPIRO facility, since no refuelling is scheduled due to the design of the reactor. On the other hand, in the reactor hall is stored some radioactive material and sources, Figure 1 represents the C-37 building and the reactor RSV TAPIRO. It’s possible to identify the conventional zone and the classified areas (reactor hall and related zones). The different colours identify the different radiological classification (risk) of the rooms.

Some rooms of the RSV TAPIRO building (C-37) are subject to limitations and restrictions due to their classification resulting from radiological risks. Access and stay in these premises is regulated and restricted by radiation safety precautions defined by the plant management and the radioprotection expert of the facility. The work areas are shown on the map and classified as follows:

CONTROLLED AREA	reactor room, reactor plant room, under-pile room, diversion tank room
SUPERVISED AREA	control room, air lock, filter room

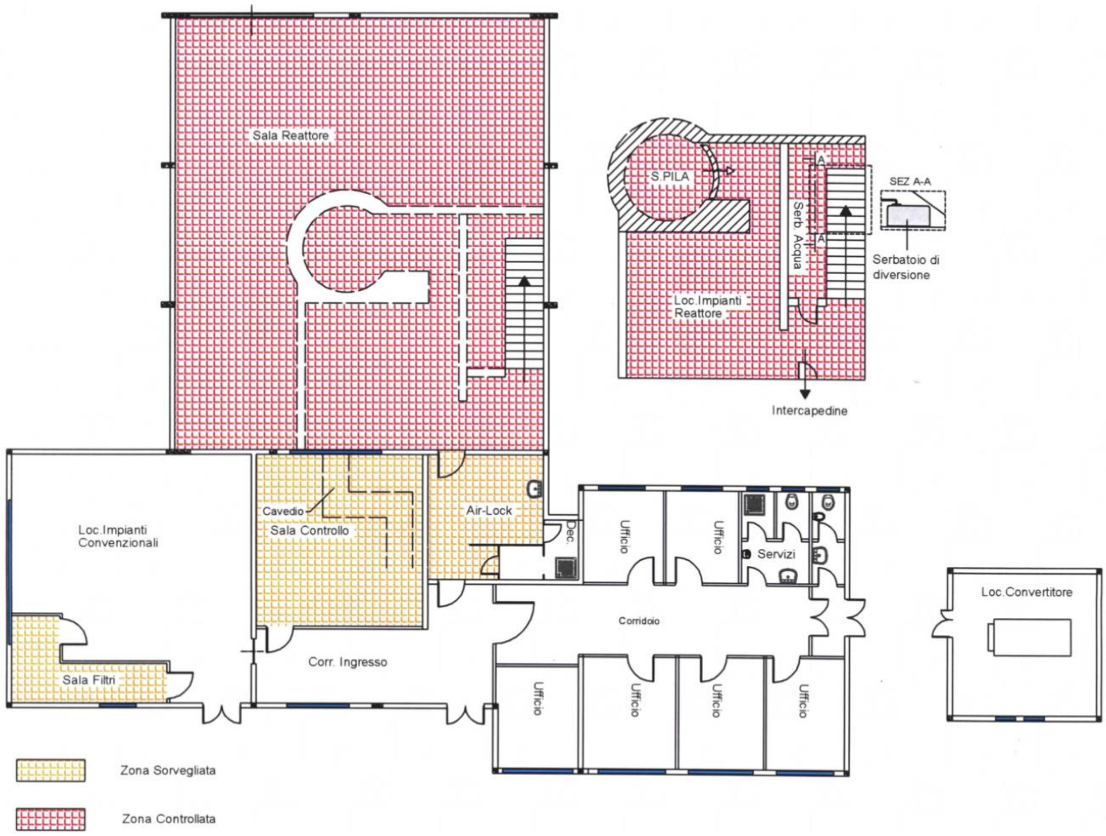


Figure 1. C-37 building and RSV TAPIRO facility

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

The fire phenomena on the selected facility have been investigated due to an event occurred in the 70s. A fire event started in to the reactor control room and provoked serious damage to the instrumentation. The fire had a severe impact on the facility, since all the electrical cable where damaged. All cables have been replaced with fire resistant ones and also an automatic detection and suppression system has been installed. Annex 1 to this document contains the calculations done to size the INERGEN system (1999).

In the reactor hall there is no permanent fire load, but occasionally and in correspondence of some experimental campaigns, it’s possible to have an increment of the fire load, evaluated and eventually detailed in the feasibility study of the experiment.

The “Locale Impianti reattore” (“Loc. Impianti reattore” in Figure 1) is in the underground and in case of fire is difficult to access. This one and the control room host some important electrical panels that could initiate a fire.

The ‘Sala Filtri’ room has no materials important to ignition and the conventional zone (green one) is dedicated to the staff rooms. In this case the fire load is due to the material inside: paper, and some furniture.

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

A FHA has been recently implemented according to national regulatory requests.

A.II.2.1.5. Periodic review and management of changes

A.II.2.1.5.1. Overview of actions

Currently, the engineering assessment, as identified before, is not subject to prescriptions involving a revaluation of the system. Some technical prescriptions fix the time for the check of the entire chain of detection and extinction of fire.

A.II.2.1.6 Licensee's experience of fire safety analyses

A.II.2.1.6.1. Overview of strengths and weaknesses identified

The weaknesses regards the lack of a FHA. At now, the needed actions to perform such evaluation have started. The expected result is the analysis of the fire risk in order to obtain the certification for fire prevention.

A.II.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

On the basis of interactions with national regulatory authority, a FHA has been recently implemented according to national legislation, with the perspective of a general review and oversight of all prevention and protection measures.

A.II.3 Fire Protection Concept and Its Implementation

A.II.3.1 Fire prevention

The minimization of the likelihood of internal fires in the RSV TAPIRO reactor is realized reducing as much as possible the fire loads and the ignition sources. The fire ignition likelihood is also minimized by reducing the propagation of fire across the various zones of the facility.

A.II.3.1.1. Design considerations and prevention means

The most relevant RSV TAPIRO's design characteristics for fire prevention are:

- the external infills of the reactor hall (the place where the nuclear fuels are located) are made with REI 30 fire resistance;
- the horizontal and vertical load-bearing structures have REI 60 fire resistance;
- the ventilation system is equipped with non-combustible filters (fire resistance class M1).

Fire prevention, as a proactive method of preventing internal fires, is implemented in the RSV TAPIRO reactor with procedures and prohibitions.

In the RSV TAPIRO installation are forbidden:

- the use of open flames;
- the deposit of flammable substances;
- the use of equipment that may cause ignition of fire.

The feasibility study of experiments or neutron irradiations evaluates the risk of fire ignition due to the increase of temperatures in the experimental apparatus, cables, and so on and foresees the installation of temperature sensors and, if possible, of additional fire detection and extinguishing systems. Furthermore, the non-accidental sources of fire are limited to particular activities of maintenance, like welding, that are very infrequent and are managed and monitored with particular procedures. Table 1 contains some evaluations, made by ENEA personnel on the fire loads of each room.

LIST OF FIRE LOADS FOR ANY SPECIFIC AREA								
FLOOR	AREA	SURFACE AREA (m^2)	MATERIALS	QUANTITY (KG)	HEAT OF COMBUSTION MJ/KG	THEORETICAL SPECIFIC FIRE LOAD (MJ/m^2)	SAFETY FACTOR FOR SPECIFIC LOAD	TOTAL FIRE LOAD (MJ)
0	OFFICES	93	FORNITURES & PAPERS			420	1.2	46872
0	CONTROL ROOM	30	ELECTRONICS DEVICES	400	21	280	1	8400
0	TECHNICAL ROOM	61	HVAC FILTERS	50	46	38	1	2300
0	MAINS ENTRY+ CORRIDOR	49	PRINTERS+TONERS	50	46	47	1	2300
0	REACTOR HALL	160	SWITCH PANNELS & SENSORS	300	21	39	1	6300
-1	HELIUM PUMP (Locale Impianti reattore)	53	SWITCH PANNELS & SENSORS	200	21	79	1	4200
TOTAL COMPARTMENT		446				158		70372

Table 1 C-37 and RSV TAPIRO Fire load evaluations

A.II.3.1.2. Overview of arrangements for management and control of fire loads and ignition sources

The fire loads and ignition sources that cannot be removed or reduced because are part of the functioning of the installation (for example, the console in the control room or the electrical power supply for the coolant pump in the reactor hall) are constantly monitored by visual checks and temperature sensors. The additional objects, which are important for the operation of the installation, like the portable radioprotection instruments, the plastic sheeting, laboratory suits, gloves, etc… are maintained in confined areas away from the potential fire sources (essentially electrical devices). The flammable waste is contained in metallic drums and committed to NUCLECO S.p.A. (the company for the management of radioactive waste) in the shortest possible time.

A.II.3.1.3 Licensee's experience of the implementation of the fire prevention

A.II.3.1.3.1. Overview of strengths and weaknesses

The precautions adopted in the design and building of the RSV TAPIRO installation, the limitation of fire load performed with cogent procedures, constitute some strong points that are combined with the presence of the SPI, the connection of their operations centre with the fire alarm station of the RSV TAPIRO, the presence of automatic fire extinguishing systems, the constant tests and monitoring of the fire systems and the test of fire-fighting organization with periodic drills. The utilization of innovative materials available in the market would certainly improve fire prevention but the actual implementations of every ameliorative solution have an impact on the economic resources and the utilization schedule of the installation.

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

As mentioned in the previous paragraphs of this document a fire event occurred in August 1978 that initiated in a component of the console in the control room and involved several electrical cables and electronic devices. The event was characterized by slow combustion with the absence of flames; more precisely we can classify this event as a smouldering event. It started with a short circuit in one of the devices of the console and the heat produced by the high intensity of the electrical current caused damage to other components of the console and in the insulation sheath and several cables. The reactivation operations of the console were characterized by the substitution of all cables with fire-resistant cables and the installation of short circuit protection circuits in the devices that have a high absorption of current. A significant improvement was made to the fire protection system with the installation in the control room of two automatic extinguishing systems, one for the power cord tunnel and one for the entire control room.

A.II.3.1.3.3. Overview of actions and implementation status

Several actions are being defined for the substitution of structures (doors, type of wall paints, ventilation valves, etc…) and for an extensive and critical examination of existing procedures. These actions will improve fire prevention and will be implemented following the graded approach and the economic resources availability.

A.II.3.2 Active fire protection

A.II.3.2.1 Fire detection and alarm

The facility RSV TAPIRO and the corresponding building C37 is organized on one unique fire compartment. The current detection and fire suppression systems have been realized during some changes to the automatic system and the modernization of the command panel occurred in 1998. Fig 2 represents the current layout of the active fire detection systems.

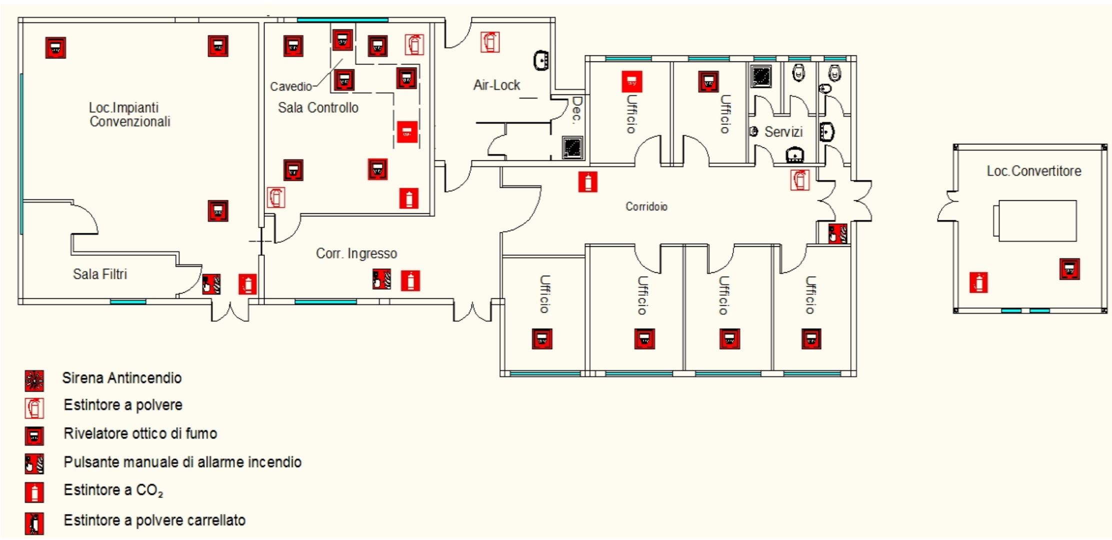


Fig 2 Fire detection system (optical detectors location)

A.II.3.2.1.1. Design approach

The facility RSV TAPIRO and the corresponding building C37 is organized on one unique fire compartment. The alarm panel is located in the building close to the Control Room and the offices of the reactor staff. An alarm is generated into the building, but replicated also into a remote alarm panel outside of the building, and into the SPI office.

A.II.3.2.1.2. Types, main characteristics and performance expectations

A technical prescription indicate a periodicity of six month for testing the entire system, from detectors to the alarm panel and to the SPI office.

A.II.3.2.1.3. Alternative/temporary provisions

In case of out-of-service of the fire detection system it is required to have a defence on the facility by the staff plant organizing a round-the clock service. The plant staff is also supported by the SPI. In some cases, in the past it has also been accepted by the regulator that a dedicated CCTV circuit has been installed in the restricted and controlled areas of the facility and that the security personnel of the Centre have implemented the number of inspections, especially during the not working hours, in order to report any abnormal situations.

A.II.3.2.2 Fire suppression

A.II.3.2.2.1. Design approach

The premises with the most significant fire load are protected by an automatic fire extinguishing (Table 2) system which is activated by two separated detection signals that protect these premises.

The protected premises are:

- control room;
- console power cord tunnel;
- conventional plant room, in which the distribution cabinets for the electrical power supply to all system users are installed.

Fig. 3 Automatic Fire suppression system

The signals coming from the smoke and temperature detectors (Fig. 2) refer to the MIPRO 2000 control unit, installed in the entrance corridor next to the access door to the control room.

These signals, displayed locally, are automatically transmitted to the SPI control room, and activate an alarm siren inside the C-37 building.

For the convenience of identifying the origin of any alarm signal the building was divided into 6 zones in each of which a certain number of detectors were installed. On the control unit it is possible to immediately check the area from which the alarm signal comes, to increase the speed of intervention. The alarms coming from the various zones cannot be dismissed in any way and arrive directly at the SPI control room regardless of the operating conditions of the plant and the time in which the event occurs.

ACTIVE PROTECTION SYSTEMS						
FLOOR	AREA	NR FIRE EXTINGUISHER DUST 6 KG	INERT GAS EXTINGUISHER	POINT SMOKE DETECTORS	FIRE CENTRAL	INTERNAL HYDRANT
0	OFFICES	2	-	YES	-	NOT ALLOWED
0	CONTROL ROOM	2	2	YES	-	NOT ALLOWED
0	TECHNICAL ROOM	1	2	YES	-	NOT ALLOWED
0	MAINS ENTRY+ CORRIDOR	2	-	YES	YES	NOT ALLOWED
0	REACTOR HALL	4	-	YES	-	NOT ALLOWED
-1	HELIUM PUMP (Locale Impianti reattore)	2	-	YES	-	NOT ALLOWED

Table 2 Active C-37 protection systems

As a further active fire protection system, on the facility and into the corresponding building there are also powder and CO2 fire extinguishers, located as represented in Fig. 2.

A.II.3.2.2.2. Types, main characteristics and performance expectations

Not implemented

A.II.3.2.2.3. Management of harmful effects and consequential hazards

A technical prescription indicate a periodicity of six month for testing the entire system, from detectors to the alarm panel and to the SPI office.

A.II.3.2.2.4. Alternative/temporary provisions

In case of out-of-service of the fire detection system it is required to have a defence on the facility by the staff plant organizing a round-of-clock service. The plant staff is also supported by the SPI. In same case, in the past it has also been accepted by the regulator that a dedicated CCTV circuit has been installed in the restricted and controlled areas of the facility and that the security personnel of the Centre have implemented the number of inspections, especially during the not working hours in order to report abnormal situations.

A.II.3.2.3 Administrative and organisational fire protection issues

A.II.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

Firefighting strategies are the combination of firefighting measures aimed at achieving the fire safety objectives which are: safety of people and protection of goods and the environment.

In the RSV TAPIRO plant, the main active fire-fighting measures adopted to reduce the fire risk of the activity to a threshold considered acceptable are:

- Management of fire safety, with the adoption of an organizational structure that includes roles, tasks, responsibilities and procedures (emergency and evacuation plan);
- Fire control, using well-located fire extinguishers and an INERGEN gas extinguishing system to protect the classified area;
- Detection and alarm, with optical and thermal detectors capable of detecting the fire as soon as possible and sounding the alarm in order to activate the technical (extinguishing system) and procedural (emergency and escape plan and procedures) firefighting measures;
- Fire-fighting operations, as the building is easily accessible to rescue teams and vehicles called to operate during an emergency;
- Safety of technological and safety systems, as they are designed, built and controlled in accordance with the provisions of the system's prescriptive body.

A.II.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

- The plant's Internal Emergency Plan contains all the detailed information regarding the behaviour that workers must adopt in the event of a fire emergency. This document contains an accurate planning of the operations to be implemented in the event of a fire emergency, in order to allow workers to exit in an orderly manner to a safe place outside.
- In particular, it identifies the SPI as the personnel in charge of firefighting.
- All the alarms of the fire detection system are centralized and remoted in the emergency room of the SPI where highly trained and trained personnel in fire extinguishing are always present 24/7. This service is also equipped with fire-fighting vehicles and equipment.
- The intervention of the SPI complies with what is written in the System Emergency Plans.

A.II.3.2.3.3. Specific provisions, e.g. loss of access

All the alarms of the fire detection system are centralized and remoted in the emergency room of the SPI where highly trained and trained personnel in fire extinguishing are always present 24/7. This service is also equipped with fire-fighting vehicles and equipment.

The intervention of the SPI complies with what is written in the System Emergency Plans.

A.II.3.3 Passive fire protection

A.II.3.3.1 Prevention of fire spreading (barriers)

With prevention we want to minimize the risk that the fire occurs. In order to reduce the probability of fire outbreaks, it is necessary to take fire-fighting measures.

In the RSV TAPIRO plant, the main passive fire-fighting measures adopted to reduce the fire risk of the activity to a threshold considered acceptable are:

- Fire resistance, through reinforced concrete structures with bearing capacity in case of fire;
- Compartmentation, referring to the entire building being delimited and isolated capable of controlling and containing the spread of fire;
- Exodus, a set of routes that ensure that the occupants of the activity reach a safe place outside.

A.II.3.3.1.1. Design approach

Passive protection includes all measures aimed at containing the effects caused by a fire with the objective of protecting people and the building that contains them. Passive protection is always present, it does not activate in the presence of a fire and it works regardless of whether or not the accidental event occurs, it does not require the action of man or a system and ultimately it does not need the fire to activate

The passive fire protection systems present in the RSV TAPIRO plant are:

- structures with fire resistance characteristics

- materials classified for their reaction to fire
- ventilation systems
  - system of exit routes commensurate with the maximum conceivable crowding
  - fire barriers (building insulation, external and internal safety distances).

In particular, as already described, regarding the structures the external infills of the reactor hall (the place where the nuclear fuels are located) are made with REI 30 fire resistance, and the horizontal and vertical load-bearing structures have REI 60 fire resistance. The ventilation system is equipped with non-combustible filters (fire resistance class M1). The C37 building has a devoted emergency plan in case of fire and a detailed internal procedure shared with the SPI.

C-37 building and also the reactor building is not divided in compartments: it exist just one compartment that is the building itself. The ventilation system, that by procedure must be shut-down during any emergency occurrence, is not equipped with fire dumpers.

A.II.3.3.1.2. Description of fire compartments and/or cells design and key features

The facility is a unique fire compartment and it correspond with the entire building. The fire resistant materials, with the specified features described before as a REI class, have been indicated in par 3.3.1.1

A.II.3.3.1.3. Performance assurance through lifetime

The performance is assured by the technical prescription indicated for the RSV TAPIRO and corresponding to the building and to the ventilation system. It' s necessary to indicate that these prescriptions have a safety meaning from the point of view of the radiological scenarios and are not dedicated or have a role, by design, in case of fire event.

A.II.3.3.2 Ventilation systems

As previously described, the ventilation system is not equipped with fire dumpers. The ventilation system is designed to ensure that the vital areas are depressed respect to the external environment (Dp > 20mm H2O). This feature of the building is verified with a periodicity (at least 1 timer per year) that is indicated in the technical prescription for the operation of the reactor. The ventilation system is divided into the main ventilation system and the emergency ventilation system. Another independent system ensure the ventilation of the under-pile zone and is activated by the control room in case it's necessary to access the under-pile room. As described in the emergency plan of the reactor in case of fire the ventilation system I shut-down by the operator in control room. The segregation realized by the dumper is designed with a safety meaning in order to avoid a release of radioactivity in the external environment. When the ventilation system is in shut-down, due to the containment of the building, the entire area is segregated from the external environment but just in term of nuclear and radiological security.
In any case, and also in case of fire alarm during the not working hours, the ventilation system is automatically shut-down in case of fire alarm.

A.II.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

Not applicable

A.II.3.3.2.2. Performance and management requirements under fire conditions

Not applicable

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

The fire protection system for RSV TAPIRO has to be improved by means of a FHA to implement the corresponding actions to define the fire compartments and adjust the ventilation system inserting fire dumper.

B. DEDICATED SPENT FUEL STORAGE FACILITIES

B.I Dedicated Spent Fuel Storage Facilities (wet and dry) at ITREC-plant

B.I.1 General information

B.I.1.1 Itrec Plant

- Name: **ITREC reprocessing plant in Rotondella Site**
- Licensee: **Sogin SpA**

ITREC (Fuel Element Reprocessing Plant), built during 1965-1975, was aimed at demonstrating on a pilot scale the feasibility of closing the Uranium-Thorium cycle by reprocessing the irradiated fuel and remotely remanufacturing the new fuel using the recovered Uranium (235+233) and Thorium.
The first plants and main buildings, which are part of the complex of facilities called the "ITREC Plant," were designed and built in the late 1960s (1968) under a cooperative agreement between CNEN (Nuclear Energy Committee) and USAEC (United States Atomic Energy Commission).
Under this agreement, the plant received 84 irradiated fuel elements from the U.S. Elk River reactor.
The fuel consists of a matrix of Th 232 oxide (the only naturally occurring isotope of Th) and high-enriched U (greater than 80%in U 235); some of the Th 232 was fertilized to U233 (as fissile as U235).
The plant initially consisted of two separate sections:

- ✓ a section devoted to the separation and recovery of Uranium (formed U233 and residual U235) and Th from fission products, by aqueous reprocessing of Elk River fuel (nitrate dissolution and solvent extraction of U and Th);
- ✓ a remote re-fabrication section of a new fuel refill for the Halden reactor, through processes of precipitation of U and Th oxalates, their transformation to powdered oxides and subsequent pelletization.

The plant was designed in a modular manner by means of movable racks to allow remote removal of the racks on which the main chemical process equipment is installed in the hot cell (Rack Removal System).
This system facilitates maintenance and modification or replacement of components and equipment making the plant flexible and adaptable to different research programs.
During 1969-1975, functional and pre-nuclear tests were completed.
In 1975-1978, the plant carried out a campaign of tests on a total of rods (pins) corresponding to 20 irradiated fuel elements (Elk River reactor, USA).
In 1979 research activities in the field of Uranium-Thorium fuel reprocessing were discontinued. This was attributable to the fall of interest at the international level with respect to the U-Th cycle on the part of the U.S., as well as technical difficulties related to the remote reprocessing stage.
Since then, the plant has had no reprocessing activities and has been used as an experimental station for the development of advanced technology processes and components. Beginning in 1987, following the outcome of the post-Chernobyl referendum, all activities were suspended and the plant was placed in a safe store condition.
Subsequently, activities for waste treatment and conditioning were initiated; these activities were conducted with specific permit applications.
The plant was operated by ENEA until August 2003. Since August 6, 2003, the plant has been entrusted to Sogin S.p.A., which is its Operator according to an authorization, prescriptive and regulatory regime articulated over time. In fact, in implementation of the provisions of Legislative Decree No. 79 of March 16, 1999, "Implementation of Directive 96/92 EC laying down common rules for the internal market in electricity," ENEL S.p.A. established Sogin S.p.A. - Società Gestione Impianti Nucleari, to which, effective 01.11. 1999 were conferred all the assets and legal relationships inherent to the exercise of activities related to the decommissioning of decommissioned electronuclear power plants, closure of the fuel cycle as well as related and consequent activities that previously, within Enel S.p.A, were the responsibility of the Nuclear Plant Management Structure (SGN).
On November 3, 2000, Sogin's shares were transferred from Enel S.p.A. to the Ministry of Treasury.

In August 2003, ENEA's fuel cycle research plants were also entrusted to Sogin for management: the EUREX plant in Saluggia, the ITREC plant in Rotondella, the OPEC and Plutonium plants in Casaccia (Rome), and the Bosco Marengo fuel fabrication plant, which was subsequently acquired by Sogin in 2005.
The operating license of the ITREC Plant, managed by Sogin but owned by ENEA, is in the hands of Sogin by Ministerial Decree dated 26/07/2006, which authorizes the safety maintenance activities and activities preparatory to decommissioning. These preparatory activities consist of:

- ✓ cementation of liquid intermediate-level waste called Finished Product (ongoing activity)
- ✓ Dry storage of Elk River Reactor irradiated fuel (ongoing activity)
- ✓ Remediation of Pit 7.1 (activity completed).

Plant activities are carried out under the following permitting and prescriptive regime:

- **Operating License (Licenza di Esercizio):** Ministerial Decree of July 26, 2006
- **Technical prescriptions**: APAT - RIS -ITR -02/2006 "ITREC Plant - Operational prescriptions for the safe maintenance of the ITREC Plant and for the execution of activities preparatory to decommissioning".
  Ministerial Decree of July 23, 2008- authorization to modify the management prescription 2.8 referred to in document APAT - RIS -ITR -02/2006.
- **Operating Regulations (Regolamento di Esercizio)**: Doc. IT G 01428_Rev01, approved by ISIN on 17/09/2021 (Doc. No. ISIN/AA/11/2021/ITREC).
- **Physical Protection (Protezione fisica):** Ministerial Decree VII-111 of July 1980 with annex Doc. (RTI)COMB/RITR(79)205.
- **Emergency Plans**:
  Off-site emergency Plan, approved by the Prefecture of Matera on March 04, 2016.
  Internal Emergency Plan, updated by the College of Safety Delegates On November 28, 2019 (SOGIN Doc. IT G 00028 rev.01)
- **Final safety report** (Rapporto finale di sicurezza): IT G 0003 rev02

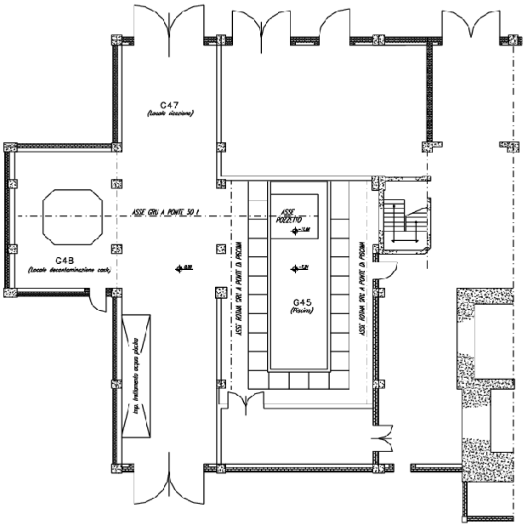
The energy sources utilized into Itrec Plant (electricity and water) are supplied from the National service.
Electric Power: the site is equipped with 3 transformers with 1 out of 3 operation which allow the voltage to be reduced from 20kV to 380V for power supplying of all users in the site. Furthermore, if the electricity normally supplied by the national grid fails, the Site is equipped with 3 diesel power generators, with operation 2 out of 3, which feed all the systems relevant to the nuclear safety of the Site including the fire-fighting pressurization pumps and the water adduction pumps from the Sinni River.
Water: the power sources are both from the national water service network (Acquedotto Lucano) and the withdrawal from the Sinni river via two adduction pumps. The water supply guarantees both the distribution of drinking water for the personnel and water reserve necessary for firefighting which includes a reserve of 400m3 deriving from a hanging tank and an additional reserve of 600m3 for a possible replenishment of the hanging tank.
Furthermore, an equipped vehicle is present on site for firefighting and is always ready to intervene. Periodically, fire simulations are carried out within the site together with the VVF fire brigade structure.
Near the Site there is only the ENEA Research Center with its own fire-fighting facilities. The area surrounding the Enea site, which houses the Sogin area, is mainly dedicated to agricultural use.
With regard to fuel storage, the following should be noted:

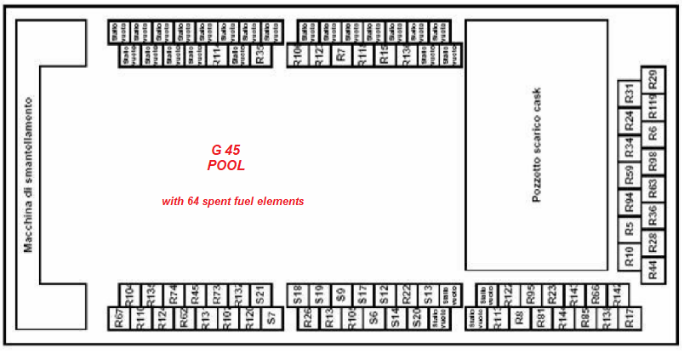
- currently the fuel is stored in a pool (wet storage) in the Itrec building (room G45).
- according to the decommissioning plan, the fuel is planned to be transferred into new fuel cans and then loaded into 2 casks, for dry storage. The casks will be stored in a dedicated storage facility DTC3, under construction (part of the ICPF building), and then transferred to the National Repository.

Therefore, in the following paragraphs, reference will be made to the 2 different fuel storage situations.

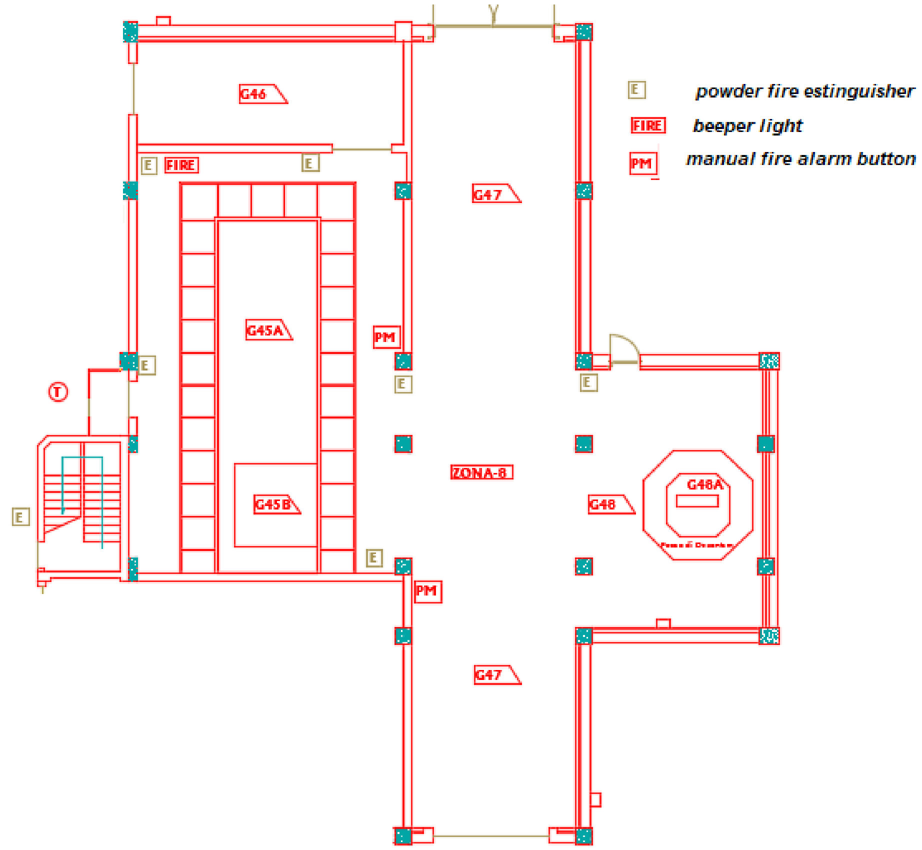
B.I.1.1 bis Spent fuel storage facilities (Wet and Dry)

WET STORAGE: Pool



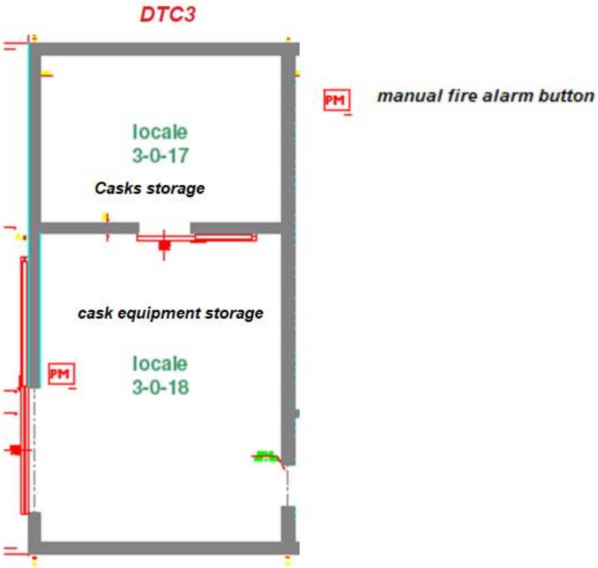


The pool in which the fuel is currently located has a prismatic shape. It measures 3 m wide and 10.7 m long in plan, with a depth of 7.24 m (its maximum depth is 11.64 m); its volume is about 280 m^3.
On the walls of the pool are 6 racks, in which are placed the 64 capsules containing the spent fuel.
No major fire hazards are present in the pool. Fire starts can be signaled by the operator through an illuminated beeper and a hand button. For fire extinguishing, powder extinguishers are present in the area.
The following figure shows the distribution of fire-fighting equipment in the pool area.



DRY STORAGE: DTC3 storage

The DTC3 storage is currently under construction and is exepected to start operation in 2026. It is intended to store the 2(two) TN24 casks containing the spent fuel now stored in the pool, awaiting for the transfer to the National Repository when available.
It measures 11.5 m wide and 22.8 m long in plan, with a heigh of 12 m; its volume is about 3200 m^3.
No major fire hazards are expected to be in the DTC3. Radiological risks are considered to be very low due to containment funcion assured by the casks. Appropriate smoke detectors will be installed in the ventilation ducts exiting the rooms, ensuring fire risk control in those areas; fire starts can be signaled by the operator through a hand button.
The following figure shows the distribution of fire-fighting equipment in the DTC3 area.



B.I.1.2 National Regulatory Framework

As per §1.2

B.I.1.3 Improvements in fire safety as a result of experience feedback

The implementation of the fire protection concept is regularly in course for Itrec Plant dedicated spent fuel without any issues.
Following improvements have been applied:

- Insertion of some sectioning valves on the main ring to optimize maintenance activities on fire line;
- Dynamic implementation of preventive/planned maintenance on fire protection systems;
- Optimization of green maintenance activities to prevent fires inside and outside the installation:
- Optimization of waste management in areas dedicated to temporary storage.

B.I.1.4 Defence in depth principle and its application

The defence in depth principles in the design of Storage spent fuel has been implemented following these different successive levels:

- **Minimize likelihood of fires**: All wastes are packaged in double metallic drum, some wastes are enclosed in a qualified fire-resistant shell;
- **Control ignition source**: All electrical and signal cables are enclosed into metallic conduit
- **Controlling and mitigating the fire**: all the areas are equipped with gaseous fire extinguishers system
- **Mitigating secondary fire effect**: All the fire compartments are designed to maintain their integrity during and after the fire with no active system – All the doors, ventilation ducts and electrical penetration are fire resistance qualified - All the compartments are equipped with high temperature sensors to activate the ventilation system only at a specified temperature.

WET STORAGE: Pool

The spent fuel elements, lay in several racks. To prevent any chemical corrosion of the structural materials of the fuel storage racks and of the capsules, the storage pool is filled with demineralized water and periodical controls of the chemical composition of pool water are imposed by the operative technical requirements.
Any type of activity carried out in the pool area is performed primarily for scheduled maintenance needs. In this case, operators follow well-defined work procedures that, following fire risk analysis, include not using combustible materials and controlling likely sources of fire ignition through the local use of portable fire extinguishers.
For secondary fire effect, the mitigation is obtained by protection of relevant SSC's. For all electrical component, the high quality and reliability SSCs, ensure protection against fire.

The pool does not present problems related to fire hazards; therefore, the wet storage of the fuel is obtained in safe conditions, also without any radiological problems.

DRY STORAGE: DTC3 storage

Once the transfer of the spent fuel will be completed, the facility will enter the decommissioning phase. The 2 casks will be transferred into a temporary storage in the site, called DMT3, located in ICPF area.
Then they will be transferred to the National Repository, when this is available.
The DTC3 storage, has been designed for fire safety, based on defence in depth (prevention, detection, control and mitigation of fire), as provided for in WENRA S- 30. This storage is still under construction and the activities will finish presumably within end of 2023.
No operators are expected to be present in DTC3 except for specific maintenance-related activities.
There are also no fire-hazard activities in the DTC3 storage. All activities will be related to cask maintenance, so the same considerations made for the spent fuel pool also apply to this area.
The DTC3 does not present problems related to fire hazards; therefore, the dry storage of the fuel is obtained in safe conditions, also without any radiological problems.

B.I.2 FIRE SAFETY ANALYSES

B.I.2.1 Dedicated spent fuel storage Itrec Plant

B.I.2.1.1 Types and scope of the fire safety analyses

For the *Wet storage* that was built in the 1960s. the Fire Safety analysis, is conducted with the implementation of the prescriptive approach dictated by Ministerial Decree 10/03/1998 in which the standards and technical rules for fire prevention, impose compliance with minimum safety requirements identified in the same regulation.
For the purpose of protection against fire, reference is made to the document entitled "Prescriptions for operation for the purpose of maintaining the safety of the Itrec plant and for the performance of activities preparatory to decommissioning" - DOC APAT RIS IR 02/2003, issued by APAT (Agency for Environmental Protection and Technical Services). In section 3.8, specific reference is made to the general site fire protection system.
This technical requirement, which also applies to the pool area, provides the following:

- 3.8.1 the fire detection systems must be operable in each area of the installation. In the event of their inoperability, place the affected area in **operating conditions B** (no operation on nuclear, fissile and/or radioactive materials, on irradiated fuel) and provide for the restoration of operability as soon as possible. The resumption of activities must be subordinated to a documented risk analysis, which evaluates, according to the fire risk of the area, the possibility of resuming activities and/or the adoption of alternative measures.
- 3.8.2 extinguishing means must be operable. With a number lower than the required number, re-establish that number as soon as possible
- 3.8.3 in the dedicated spaces, the mobile extinguishing devices envisaged and the equipment of the firefighting team must be available and functioning. In case of unavailability, restore the equipment in strictly technical times.

In particular, it has to be considered that the residual heat of spent fuel still in storage in the pool is very low and also in the absence of the dedicated cooling systems the heat removal function ca be assured by the evaporation of the water in the pool.
For the *Dry storage* the Fire safety analysis is referred to a deterministic analysis such as a Fire Hazard Analysis (FHA) according the new regulation established also reflected in the ISIN technical guide n.30.

The following paragraph refers to the Dry storage facility under contruction.

In addition, based on selected accidents scenarios, for both wet and dry storage, the release of a certain amount of radioactivity to the environment (source term) has been evaluated with conservative assumption and the resulting exposure of workers and population estimated.

The resulting doses for workers and the population are lower than the radiation protections objectives assumed in the design.

B.I.2.1.2 Key assumptions and methodologies

The fire hazard analisys is an iterative process, consisting of the following steps:

a) *scope of the design*: the activity and its operation are described qualitatively and quantitatively, in order to clarify the scope of the design.
b) *safety objectives*: the safety objectives of the design applicable to the activity, are specified;
c) *risk assessment*: the fire risk assessment is carried out;
d) *risk profiles*: risk profiles are determined and assigned;
e) *fire prevention strategy*: risk mitigation is carried out through preventive, protective and management measures that remove hazards, reduce risks or protect against their consequences:
   i. defining the overall fire prevention strategy,
   ii. attributing performance levels for all fire prevention measures;
   iii. identifying the design solutions that guarantee the achievement of the assigned performance levels;
f) if the result of the design is not considered compatible with the purpose defined in point a), the designer iterates the steps referred to in point e) of this methodology.

The assumptions of fire scenarios do not consider malicious actions, prevented by the Physical Protection of the Site and the personnel selection.

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

Fire phenomena analysis has been reported below only for dry storage facility, because in wet storage fire risk is considered negligible, considering the significant fire loads and ignition sources are not present. Considering the latter aspect, the spent fuel stored in the pool is quite old and therefore there is a very low decay heat producted.

Analysing the Dry storage facility, the identification of the characterizing fire risk elements is carried out in accordance with the provisions of the Decree of the Minister of the Interior of 4 May 1998 and the Decree of the Minister of the Interior of 10 March 1998, allowing to define the fire scenarios, as projections of possible fire events.

Specifically, for the new Cask DTC3 storage facility, a fire risk assessment was conducted based on the principle of defense in depth. It foresees:

- Minimizing the combustible materials present and the possibility that the fire may start, feed and spread rapidly; in particular:
  - ✓ No furniture or equipment made of wood or with appreciable use of plastic material is provided in any room
  - ✓ Electrical/electronic equipment will be made of non-flame propagating material.
  - ✓ Power and control cables will be, for most of their route, placed in metal conduits; they will also be of the non-flame propagating type, with low toxic gas development.
  - ✓ Pipe thermal insulation will be made of class 0 material
- Finishes (doors, curtain walls, etc.) must have a minimum fire resistance of REI 60 and a fire reaction class of 0 (Class 0 - non-combustible materials) and in any case no higher than 1 (Class 1). No intumescent paints shall be used.
  - ✓ The floors will be concrete treated with decontaminable epoxy paint in aqueous dispersion; while the walls will be treated with decontaminable epoxy resin-based, non-flammable paints.

- The assessment of the specific fire load, considering the combustible materials present (electrical equipment and electrical cable insulation in quantities congruent with the design configuration); as part of the assessment, the fire load is classified:
  - ✓ "Zero load" for qf < 100 MJ/m2, with reference to DM March 9, 2007
- Adequate fire compartmentation so as to confine any fire that, despite the fire prevention criteria adopted, should occur
- Fire detection and reporting that can detect the event in a timely manner
- Fire suppression through the adoption of an appropriate extinguishing system.

For the calculation of fire loads, the following assumptions were considered:

- Fire loads, essentially consisting of equipment motors, were conservatively considered as a fuel load, with a weight equivalent to 30 percent of the installed electrical power and a calorific value of 42.5 MJ/kg.
- The power and control cables will be of a flame-retardant type, with low toxic gas development. A conservative assumption has also been made for these components, namely that 20 percent of the total weight of the cables (calculated proportionally to the installed electrical power of the subservient component) in each room is combustible material, with a calorific value of 20.5 MJ/kg.
- Substantial amounts of paper/clothing (100 kg max) were assumed in some rooms, while in the filter room an overall filter area, considered to be made of combustible paper, with a calorific value of 340 MJ/m2 was calculated. A 4000 m3/h HEPA unit module consists of panels each with an area of 37 m2 (indicative total ventilation system flow rate of 16000 m3/h). The filters to be used will consist of self-extinguishing micro-fiber glass paper.

The following formula was adopted to calculate the nominal value of the fire load, as given in the DM 9-03-2007:

$$q_f = \frac{\sum_{i=1}^{n} g_i H_i m_i \psi_i}{A}$$

with:

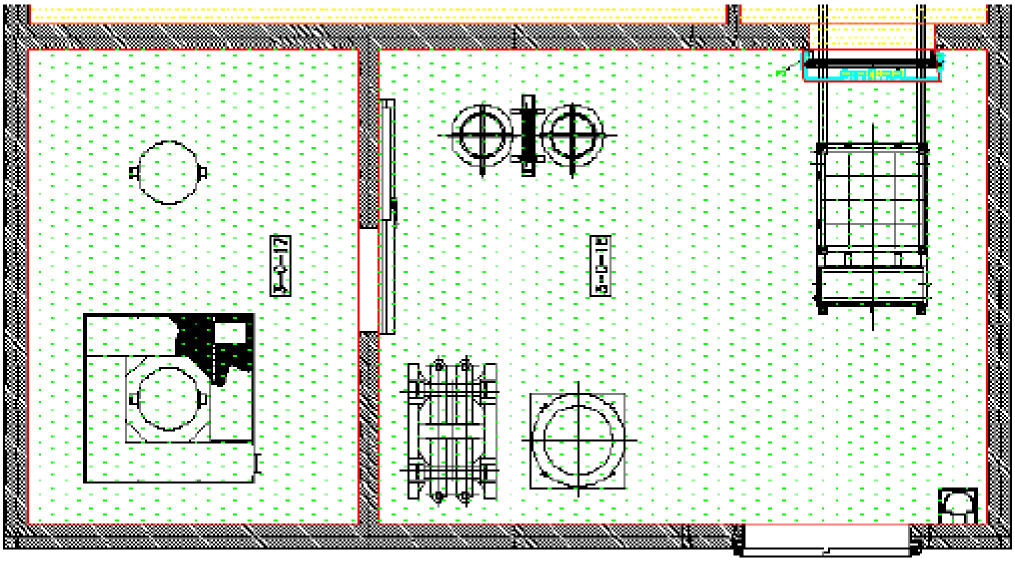
g_i = Mass of i-th combustible material [kg].

H_i = Lower heating value of the i-th fuel material [MJ/kg]. Hi values of combustible materials can be determined experimentally in accordance with UNI EN ISO 1716:2002 or be borrowed from technical literature.

m_i = Combustion participation factor of the i-th combustible material equal to 0.80 for wood and other materials of cellulosic nature and 1.00 for all other combustible materials.

ψ_i = Factor limiting participation in combustion of the i-th combustible material equal to 0 for materials contained in containers specially designed to resist fire; 0.85 for materials contained in non-combustible containers not specially designed to resist fire; 1 in all other cases.

A = Gross plan area of compartment [m^2].



Applying the formula, the fire loads are shown in the following table. According to these fire loads, fire detection systems were designed, which, in the cask storage and equipment storage area, led to the installation of 2 smoke detectors.
Regarding the fire loads related to the DTC3 building, reference is made to the following table:

			specific fire load		
Room	Item	Area m^2	MJ/m^2	Kgw.eq/ m^2	smoke detectors
3-0-17	Cask storage	92	0	0	2
3-0-18	Equipment cask storage	172,2	6,46	0,35	-

For the outward opening related to DTC3, no special fire resistance requirements are required because the specific fire load is low and there are no gratings or windows at these openings such as to create a draught effect in other rooms.
The load-bearing structures, regardless of the specific fire load assessment, were conservatively designed with fire resistance characteristics (R120).

The only area where fire loads of any significance may be present, albeit for very limited periods, is the cask equipment area (room 3-0-18). This area, in fact, contains the fire loads due essentially to the overhead crane motor, electrical cables, and cask monitoring equipment.

An HAZOP (**HAZ**ard and **OP**erability Analysis), concerning the fire risk, was finally performed. It allows, through a systematic, structured and comprehensive examination of technical information, to ensure that all major "hazards" are identified and adequately taken into account. The end result of this analysis is to identify a list of events that could lead to radiological consequences for workers and the general public, with the assignment of the category to which it belongs:

- CATEGORY I = normal condition;
- CATEGORY II = abnormal conditions [minor failures and malfunctions];
- CATEGORY III = incidental conditions [unlikely incidental events];
- CATEGORY XT = extreme conditions [very unlikely and remote but likely to cause harm to the public];
- CATEGORY OUT = irrelevant/excluded conditions [with no radiological impact].

The category of Hazop analysis performed is **Category 1** (normal operation of the installation and events operations planned for it, including stops for inspection and maintenance)

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

In document IT100480 (Detailed Project Report- RPP for dry storage of irradiated fuel of Elk River) potential fire scenarios were considered; in particular:

- fire outside the system;
- fires for internal causes

The FHA developed demonstrates that any credible fire scenario, doesn't lead to an unacceptable radioactive release to the public and environment.
For residual fire risk reduction, all provisions are put in place to fully implement the provisions of Legislative Decree 81 of 09/04/2008 and to Legislative Decree 101 of 31/07/2020.
In addition, maintenance work and inspections on fire protection systems and equipment are carried out in accordance with the provisions of Article 4 of Ministerial Decree 10/03/1998. Fire extinguishing equipment is overhauled at least every six months by specialized personnel.
The ground surrounding the storage facilities for a radius of at least 5 meters shall be kept clear of grass and flammable or combustible material.
The amount of flammable or radioactive substances or products kept in the warehouses is never exceeded.
Keeping of the register provided for in Article 6 paragraph 2 of Presidential Decree No. 151 /2011 "The controls, checks, maintenance work and information referred to in paragraph 1 must be recorded in a special register by those responsible for the activity. This register must be kept up to date and made available for the purpose of controls under the competence of the Command."
The site implements all regulations on the protection of health and safety in the workplace in accordance with the provisions of Legislative Decree 81/2008, and in particular provides adequate information and training for employees on the fire risks associated with the specific activity, the prevention and protection measures adopted, precautions to avoid the outbreak of fire, and the procedures to be implemented in the event of a fire.

B.I.2.1.5 Periodic review and management of changes

Any change to fire protection/fighting systems must be prior authorized by Italian National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) and National Fire department (VVF).
Fire Safety Analyses are carried out and re-evaluated when OPs (Operational Plan) or DPs (Detailed project) are submitted. Fire Risk Assessments, are carried out considering the existing situation from the point of view of fire prevention. It should also be noted that the review of the assessments is updated periodically as required by the regulations, at the time of regulatory updates (e.g., DM of September/2021) and when requested by the Regulatory Authorities.

B.I.2.1.6 Licensee's experience of fire safety analyses

B.I.2.1.6.1 Overview of strengths and weaknesses identified

No specific weakness or strengths of fire safety analysis has been identified up to on ITREC Plant now in the experience of SOGIN.

It should be considered that even if the Fire Safety analysis is not be conducted for the old wet storage facility the fire protection concept has been however determined on the basis of the prescriptive approach dictated by Ministerial Decree 10/03/1998 and setting up the minimum fire safety requirements.
The spent fuel will be transfer within few years into the new dry storage facility currently under contruction. For this new facilities the fire analysis has been conducted according to the update national legislation and technical guide n.30.

B.I.2.1.6.2 Lessons learned from events, reviews, fire safety related missions, etc.

No fire events had been recorded during the operation of the wet storage spent fuel facility.
An example of lesson learned related the cask temporary storage project (dry storage) comes from the requirements received from the Fire Department (Prot. N 1962 dated 22/03/2011) in the approval phase. In the document, Fire Department, while approving the project, prescribed the following:

- emergency exits and the routes to reach them must be marked appropriately, even when there is no power supply;
- Manual door-opening devices installed along escape routes must comply with the requirements of the Ministry of the Interior's DM 3/11/2004;
- filter rooms must be equipped with a 30 kg wheeled fire extinguisher;
- The automatic fire detection and alarm system shall comply with UNI Standards and be equipped with manual alarm buttons in such numbers that they can be reached by paths not exceeding 30 meters;
- the register required by Article 5 paragraph 2 of Presidential Decree 37 of 12/01/1998 must be kept up to date.

These prescriptions were found to be useful and implemented in the final design.
It should also be noted that the installation has not been subject to international fire prevention inspections.

B.I.3 FIRE PROTECTION CONCEPT AND ITS IMPLEMENTATION

B.I.3.1 Fire Prevention

B.I.3.1.1 Design considerations and prevention means

In the ITREC plant, the facilities involved for spent fuel storage, the Pool into operation and the Dry-storage (DTC3) under construction are designed to minimize the likelihood of fire through proper systems layout and as far as practicable, elimination and/or reduction of fire loads and ignition hazards by separating ignition sources from flammable materials.
Additional preventive measures during the operation are obtained through administrative procedures.
The facility complies with the Fire Prevention Certificate granted by the national component fire-fighting authority.
The systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards.
The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth.

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

The management of fire prevention is stated into the licensee documents.

In particular, the document IT Q 00031 “Indice del Manuale di Operazione - Impianto ITREC” contains procedures called "surveillance procedures".
For residual fire risk reduction, all provisions are put in place to fully implement the provisions of Legislative Decree 81 of 09/04/2008 and to Legislative Decree 101 of 31/07/2020.
In addition, maintenance work and inspections on fire protection systems and equipment are carried out in accordance with the provisions of Article 4 of Ministerial Decree 10/03/1998.
The existing procedures require that:

- the amount of flammable or radioactive substances or products kept in the warehouses is never exceeded the acceptance limits;
- the ignition source in case of introduction in the working ares are properly controlled;
- the ground surrounding the storage facilities for a radius of at least 5 meters shall be kept clear of grass and flammable or combustible material.

Compliance is assured with the requirements of Presidential Decree No. 151 /2011 "*The controls, checks, maintenance work and information referred to in paragraph 1 must be recorded in a special register by those responsible for the activity. This register must be kept up to date and made available for the purpose of controls under the competence of the Command.*"
The site implements all regulations on the protection of health and safety in the workplace in accordance with the provisions of Legislative Decree 81/2008, and in particular provides adequate information and training for employees on the fire risks associated with the specific activity, including all the necessary prevention measures.

Considering that the spent fuel pool area is in a controlled zone, the introduction of materials that constitute fire loads and sources of ignition is not allowed. Access to spent fuel pool is available only following specific authorization. In addition to activities reported in technical prescriptions, maintenance activities can be carried out only accompanied by specific work permits. The activities carried out involve the removal of any ignition source materials and the recover of the work areas, as foreseen in normal activities. The same approach will be adopted for the future DTC3 dry fuel storage facility.

B.I.3.1.3 Licensee's experience of the implementation of the fire prevention

The fire prevention measures adopted on the site comply with the specific requirements established by national legislation regulating fire protection. No major issues had been highlited in their application.

B.I.3.1.3.1Overview of strengths and weaknesses identified

No relevant weakness or strengths of fire prevention have been identified.

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

No events relevant for fire safety have been recorded.

No international review missions have been conducted.

B.I.3.1.3.3 Overview of actions and implementation status

No specific additional measures or aticons are planned in relation to fire prevention implemented on the site.

B.I.3.2 Active Fire Protection

B.I.3.2.1 Fire detection and alarm

B.I.3.2.1.1 Design approach

In the spent fuel pool room (G45) there is no fire detection system, as reported in the authorization documents issued by the fire authority, because there are no substances present that could generate a fire or an explosion, nor systems and equipment that constitute ignition sources.

For the Wet storage pool the fire detection is expected to be provided by the operators present in the pool area during maintenance or other working activities. In case of intitiating fire the operators activate the alarm with the dedicated manual bottons present in the area.

For the dry storage (DTC3) under construction the fire detection systems are aimed at:

- quickly detect a possible fire.
- alert the operator for any manual request for intervention of the CO2 fire suppression in case of fires in the inaccessible rooms (equipped cells).
- Remote transmission of alarm signals to predetermined area in an internal emergency operational plan.

The choice to adopt the "Fire detection and alarm" derives from the evaluation of the fire risks; for different environments, such tools are necessary for risk reduction purposes.

B.I.3.2.1.2 Types, main characteristics, and performance expectations

<u>NEW STORAGE BUILDING DMC3/DTC3</u>

The fire-fighting system of the DTC3 warehouse was implemented based on the following general principles:

1. Fire prevention;
2. Fire detection;
3. Fire mitigation.

The fire protection system performs the following functions:

- Ensure, in the event of a fire, prompt and adequate reporting to the central control room switchboard in order to alert operators and enable timely execution of emergency procedures;

- Ensure a local sound and visual signal in order to allow safe evacuation of operating personnel;
- Guarantee the transfer of the fire alarm signal to the guard station ("guardian") located at the Trisaia site;

Detection and alarm provisions related to the DTC3 building, on the basis of the fire loads and the results of the fire hazard analyses are summarized in the following table:

		specific fire load		
Item	Area m^2	MJ/m^2	Kgw.eq/ m^2	smoke detectors
Cask storage	92	0	0	2
Equipment cask storage	172,2	6,46	0,35	-

The Fire detection and warning system consists of two detectors linear thermal detectors installed in the outlet ventilation duct of the storage and maintenance cask, and not in the rooms themselves to avoid undue radioactive doses related maintenance interventions and because the rooms in question are characterized by a negligible/zero fire load. The detectors are also characterized by a control remote without the use of "programmable" systems;

All detectors related to the cask storage facility report to a control unit, as well as the manual signal buttons, the control modules of the optical/acoustic plates.
The fire detection system is equipped with two sources of power supply, primary and secondary, each of which is capable by itself of ensuring the proper operation of the entire system.
Primary power, of the fire-fighting system is provided by the normal system power supply; secondary power is provided by dedicated stand-alone emergency batteries (detection system batteries) having an autonomy of at least 72 hours and ensuring the simultaneous operation of the internal alarm annunciator for at least 30 minutes after the alarm is issued (normally placed near of the respective control unit).
Each control unit is connected with the respective plant control and supervision system, where a cumulative alarm signal will be repeated.
This cumulative signal is also sent to the permanently manned supervisory (guard) station at the Trisaia site.

B.I.3.2.1.3 Alternative/temporary provisions

In case of absence of operability of the fire detection systems, no operations shall be carried out in the affected area on nuclear materials, fissile materials and/or radioactive materials and handling on pool irradiated fuel. In the transitional period provide as soon as possible to restore the operability of the System in the shortest possible time: any resumption, in the transitional period, of activities in the affected area shall be subject to a properly documented risk analysis with the adoption of alternative measures.
The above, as mentioned in the previous paragraphs, is well summarized in the section 3.8 of the document "Prescriptions for operation for the purpose of maintaining the safety of the Itrec plant and for the performance of activities preparatory to decommissioning", issued by National Regulator.

B.I.3.2.2 Fire suppression provisions

In the following some general reference information on the configuration of the fire suppression provisions of the ITREC plant are provided.

Fire fighting system of the site
The fire-fighting system is capable of simultaneously feeding 4 hydrants of 120 l/min each with a pressure of at least 4 ate, for the time necessary to empty the maximum water reserve which, if necessary, can go from 420 m3 of the hanging tank to 1,020 m3 with the addition of the underground tank of potable water, by activating an auxiliary pump, with a flow rate of 60 m3/h and a head of 60 mm.c.a.

The ring-connected fire network feeds the following hydrants:
- vital zone = n°15 (Sogin Area)

- protected area = n°11 (Sogin Area)
- inside buildings in the protected area = 4 hose reels (Ø UNI 45 mm)
- external zone of the perimeter area = n° 48

In the Sogin area, the system consists of 26 hydrants of the vertical above-ground type with two outlets (UNI Ø 70 mm) equipped with a fire box and connected to a ring pipe (UNI Ø 100 mm).

The ITREC protected area is equipped with 26 vertical hydrants above ground, located outside, with two outlets (Ø 70 mm) and 5 hydrants, located inside the buildings, with one outlet (Ø 45 mm), inserted in a tube forming a water ring (Ø 100 mm).
The fire ring, when the alarm occurs, is pressurized by two ROTOS motor pumps.

There is no fixed fire extinguishing system in the spent fuel pool, but only mobile fire extinguishers.

B.I.3.2.2.1 Design approach

WET STORAGE

The design approach for fire suppression is related to the methodologies used in the 1960s.

All modifications and improvements have been made over the years. Maintenance and verification activities play a key role in ensuring the proper functioning of fire suppression systems.

In the near future the spent fuel will be removed from the pool and to be located in two casks for dry storage and the pool building will be dismantled as part of the ITREC plant decommissioning plan.

DRY STORAGE

The selection of fire-fighting equipment in the cask storage building was carried out in accordance with the provisions of the DM 10/03/1998.

For fire risk purposes, fires have been classified in the following table:

Room / Area	Fire load	Risk
Casks storage (locale 3-0-17)	Presence of electrical lighting systems, gas monitoring systems, bridge cranes, with cables laid in metal conduits with little possibility of catching fire. Occasional presence of people (once / week, for quick inspection of pressure gauges).	insignificant
Cask equipment storage (locale 3-0-18)	Presence of non-flammable materials except for the bridge crane engines and a vehicle for loading/unloading equipment or packages. Non-continuous presence of people (transit room to move to loc. 3-0-17). Small switchboards.	low

With respect to mobile fire extinguishing media, the rooms manned and accessible during normal operations will be equipped with standard manual extinguishing devices (CO2 fire extinguishers or other extinguishing means).

B.I.3.2.2.2 Types, main characteristics, and performance expectations

The following considerations apply also for Wet and Dry storage.

Itrec Site

The ITREC site and all the buildings included therein, are equipped with fire protection systems.
The whole area of the Site is equipped with a fire-fighting network capable of supplying water to the hydrants and the various withdrawal points, whenever it is necessary, to intervene to extinguish fires. The water distribution network consists of a 420 m3 hanging tank and a series of UNI 70 above ground hydrants, each equipped with a fire box.
The supply water to the hanging tank is ensured by two submersible electric pumps, one in reserve for the other, which draw water from the Sinni River with a flow rate of 500 l/min.

In addition to and/or out of service of the withdrawal system from the Sinni River, the hanging tank can also be fed through the direct connection with the main supply network of the Acquedotto Lucano as well as by withdrawing the potable water contained in an underground tank having a capacity of about 600 m3.
Normally the hydrostatic pressure measured in the network is equal to about 3.5 ate; in the event of a fire emergency, this pressure is brought to approximately 7 ate by switching on three electric pumps, two of which must be operated simultaneously for a total flow rate of 90 m3/h (60+30) and a reserve of 60 m3/h.

Portable fire extinguishers

All premises of the buildings located in the ITREC Site are equipped with powder - or CO2 -loaded fire extinguishers. The quantity of extinguishing agent available is proportionate to the volume of the room to be protected and to the normally present fire load.
Fire extinguishers are loaded with different extinguishers according to the type of fire to be extinguished; each fire extinguisher is characterized by a certain extinguishing capacity identified by one or more acronyms.
The number and positioning of the fire extinguishers installed is such that they can all be reached after a distance of no more than approximately 15 m, not obstructing escape routes in any way.
The fire extinguishers have been located near the entrances and stairs and fixed in a suspended position to the walls by means of suitable attachments which allow them to be easily unhooked; the handle of the fire extinguisher is normally located at a height of more than 1 m.
Appropriate signaling signs of the type compliant with the standards of safety signs indicate the presence of fire extinguishers.
Particular attention has been paid to ascertaining that none of the fire extinguishers has been placed in such a position as to be subject to the direct action of heat, including exposure to sunlight.

The extinguishing intervention will provide for a discharge of extinguishing material only in the damaged room. The discharge will have the purpose of quickly bringing the concentration of the extinguishing gas in the air to the design value, a necessary condition to ensure the extinguishing of a possible fire.

The accessible premises of the ITREC building and in all premises of the buildings located in the ITREC Site Area are equipped with powder or CO2 fired extinguishers; the quantity of extinguishing agent available is proportionate to the volume of the room to be protected and to the normally present fire load.
Fire extinguishers are loaded with different extinguishers according to the type of fire to be extinguished; each fire extinguisher is characterized by a certain extinguishing capacity identified by one or more acronyms.
The number and positioning of the fire extinguishers installed is such that they can all be reached after a distance of no more than approximately 15 m, not obstructing escape routes in any way.
The fire extinguishers have been located near the entrances and stairs and fixed in a suspended position to the walls by means of suitable attachments which allow them to be easily unhooked; the handle of the fire extinguisher is normally located at a height of more than 1 m.
Appropriate signalling signs of the type compliant with the standards of safety signs indicate the presence of fire extinguishers.
Particular attention has been paid to ascertaining that none of the fire extinguishers has been placed in such a position as to be subject to the direct action of heat, including exposure to sunlight.

B.I.3.2.2.3 Management of harmful effects and consequential hazards

In the spent fuel pool and in dry storage facility there are no automatic estinguishing systems, so that any harmful effect and consequential hazards could be occoured.

B.I.3.2.2.4 Alternative/temporary provisions ITREC - DMC3/DTC3

The following also applies to Wet and Dry Storage.

In the event that the extinguishing systems are put out of service or fail for any reason, all operations involving nuclear materials, fissionable materials and/or radioactive materials and the handling of irradiated fuel in the pool will be suspended (operating conditions B). In the transitional period, the operability of the systems will be restored as soon as possible.

Further information for alternative provisions for the emergency situations are provided in the following para. B.I.3.2.3.3 Specific provisions, e.g. loss of access ITREC.

B.I.3.2.3 Administrative and organisational fire protection issues

B.I.3.2.3.1 Overview of firefighting strategies, administrative arrangements, and assurance

As regards the administrative and organizational fire protection issues, in the Itrec Plant, the involvement of a specific fire-fighting competence is managed by:

- ✓ Internal fire-fighting staff
- ✓ On site fire-fighting brigade
- ✓ National fire brigades (VVF)
- ✓ Procedures and other fire prevention and firefighting documentation as for example:
- ✓ Internal emergency plan;
- ✓ Off-site emergency plan;
- ✓ Training plan.

B.I.3.2.3.2 Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite ITREC

The firefighting strategies are assured by written procedures reported in the plant documentation.
All the on-site fire-fighting team are trained according to the national law for the higher level of fire risk with final exam certification by the fire department.
As per the technical prescription an annual fire drill is performed by all plant personnel also involving the off-site fire brigade. The national fire department and ISIN is informed of the drill.
The result of the drill is reported in a register which also indicates the improvement actions for the subsequent phases.
Security personnel are trained to handle fire alarm signals and have written procedures for intervening in an emergency.
The reference documents of the site are the following:

- Internal Emergency Plan doc. IT G 00028 of 28/11/2019;
- Off-site emergency Plan under review/update;
- Fire emergency plan IT G 0029

The Off-site emergency will be declared in accordance with the provisions of the Off-site emergency plan and, for the purpose of declaring the state of pre-alarm and alarm, to safeguard the population, the following two conditions are defined:

- The Pre-alarm status will be declared whenever one of the reference incidents occurs, or in any case, an anomalous event likely to lead to a release of radioactive substances into the external environment,
- The alarm status will be declared whenever the evolution of the event for which the pre-alarm was declared determines an effective release of radioactive substances into the external environment or when a release of radioactive substances into the external environment occurs in any case.

In the event of an emergency, the responsibilities will be divided as follows:

- The Plant Manager, or his substitute or on-call assumes responsibility and performs the functions envisaged by the plan and in particular is responsible for the operations to be carried out in order to guarantee the safety of people and the safeguarding of the assets present within the Plant and outside of it. Furthermore, if the situation evolves towards an external involvement, he is responsible for declaring the start of the pre-alarm and/or alarm state to the competent Authorities.
- The radiation protection expert or his contact assumes the responsibilities envisaged in the emergency plan and in particular is responsible for the radiation protection interventions aimed at ascertaining the radiological situation inside the building where the accident occurred, as well as aimed at protecting the personnel involved in the incident or in charge of interventions to deal with it;

- The Plant Supervisor coordinates the actions of the intervention teams on the plant systems directly at the site of the accident aimed at limiting the accident.

B.I.3.2.3.3 Specific provisions, e.g. loss of access ITREC

The following also applies to Wet and Dry Storage.

The entrance to the Sogin Site and the internal road network allows easy transit and maneuvering to emergency vehicles, within the site the land is flat, and the viability is guaranteed by roads and squares.
The layout ensures that the building is easily accessible and can be approached by the Fire Brigade.
The buildings are appropriately spaced from each other and have separate and independent accesses.

For the purposes of firefighting, below is the list of means and equipment envisaged for the management of fire safety in an emergency, the equipment of the emergency teams and the equipment provided on site at the plant level:

Firefighting means:
- N° 1 IVECO tanker mod. 600 of the Morselli and Maccaferri workshops equipped with 2 hose reels for launching pressurized water.

Fire extinguishing means:

- External fire network consisting of 27 UNI 70 above ground column hydrants to protect the SOgin area offices and systems and 3 UNI 45 hydrants installed in building R26 (Laboratory building) equipped with pipes and nozzles all connected to the fire network general, having a network flow rate of 1.500lt/min at the maximum pressure of about 7 atm obtained through a pressurization system consisting of 2 electric pumps.
  The rain extinguishing systems of the storages are also connected to the fire water mains.

Fire detection means:

- Automatic fire detection system with smoke detectors serving all buildings

Equipment of the emergency teams:

- N° 4 firefighter helmets of the Amber type;
- N° 4 pairs of protective gloves in 100% heat-reflecting aramid fiber (DPI III cat.);
- N° 4 pairs of 100% aluminized aramid fiber socks (DPI III cat.);
- N° 4 overalls in 100% aluminized aramid fiber each complete with bag for the protection of the breathing device (PPE III cat.);
- N° 1 acid protection suit complete with boots and hood;
- N° 1 suit for the protection of acids complete with cappuccino;
- Breathing devices (self-protectors) complete with case;
- N° 4 pairs of dielectric gloves;
- N° 1 electric cable cutter;
- N° 3 CO2 fire extinguishers of 5 kg;
- N° 4 powder fire extinguishers of 6 kg;
- N° 2 crowbar;
- N° 4 fireman's ax belts;
- N° 4 fireman's axes.

B.I.3.3 Passive Fire Protection

B.I.3.3.1 Prevention of fire spreading (barriers)

B.I.3.3.1.1 Design approach

Wet storage

The spent fuel pool is made up of a single fire compartment, with REI doors separating and isolating adjacent rooms. Furthermore, the room has a ventilation system whithout fire dampers.

Dry storage

With reference to the DM 10/03/1998, to be able to define the fire compartments inside the DMC3/DTC3 buildings, a risk analysis was performed starting from the identification of the rooms / groups of rooms to be protected, regardless of the specific fire load calculated, based on the following criteria:

- premises with radioactive sources or significant contamination (for the purpose of potential external radiological impact);
- stairwells;
- control room;
- rooms with significant electrical/electronic equipment.

Once the compartment to be protected was identified and the specific fire load calculated, the fire resistance characteristic (REI) was defined, which applies both to civil works (walls and doors) and to electrical and mechanical penetration with reference to the Decree Ministerial Decree of 9 March 2007 (Fire resistance performance of buildings in activities subject to the control of the National Fire Brigade)

As far as the fire-fighting system in the field of detection and extinction is concerned, a classification of the plant areas has in any case been carried out based on the specific fire loads present inside the buildings themselves, a classification necessary for the type of protection to be used.
The structure of the DMC3/DTC3 building is however designed to ensure a fire resistance equal to R120 regardless of the calculated fire load.
Fire separation is guaranteed through the presence of structures with fire resistance characteristics.
The building is divided into a series of compartments to divide the different risk areas. The partition of the building into fire areas and the consequent division into compartments are based on the principle of preventing a fire that has developed in one area from spreading to other areas of the building with consequent further damage. The fire areas are separated from each other by fire resistant structures.
It is avoided that a possible fire spreads, or that the fumes spread through the ventilation systems. Compartments were defined based on fire load calculations and based on functional and risk fragmentation logics.
Accordingly with the third level of defence in depth concept is assumed that fire extinguishing systems fail and that firefighters do not respond quickly enough which causes fire development. In this scenario the confinement of radioactive spread is guarantee by the fire compartment of each area designed to withstand the worst-case scenario.

B.I.3.3.1.2 Description of fire compartments and/or cells design and key features

The structures of the DTC3 building will be designed to ensure a fire resistance of R 120, as a precautionary measure.
For the openings facing the outside, no fire resistance requirements are required as the specific fire load is low and there are no grilles or windows in correspondence with these openings such as to create a draft effect in other rooms.
As far as the smoke detectors are concerned, there are no smoke detection systems or linear thermal systems inside the "Cask deposit" room (as it is more than 12 m high).
As regards the extinguishing system, given the very low values of the specific fire loads, all rooms manned and accessible during normal operations will be equipped with standard manual extinguishing devices (CO2 or powder extinguishers).

B.I.3.3.1.3 Performance assurance through lifetime

There are no specific performance guarantee issues. Maintenance and inspection are carried out in accordance with national laws and the technical requirements of the operating license.

B.I.3.3.2 Ventilation systems

B.I.3.3.2.1 Ventilation system design: segregation and isolation provisions (as applicable)

PreFilters and filters before stack expulsion are designed to be operable at high temperature (250° C/280° C).

The ventilation system of the cask storage area and the cask equipment area is located on the first floor of the DTC3 area

Through this VLO-4 ventilation system and the associated instrumentation (Transmitters / Temperature and Humidity Indicators), the system guarantees, uninterruptedly 24 hours a day:

- the filtration of the incoming air to avoid the accumulation of dust;
- the control of thermo-hygrometric conditions such as to avoid the formation of condensation by controlling the minimum air temperature;
- a number of air changes compatible with the possible presence of personnel;
- dispersion of the effluent air outside.

In the event of a fire detection alarm, the control unit will send a signal to the DCS cabinet of the building concerned which will command:

- The closure of the delivery fans.
- The closure of the recovery fans.

Ventilation is stopped as the compartmentation of the filter room involves the closure of the relative fire dampers, therefore it is not possible to keep the extraction fans running.

B.I.3.3.2.2 Performance and management requirements under fire conditions

In case of fire the ventilation system configuration is:

- Supply air off
- All fire dampers closed

This configuration is maintained until the fire is extinguished or by the suppression system or due to the lack of oxygen to sustain the combustion.
The operator after checking the temperature inside the fire compartment (there are fire resistant thermocouples for each storage area) could restart the extraction fan of the ventilation system.

In the event of a fire alarm, all fire dampers in the building concerned will be closed to ensure the tightness of the compartments provided.

The fire dampers will be controlled and powered directly by the DMC3/DTC3 fire system control units for the building

The shutters will all be of the "fail to close" type (they close in the event of a power failure).

B.I.3.4 Licensee’s experience of the implementation of fire protection concept

The implementation of the fire protection concept is regularly in course for the ITREC plant without any issues.
The fire risks have been well defined and analysed with a conservative approach considering the applicable legislation, the basic safety standards for similar systems.
The fire risk assessment identified the functional requirements and performance criteria of the fire protection systems to be adopted in the building.
Since there have been no events such as to ascertain the effective efficiency of the fire protection systems, their required capacity/performance is verified in a documentary manner (e.g. REI certifications, plant declarations of conformity).
The main criticalities encountered are linked to the construction of the plant, dated back to the 1960s, with consequent difficulties in adapting the prevention and protection measures to current standards. A further critical issue is linked to the transformation of the site buildings according to future decommissioning activities.

B.II. Dedicated Spent fuel storage facilities at ESSOR-B-plant JRC of Ispra)

B.II.1 General information

B.II.1.1 Nuclear installations identification

Name:

1. Spent Fuel Pool in ADECO – 4209-4210 ESSOR rooms
2. TSA (Transit Safe Area) – Cell 4305 ADECO Laboratory -ESSOR – special fissile materials and spent fuel interim storage

Licensee: The ADECO Laboratory, which hosts the Spent fuel pool and TSA is operated under a license granted to the European Commission – Joint Research Center (JRC) of Ispra.

Description of the site and of the installation, including other installations located within it.

Both the Spent Fuel Pool (1) and the TSA (2) storages are operating inside INE/ADECO Laboratory in Building 81. The INE hot laboratory ADECO (Atelier de Démantèlement Eléments Combustibles Orgel) also houses other laboratories and offices that are grouped into four main areas with decreasing risks of radioactive contamination (see Figure 1 below). The ADECO laboratory was initially designed to handle, dissect and control irradiated fuel elements from the ESSOR reactor or other plants.

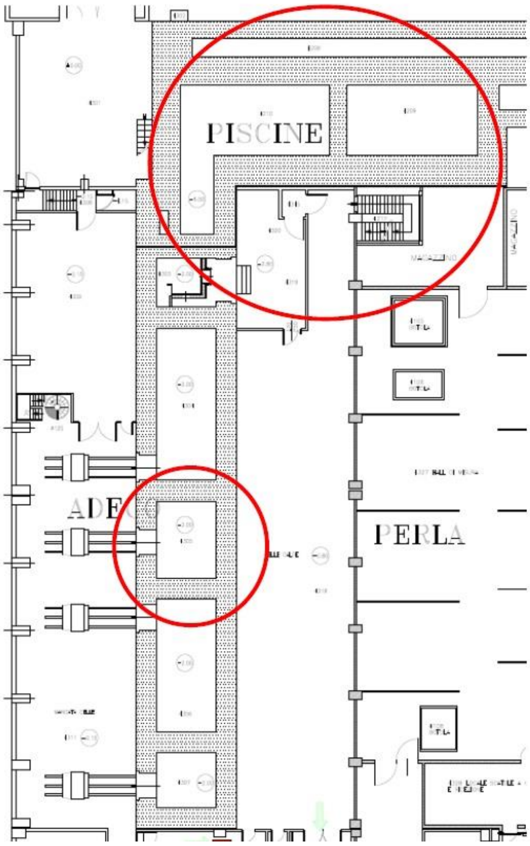


Figure 1: Spent Fuel Pool (1) and the TSA (2) storages are operating inside INE/ADECO Laboratory in Building 81

1. Spent Fuel Pool

The Spent fuel pool is in the north area of Building 81 and includes two basins connected by a water channel (cells 4209/4210). The decay pool was designed to allow the storage of irradiated fuel elements for the time necessary before their transfer to the ADECO laboratory for elements coming from the EZ (Experimental Zone), or to the reprocessing plants outside the centre for elements coming from the DZ (Driver Zone). Possible activities that can be performed in the pool are:

- handling of irradiated fuel elements;

- separation of the active part of fuel elements from extensions;
- storage of sealed radioactive sources;
- storage, handling and dismantling of radioactive material with non-transferable contamination.

The pool is filled with demineralized water, supplied by the INE plant, and is equipped with a filtration system. The current system is adapted, in terms of capacity and performance, to the reduced current needs and consists of a circuit including cartridge and bag filters. The pool area is equipped with conventional lighting and electrical system, light sockets, and motive power for the temporary connection of mobile equipment, emergency lighting system consisting of self-powered lamps. In the area, there are distribution systems for demineralized water, industrial water, and compressed air.

The pool water refrigeration system is no longer in operation because it is no longer necessary.

Considering the original plant configuration, it does not foresee the presence of redundant and completely separated components (pumps, heat exchangers) of the spent fuel cooling system.

However, in case of an availability of pool water cooling system, due to the very small residual heat associated to the fuel elements stored, heat can be removed even for long time by natural circulation and associated evaporation. The radiological releases due to possible damage of the fuel are not envisaged.

The building of the decay pool is equipped with:

- a ventilation system that keeps the rooms under negative pressure and constant hygrometric conditions;
- a fire prevention system with heat detectors;
- a monitoring system for any water leaks;
- a system for monitoring the water level in the spent fuel pool;
- a radiological monitoring system.

2. <u>TSA (Transit Safe Area or ADECO Laboratory Cell 4305)</u>

The ADECO cell 4305 is now authorized by Ministerial Decree as an alternative facility to the irradiated nuclear fuels Dry Pits, meeting the latest technical criteria. The walls of the cell are made of barytic concrete and equipped with a stainless-steel liner, covering the floor. This liner is connected to the vertical walls of the cell. Its original function was to collect any liquid release inside the cell. The cell is equipped with an operator's station on the front side (front-cell Room 4318) equipped with two manipulators and a window that guarantees shielding effectiveness equal to that of the walls while retaining its properties up to an integrated dose of 107 Gy. The gap between the frame and the window is filled with lead. The shielding window is protected by a crystal plate with impact protection function on both the inner and outer sides. The cell communicates with the rear area through a plug door on the rear wall and a hatch placed on the roof for the introduction of large components. In addition, the cell communicates with adjacent cells through passages equipped with double doors (intercell SAS with a shielding door and a sealing door). The plug door and the hatch are made of barytic concrete. Penetrations on the walls are used for the passage of auxiliary systems and are closed by shielding caps made to break down the radiation streaming. The cell is equipped with a drainage pipe that can be intercepted to the Laboratory's liquid effluent collection system. The cell is finally equipped with openings for the entry of the ventilation (ceiling) and for the air extraction ducts (floor).

Key parameters

- *Type of facility:* Spent Fuel Pool (1 - Wet Spent fuel storage); TSA (2 - Dry Spent fuel temporary storage)
- *Year of start of operation*: Spent Fuel Pool (1- in 1968); TSA (2- in 2022)
- *Scheduled end of operation*, if any:
  Spent Fuel Pool (1 –once the spent fuel is transferred in TSA);
  TSA (2 –once the spent fuel is transferred in the National Repository or other solutions to be defined).

B.II.1.2 National regulatory framework

As per §1.2

B.II.1.3 Improvements in fire safety as a result of experience feedback

The periodic inspections by the Regulatory authority are valid elements of performance improvement. The VRI procedure improves the aspects of Fire Prevention based on Fire Safety Engineering systems, aimed at reducing fire risk.

B.II.1.4 Defence in depth principle and its application

The fire prevention system has been designed and, over time, implemented according to the criteria:

- Minimize the likelihood of fires
- Eliminate combustible material and potential sources of ignition to the practicable extent.
- Strict control of these sources of ignition by limiting their number and location, for example separate ignition sources from combustible material.
- Fire control and mitigation by early fire detection and extinguishing.
- Prevent the spread of fires.
- Mitigate the side effects of fire and maintain safety functions identified as necessary in the event of a fire, including the protection of the relevant systems structures and components.

The means of protection are then implemented and organized into several successive and independen levels.

In compliance with the general principle of defense in depth the detection systems, the compartements/ barriers and ventilation systems are implemented.

The presence of the Fire Brigades inside the JRC, whose intervention is ensured in a short time, is an added value. For most systems the fire suppression is implemented by firefighters and not by automatic extinguishing systems.

B.II.2 Fire Safety Analyses

B.II.2.1 Fire Safety Analyses for Spent Fuel Pool and TSA

A deterministic safety analysis (FHA) was adopted for the fire risk assessment. The conducted Fire hazard analysis has allowed to define and to implement the measures necessary to ensure the safety of worker and other people present in the workplaces, as well as to prevent radioactive releases as results of the fire.

In the workplace, possible ignition sources and different fire loads that can cause fire or that can favour the spread of a fire have been considered.

The workplace will be continuously monitored to ensure that existing fire safety measures and risk assessment are reliable. The risk assessment is reviewed if there is a significant change in the activities, materials used or stored, or if the building is subject to renovation or extension.

The activities subject to specific risk are managed in the work sheets: work under voltage, particular escape routes, open flames, work at height, reduced information on places with measures such as specific suitability, simultaneous presence of at least 2 people, use of two-way radios, work in areas under the cover of cameras...). A control procedure is also implemented, as these provisions may sometimes be disregarded.

Moreover, the presence of a visual control (through cameras) implemented fo security reasons allows to detect potential dangerous situations and to transmit the information to the firefighters or to the control room (Article 22, paragraph 2, e) Legislative Decree 81/08).

B.II.2.1.1. Types and scope of the fire safety analyses

As said, a deterministic safety analysis (FHA) was adopted for the fire risk assessment.

B.II.2.1.2. Key assumptions and methodologies

In order to accurately identify the fire risks and the preventive and protective measures for fire protection purposes, the activity has been completely re-evaluated, also in consideration of the recent regulations issued by the competent bodies (Legislative Decree 151/2011, Legislative Decree 81/08 and Ministerial Decree 10.03.98).

A fire hazard assessment (according to the Italian legislation denominated VRI – fire risk assessment) has been conducted for the ESSOR nuclear installation which, as said, includes both the spent fuel pool and the TSA.

The document is an update of the ESSOR Nuclear ~~Plant~~ Installation (INE) safety report, with the aim of providing an overview of the installations, taking into account the changes that have occurred to date.

The document describes the ESSOR Nuclear Plant (INE), with reference to:

- The environmental framework of the area where INE is located.
- A description of the buildings and systems which INE is composed of.
- The overview of the installations, the management methods and the conditions limiting the operation.
- Previous operating experience.
- The plant characterization including radioactive material and radiation levels.

The document identifies the reference configuration to be taken for future uses of the plant, future activities and relevant authorization activities.

The dimensional and performance data relating to the systems and installations are deduced from the ESSOR safety report, from the safety reports relating to plant modifications and from the project documents. The data refer to the situation at the date of drafting the report.

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

As regard the fire phenomena analyses, is worthy to highlight that the spent fuel currently present in the pool will be transferred inside the TSA.

<u>TSA</u>

In the process of identifying design fire scenarios, the following conditions are decisive:

- state, type and quantity of fissile material: the irradiated material is non-combustible to the fire and is contained within a metal envelope (Pot à Aiguilles).
- configuration and position of the fissile material: the irradiated material is placed in a defined and confined area (cell 4305).
- fire growth rate and output thermal peak: the fire load associated with all fissile material inside the cell 4305 is zero. The lighting lamp and the camera are present only during loading/unloading and inspection/maintenance. In all other conditions, the lamps and the camera are disconnected and, in any case, brought outside the cell.
- characteristics of the building: the cell is designed to withstand a reference earthquake and is entirely made of reinforced concrete.
- on-site people conditions: during the loading operations there will always be staff trained to intervene in case of fire.

The switchboards and power supply lines are all external to the cell 4305. The potential sources of ignition are therefore only the lighting lamps and the camera in the cell 4305, and only during loading/unloading and inspection/maintenance. A possible breakage or explosion of the lighting lamps is not capable of generating fires, since no combustible material is present. In addition, there are no gas lines or flammable liquids inside the cell 4305.

There are no dangerous equipment and installations from a fire point of view. The physical separation between the cell and the external environment is also maintained during the loading of the material.

There are no specific risk areas. Any fire event that may occur in areas adjacent to cell 4305 (storage) is considered external fire. Regarding the assessment of possible events outside the cell 4305, reference is made to the fire risk of the ADECO laboratory and the PETRA Experience. In particular, cell 4307 is considered to have the highest fire load associated with the presence of the dodecan-TBP mixture.

The exposed assessments, based on stoichiometric combustion of the dodecan, the subsequent development of hot fumes and the non-operating fire protection systems have led to determine the temperature achievable in the absolute filters of the ventilation system compatible with the characteristics of the filters adopted.

As regards the propagation from Room 4318 (front-cell area), comprising the electrical cabinets and the instrumentation ones (leaning against the wall opposite to that of the cells), the cranes control panel inside the cells, the gangways with connection cables to the cells, the cell console (with light control buttons, ventilation valves, cranes, etc.) and telemanipulators, there was a substantial guarantee of sealing in the separation between room 4318 and cell 4305, being the fire load less than the resistance offered by the separation consisting of reinforced concrete wall and lead glass. The fire protection devices installed in the front-cell room (fire vents, portable fire extinguishers, smoke and temperature detectors) have been defined with the agreement of the Fire Brigade of the Centre.

Based on these considerations, the spread of a fire outside cell 4305 was not reasonably assessed as possible.

Identification of fire hazards

- The TSA/POOL cell complex is separated from other activities by open space.
- The TSA/POOL cell complex is divided into different fire compartments, depending on the intended use, the fire load and the danger of the area. The individual fire compartments will be separated from each other by fire-resistant structures.
- The fire resistance of the separating structures was determined based on the results of the subdivision work carried out in 2014 and, on the basis of the relative documentation, the CERT REI 2018 attached to the Fire Documentation useful for the Fire Certification and relative EIS have been issued.

Overall assessment of hazardous substances for fire-fighting purposes with quantities and types

This paragraph briefly describes the main dangerous combustible substances relevant for fire-fighting purposes, with quantities and types, and the main fire protection devices of the whole activity.

Dangerous substances

Within the areas concerned there are no combustible substances relevant for fire prevention purposes, apart from electrical systems currently in disuse and without voltage, sometimes represented by a large number of electrical cables, laid in bulk in metal cable-trays, or fixed to the wall and / or ceiling through cable-trays made of various material, electrical panels, and boxes without power supply. The material is currently in contact with residual and limited parts of the electrical system with power supply and therefore the overall system represents a huge danger of ignition due to natural/accidental events, or events caused by human activity.

To date, the work activities within the controlled zones are limited to the scheduled maintenance of the facilities, performed by external companies, to environmental monitoring with radiation protection systems, to instrumental surveys of various types preparatory to the executive design of the decommissioning phases, to cleaning works of the rooms.

In order to face with Emergencies in the Conventional field, including Firefighting and Nuclear, the following Emergency Plans are in force:

INE on site emergency plan

An on site Emergency Plan (Piano di Emergenza Interno, PEI) has been prepared to deal with any accidents that may occur within INE.

It defines the various degrees of accident, the associated emergency operations and the resulting operational responsibilities. The PEI provides for the application of procedures that involve both internal and external INE structures and require, in relation to the extension of the consequences of an accident, the activation of the Plant Emergency Plan and / or the Off-site Emergency Plan. If the person responsible for the INE Internal Emergency Plan ascertains that the radiological consequences of an accident may extend outside the INE fence, the activation of the PCC (Posto Centrale di Comando - Central Command Post) is required, whose management is undertaken by the relevant responsible person.

The PEI of INE complex is consistent with the instructions contained in the document "Internal Emergency Plan of the JRC-Ispra site" where, as far as INE is concerned, the "Building Responsible" is represented by the Supervisor on duty.

The following Service Orders are attached to the Internal Emergency Plan:
- Declaration of a State of Emergency and behaviour required of personnel present in INE.
- Tasks of the Meeting Place Responsible during INE Emergency.
- Personnel who must gather in the Main Control Room in case of INE emergency conditions.
- Tasks of staff during INE Emergency.
- Reporting accidents to the Main Control Room.

JRC-Ispra on site emergency plan

The JRC-Ispra site Internal Emergency Plan (Piano di Emergenza Interna dello Stabilimento, PEIS) currently in force specifies the general guidelines to be followed in the event of an accident or a danger, which may injury people or damage buildings, equipment or the environment.

Its objectives are:
- Emergency aid to victims.
- Protection of people, buildings, equipment and the environment within the site.
- Contingent limitation of damage resulting from the accident.
- Return to normal conditions.

Regarding INE, the PEI procedure, held at the Main Control Room, defines the modalities of activation of the PCC and indicates the sequence of measures that the PCC puts in place to deal with an emergency situation, the consequences of which:
- Present a risk of irradiation and/or contamination within the plant.
- may raise concerns about the extension of this risk in the area surrounding the site.

The PEI of INE is consistent with the instructions contained in the document "Internal Emergency Plan of the Ispra Plant" where for INE the " Building Responsible" is represented by the Supervisor on duty.

JRC-Ispra Off-site emergency Plan

The JRC-Ispra Off-site emergency plan, published in 1974 by the Prefecture of Varese, was revised in 1982 and then in 1994, leaving unchanged the technical assumptions analysed for the ESSOR reactor in operation.

The new technical conditions/assumptions of the JRC-Ispra Emergency Plan were forwarded to ANPA by letter dated 29/6/2001, n.CCR/B6/247/01.

Following the requests for additions and the related updates to the 'technical assumptions' document, in 2015, ISPRA (ex APAT) carried out a critical analysis of this revision and its own verification assessments (doc. ISPRA RIS/RT/02/2015/ESSOR).

The prefecture of Varese, by decree no. 16891 of 29/05/2017, approved and transmitted the Off-site emergency plan of the ESSOR nuclear plant in Ispra (Varese) version 2017.

To deal with any incidental situations, the ESSOR Nuclear Plant uses the facilities operating in the JRC-Ispra Centre in accordance with the procedures, approved by the competent authorities, contained in the JRC Off-site emergency plan.

In case of general alarm for second- and third-degree accidents in the JRC-Ispra site caused by a plant external to INE, the INE Emergency Manager shall follow the instructions given by the director of the Off-site emergency, the Central Command Post and will implement, accordingly, a coherent safety plan for INE.

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

Following the outcome of the risk assessment, one or more of the following measures to reduce the likelihood of fire outbreaks shall be taken (in cases where this has not yet been done):

A) TECHNICAL MEASURES.

B) ORGANIZATIONAL-MANAGERIAL MEASURES.

To adopt appropriate fire safety measures, the most common causes and dangers that may lead to the occurrence and spread of a fire have been considered.

In order to prepare the necessary measures to prevent fires, particular attention was paid to:

- Storage and use of easily combustible materials.
- Use of heat sources.
- Electrical systems and components.
- Presence of smokers.
- Maintenance and renovation work.
- Uncrowded areas.

As far as electrical systems and componets are concerned, a plan to replace old electrical cables and components is ongoing.

Where possible, the quantity of easily combustible and flammable materials has been limited to that strictly necessary for the normal conduct of the activity and kept away from escape routes.

Emergency shut-off valves will be subject to regular maintenance and inspection. The intake ducts will be kept clean to avoid the accumulation of grease or dust.

Smoking has been banned throughout the site. Special smoking areas have been identified outside the buildings, where smoking is not dangerous. In such areas will be made available ashtrays, which will be emptied regularly. Ashtrays shall not be emptied into containers made of easily combustible materials, nor shall their contents be accumulated with other waste.

The following issues have been taken into consideration in relation to the presence of maintenance and renovation works:

a) Accumulation of combustible materials.
b) Obstruction of escape routes.
c) Creation of openings on fire-resistant floors or walls.

Fire prevention personnel will carry out regular checks in the workplace to ascertain the efficiency of fire safety measures; these checks are recorded on a special register, in accordance with Art. 5 of Presidential Decree 37/98. Workers must notify fire prevention personnel of any potential danger they become aware of.

Training and information for workers

Generality

It will be the employer's responsibility to provide workers with adequate information and training on the basic principles of fire prevention and on the actions to be taken in the event of a fire.

Meetings have already been held on preventive and protective measures relating to fire safety at work.

Fire information

The employer has ensured that each worker has received adequate fire information, also according to the indications of the Ministerial Decree of 10 March 1998.

Appropriate information shall be provided to maintenance personnel and contractors to ensure that they are aware of the general fire safety measures in the workplace, the actions to be taken in the event of a fire and the evacuation procedures.

Fire training and drill

All workers who carry out tasks related to fire prevention, firefighting, emergency management have received specific fire training according to the minimum contents listed in Annex IX of the Ministerial Decree of 10 March 1998. Workers will participate in fire drills, carried out at least once a year, to put into practice the procedures of exodus and first intervention, according to the indications of the Ministerial Decree of 10 March 1998.

The main results of deterministic Fire Hazards Analysis (FHA) are attached to the ESSOR DVR.

B.II.2.1.5. Periodic review and management of changes P.60

B.II.2.1.5.1. Overview of actions

In relation to the operational procedure adopted within the JRC-Ispra, the VRI document should be updated within 5 years. Within this period, the requirements that have been completely/partially fulfilled must be verified and the forecast documents updated.

B.II.2.1.5.2 Implementation status of modifications/changes

The removal of cables and electrical components within the Controlled Zones has begun and is currently underway to comply with Fire Regulations.

B.II.2.1.6 Licensee's experience of fire safety analyses

The fire risk assessment is being continuously updated and verified. Work is beginning on mathematical modelling systems based on FSE criteria.

B.II.2.1.6.1. Overview of strengths and weaknesses identified

Considering that the ESSOR Plant (INE), which includes the Spent Fuel Pool (1) and the TSA (2), is close to obtain the authorisation for the decommissioning phase, no specific weakness in the fire safety analysis has been identified. For both Spent Fuel Pool (1) and the TSA (2), a strength is related to the fact that the fire protection concept has been determined on the basis of the prescriptive approach dictated by Ministerial Decree 10/03/1998 setting up the minimum fire safety requirements. For these facilities the fire analysis has been conducted according to the updated national legislation and technical guide n.30. Another strength is related to the JRC priority given to the project for the transfer of the spent fuel from the Spent Fuel Pool (1) into the TSA dry storage facility (2) and later on in a facility outside the JRC to be defined.

B.II.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

For the Spent Fuel Pool (1) and the TSA (2) there are no particular Lessons learned to report. There were no fire events and no ISIN requirements as result of inspections and assessments as part of the regulatory Oversight. Documentation controls and verifications for the fire protection updates is foreseen at least every 5 years.

B.II.3 Fire Protection Concept and Its Implementation

B.II.3.1 Fire prevention

B.II.3.1.1. Design considerations and prevention means

Fire prevention requires precise calculation of the fire load to predict correct locations of different flammable material and temporary nuclear waste storage areas.

As regards the calculation of the **fire load**, it was conducted exclusively for rooms where there are combustible materials in significant quantities; this calculation was carried out according to the Ministerial Decree 16/02/2007.
The calculation concerns the premises of ADECO (Pool+TSA)

The values of Fire Load found, although extremely variable mainly based on the amount of electrical equipment in disuse, compared with the classes of fire resistance attributed to the different rooms, show a significant margin of safety of buildings against fire.

Under these conditions there is no risk of release due to structural failure.

Regarding the consequences of possible fires on safety-relevant systems and equipment, equipment that allows the control of maintenance and monitoring work within TSA and Pool is considered relevant.

In particular, the most serious consequences are those that could result from a fire involving the radiation protection system and the ventilation system of the cells.

However, monitors are located in distant positions and in areas almost completely free from electrical cables, with or without power, or from other flammable material. The malfunction of monitors generates a visual and audible alarm signal at the room of Health Physics.

In ADECO, the smoke signal automatically closes the air supply in the cells and the vacuum is ensured by the extraction. If the plastic protective sleeves of the telemanipulators were damaged, the depression of about 70-80 mm H2O would ensure the absence of uncontrolled release to the outside of radioactive contamination. In ADECO there is a HALON automatic shutdown system.

Passive defence, to limit and minimize the consequences of a fire, consists in <u>**reducing the amount of flammable material and combustible**</u> present in cells and adjacent rooms.
Management requirements provide for maximum quantities of flammable substances and solvents in case of presence of irradiated fissile material.

Most of fuels present in the rooms consist mainly of power supply cables, auxiliary circuit control cables, disused switchboards.

In addition to the cells, Pool and TSA, the immediately adjacent rooms were examined. The other rooms were not considered due to the low-risk rate of fire propagation triggered in such rooms, with propagation to the inside of the cells in the controlled zone. The calculation of the fire load was carried out where the amount of combustible material become significant and where REI class of walls and floors is not compatible with existing structures. In fact:

- The walls of adjacent rooms have variable but minimum thickness of bricks + plaster of at least 15 cm (class 45)
- Concrete slabs at least 25 cm thick (class 180).
- The walls of the CELLS made of concrete have a thickness of 1.1 m, floors 1.2 m thick and floors 1.1 m thick, therefore abundantly in REI 180 class.

The evaluation is carried out in accordance with the following legislation:

- - General method: Decree of the Ministry of the Interior March 9th 2007 (OJ no. 74 of 29-3-2007 – Ordinary Suppl. n. 87) "Fire resistance performance of buildings in activities subject to the control of the National Fire Brigade".
- - Definitions: Ministerial Decree 30.11.1983, Ministerial Decree 26.06.1984, Ministerial Decree 09.03.2007

FIRE RESISTANCE CLASS REI table 4 Decree 9/03/2007

The fire resistance class necessary to guarantee Level III according to the specific fire load of the project EXPRESSED IN MJ/sqm is derived from Table 4 of the Annex to the Decree of the Ministry of the Interior March 9th 2007.

The fire load calculation for the most exposed environments was carried out according to the quantity and type of combustible materials present. The calculation of the **fire load** was conducted exclusively for rooms where there are combustible materials in significant quantities; this calculation was carried out according to the Ministerial Decree 16/02/2007. The calculation concerns the premises of ADECO (Pool + TSA).

The most serious consequences are those that could result from a fire involving the radiation protection system and the ventilation system of the cells.

However, monitors are located in distant positions and in areas almost completely free from electrical cables, with or without power, or from other flammable material. The malfunction of monitors generates a visual and audible alarm signal at the room of Health Physics.

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Passive defence, to limit and minimize the consequences of a fire, consists in **reducing the amount of flammable material and combustible** present in cells and adjacent rooms.
Management requirements provide for maximum quantities of flammable substances and solvents in case of presence of irradiated fissile material.

Most of fuels present in the rooms consist mainly of power supply cables, auxiliary circuit control cables, disused switchboards.

Dangerous substances

Within the areas concerned there are no combustible substances relevant for fire prevention purposes, apart from electrical systems currently in disuse and without voltage, sometimes represented by a large number of electrical cables, laid in bulk in metal cable-trays, or fixed to the wall and / or ceiling through cable-trays made of various material, electrical panels, and boxes without power supply. The material is currently in contact with residual and limited parts of the electrical system with power supply and therefore the overall system represents a huge danger of ignition due to natural/accidental events, or events caused by human activity.

To date, the work activities within the controlled zones are limited to the scheduled maintenance of the facilities, performed by external companies, to environmental monitoring with radiation protection systems, to instrumental surveys of various types preparatory to the executive design of the decommissioning phases, to cleaning works of the rooms.

The fire protection system consists of:

a) Methods of prevention.
b) Detection equipment.
c) Extinguishing systems and installations.

Prevention is entrusted to risk reduction activities, such as, for example, the removal of electrical cables from disconnected equipment, and procedures that prevent the accumulation of flammable materials in unprotected areas

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

<u>TSA/Pool</u>

Fire risk mitigation procedures by reducing the fire load.
Action are in progress through the reduction of the existing fire load in the premises inside the classified zone by removing the electrical cables and electrical system components no longer live.

Electrical cables are a significant aspect for fire safety in buildings and installations: these materials can be removed and stored in special containers, possibly with lids, similarly to what has already been done for other material, within the Controlled Zones, and left on site, far from possible ignitions, (provided that the containers are closed and are of the non-fire propagating type, in order to eliminate the risk of ignition and propagation of flame) or transferred elsewhere. On-site storage must take place without affecting the widths of escape routes, without obscuring emergency routes and exits from view and without obstructing evacuation routes.

The removal procedure should include the identification of cables with power supply and their temporary displacement, the removal of cables in disuse and of the flame-spreading type and, subsequently, of those in disuse and of the non-flame-spreading type.

Any cables with power supply not in accordance with the norm should be replaced with others in compliance, in case of power supply of essential utilities.

Where not possible, any remaining flame propagating cables shall be compartmentalized in sections along their route, where appropriate, using firefighting paints / foams.

The procedure, once started, would allow to quantify more precisely the mass of the materials removed and those remaining, in order to define more precise operational detail procedures in terms of time resources and programming of the subsequent phases.

An estimated time of 5 YEARS is required for complete cable removal.

A significant reduction in risk could be achieved by reducing the amount of cables present by at least 50%.

Once the existing cables that still must remain in operation have been defined, it is then necessary to check the functionality of the differential protection devices and replace them, if necessary.

It is necessary to provide a general disconnector switch from the main panel, identifying the drawers in the electrical room to be disconnected.

If it is necessary to provide a temporary power supply of an electrical equipment, the electrical cable will have the length strictly necessary and will be positioned in such a way as to avoid possible damage.

Electrical repairs must be carried out by competent and qualified personnel.

Easily combustible materials shall not be located near luminaires, in particular where liquid decanting takes place.

The risk of ignition of fire inside buildings 80-81-82-83 is minimal, as operational activities with significant risk are no longer in place. However, there are work activities still related to the presence of people and machinery, such as activities by plant maintenance companies, cleaning, companies operating in activities related to future tasks related to decommissioning, and other monitoring activities, such as radiological checks and more.

The following additional fire risk mitigation procedures will be recommended:

- Eliminate voltage to any old parts of the electrical system not yet deactivated.
- Identify the parts of the electrical system still with power supply and separate it from the one in disuse realizing, if necessary, differentiated clamping systems.

Inside rooms, avoid hot maintenance work with the use of emery and equipment that may develop ignition sparks (see point 1.4.1.2 M.D. March 1998), or if necessary, adopt specific processing procedures, possibly in the presence of fire brigade. For hot working, always follow the Site Procedures referred to in Doc. IMS-IPR-S6.5-RM-0044-EN.

TSA

The characteristics of the ADECO Laboratory fire protection system have also been analysed in relation to the fire risk assessment characterizing the storage in its operational configuration, based on the following general principles:

- preventing fires, that is establishing all the organizational (administrative controls, procedures, etc.) and structural actions (subdivision, sources of ignition, etc.) that guarantee a reasonable certainty that the fire does not start and/or spread.
- Quickly detecting, controlling and extinguishing any fire that may involve potentially contaminated materials and/or radioactive material.
- Minimising the risk to workers and the external environment due to the release of radioactivity because of fire.

Regarding the national regulations on fire prevention, it is worth noting that at present there are no specific regulatory references for this activity, identified at number 79 of D.M. 16/02/1982, and therefore reference should be made to the general fire prevention rules:

- D.P.R 29/7/1982 n. 577 art.3.
- M.D. 30/11/1983.
- M.D. 10/03/1998.
- M.D. 4/05/1998.
- D.P.R. 12/01/1998 n. 37.

As regards technical standards, reference will be made to the UNI standards within the limits of their applicability for this type of installation and, where not possible, to international standards NFPA, IAEA, BS, FM, DIN. At the international level, the following documents have been taken as references:

- DOE 5480.7A.
- Regulatory Guide 1.191.
- NFPA 801.

CHARACTERISTICS OF THE MATERIAL TO BE STORED AND LOADING TABLE

The material to be housed consists of irradiated nuclear fuel in the form of whole elements, rods, fuel pins or experimental devices (Test Rigs). To be housed in the temporary storage, the fuel is placed inside cylindrical steel containers called Pots.

The inventory to be kept in the new storage can be divided in two separate sets:

A) Material transferred in the Cell 4305 by the:
   - Special Fissile Material and Irradiated Fuel Storage of Area 40, Building 39/b: B/2, B/3, C/1, C/2, D/1 and D/2.
   - Rear-cell room of ADECO, stored inside a container for the transfer of existing Pots, called Château à Aiguilles.

B) Material to be transferred into Cell 4305 in subsequent stages by the Safety Strategy:
   - Material currently stored in the dry wells of cell 4411 of the ADECO Laboratory (ADECO Dry Wells).
   - Material currently stored in the decay pool of the ESSOR reactor (ESSOR Spent Fuel Storage Pond).

B.II.3.1.3 Licensee's experience of the implementation of the fire prevention

The fire prevention system is continuously updated and verified.

B.II.3.1.3.1. Overview of strengths and weaknesses

The ESSOR Nuclear Power Plant (INE), which includes the Spent Fuel Pool (1) and the TSA (2), is located at the Joint Research Centre, which enjoys autonomy and extraterritoriality as it belongs to the European Commission despite being in Italy, in Ispra (VA). The site has its own fire station that intervenes in all types of emergencies. This represents one of the main strengths for fire prevention, as:

- Monitoring is guaranteed continuously, 24 hours a day, 7 days a week.
- Interventions are carried out in a period of no more than 5 minutes.
- emergency personnel have specialized training.
- the Service is equipped with dedicated means to deal with technical, fire-fighting, NBCR (Nuclear,
- Bacteriological, Chemical and Radioactive) and health emergencies.

Suggestions indicated for the fire prevention are frequently implemented based on activities in progress: this is a further element of strength.

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

The gas system of cells 4411 and 4304 has recently undergone an unexpected degradation of the extinguishing charge.

Analysis of this situation led to the following conclusions:

- the extinguishing gas is NAF S III, no longer in compliance and therefore not reintegrable.
- the current good technique provides for the prohibition of any gas fire extinguishing system in the event of the presence of personnel.
- the provision of portable auxiliary fire extinguishers available based on the ERSS assessment.
- the disposal by protocol of the gas no longer in accordance with the rules.
- the reassessment of future operational needs due to the obligations arising from the Safety Report.

An internal procedure is operational to verify the status of ongoing and planned actions in the field of safety in general and fire prevention in particular.

B.II.3.1.3.3. Overview of actions and implementation status

In order to know in real time the presence of the staff in the various technical areas of the plant, for a better management of the activities, the physical subdivision of the accesses, now granted through personal identification card, has recently been completed. The fire load is being decreased through the removal campaign of obsolete cables and not relevant systems. Regular inspections by the Control Authority represent an added value.

B.II.3.2 Active fire protection

B.II.3.2.1 Fire detection and alarm

In both facilities there are Fire smoke detectors installed. They immediately automatic alert the 24/7 manned Control Room and the Fire Station inside the JRC; all facilities are powered by preferential lines from generators (***WENRA SV 6.8, S 4.1, S 5.1).***

B.II.3.2.1.1. Design approach

TSA and Spent Fuel Pool

The fire detection and alarm system is implemented according to the FHA results.

B.II.3.2.1.2. Types, main characteristics and performance expectations

TSA and Spent Fuel Pool

The detection systems consist of a network of fire detectors and a network of smoke detectors.

The detectors, installed in the different rooms, are collected in groups and each refer to a power, signalling and alarm control unit. The alarms are reported in the main manoeuvring room (on the EQ4 panel and on the SPINE system) and to the JRC fire brigade.

In particular, in the facilities for spent fuel storage the following fire detection and alarm systems are installed:

a) In the 4305 TSA cell and other cells located in its vicinity (4303, 4304, 4306, 4307, 4411) are equipped with fire and smoke detectors.
b) The main control room in Building 83 is equipped with fire detectors; equipped hydrant boxes are available nearby.
c) The electrical room in Building 83 is equipped with fire detectors, smoke detectors and CO_2 extinguishers.
d) The emergency diesel generator room in Building 85 is equipped with fire detectors, powder extinguishers, CO2 extinguishers and an equipped fire hydrant box.
e) In the spent fuel pool there is a fire prevention system with heat detectors.

With regard to the storage activities in cell 4305, it can be stated that extinguishing systems are available and appropriate to the activities outside the cell and inside the cell during the set-up and dismantling phases.

The alarms of the detectors are reported in the main operating room (on the EQ4 panel and on the SPINE system) and to the JRC-Centre Fire Station. In particular, the ADECO hot cell alarms are grouped together with the "Petra Fire" alarm.

The JRC site is permanently manned by a Fire Brigade team, trained to intervene, if necessary, on the ESSOR Nuclear Plant (INE).

Power supply

The power supply is provided by the JRC Infrastructure Unit. If the power supply from the external grid fails, the power to the 380 V grid is provided by the INE emergency generator, able to power all the INE systems.

However, monitors are located in distant positions and in areas almost completely free from electrical cables, with or without power, or from other flammable material. The malfunction of monitors generates a visual and audible alarm signal at the room of Health Physics.

In ADECO, the smoke signal automatically closes the air supply in the cells and the vacuum is ensured by the extraction. If the plastic protective sleeves of the telemanipulators were damaged, the depression of about

70-80 mm H2O would ensure the absence of uncontrolled release to the outside of radioactive contamination. In ADECO there is a HALON automatic shutdown system.

B.II.3.2.1.3. Alternative/temporary provisions

If activities requiring the temporary disconnection of the smoke detection systems, these must be carried out in the presence of fire-fighting personnel and in connection with the JRC site Fire Station.

B.II.3.2.2 Fire suppression

In TSA/ESSOR Pool there are no manual or automatic fire extinguishing systems.

B.II.3.2.3 Administrative and organisational fire protection issues

Each fire alarm situation is managed directly by the Fire Brigades on site. The procedure is activated by the security staff who work 24/7.

A suitable VRI procedure within the JRC is active for the verification of fire loads within each room. The procedure of verification, control and scheduled maintenance is active as per current laws on active and passive detection/extinction systems.

Periodic training procedures for fire-fighting personnel are active for the first interventions. Then, the internal garrison of the Fire Brigades intervenes immediately.

The internal personnel of the Fire Brigade is trained and equipped to operate in the nuclear field.

B.II.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

As regards the firefighting arrangements and strategies for in the Spent Fuel Pool (1) and TSA (2), the following points applies:

- ✓ On site fire-fighting brigade (24hr/7days) that can perform also an on-site inspection/patrol on demand;
- ✓ Nuclear technical experts available outside normal working hours, based on needs;
- ✓ National fire brigades (VVF) located in the vicinity of the JRC site;
- ✓ Continuous maintenance of significant systems for the purposes of Fire Prevention;
- ✓ Video Surveillance Systems;
- ✓ control and monitoring systems of staff presences in each specific area;
- ✓ continuously downgrading the fire loads with appropriated dedicated measures;
- ✓ continuous updating of procedures/documentation as for example:
    - Emergency plans;
    - List of prohibited flammable materials introduced based on activities;
    - Training plan.

B.II.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

The technical staff in the Control Room constantly monitors the alarm system and can activate the Fire fighters according to the JRC's internal emergency procedures. The employees are constantly trained. Periodic fire evacuation exercises are activated. All the people present within ESSOR are informed about the documentation and procedures to be adopted in the event of a fire alarm and are instructed to move towards the Meeting Points. Fire fighters' vehicles are equipped with all the devices necessary to extinguish a fire.

B.II.3.2.3.3. Specific provisions, e.g. loss of access

The on site Emergency Plan of the JRC is in place, due to the fact that fire brigades are dedicated firefighiting personnel always present on the site, they are regularly trained and can have access to any relevant area, including the spent fuel storage facilities.

B.II.3.3 Passive fire protection

B.II.3.3.1 Prevention of fire spreading (barriers)

The fire compartments are designed based on the actual fire loads and in accordance with the Italian Law.

All passive protection systems are subject to scheduled maintenance according to law.

B.II.3.3.1.1. Design approach

TSA

The ADECO cell 4305 (TSA) intended for storage may be considered as an isolated compartment for fire-fighting purposes.

B.II.3.3.1.2. Description of fire compartments and/or cells design and key features

Spent fuel Pool

The perimeter containment structures of the Pool are made of reinforced concrete, therefore they have greater fire resistance characteristics than REI 120.

Structural Design Aspects of Cell 4305 – COMPARTMENTS (TSA)

The ADECO Laboratory is in the west of the ESSOR complex, within the civil structures bounded to the north by the POOL Building and to the south by the WORKSHOP Building.

These structures, separated from the contiguous buildings by vertical joints that extend from the depth of the foundation (-6.00 m) to that of the roof (+ 14.00 m), cover a plan of 33 x 28 m (according to the North-South and East-West directions respectively) and in turn consist of two buildings made independent, in elevation, by a similar vertical joint at full height.

The ADECO laboratory is characterized by the presence of a massive box structure in barytic concrete (hot cells), arranged according to the North-South axis and set, at -3.10 m, on a double row of large pillars on which they were made, in the course of subsequent structural adjustment, longitudinal and transverse stiffening septa; the hot cells rise to an altitude of 2,70 m south of the vertical joint and up to an altitude of +10,70 m for a large part of their extension north of that joint.

It should be considered that:

- The walls of the cell are constructed with thicknesses able to withstand with margins consequences of fires generated by the fire loads existing in the plant area.
- Penetrations between contiguous cells and between these and the surrounding premises exclude, with reasonable certainty, the spread of a fire to/from the cells. The cell 4305 is separated from the cell 4304 by a penetration 1.1 m long, closed on one side with a tight metal door and a shielding door; the similar penetration towards the cell 4306 has the metal door and the shielding door blocked.
- The ventilation system keeps the air flows in the cells in parallel. However, it is not possible to hypothesize a return of air from one cell to another through the intake manifold, because in case of fire alarm the valves are closed on the ducts entering the cell and the intake fans are stopped, the air extraction fans from the cells remain in motion and ensure the evacuation of the fumes. In case of overpressure in a cell, generated by combustion, it can be assumed the passage of air to the other cells through the supply manifold. However, absolute filters (no. 2 batteries in series) would filter the air flow and considering also the path length is not reasonably hypothetical to transport flames from one cell to another. However, overpressure in the cells because of the fire is extremely unlikely (in the event of loss of depression, the flow fans automatically stop while the extraction fans remain in motion). In addition, the air extraction fans from the cells remain in motion and ensure the evacuation of fumes.

- Regarding the fire resistance of the supporting structures, the fire resistance class 180 has been assigned with reference to Tables 2 and 3 of Circular No. 91 of 14/09/1961 (Ministero dell'Interno -- Direzione Generale dei Servizi Antincendi - "Fire safety standards for steel buildings for civil use") in force at the time.
- The walls and floors of separation with adjacent rooms are made of reinforced concrete of sufficient thickness to ensure minimum performance of REI 120

The 4305 cell is finished with the following materials:

Floor and walls: the floors are covered with stainless steel liners and the walls are in concrete treated with decontaminable epoxy paints. This type of paint does not propagate the flame, producing only a limited carbonization of the surface.

B.II.3.3.1.3. Performance assurance through lifetime

Access routes are always kept clear and accessible. Under any evolution of the fire loads the fire barriers remain efficient since there is a strategy to downgrading the fire load and to keep the area divided in separate compartments. There is always an attention to upgrade the systems according to the new norms/laws and standards.

B.II.3.3.2 Ventilation systems

The ventilation systems that pass through adjacent compartments are equipped with fire dampers controlled by a smoke detection system. The damper closes the air circulation.

The parts of ventilation systems outside the compartment have the same fire resistance characteristics as the compartment.

B.II.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The air treatment unit is designed to provide the nominal performance in both "summer" and "winter" operation. The station in room 4428 consists of a series of batteries, in the following order: filtration, pre-heating, refrigeration and humidification. The ventilation system is divided into a supply circuit and an extraction circuit. During a fire event, it is possible (in case the filtration system is not compromised) to interrupt manually the flow of supply and continue with the extraction reducing the presence of oxygen.
The fire dampers are under consideration to be installed for both spent fuel pool and TSA in the next future; they are already installed in the more recent facilities of the INE plant, in the framework of the related authorisation phases. The existing fire dampers have the same REI characteristics as the compartments crossed. They are subject to statutory maintenance and connected to the smoke detection system.

B.II.3.3.2.2. Performance and management requirements under fire conditions

The ventilation system in hazardous areas is provided with automatic fire damper in order to avoid the spreading of fire. Means available to prevent the spread of fire are fire damper and compartimentation.

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

JRC experience suggests the importance of the always updated collaboration agreement between the Varese provincial Fire Brigade and the Internal JRC Fire Brigade Command. The exchange of information concerns for example the dosimetry, protection devices/procedures, firefighter trainings.
Some actions envisaged as VRI requirements are being activated, such as the installation of smoke detection sensors inside the channels, the installation of additional fire dampers and the replacement of existing channels with others suitably classified REI.

B.III DEPOSITO AVOGADRO (WET AND SPENT FUEL STORAGE FACILITY)

B.III.1 General information

B.III.1.1 Nuclear installations identification

- Name Deposito Avogadro
- Licensee DEPOSITO AVOGADRO SpA

The storage facility for the spent fuel elements owned by ENEL, today SOGIN, was built in the buildings and with the existing plants of the former AVOGADRO reactor, suitably modified for the conversion of the site into a temporary storage facility for irradiated fuel elements.

The Plant is located on the Technological Area of Saluggia "Livanova Site Management" in the territory of the province of Vercelli.

The facility, with its auxiliary systems, is derived, as mentioned above, from the Avogadro RS-1 research reactor (of the pool type) already owned by SORIN S.p.A.

This reactor operated from 1959 to 1971.

By eliminating all the equipment inside the pool, at the time used for the operation of the reactor (core and its accessories, experimental equipment, etc.) and made some structural additions, the pool was made accessible for the storage of irradiated fuel elements.

For the removal of the decay heat of the irradiated elements, the cooling system of the former Avogadro RS-1 reactor is used, suitably adapted.

The facility, in addition to its own radiation protection equipment, benefits from the assistance of the Radiation Protection Center, part of the same company and with operational headquarters in Turin, in via Plava 80.

The operation of the facility was authorized in 1981 with a decree of the Ministry of Industry, Commerce and Artcrafts, the license body of the time, and subsequently reviewed in 1988 and 2000, with technical specifications issued by the competent regulatory authority (ANPA at the time).

The large part of the spent fuel has been transferred to UK and France for reprocessing. Only 64 elements, mainly generated from the Garigliano Nuclear Power Plant, remains to be transferred in the near future. Once all the fuel will be removed from the pool, the facility will enter in its decommissioning phase

The facility consists of the following main items / systems:

STORAGE BUILDING

The Storage Building consists of the containment building of the former Avogadro RS-1 reactor and, as such, was originally designed and built to be able to withstand, among accidental loads, an internal over-pressure of 750 kg / m².

It consists of a cylindrical structure in reinforced concrete, with a diameter of 32 m, height 24 m, and a thickness varying between 10 and 20 cm, closed at the top by a spherical dome with a thickness of 7 cm, with a mount of 5 m, and closed below by a reinforced concrete slab (illustrative section in fig. 2).

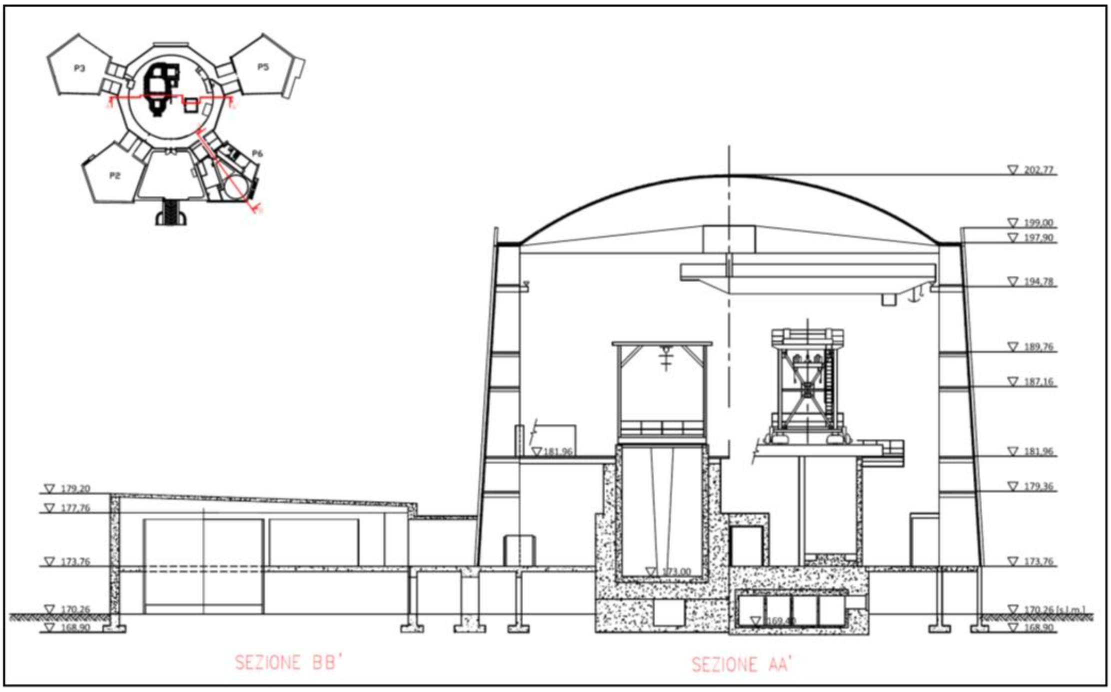

Figure 2 – Section of the Avogadro Deposit

In the building there are the storage pool for spent fuel elements and the Decontamination Room for transport containers.

All the openings of the building are closed with sealed doors, made by rubber gaskets.

The building is equipped with a 15 t capacity polar crane (1 t auxiliary hook), an overhead crane for handling transport containers and a gangway crane for handling fuel elements.

Attached to the Storage Building are the rooms containing auxiliary systems, radiation protection equipment, as well as the Control Room and offices

SPENT FUEL ELEMENT POOL

The irradiated fuel element pool has a volume of about 600 m3, and performs the following tasks:

The spent fuel pool is illustrated in figures 3 and 4.

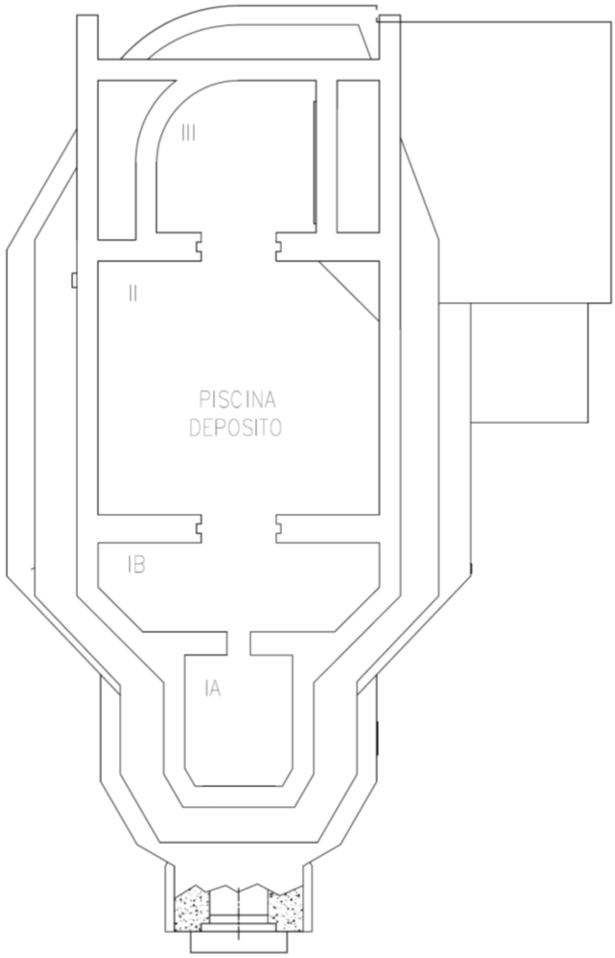

Figure 3 – Cross section of the spent fuel pool of the Avogadro Deposit at an altitude of 183.00 m s.l.m.

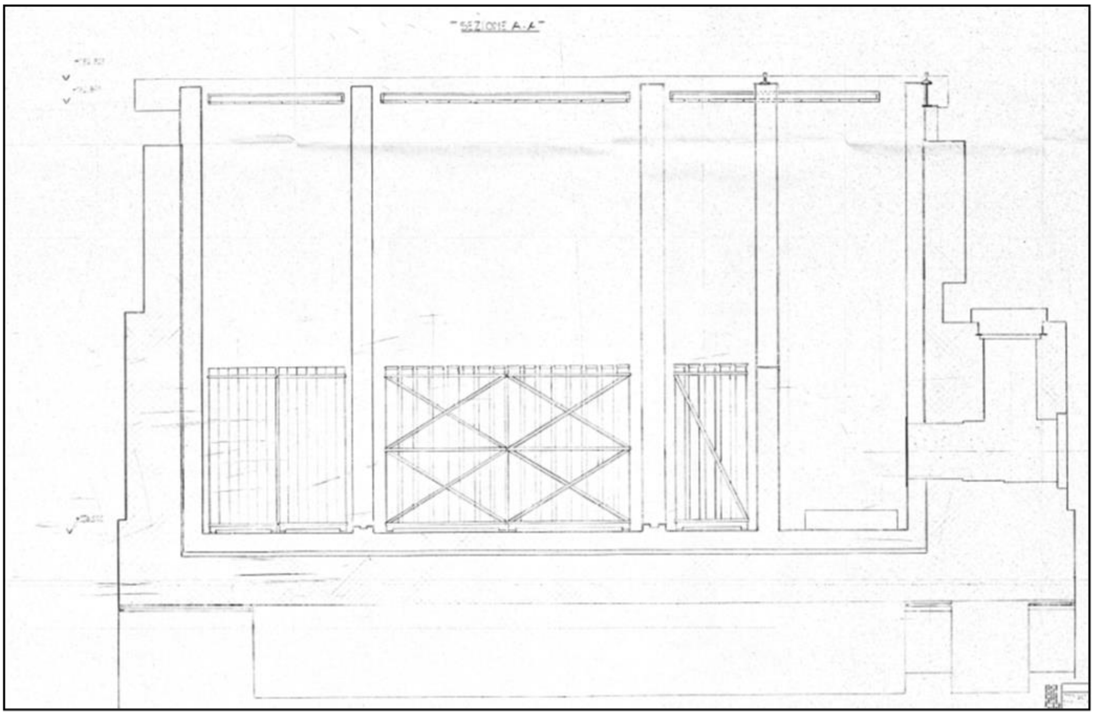

Figure 4 – Section of the spent fuel pool of the Avogadro Deposit

It is divided into three main sections (IB, II, III) and an additional section (IA), delimited by three partitions in reinforced concrete and each equipped with a slot that allows the passage of fuel elements under the necessary water head.

The volumes of the three main sections are:

- Section IB: 104 m3,
- Section II: 310 m3,
- Section III: 97 m3.

In the three sections are arranged the racks for the storage of fuel elements.

The additional section IA (volume of about 62 m3), located at one end of the pool adjacent to Section IB, is intended to accommodate the transport containers of the elements on the occasion of arrivals and shipments.

On the bottom of this section there is a special structure (shock absorber) to absorb energy in case of fall of the transport container in order to safeguard the integrity of the slab.

The pool, which fulfils, as mentioned above, the triple task of biological screen, static container and waterproof medium, basically consists of two distinct structures, one inside the other, divided by a waterproof membrane.

The external one, of greater thickness, has essentially static functions; The internal structure, with a constant thickness of 40 cm, has the function of protecting the waterproofing from nuclear radiation and any thermal effects.

The waterproof membrane consists of four successive layers of asbestos sheets and aluminium foil bituminated and hot-bonded with high melting point tar.

The pool is built in barite concrete in its lower part and constitutes a monolithic whole, that is, without joints and shootings; it rests on a bed of sand to allow thermal expansion and shrinkage; the entire tank (walls and bottom) is internally covered with stoneware tiles and sealed with Heraldite.

From the point of view of shielding, the thickness of the walls of the pool guarantees adequate protection against radiation from what it contains.

Fuel element storage racks are of the high-density type without neutron absorbers.

Each rack consists essentially of a bundle of stainless steel channels, connected to each other and to a base whose function is to transmit the vertical load on the floor of the pool and to establish a passage area such as to allow adequate circulation of water.

The racks for Trino elements have channels of square section, with an internal side of 212 mm, made of sheet metal with a thickness of 5 mm while those for the Garigliano elements have channels with an internal side of 193 mm and a thickness of 5 mm.

The capacity of the racks is: n° 216 Trino elements (in position II), n° 328 Garigliano elements (divided into positions IB, II and III).

In position IB is also installed a special five-position rack intended to accommodate one or more containers to accommodate any damaged elements.

Structurally flanked by the storage pool is the Decontaminator Room, consisting of a concrete structure made specifically for washing and decontaminating transport containers; It is equipped with sliding metal shutters and an internal system that allows:

- washing the container with industrial and demineralized water;
- the discharge of gases/vapours and water in a controlled manner (through a cooling and depressurization system);
- the collection of samples both in the gas phase and in the liquid phase.

POOL COOLING SYSTEM

The system is designed to remove the heat generated in the pool by the spent fuel elements, maintaining the temperature of the pool water at values that allow a comfortable environment for the staff working on the edge of the pool during the handling of fuel elements.

The cooling of the pool water is obtained by means of the Pool Water Cooling System, which is divided into three sections:

- Primary Circuit,
- Secondary Circuit (including the Well Water Circuit),
- Emergency Replenishment Circuit.

INSTRUMENTATION AND CONTROL ROOM

The supervision and control of the Plant, from the point of view of the operation of the various fluid systems, are carried out through the Control and Supervision Instrumentation System.

This system allows to detect those physical-chemical parameters representative of the conditions of the Plant (storage pool, cooling circuits, purification, demineralization, ventilation and conditioning) and provides the necessary indications and controls those alarms and automatic interventions that are deemed necessary to manage the plant in safe conditions.

In the control room all the information necessary to carry out the surveillance of the plant is sent and the commands for manual interventions on the most important components are reported.

The Control Room is located outside the Storage Building, at the entrance to the access Pentagon. In this room resides the operator during the surveillance shift, which monitors and, where required, records the conditions of level and temperature of the water in the pool, the temperature of the cooling circuits, the temperature, pressure, humidity and radiation levels in the container.

POWER SUPPLY

The electrical services of the plant are powered by 380 V (three-phase) and 220 V (single-phase) voltage, through a 500 KVA resin transformer-lowerer, with a 6,000/380 V ratio, connected to a star / triangle with neutral at the center of the star.

The primary distribution of motive power and light is carried out with a protected panel equipped with circuit breakers, with high interrupting power with magnetic protection only, from which the three-phase cables with neutral leading to the main users or to the secondary local distributions depart.

The latter are protected with a general disconnector and with valves and contactors on the individual departures.

The contactors are equipped with thermal protection for the individual motors.

The distribution is of the industrial watertight type, the insulation level of the equipment is 600 V. The cables are insulated in neoprene for a nominal voltage of 1,000 V of operation. In case of power failure from the normal supply lines, some of the most important services of the plant are switched to an emergency power supply, available to the entire Livanova area, consisting of a Diesel-electric system automatically started by a minimum voltage relay when the normal power source fails.

An IVECO DAIFO motor-generator unit, type GS 8 061 I06.05 A 610, is installed at a non-floodable altitude inside Avogadro Plant, designed to supply the electricity supply in the event of a lack of voltage coming from the network and from the Livanova motor-generator groups.

For its operation, Deposito Avogadro benefits from the supply of the following utilities byLivanova Site Management, owner of the industrial district of Saluggia within which the plant is located. This supply is regulated by an agreement stipulated between the parties.

1. Electricity and electricity supply, compressed air, industrial water, drinking water
2. Fixed telephony
3. Hot water for heating
4. Management of fire prevention facilities in the area (water distribution network and anti-fire vehicles)
5. Pest control service
6. Road network maintenance, green areas, drainage network, technological alarm network
7. Canteen and Infirmary / Medical Room
8. Guard and surveillance
9. Temporary storage of radioactive materials

As far as fire prevention is concerned, it is specified when the Avogadro staff is not present in the event of a fire alarm, the Livanova Site Management staff assigned to surveillance and appropriately trained, is required to intervene immediately by proceeding to:

10. Immediate analysis of the situation with verification of actual fire onset.
11. Request for intervention of the personnel available at the Avogadro Depot and if necessary of the Fire Brigade

B.III.1.2 National regulatory framework

As per §1.2

B.III.1.3 Improvements in fire safety as a result of experience feedback

Fire safety is developed and improved through the constant periodic maintenance of the systems and protective measures, periodic training of firefighters is carried out and the risk assessment is periodically updated by implementing and updating the systems to comply with current legislation.

Operational feedback it is shared through regular meetings and training events

B.III.1.4 Defence in depth principle and its application

The following criteria of defence in depth have been adopted in the fire risk assessment:

- First level of defense
  Reduction of fire load, minimizing storage materials, maintain fire compartmentalization of various work areas
- Second level of defense

For active fire protection there is a smoke detection and fire alarm system in all work areas and a fire water system with uni45 wall hydrants positioned in the internal rooms and uni 70 above ground hydrants positioned in the external areas.

- Third level of defense
  Passive protection of work areas with horizontal and vertical fire resistant compartments, fire doors with panic bar for escape routes.

Fire prevention and protection measures are defined according to the fire risk assessment of the installation. They are based on the general criterion of defense in depth which provides for the adoption of fire prevention, control, detection and extinguishing measures.

B.III.2 Fire Safety Analyses

B.III.2.1 Fire Safety Analyses for Dedicated spent fuel storage facilities

B.III.2.1.1. Types and scope of the fire safety analyses

The fire risk assessment is aimed at:

1. Qualitative and quantitative estimation of the fire risks present in the various rooms of the Storage facility and the identification of the necessary fire prevention and prerotation measures to be implemented to deal with them with reference to the specific fire load of the project and to the sources of trigger.
2. Verification of the adequacy of the measures already in place (detection systems, fixed and mobile extinguishing systems, compartments, escape routes, smoke evacuation system, emergency plans) and to any need for further measures in a performance perspective aimed at raising fire safety during the life of the storage facility.

B.III.2.1.2. Key assumptions and methodologies

Fire risk assessment drawn up according to Ministerial Decree 10/03/98 and updated according to Ministerial Decree 1,2,3 September 2021, which imply the compartmentalisation of the work areas with fire-resistant masonry and doors for the containment of the fire risk, minimization of the fire, identification of escape routes adequately marked with special signs for the evacuation of operators, installation of an emergency lighting system to guarantee evacuation, installation of generators to guarantee continuity of service in the event of a power failure, double line power supply derived from the energy distributor and safety line derived from the Livanova - Sorin plant.

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

The fire risk assessment was carried out to define and implement measures necessary to ensure the safety of the of workers and other persons present at the workplace, as well as prevent radioactive consequences due to a fire.
These measures include:

- risk prevention;
- information for workers and other persons present;
- worker training;
- technical and organisational measures to implement the necessary measures.

The fire risk assessment shall take into account:

a) the type of activity;
b) stored and handled materials;
c) equipment at the workplace, including furnishings;
d) the construction characteristics of the workplace including coating materials;

e) the size and structure of the workplace;
f) the number of persons present, whether employees or other persons, and their readiness to leave in an emergency.

The fire risk assessment was carried out according to Annex I to DM 10/03/98 and it follows a prescriptive approach, requesting the application of all the measures to reduce the fire risk:

- realization of compartments for different work areas such as to not spread a possible fire and limit it to the compartment concerned;
- limitation of the fire load of the materials stored in the area;
- the compliance of work equipment with current regulations and the execution of regular maintenance;
- large use of metal furnishings, which are not a source of increasing risk;
- limitation in the number of people present in the different areas.

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

The fire risk assessment was carried out in compliance to par. 1.4 of DM 10/03/98, dealing with the following points:

(a) identification of any fire hazard;
(b) identification of workers and other persons present at the workplace exposed to fire risks;
(c) elimination or reduction of fire hazards;
(d) assessment of residual fire risk;
(e) verification of the adequacy of existing safety measures or identification of any further measures and measures necessary to eliminate or reduce residual fire risks.

With reference to point (a), combustible materials are present in limited quantities, are correctly handled and safely stored, are not subjected to ignition sources and therefore do not constitute an obvious fire hazard.

In the workplace there may be no ignition sources and heat sources that are potential causes of fire or that can favor the spread of a fire. There are no following:

- presence of flames or sparks due to work processes, such as cutting, sharpening, welding;
- presence of heat sources caused by friction;
- presence of machines and equipment in which heat is produced which are not installed and used according to the rules of good practice;
- use of open flames;
- presence of electrical equipment not installed and used according to the rules of good technique.

With reference to point (b), it should be noted that:

- there are no workers exposed to sources of risk in the workplace,
- there is an occasional public in such a number as to determine a crowded situation;
- there are no persons whose mobility, hearing or sight is restricted;
- there are people who are not familiar with the places and their escape routes;
- there are no people who may be unable to react promptly in the event of a fire or may be particularly unaware of the danger caused by a fire, as they work in isolated areas and the escape routes are long and not easy to implement.

With reference to point (c), it should be noted that the work areas are divided into compartments with fire resistance class REI 120 in order to reduce any propagation of sources of danger.

With reference to point (d), the work activity has been classified as high risk not because there are sources of ignition or presence of highly combustible materials, but because it is classified as an activity at greater risk in case of fire.

With reference to point (e), it should be noted that in the activities subject to mandatory control by the provincial fire brigade commands, which have implemented the measures provided for by current legislation, in particular as regards the fire behavior of structures and materials, compartments, escape routes, extinguishing means, detection and alarm systems, technological systems, it is to be considered that the measures implemented in accordance with the current provisions are adequate.

A) Escape routes:

1) reduction of the exodus path: the exodus paths are short and immediately evident;
2) protection of escape routes: all escape routes lead directly outside or are placed in fire-resistant compartments REI 120;
3) installation of signs: the signs are positioned along the escape routes and at the emergency exits;
4) enhancement of emergency lighting: ordinary lighting has a double safety power supply with generator and there are also autonomous emergency lamps;
5) personnel responsible for emergency management and the implementation of evacuation measures: there are personnel with training courses for high risk, and also the emergency team of the Livanova complex with H24 presence;
6) 8) Crowding limitation: crowding is limited.

B) Extinguishing equipment and equipment:

In the activity there is a fixed fire extinguishing system consisting of hydrants uni 45 for internal protection and hydrants above ground uni 70 for external protection. The main water network is underground and protected from possible sources of risk.

C) Fire detection and alarm:

In the activity there is an automatic fire detection and alarm system built according to uni 9795 and regularly maintained.
Each automatic detector is subject to a radius area of 6.5m and the optical acoustic alarm panels are located in each compartment and easily audible.

D) Information and training:

In the activity, a program of control and regular maintenance of the workplaces has been prepared.
The assessment of the fire load was carried out on the basis of tables of the calorific value of the materials and was updated over time through the Claraf application made available to the Fire Brigade Command.
On the following pages are theplans with the fire-fighting devices relating to the four reference heights of the installation:

1. Ground Floor Level (170,26 m a.s.l.)
2. Entrance square level (173,76 m a.s.l.)
3. Deck level (181,96 m s.l.m.)
4. Upper Level (187,16 m a.s.l.)
5. Livanova Site Management - Fire Fightihing Protection System of the District

B.III.2.1.5. Periodic review and management of changes

The revision of the evaluations is updated periodically as required by law, on the occasion of substantial changes, on the occasion of regulatory updates (the evaluation is coordinated with the Ministerial Decree of 3 September 2021) and when requested by the Supervisory Authorities.

B.III.2.1.5.1. Overview of actions

A review of the risk assessment is performed on the occasion of substantial changes in the activity. In case of no changes of the risk conditions, a periodic check is carried out on the state of maintenance of the active and passive fire protection devices.

B.III.2.1.5.2 Implementation status of modifications/changes

No changes of activities are occurred in the plant.

B.III.2.1.6 Licensee's experience of fire safety analyses

B.III.2.1.6.1. Overview of strengths and weaknesses identified

As far as the strengths are concerned, it must be considered that for the Fire Safety analysis the prescriptive approach dictated by the DM 10/03/1998 was used, in which the standards and technical rules of fire prevention, impose compliance with minimum safety requirements identified through the assessment of the risk of fact carried out upstream by the legislator. The application of the approach is, being well codified, simple to apply both for designers and for control bodies as the standard is applied directly to comply with the requirements without complex processing and use of calculation codes.

As far as weaknesses are concerned, the prescriptive approach used pursuant to DM 10/03/1998 is rigid, bound by fire prevention standards and technical rules. These standards for complex plants, such as nuclear ones, do not consider the specificities of the production processes carried out, the plant and structural peculiarities, the particular activities carried out including decommissioning, the combination and interrelation of the different risks, radiological, conventional, etc. Furthermore, this approach does not allow a quantitative assessment of safety, as the performance approach would allow, which allows to obtain results that are closer to reality and to measure fire protection measures to real needs. Furthermore, the prescriptive method, linked to standard regulations, treats fire empirically and cannot take into account current scientific studies on fire behavior based on different situations and complex scenarios.

It should be noted, however, that the structure is existing and built in application of the regulations in force during the period of commencement of the activity and the request of the CPI to the command of the fire brigade, while the performance approach can be applied more easily to new structures.

B.III.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

Not Applicable. No fire events are reported and there are no requirements from the control bodies. If it reports on the occasion of the request of the CPI and on the occasion of the modification concerning the adduction of a new paper archive an inspection of the fire brigade during which no prescription minutes have been issued.

B.III.3 Fire Protection Concept and Its Implementation

B.III.3.1 Fire prevention

B.III.3.1.1. Design considerations and prevention means

The plant was designed with compartmentalization of the work areas and in particular of the areas where there is a storage of radioactive materials to reduce the likelihood of spreading of fire and radioactivity. The electrical system was designed to ensure continuity of service and avoid voltage and electricity blackouts in order to reduce any propagation of radioactive substances.

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

A periodic verification of materials in storage is carried out, together with the control of ignition sources. Hot work interventions are limited and, in any cases, they are conducted according to strict procedures in order to reduce the fire risk.

B.III.3.1.3 Licensee's experience of the implementation of the fire prevention

B.III.3.1.3.1. Overview of strengths and weaknesses

Not particular strengths and weaknesses are identified.

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

Not particular lessons learned are identified.

B.III.3.1.3.3. Overview of actions and implementation status

Fire prevention measures are dictated by legislation and therefore are consolidated and easy to apply. On the other hand, situations that deviate from the expected standard require a regulatory interpretation and ad hoc management that requires a risk assessment according to a performance approach, which however is difficult to apply in an existing structure as it was designed in times prior to the performance approach.

B.III.3.2 Active fire protection

B.III.3.2.1 Fire detection and alarm

B.III.3.2.1.1. Design approach

It should be noted that the choice to adopt "Fire detection and alarm" derives from the assessment of fire risks in which, for the different environments, it provides for these systems to reduce the risk.
The purpose of fire detection and alarm measures is to ensure that people present at the workplace are alerted to a fire before it threatens their safety. The alarm must initiate the procedure for evacuating the workplace and activating the intervention procedures.
The purpose of automatic fire detection is to alert people present in time to implement emergency procedures.
The activation of the smoke detection and fire alarm system is directed by means of an optical and audible alarm both to the control room of the Avogadro Plant and to the control room of the Livanova/Sorin district which are continuously manned.
The smoke detection and fire alarm system are equipped with fire resistant cables.

B.III.3.2.1.2. Types, main characteristics and performance expectations

The smoke detection and fire alarm system is independent in each compartment and belongs to a single fire alarm control unit. The system is installed with a closed loop and with fire resistant cable, and considering that line insulators are present in the various areas, in the event of a fire in one compartment, the system continues to operate in the adjacent compartments.
This system includes:

- a network of optical smoke detectors, suitably positioned to cover the affected areas of the Storage Building and the rooms attached to it; the presence of smoke causes the activation of a local optical signal and provides the alarm to the centralization unit located in the Control Room;
- a centralization unit, consisting essentially of circuits for activating the detection zones, receiving signals, supplying the detectors, indications of:
  - alarm related to each detection zone and general (optical and acoustic); normal feeding;
  - breakdown;
- an alarm repeater panel for fire detection and failure of the System located in the Surveillance Guardhouse of the District;
- an auxiliary power supply.

B.III.3.2.1.3. Alternative/temporary provisions

In case of deactivation of the smoke detection system, the procedure provides for the visual detection by the firefighters, who periodically during the work activity will supervise through periodic inspections.

B.III.3.2.2 Fire suppression

B.III.3.2.2.1. Design approach

The fire extinguishing equipment and systems for the different parts/buildings/premises of the Site have been defined with reference to Annex V of Ministerial Decree 10-03/98.

It is equipped with a water network for powering the external and internal fire outlets of the buildings.
The water supply is ensured by a storage tank fed by a submersible pump installed in an artesian well.
The main water network outside the buildings, consisting of underground pipes, feeds a series of above-ground column fire outlets and UNI 70 column sockets underground.
From the main network is derived the internal water network that feeds a series of UNI 45 fire outlets.
In case of need, the fire-fighting network can be connected to one of the wells that feed the Pool Water Cooling System.
There are also fire extinguishers of different types and capacities located in selected points of the Warehouse (powder and CO2, depending on the material present in the area).
In relation to the risk assessment, and in particular for the reduction of fire risk, in addition to fire extinguishers, fixed manual extinguishing systems have been provided.
Portable fire extinguishers are located along exit routes, near exits and fixed to the wall. The fire hydrants are located in visible and accessible points along the exit routes, with the exception of stairs. Their distribution makes it possible to reach every point of the protected surface at least with the jet of a spear.
The installation of manual extinguishing means is indicated with appropriate signs.
The water pipes to ensure earthquake protection are buried or built into the walls where possible.

B.III.3.2.2.2. Types, main characteristics and performance expectations

In the activity there is a fixed fire extinguishing system consisting of hydrants UNI 45 for internal protection and hydrants above ground UNI 70 for external protection. The main water network is underground and protected from possible sources of risk.
The fire-fighting water system is unique for the Livanova area and consists of pipes d = 200 "arranged in a ring with some interconnection bypasses in case of failure.
On the occasion of the periodic renewal of fire compliance carried out in January 2023, a static and dynamic pressure test of the system was carried out that responds to regulatory requirements. The test was carried out by the contract maintenance company with the simultaneous opening of No. 4 hydrants UNI 45 located in an internal position, positioned on the ring network and located in a more unfavorable position. A static pressure of 4.8 bar and a variable dynamic pressure were detected depending on the number of hydrants in operation. In this case, a dynamic pressure of 4.0 bar was obtained with 1 hydrant UNI 45 in operation, a pressure of 3.8 bar with 2 hydrants UNI 45 in operation, a pressure of 3.5 with 3 hydrants UNI 45 in operation, and a pressure of 3 bar with 4 hydrants UNI 45 in operation. The test was performed with instrument Model F.M. 12 Stream with DN45-UNI811 connection and nozzle ø 12mm.
In the event of breakage of the water system, the emergency procedures indicated in the evacuation plan are activated, the system will be closed and disconnected by means of a zone valve and, where necessary, the work area will be evacuated and safety of machines and equipment.

There are manual extinguishers consisting of wall hydrants and mobile units which can be used in different phases of the fire.

B.III.3.2.2.3. Management of harmful effects and consequential hazards

System redundancies ensure system reliability and operation as a result of malicious events due to unintentional maneuvers. The wall hydrants are manually actuated according to the needs and are in any case located in areas where as result of any inadverted actuation or fault, the consequent effects are not expected to impair safety functions.

B.III.3.2.2.4. Alternative/temporary provisions

The fire-fighting water system is unique for the Livanova area and consists of pipes arranged in a ring with some interconnection bypasses in case of failure.

In case of lack of water supply, the system has above-ground hydrants that allow firefighters to enter water into the water system through tankers. (See Livanova Site Management - Fire Fightihing Protection System of the District)

B.III.3.2.3 Administrative and organisational fire protection issues

B.III.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

The administrative measures consist of periodic verifications and controls of the firefighting systems in compliance with deadlines indicated in the fire register, where they are all recorded in compliance with the requirements of the national legislation.

B.III.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

The pertaining procedures are reported in the emergency plan which is periodically updated.
In case of intervention of the fire brigades, the management of the activities is in their hands with the support of the internal fire-fighting personnel.
Knowledge of fire safety systems, knowledge of plant risks and adequacy of intervention times are guaranteed by the continuous provision of training courses and staff training, site inspections and planned exercises.
The documentation consists of the examination of the project approved by the fire brigade for the issue of the fire prevention certificate, periodic renewals of fire compliance, emergency and evacuation plan, risk assessment, fire register and lay out plans.

B.III.3.2.3.3. Specific provisions, e.g. loss of access

There is an emergency secondary entrance to the site, UNI 70 hydrants are installed within the perimeter of the site.
Specific considerations:

- **Storage Building**: considering that the fuel elements are immersed in the pool with about 600 m^3 of water and the content of drums stored inside the building consists of non-combustible materials (cement, iron, steel, lead), significant releases of radioactive materials to the external environment can be excluded.
- **Gamma cells:** according to the fire hazard analysis there are no conditions for starting a fire in the area where they are located; the monitoring function of the possible release of radioactivity is not affected.
- **Storage Building Cavity:** assuming the possibility of a fire due to short circuit of the lighting system, with the involvement of a waste drum, the associated release of radioactivity to the external environment could not genarate an exposure of persons of the public exceeding the emergency intervention level established by the national legislation.

Considering the original plant configuration, it does not foresee the presence of redundant and completely separated components (pumps, heat exchangers) of the spent fuel cooling system. However, in case of an availability of pool water cooling system, due to the very small residual heat associated to the fuel elements stored, heat can be removed even for long time by natural circulation and associated evaporation. The radiological releases due to possible damage of the fuel are not envisaged.

B.III.3.3 Passive fire protection

B.III.3.3.1 Prevention of fire spreading (barriers)

B.III.3.3.1.1. Design approach

In compliance with the requirements of national legislation, in order to minimize the spreading of possible fire, work areas have been divided into compartments.

The compartments have been defined vertically for each floor with fire-resistant floors REI 120 and horizontally for work areas, technical rooms, warehouses, or structurally, being the complex consisting of a pentagon with a central compartmentalized ring.
All work areas are also compartmentalized with fire-resistant masonry/doors.

B.III.3.3.1.2. Description of fire compartments and/or cells design and key features

The fire resistance of the compartments was identified in REI 120, as reported in the documentation presented for approval to the local command of the fire brigade. Structural integrity is verified and maintained periodically to ensure fire resistance performance.

The compartments are made with a metal bearing structure and reinforced concrete walls, the internal mutatires are made of bricks and fire doors. The floors are incombustible, all the walls are plastered and with fire reaction class 0.

B.III.3.3.1.3. Performance assurance through lifetime

Access routes are always kept clear and accessible.
In the case of changes in the distribution of fire loads, it is necessary to update the fire assessment and the associated iplications for the configuration of compartements and a new reference project has to be presented to the local command to the fire brigades, according to DM 3 August 2015.

B.III.3.3.2 Ventilation systems

B.III.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The ventilation systems consist of non-combustible metal ducts, and in the crossings of each compartment fire dampers have been installed connected to the smoke detection and fire alarm system, which close in the event of an alarm.

Fire dampers have been installed to prevent a fire from spreading from one compartment to another. In the event offire alarms, the fire-fighting personnel will manually deactivate the ventilation system.

B.III.3.3.2.2. Performance and management requirements under fire conditions

- the fire resistance rating of ventilation systems, and any possibilities to isolate the fire compartment penetrations by suitably rated fire dampers (automatically where appropriate),
- Fire dampers have the same degree of fire resistance as the compartment.
- means available to prevent the spread of fire.

B.III.3.4 Licensee’s experience of the implementation of fire protection concept

The fire risks have been well defined and analyzed with a conservative approach considering the applicable legislation, the basic safety standards for similar plants are good, there are no areas with particular risks or active ignition sources.

The fire risk assessment has identified the functional requirements and performance criteria of fire protection systems to be adopted in the various buildings; the overall efficiency of fire protection systems and their required capacity/performance is ensured by REI certifications, components/system declarations of conformity and verified through periodic tests. The fire protection project and its updates are subject to the approval of local fire brigade command and also oversighted by the comptent regulatory authority.

C. WASTE STORAGE FACILITIES ON NUCLEAR INSTALLATIONS SITES

C.I WASTE STORAGE FACILITIES AT TRINO NPP SITE (D1 AND D2)

C.I.1 General information

C.I.1.1 Nuclear installations identification

- Name: **D1 and D2 waste storage facilities** at "**Enrico Fermi" Trino NPP site**
- Licensee: **So.G.I.N. S.p.A**

The Enrico Fermi NPP is located in the territory of Trino town (Vercelli), near the Po river. The NPP is in decommissioning phase. It was a PWR, with a power of 270 MWe. The Site is owned by Sogin, except for the electrical station, owned by the electric power provider (Terna S.p.A.).

The site is surronded by the river and canals, on the nothern side is located an abandoned factory.

Two waste storage facilities (denominated D1 and D2) were realized in the site to host the waste produced during the plant lifetime.

Both the waste storage facilities are located within the boundaries of the Trino NPP classified area. D1 was built in 70s and D2 was built in 80s and are still in use.

The installations share the same electrical supplies, onsite fire brigade and fire detection and protection systems.

The main offsite firefighting resources are: electric and water supply. Electric power is supplied by Terna, that owns the part of the NPP land where supply components are located. Water supply consists of four wells located in the NPP land, depending on the aquifer level and ability to ensure the water requested by the NPP fire protection system.

At present, the D2 waste storage facility is not into operation. The Trino NPP Decommissioning Project foresees the refurbishment of both D1 and D2, in order to comply with the actual safety and security standards. The D2 facility will be the first one to be refurbished. In order to allow the reconstruction activities, the waste present in the D2 facility has been temporary transferred in a temporary storage facilty on the site.

The wastes stored in D1 and D2 facilities are conditioned and not conditioned, even with combustible materials as illustrade in the following.

C.I.1.1.3. Key parameters per installation

- Type of facility: **On-site temporary waste storage facilities (D1 and D2) for radioactive solid waste (LLW and ILW)**
- Year of first operation: **2012**
- Scheduled shutdown date: **2040 is the scheduled end for decommissioning activities**

C.I.2 Fire Safety Analyses

C.I.2.1 Fire Safety Analyses for Waste storage facilities on nuclear installations sites

C.I.2.1.1. Types and scope of the fire safety analyses

The analysis about D1 and D2 waste storage facilities has been performed as part of the NPP fire hazard analysis. The fire hazard analysis is based on the Ministerial Decree 10th March 1998: through a previous fire hazard assessment, the legislator established rules and norms in order to provide minimal safety requirements whose observance guarantees the minimization of the fire risk. It is a qualitative fire hazard assessment: the main fire and explosion hazards have been identified, considering the combustible materials displacement, then an estimation of the probability of occurrence and of the magnitude of the consequences has been associated with each fire or explosion scenario. The analysis is part of an approval procedure, aimed at the issuing of a fire protection certificate by the local command of fire brigade, according to the requirements established in the conditions attached to the decommissioning license.

A subsequent analysis, aimed at the fire protection system sizing, has been conducted: it took into account not only the combustible material contained in the areas, but also the importance by a safety point of view of the systems contained in an area, the possible radioactive source term due to the fire accident in the specified area and the possibilities of contemporaneity between events. This is an application of the defence in depth that will be better discussed in the following paragraph.

Since decommissioning activities could change the routinary configuration of combustible materials and extinguishing systems, Specific fire hazard assessment are requested by the authority for each decommissioning activity.

Combustible material storage is accepted only for maintenance activities and is limited at the strictly needed time. The number of fire fighting equipment is compliant with the Italian standards. A firefighting team is periodically tested for readiness and competence.

The only event combinations credible is the contemporaneity of activities and the consequent increasing of the combustible materials amount in the area.

In the fire hazard assessment, a conservative amount of the waste in the area is considered to participate to the fire event and it is considered as source term. The spreading of the source term and the consequent dose to population and workers are evaluated. This values are used as reference scenario for the issuing of the Coordinated Emergency Plan.

The fire fighting equipment and its position, the firefighting team and its testing, the amount of combustible material, the Plant procedures ensure that, in a fire event scenario, the fire spreading would be contained in short time, limiting the waste involved and, therefore, the source term.

C.I.2.1.2. Key assumptions and methodologies

Based on italian standards and regulations, the main assumptions considered in fire safety analysis are:

- No SSCs identified as important to safety are located in the D1 or D2
- D1 and D2 waste storage facilities are located far from buildings where activities are normally performed.

Moreover, on-site firefighting personnel is periodically instructed and tested in order to maintain readiness and competence.
Off-site fire brigades are annually involved in the Trino Nuclear Emergency Simulation. Both readiness and specific competence that shall be used in a nuclear facility are tested by their supervisors.
At the end of the Nuclear Emergency Simulation, consideration about intereferences and improvements about technical equipment and procedures are discussed together by Trino Management and Fire Brigades Supervisors.
Mitigation actions take conservatively into account the worst credible scenario.

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

Italian standards and regulation are the result of the collected experience about fire events and spreading. Thus, the application of the guidelines and its assessment by competent office of the fire brigades ensure that fire effects as e.g., temperature, pressure, etc. are priorly taken into account.

The fire hazard analysis has been performed in accompliance with the Ministerial Decree 10th March 1998. This methodology is based on the following steps:

- identification of the main scope fo the analysis: the waste storage facilities are included in the main analysis regarding the Nuclear Power Plant, considered as plant for the peaceful use of nuclear energy;
- identification of the main "vertical" norms to be applied (activity): the waste storage facilities are considered in the activity "plants in which nuclear fuel are detained or produced or radioactive waste are stored";
- identification of the risk sources: combustible materials are listed, in the specific case of the waste storage facilities, the ammount of combustible materiali is neglegible. In this phase of the analysis, also other kind of dangerous substances or compounds are considered: the radioactive waste stored in the storage facilities is taken into account;
- identification of the main characteristics of each building: structural characteristics, system and functional characteristics; compartimentation; combustible materials; maximum conceivable personnel presence; emergency exits; ventilation; fixed extinguishing plants and mobile extinguishing tools; fire detection system; signage;
- qualitative fire hazard assessment: the result of this analysis concerning the whole Trino NPP is that the fire hazard is low. The same is applied to the waste storage facilities;
- reduction of residual fire risk:
  - fixed fire extinguishing system and mobile fire extinguishing tools are reported;
  - radioactive containment measures are reported;
  - emergency management: the emergency plan concerns the whole Trino NPP, but the waste storage facilities are mainly considered, containing the maximum source term in case of a radioactive spreading due, for instance, by a fire. The Trino Emergency Plan involves all the local authorities, for instance fire brigades, local sanitary system, etc.;
  - information and training about the fire extinguishing procedures are reported;
  - controls and maintenance of the fire prevenction measures are reported.

The complexity of a fire event in D1 and D2 waste storage facilities is managed through the flexibility of the fire fighting team and procedures: Nuclear Emergency procedures contains guidelines for radiological survey team that give radiological data about possible radioactive spreading outside the plant boundaries, following instruction of an Emergency Manager. The Emergency Manager is in an isolated position and has access to meteorological data.
A fire event in D1 and D2 of severe entity is not credible.

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

The fire hazard analysis shows that:

- the waste storage facilities contain a minimal amount of combustible material;
- their distance from other buildings and the compartimentation realized through 50 cm thick walls reduce the possibility of fire spreading;
- the fire extinguishing system in the nearby of the waste storage facilities is sufficient to avoid the fire spreading inside the building;
- the emergency plan, the fire extinguishing team and the organizational procedures to ensure readiness in case of fire, are adequate to the risk.

C.I.2.1.5. Periodic review and management of changes

C.I.2.1.5.1. Overview of actions

In the first case, each decommissioning activity is ruled by a procedure that foresees also a specific fire hazard assessment. This fire hazard assessment is performed by an expert and is supervised by the ISIN for approval.

In the second case, changes are not permitted on the existing systems if not specifically approved by the NRA: even during normal manutentive activities, any component can be replaced with other having same or better characteristics. System changes can be proposed by the licensee through a specific procedure involving safety related roles, the issued documentation is submitted to the ISIN for approval. This procedure includes also changes in the fire protection systems.

It is the case of the reconstruction of existing facilities like D2, whose project had also to comply with the requirements of technical guide 30, which includes specific provisions of fire protection.

As required by the Italian Legislation, the fire analysis is revised every 5 years, in order to evaluate changes to the conditions described in first stance. Authorithies (for instance, Fire Brigades and ISIN) can require a specific update whenever needed.

C.I.2.1.5.2 Implementation status of modifications/changes

The renewal of the D2 waste repository is the main modifications ongoing. At the moment, the executive design is being produced. Demolition works should start within the next 6 months.

C.I.2.1.6 Licensee's experience of fire safety analyses

C.I.2.1.6.1. Overview of strengths and weaknesses identified

The fire safety analysis for waste storage facility D1 is based on a methodology (complaint with the DM 10/03/1998) that has the following strenght:

- It is based on an analysis performed by the legislator: it is based on the experience grown by experts;
- It is based on a well known approach, therefore it is well codified and then it is easy for the issuer to compile and the authorities to evaluate.

On the contrary, this approach is not fully appropriate for nuclear installations due to their complexity.

C.I.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

No fire events are reported. No specific addiotanal requirements related to fire safety analysis have been formulated by authorities. No international review missions have been conducted on the facilities.

C.I.3 Fire Protection Concept and Its Implementation

C.I.3.1 Fire prevention

C.I.3.1.1. Design considerations and prevention means

The probability of fire event is reduced by organizational measures: the storage of combustible materials different from existing radioactive wastes is minimized.

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

According to the first step of defense in depth, fire loads are minimized and possibile ignition sources are strictly controlled.

Until its conditioning, some of the waste in storage is combustible. Combustible solid radioactive waste mainly consists of:

- Plastic gaskets of the packages.
- Cables and electrical equipment.
- Empty plastic containers.
- Ventilation filters.
- Miscellaneous material (wood, paper, etc.).
- Organic ionic exchange resins.

The ammount of combustible radioactive waste is reduced as much as possible during the production phase.

There is no evidence of gaseous generation inside the waste.

The highest concentrations of fire load are related to the resins stored in the area.

Fixed fire loads are related mainly to the communication and lighting systems estimated at a few kilos of plastics (for a total value of the fire load of some MJ / sqm).

Transient fire loads can be assumed for specific daily storage needs of extraordinary activities (cables, electrical equipment, etc.), estimated at a few kilos of plastics (for a total value of the fire load of some MJ / sqm).

The ignition (i.e. the malfunction of electrical equipment) of these components is possible and would essentially result in the formation of smoke with a very low probability of propagation of fire. The probability of such occurrences is however very low due to the presence of informed and qualified personnel, periodic inspection and consequent maintenance.

The handling devices (forklift) are electrically powered to avoid the presence of flammable liquids inside the building (diesel or petrol). The forklifts have minimum quantities of oil. The forklifts are charged in a separate area.

- *Controlling and mitigating the fire*: The area is surveilled periodically through the day. Once a month, the waste containers state of conservation is checked. Fire protection system (high and low water pressure hydrant system) is located near the buildings and is tested periodically. Emergency procedures are tested periodically to ensure readiness and effectiveness.
- *Mitigating secondary fire effect*: The buildings are in a less occupied zone of the classified area. The building compartimentation is realized through 50 cm thick reinforced concrete wall.

Combustible waste is stored in metallic containers. The use of mobile ignition sources inside the waste storage facility is limited at the time strictly needed by waste management or maintenance activities.

Each waste management or maintenance activity follows this steps:

- evaluation by the main safety roles;
- start of operation is given by the Plant Unit (that collects information about the Plant condition and activities overlapping.

It is envisaged that all the combustible wastes will be conditioned in solid matrix in the near future, so that all flammable characteristics will be eliminated.

C.I.3.1.3 Licensee's experience of the implementation of the fire prevention

C.I.3.1.3.1. Overview of strengths and weaknesses

The fire prevention has been implemented following Italian laws and regulation. This approach is well known and derives from a general fire risk assessment performed by the regulator with the assistance of competent authorities (for instance Firebrigades). Due to this, the approach can ensure that the minimal requirements are fullfilled. Since the approach is strictly regulated, its application is easily performed.

However, some scenario involving the presence of nuclear waste can not be managed only by the pure application of law, norms and regulations, it is necessary a more specific approach, that, in our case, implies some organizational feature, like a more complex emergency plan. This is done to comply with nuclear regulatory authority requirements.

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

No fire events have been recorded. Trino NPP has not received any international review mission.

C.I.3.1.3.3. Overview of actions and implementation status

The refurbishment of the D2 waste storage facility is the main ongoing modification. Demolition works should start within the next 6 months. New electrical cables and systems will be installed with enhanced fire resistant characteristics.

When the new storage facility will enter into operation, updated procedures will be adopted to minimize the presence of combustible materials and to control possible ignition sources.

As said, exisiting combustible radioactrive wastes are expected to be conditioned in the near future.

C.I.3.2 Active fire protection

C.I.3.2.1 Fire detection and alarm provisions

C.I.3.2.1.1. Design approach

The actual fire hazard analysis considers the actual situation and a fire detection system is not required in the waste storage facilities. For the refurbishment of D2 building a new fire hazard assessment has been issued and according to its conclusions a fire detection system has to be provided.

The physical barriers (walls and internal structures) are rated to withstand external relevant hazards.

C.I.3.2.1.2. Types, main characteristics and performance expectations

As stated before, since, as a result from the fire hazard analysis, the amount of combustible material different from waste introduced in the facility is negligible, the fire detection system is not required in the D1 repository.

Regarding the new D2 waste repository that has yet to be realized, the detection system is foreseen and the independence of the fire detection system in different areas is achieved by the compartimentation provided by the walls.

C.I.3.2.1.3. Alternative/temporary provisions

Regarding the new D2 waste repository that has yet to be realized, in case of temporary unavailability of the fire detection system, some alternative actions will have to be undertaken in compliance with the technical specifications.

C.I.3.2.2 Fire suppression provisions

Both waste storage facilities are not provided with a specific fire suppression system, according to the results of the fire hazard analysis. Hydrants of NPP estinguishing system that are located in the nearby of waste storage facilities will be used in case of fire.

The D2 storage facility under construction comprises a drenage system designed to collect the water in dedicated tanks connected to radwaste (liquid treatment system) system of the plant. This in order to manage the water possibly used for the possible suppression of a fire with the existing firefighting system.

C.I.3.2.2.1. Design approach

As said, for the fire suppression in relation to storage facilities, the main NPP fire estinguish system will be used. In the following the description is therefore addressed to such a system

C.I.3.2.2.2. Types, main characteristics and performance expectations

The fixed fire extinguishing system is redundant and the water and energy supply are diversified.

The NPP Emergency procedures (tested periodically) considers also communication and interaction with the local fire brigades.

The fire fighting team is trained to use both fixed and manual firefighting equipment.

The fixed fire extinguishing system is redundant and the water and energy supply are diversified. The fire extinguishing system can provide 100 m^3/h for 12 hours consecutively, without water addiction from the aquifer (main water source for the fire extinguishing systems). Water can be added to the main tank from the aquifer with a flow of more than 60 m^3/h.

C.I.3.2.2.3. Management of harmful effects and consequential hazards

Firefighting systems, in particular hydrants, that can serve the waste storage facilities are located in the near vicinity but outside the building. Is therefore expected that no particular consequential effects, affecting the facility, could be generated by inadverted use or faults of the exisiting fire estinguishing system

C.I.3.2.2.4. Alternative/temporary provisions

As requested by the technical specifications established with the authorization for decommissioning, whenever the fire extinguishing systems are not working, the activities in the involved areas must be interrupted and mobile extinguishing features shall be provided in the nearness. Action to reactivate the fire extinuishing systems must be planned and performed.

C.I.3.2.3 Administrative and organisational fire protection issues

C.I.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

The operability of the fire protection systems and organization is required by the technical prescription issued by the ISIN regarding the E. Fermi NPP. Therefore, technical and organizational procedures are issued by Sogin to ensure the operability through periodical inspections, maintenance and testing.

C.I.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

The general firefighting strategy is mainly established by the law and is revised together with the local fire brigades autorithies. In general, a common plan is established in order to coordinate any kind of major accident (including fire hazard in the waste storage facilities) with the offsite resources. The plan is reported in a specific document revised whenever the NPP conditions should change.

Members of the fire fighting team must have a specific training certificate, the training is provided in accompliance with requirements established in the law. It includes a general training about fire scenarios, a specific training about fire hazard in the NPP and a practical simulation to be arranged on site. The training takes place every six months, a fire emergency simulation takes place once a year, a coordinated fire emergency simulation (including nuclear aspects and involving offsite resources) takes place once a year.

During the emergency simulations, the procedures are tested and subsequently changed, if needed. Through the years, procedures have been modified as requested by changes in the SSC, in the configuration or use of the areas or to optimize the sequence of actions in order to minimize the intervention time.

Any role involved in the fire emergency management is taken into account by a specific procedure. These procedures are usually revised after each emergency simulation, if needed.

Coordination between the plant personnel and the offsite resources is achieved through the following consideration:

- procedures are discussed with the fire brigades technicians;
- in case of fire emergency, up to the fire brigades arrival, the fire fighting direction is in charge of the Plant Supervisor (trained in fire fighting procedures). After the fire brigades arrival, information are given to the fire brigade's team head and he gets in charge of the fire fighting direction.

In case of fire emergency and fire brigades intervention, one of four path is communicated to the fire brigade tank driver: it ensure the safer path in order to avoid contamination due to smoke spreading. Even if the resources are trained about the specific hazards of the plant, the Plant Supervisor (as former Fire fighting team head) gives information about the scenario.

During an Emergency, security controls are bypassed, but only emergency machine (fire brigades, radiometrical survey team, etc.) can access to the site.

Every year a nuclear emergency simulation takes place in Trino Site. Due to the characteristics of the possible source term, a fire event scenario is usually performed. Firebrigades are usually involved as role players or observers, so as the ISIN. The Nuclear Emergency Simulation is an important moment for safety culture reinforcement:

- The internal emergency team competence can be evaluated by the firebrigades that usually share some indications about the best way to mitigate a fire scenario;
- Firefighters from firebrigades can test their procedures, especially in relation with the radioactive site scenario.

Eventually, both internal and external fire fighting teams can receive advantage by the coordinated execution of the Nuclear Emergency Simulation.

Onsite and Offsite Firefighting resources can access to:

- the Coordinated Emergency Plan: this document describes how both Sogin firefighting personnel and offsite authorities must act during both fire and nuclear scenarios;
- the Firefighting manual: this documents collects all the references and the technical aspects regarding the plant, the fixed and mobile firefighting features and the Personal Protective Equipment that could be used during an operation;
- Emergency procedures: the procedures are available both for fire fighting and nuclear emergency scenarios.

C.I.3.2.3.3. Specific provisions, e.g. loss of access

Onsite firefighting personnel access by foot, therefore loss of access routes is not credible.

Offsite firefighting personnel can access the site though at least 2 routes. The loss of the access routes could happen due to a flooding. The combination of a flooding and a fire event has not be considered due to the estimated very low probability.

About the spreading of smoke, contamination and irradiation:

- The Onsite firefighting team is provided with adequate Personal Protection Equipment;
- In the case the offsite firefighting team should not be yet prepared for a smoke and contamination spreading, while accessing the site the right path is decided and communicated on the basis of meteorological and visual information, by the Emergency Plan Director.

C.I.3.3 Passive fire protection

C.I.3.3.1 Prevention of fire spreading (barriers)

C.I.3.3.1.1. Design approach

As reported in the fire safety analysis, due to radiation protection requirements, the waste storage facilities wall thickness is bigger than normally required from a fire safety point of view. For this reason, no further requirement is established.

C.I.3.3.1.2. Description of fire compartments and/or cells design and key features

As reported in the fire safety analysis, due to radiation protection requirements, the waste storage facilities wall thickness is bigger than normally required from a fire safety point of view. Both waste storage facilities are provided with two doors produced in Steel. As reported in the fire safety analysis, the doors are connected with open areas and their dimension is sufficient to ensure a simple evacuation path from the building.

The thickness of the wall is the required characteristic: since no visible change happens, no further verification is needed.

The spreading of fire inside waste storage facilities is avoided through high wall thickness, isolated facilities position and combustible free areas in the surrounding.

C.I.3.3.1.3. Performance assurance through lifetime

Access routes for firefighting are maintained by maintenance and periodic tests. Wall thickness has been assessed to have adequate resistance in front of the evolution of the fire loads.

C.I.3.3.2 Ventilation systems

C.I.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

As reported in the fire safety analysis, the waste storage facilities are not provided with a ventilation system.

C.I.3.3.2.2. Performance and management requirements under fire conditions

As reported in the fire safety analysis, the waste storage facilities are not provided with a ventilation system.

C.I.3.4 Licensee’s experience of the implementation of fire protection concept

Content of the assessment

Due to the age of the existing storage facilities, the need of their upgrade has been identified also in relation to the fire protection system and refurbishing program is ongoing starting from D2 to be compliant with the updated norms and regulations.

The following strenghts can be highlighted:

- the organizational framework has shown to be capable to withstand changes as required to introduce improvements due the age of installations;
- a systematic training program of the personnel is conducted, so as to be able to manage unforeseenable difficulties in case of real accidents.

C.II WASTE STORAGE FACILITY 2300 (EUREX)

C.II.1 General information

C.II.1.1 Nuclear installations identification

- Name: Waste storage facility building **2300**
- Licensee: **So.G.I.N. S.p.A**

The waste storage facility 2300 was built in the 70's, in order to store solid waste drums and containers produced during EUREX reprocessing facility located at Saluggia, in the territory of the Province of Vercelli

The 2300 storage facility building has walls and roof in corrugated metal and it presents a L-shaped plan made from two adjacent bodies, the former 14 × 26 m, 12 m high and the latter 10 × 40 m, 10 m high. The two bodies are a common space, each one equipped with a full height sliding door. The 2300 building, constructed in the 70's, has a very simple design concept with no significant equipment inside (just the door opening system, the fire detection and the internal lighting).

A plan to transfer the radioactive waste stored in the 2300 bld. to the new D-2 storage facility is on goingand will be completed in 2024. Low and intermediate level radioactive waste, mainly to be conditioned, remain to be transferred.
After that the building will be refurbished to accommodate wastes coming from the decommissioning of EUREX facility.

C.II.1.1.3. Key parameters per installation

- Type of facility: **Temporary storage facility for radioactive solid waste (LLW and ILW), conditioned and not**
- Year of first operation: **1970**
- Scheduled shutdown date: **2024 (transfer of the radioactive waste to the D2 storage facility) – 2030 completion of the refurbishment of the building - 2041 (final demolition)**

C.II.1.2 National regulatory framework

As per §1.2

C.II.1.3 Improvements in fire safety as a result of experience feedback

The fire protection concept is regularly implemented the 2300 waste storage facility without any particular issue. The radioactive waste previously stored in the 2300 is being transferred to the D2 storage facility.

Any new activity or any infrastructure modification that may impact the fire safety must be submitted to National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) and National Fire department (VVF) for approval.

C.II.1.4 Defence in depth principle and its application

The defence in depth principles in the design of 2300 waste storage facility have been implemented following these different successive levels:

- fire prevention through organizational actions (controls, procedures…) and structural issues (flammable fire load…) that ensure reasonably that the fire will not ignite and/or spread;
- quickly detect, control and extinguish a fire that may involve radioactive waste;
- minimize the risk to workers and the external environment due to the release of radioactivity as consequence of a fire.

Passive fire prevention is achieved through a reduction of risk (no free flame use, no additional fire load apart the waste content, assistance during operations, operators trained with fire prevention and fighting concepts) on a standard basis.

The progressive transferring of waste to a more robust fire-resistant structure (waste temporary storage facility D-2) will be achieved in the next years, reducing greatly the fire risk.

The methodology used to carry out the fire hazard assessment is based on the following topics:

a. identification of fire hazards;
Note: For example, the following are assessed: ignition sources, combustible or flammable materials, fire loads, ignition-fuel interaction, any significant quantities of mixtures or hazardous substances, processes that may lead to fires or explosions, possible formation of explosive atmospheres, …

b. description of the context and environment in which the hazards may be found;
Note Examples include accessibility and viability conditions, company layout, distances, separations, isolation, building characteristics, type of construction, geometrical complexity, volume, surface areas, height, underground levels, plan-volumetric articulation, compartmentalisation, ventilation and surface areas available for the extraction of smoke and heat, etc.

c. determination of the quantity and type of occupants exposed to the risk of fire;
d. identification of preventive measures which can remove or reduce the hazards which give rise to significant risks.
e. qualitative or quantitative assessment of the consequences of the fire on occupants, property and the environment;

Where relevant vertical technical regulations are available, the assessment of fire risk by the designer is limited to the peculiar aspects of the specific activity concerned.
In areas of activity where inflammable substances are present in the form of combustible gases, vapors, mists or dusts, the fire risk assessment also includes the risk assessment for explosive atmospheres.

C.II.2 Fire Safety Analyses

C.II.2.1 Fire Safety Analyses for Waste storage facilities on nuclear installations sites

C.II 2.1.1. Types and scope of the fire safety analyses

A FHA has been conducted on the basis of the national legislation.

The design of the 2300 waste storage facility was developed with the aim of equipping the installation with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment.

2300 waste storage building was constructed in the early 70's, according to law and rules of the period, so the design is compliant with the regulatory frame of the period. The following analysis is then made on a post-construction consideration.

The fire safety design of the facility, based on the performed FHA, was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

a) safety of human life,
b) protection of people (protection of workers and the possible impact on public),
c) protection of property and the environment.

The primary objectives of fire protection are achieved if the activities have been designed, implemented and managed in such a way as to:

a) minimize the causes of fire and explosion;
b) guarantee the stability of the load-bearing structures for a set period of time;
c) limit the production and propagation of fire within activities;
d) limit the spread of fire to adjacent activities;
e) prevent environmental radiological impact in case of fire;
f) ensure that the occupants can leave the activity safely or that they be rescued in another manner;
g) ensure that the firefighter/rescue squads are able to work under safe conditions.

A safety analysis of the 2300 storage facility has been conducted assuminga deterministic fire event om conservative basis, considering that:

- waste cannot self-ignite;
- waste is all contained within metal casings;
- no significant ignition sources are present;
- no other combustible materials are present in significant amount;
- all areas of the storage facility are protected by a fire detection system;
- manual extinguishing systems are available for the storage areas.

Therefore, the complete combustion of the combustible material contained in the packages presupposes a very rare chain of events:

- missing/opening of the metal container
- presence of a trigger source
- contact of the burnable content of the container with the ignition source
- partial or total malfunction of detection system
- no alarm or action by operators.

On the basis of the accident scenario described, a certain number of drums inside the compartment are however assumed to be involved in the fire in the Impact Analysis for Off-site Emergency Plan. The fire of the material contained in the drums involves the release of a certain amount of radioactivity to the environment (source term).

The consequences to the environment were evaluated in terms of dose to the population and operators involved in the restoration operations and in terms of soil contamination, considering conservatively a release at the ground level.

The doses resulting for the population in a radius of about 1,5 km from the fence, may request some counteractions (people sheltering) according to international standards.

C.II.2.1.2. Key assumptions and methodologies

The very simple design concept of 2300 building, constructed in the 70's and with no significant equipment inside (just the door opening system, the fire detection and the internal illumination), does not leave to identify this point.
The assumptions of fire scenarios do not consider malicious actions, prevented by the Physical Protection of the Site and the personnel selection.

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

The identification of the characterizing fire risk elements is carried out in accordance with the provisions of the Decree of the Minister of the Interior of 4 May 1998 and the Decree of the Minister of the Interior of 10 March 1998, allowing to define the fire scenarios, as projections of possible fire events.

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

The FHA developed for 2300 repository demonstrate that any credible fire scenario, including external aircraft crash, doesn't lead to an unacceptable radioactive release to the public and environment.
However, due to the fact that the fire scenario in the 2300 repository is the worst one for the Saluggia Site, resulting the main critical event in the Impact Analysis for the Off-site Emergency Plan, the transfer of waste to a more robust structure (D-2 repository) in progress will solve the problem in a short term.

C.II.2.1.5. Periodic review and management of changes

C.II.2.1.5.1. Overview of actions

Any change to fire protection/fighting systems must be prior authorized by the National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) and National Fire department (VVF).
However, periodic fire assessment is performed when the Fire Prevention Certificate has to be renewed (every five years) or after request by ISIN.
For this reason, some years ago, the additional positioning of some wheeled fire extinguishers was implemented.

C.II.2.1.5.2 Implementation status of modifications/changes

No modification is expected as all the waste are going to be transferred to the new D2 storage facility.

C.II.2.1.6 Licensee's experience of fire safety analyses

C.II.2.1.6.1. Overview of strengths and weaknesses identified

No weakness or strengths of fire safety analysis has been identified in the experience of the licensees even if the fire impact analysis suggested the transfer of waste to a more robust repository (D-2).

In the meanwhile, some wheeled fire extinguishers have been put in place.

See EUREX D.IV.2.1.6.1.

C.II.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

No fire events are reported. No fire safety related missions have been conducted.

C.II.3 Fire Protection Concept and Its Implementation

C.II.3.1 Fire prevention

C.II.3.1.1. Design considerations and prevention means

During the 2300 waste storage facility operation the likelihood of fire is minimize by separating ignition sources from flammable materials.
Additional preventive measures during the operation are obtained through administrative procedures.
The facility complies with the Fire Prevention Certificate granted by the national competent fire-fighting authority.
The systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards.
The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in storage areas.
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.

- Fire detection and reporting capable of promptly detecting the event.
- Fire suppression through the adoption of manual intervention.
- Progressive transfer of the waste to other modern storage facilities of the site (scheduled to be completed in 2024).

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

The management of fire prevention is stated into the authorization documents (Fire Prevention Certificate); internal organization provides good practices for fire prevention (no flammable material left after operations, free flame and smoking prohibitions, periodic fire fighting drills…).

C.II.3.1.3 Licensee's experience of the implementation of the fire prevention

C.II.3.1.3.1. Overview of strengths and weaknesses

No weakness or strengths of fire prevention have been identified in the experience of SOGIN.

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

No events have been recorded. No international missions have been conducted.

C.II.3.1.3.3. Overview of actions and implementation status

No substantial changes are expected as all the waste are going to be transferred to the new D2 storage facility.

C.II.3.2 Active fire protection

C.II.3.2.1 Fire detection and alarm

C.II.3.2.1.1. Design approach

The functions of the 2300 fire detection systems are:

- quickly detect a possible fire;
- minimize the risk to workers and the external environment due to releases of radioactivity following fires;
- the detection system is designed to protect all 2300 building areas;
- remote transmission of alarm signals to patrolled area described in the internal Emergency Operational plan.

C.II.3.2.1.2. Types, main characteristics, and performance expectations

This system consists of automatic fire detectors.
Automatic fire detectors are installed in all areas of the building.
The fire detectors are multicriteria type (smoke detection / temperature detection) installed on the ceiling.
The detectors are positioned, installed, and possibly adequately protected so that they cannot be subject to mechanical, chemical, or other damage that could affect their correct functioning.
In the presence of a fire, the sensors will send a signal to the control unit, activating the remote alarm.
Within the individual areas, audible and luminous alarm signals are installed.

C.II.3.2.1.3. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire detection unavailability the following provision are applied:

- all the handling operation in the waste storage area affected by fire detection unavailability must be interrupted and ISIN informed;
- in the affected waste storage area, alternative measures may be put in place (e.g., fire watch periodical surveillance).

C.II.3.2.2 Fire suppression

C.II.3.2.2.1. Design approach

Manual fire suppression is made by external water hydrants of the site network and wheeled fire extinguisher, in addition to normal ones, placed near the building.

C.II.3.2.2.2. Types, main characteristics, and performance expectations

The extinguishing power is adequate for fire extinction.

C.II.3.2.2.3. Management of harmful effects and consequential hazards

None by the system itself.

C.II.3.2.2.4. Alternative/temporary provisions

Not applicable (fire extinguisher are periodically checked and replaced where needed). In case of fault, operations must be stopped and alternative measures may be adopted and communicated to Safety Authority.

C.II.3.2.3 Administrative and organizational fire protection issues

C.II.3.2.3.1. Overview of firefighting strategies, administrative arrangements, and assurance

See EUREX D.IV.3.2.3.1.

C.II.3.2.3.2. Firefighting capabilities, responsibilities, organization, and documentation onsite and offsite

See EUREX D.IV.3.2.3.2.

C.II.3.2.3.3. Specific provisions, e.g., loss of access

See EUREX D.IV.3.2.3.3.

C.II.3.3 Passive fire protection

(Section 01.4 – for Passive fire protection)

C.II.3.3.1 Prevention of fire spreading (barriers)

C.II.3.3.1.1. Design approach

Fire separation to nearby buildings is guaranteed by adequate distance.
In 2024 the transfer of all waste from 2300 bld. to D-2 storage will be completed.

C.II.3.3.1.2. Description of fire compartments and/or cells design and key features

No fire compartments are present in the 2300 building.

C.II.3.3.1.3. Performance assurance through lifetime

No issues are developed for the performance assurance. Maintenance and control are performed accordingly to national law and license technical prescription.

C.II.3.3.2 Ventilation systems

C.II.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

No ventilation system is present.

C.II.3.3.2.2. Performance and management requirements under fire conditions

Not applicable.

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

Content of the assessment

The implementation of the fire protection concept is regularly in course for the 2300 storage facility without any particular issues.

C.III D-2 STORAGE FACILITY (EUREX)

C.III.1 General information

C.III.1.1 Nuclear installations identification

- Name: **D-2 storage facility**
- Licensee **So.G.I.N. S.p.A**

The waste storage facility D-2 was built in 2013, in order to increase the storage volume in the Saluggia Site for the decommissioning of the EUREX plant.

D-2 storage is a very robust building, about 85 × 30 m wide and 10 m high, divided in multiple sectors (two storage aisles and service areas) by thick full-height walls for shielding and aircraft resistance design criteria.

Design and construction had a very deep focus on fire prevention and fighting and where the fire involvement of some specific waste (alpha combustible in drums) may lead to doses beyond design limits – even in a total theoretic accident scenario – additional features are adopted, as sheltering inside fire resistant boxes placed in the storage area.

The building is appropriately spaced from other Site installation and has separate and independent access.

C.III.1.1.3. Key parameters per installation

- Type of facility: **Temporary storage facility for radioactive solid waste (LLW and ILW), conditioned and not**
- Year of first operation: **2020**
- Scheduled shutdown date: **2041**

C.III.1.2 National regulatory framework

As per §1.2

C.III.1.3 Improvements in fire safety as a result of experience feedback

The fire protection concept is regularly implemented in the D-2 storage facility without any particular issue.

It has to be considered the the D-2 facility is a new construction realizes in compliance with the moste recent standards, also in relation to fire protection.

It has to be considered that any new activity or any infrastructure modification that may impact the fire safety must be submitted to National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) and National Fire department (VVF) for approval.

C.III.1.4 Defence in depth principle and its application

The defence in depth principles in the design of D-2 waste storage has been implemented following these different successive levels:

- fire prevention through organizational actions (controls, procedures…) and structural issues (compartmentalization, ignition triggers or sources…) that ensure reasonable assurance that the fire will not ignite and/or spread;
- quickly detect, control and extinguish a fire that may involve potentially contaminated materials or safety relevant equipments;
- minimize the risk to workers and the external environment due to the release of radioactivity due to by fire.

Passive fire prevention is achieved through a reduction of risk (no free flame use, no additional fire load apart the waste content, assistance during operations, operators trained with fire prevention and fighting concepts) on a standard basis.

In the next years, according to overall decommissioning plan of the Site, all waste (included combustible one) will be conditioned in the scheduled Waste Management Facility, reducing near to zero the risk for fire impact.

Content of the assessment

The methodology used to carry out the fire hazard assessment is based on the following topics:
a. identification of fire hazards;
Note: For example, the following are assessed: ignition sources, combustible or flammable materials, fire loads, ignition-fuel interaction, any significant quantities of mixtures or hazardous substances, processes that may lead to fires or explosions, possible formation of explosive atmospheres, …
b. description of the context and environment in which the hazards may be found;
Note Examples include accessibility and viability conditions, company layout, distances, separations, isolation, building characteristics, type of construction, geometrical complexity, volume, surface areas, height, underground levels, plan-volumetric articulation, compartmentalisation, ventilation and surface areas available for the extraction of smoke and heat, etc.
c. determination of the quantity and type of occupants exposed to the risk of fire;
d. identification of preventive measures which can remove or reduce the hazards which give rise to significant risks.
e. qualitative or quantitative assessment of the consequences of the fire on occupants, property and the environment;
Where relevant vertical technical regulations are available, the assessment of fire risk by the designer is limited to the peculiar aspects of the specific activity concerned.
In areas of activity where inflammable substances are present in the form of combustible gases, vapors, mists or dusts, the fire risk assessment also includes the risk assessment for explosive atmospheres.

The lifetime of D-2 repository has been divided into 3 main phases:
1) Solid radioactive waste (conditioned or not) is transferred from the another older storage (2300 bld.).
2) Unconditioned waste is treated and conditions.
3) Concrete drums from liquid waste conditioning are stored.

During phase 1, ignitions and consequent developments of fire are extremely unlikely and even more during phase 2 and 3, where no radioactive material may be affected by fire.
During the loading and/or handling phases of the waste, carried out by electric crane, accident scenarios are foreseeable that slightly increase the probability of ignition and fire development.
The use of water within the repository, in order to extinguish fire, and the possible contamination of the water itself is managed by the water collection system, suitable for a following decontamination by filtration.
The storage involves the presence of waste, some of which is combustible, in several successive phases and therefore in different configurations from the point of view of fire risk. As more unconditioned waste is conditioned and returned to storage, the fire risk is progressively reduced.

C.III.2 Fire Safety Analyses

C.III.2.1 Fire Safety Analyses for Waste storage facilities on nuclear installations sites

C.III 2.1.1. Types and scope of the fire safety analyses

A FHA has been conducted on the basis of the national legislation.

The design of the D-2 storage facility was developed with the aim of equipping the installation with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment.

The fire safety design of the facility, based on the performed FHA, was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

d) safety of human life,

e) protection of people (protection of workers and the possible impact on public),
f) protection of property and the environment.

The primary objectives of fire protection are achieved if the activities have been designed, implemented and managed in such a way as to:

h) minimize the causes of fire and explosion;
i) guarantee the stability of the load-bearing structures for a set period of time;
j) limit the production and propagation of fire within activities;
k) limit the spread of fire to adjacent activities;
l) prevent environmental radiological impact in case of fire;
m) ensure that the occupants can leave the activity safely or that they be rescued in another manner;
n) ensure that the firefighter/rescue squads are able to work under safe conditions.

A safety analysis of the D-2 storage facility has been conducted assuming a deterministic fire event for each compartment. There is no credible combination of external event such as seismic event and consequent fire because there are no flammable gas line or flammable liquid and all the electrical components are seismic verified to retain their position during the earthquake.
In addition, the D-2 facility is aircraft impact resistent.

Fire risk analysis has been performed according to following input, suggesting a fire event as very remote:

- Waste cannot self-ignite
- Waste is all contained within metal casings
- No significant ignition sources
- No other combustible materials are present
- All areas of the storage are protected by a fire detection system
- Two separate and independent manual extinguishing systems are available for the storage areas
- Storage areas shall be protected by fire-resistant structures

Therefore, the complete combustion of the combustible material contained in the waste packages presupposes a very rare chain of events:

- missing/opening of the metal container
- presence of a trigger source
- contact of the burnable content of the container with the ignition source
- partial or total malfunction of detection and extinguishing systems
- no alarm or action by operators.

On the basis of the accident scenario described, a certain number of drums inside the compartment are however assumed to be involved in the fire. The fire of the material contained in the drums involves the release of a certain amount of radioactivity to the environment (source term).
The consequences to the environment were evaluated in terms of dose to the population and operators involved in the restoration operations and in terms of soil contamination, considering conservatively a release without filtration.
The doses resulting from workers and the population are lower than the objectives assumed in the design of the facility in full compliance with the National limits.

C.III.2.1.2. Key assumptions and methodologies

The design of fire safety is an iterative process, consisting of the following steps:

a) scope of the design: the activity and its operation are described qualitatively and quantitatively in order to clarify the scope of the design. Note for example, the description of the activity may include location and context, purpose, constraints, organizational structure and responsibilities, type and quantity of occupants, production processes, construction works, facilities, type and quantity of materials stored or used, etc.
b) safety objectives: the safety objectives of the design applicable to the activity, are specified;
c) risk assessment: the fire risk assessment is carried out;
d) risk profiles: risk profiles are determined and assigned;
e) fire prevention strategy: risk mitigation is carried out through preventive, protective and management measures that remove hazards, reduce risks or protect against their consequences:

    i. defining the overall fire prevention strategy,
    ii. attributing performance levels for all fire prevention measures;
    iii. identifying the design solutions that guarantee the achievement of the assigned performance levels;

f) if the result of the design is not considered compatible with the purpose defined in point a), the designer iterates the steps referred to in point e) of this methodology.

The assumptions of fire scenarios do not consider malicious actions, prevented by the Physical Protection of the Site and the personnel selection.

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

The identification of the characterizing fire risk elements is carried out in accordance with the provisions of the Decree of the Minister of the Interior of 4 May 1998 and the Decree of the Minister of the Interior of 10 March 1998, allowing to define the fire scenarios, as projections of possible fire events.

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

The FHA developed for D-2 repository demonstrates that any credible fire scenario, including external aircraft crash, doesn't lead to an unacceptable radioactive release to the public and environment.

C.III 2.1.5. Periodic review and management of changes

C.III.2.1.5.1. Overview of actions

Any change to fire protection/fighting systems must be prior authorized by italian National Inspectorate for Nuclear Safety and Radiation Protection (ISIN) and National Fire department (VVF).

C.III.2.1.5.2 Implementation status of modifications/changes

The facility has recently started operation, therefore there are no planned modifications or changes.

C.III.2.1.6 Licensee's experience of fire safety analyses

C.III.2.1.6.1. Overview of strengths and weaknesses identified

No weakness or strengths of fire safety analysis has been identified in the experience of the licensees.

See EUREX D.IV.2.1.6.1.

C.III.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

No fire events are reported or investigated. Spurious actuation of automatic fire suppression system by water is one of major event reported in licensee experience related to similar facility and, for this reason, a manual activation with 24 hours' surveillance has been adopted.

C.III.3 Fire Protection Concept and Its Implementation

C.III.3.1 Fire prevention

C.III.3.1.1. Design considerations and prevention means

The D-2 storage facility is designed to minimize the likelihood of fire through proper system layout and design and, as far as practicable, elimination and/or reduction of ignition hazard by separating ignition sources from flammable materials.
Additional preventive measures during the operation are obtained through administrative procedures.
The facility complies with the Fire Prevention Certificate granted by the national component fire-fighting authority.
The systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards.
The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in storage areas.
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.
- Arrangement of contaminated materials (combustible and non-combustible) in the storage rooms so that the consequences of the fire in the storage area are maintained within the objectives of radiation protection for the population even in case of failure of the fire-extinguishing systems.
- Plan to condition existing combustible waste.

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

Fire prevention provisions to manage and control the fire load and ignition sources are established into the authorization documents.

C.III.3.1.3 Licensee's experience of the implementation of the fire prevention

C.III.3.1.3.1. Overview of strengths and weaknesses

No weakness or strengths of fire prevention have been identified in the experience of the licensees.

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

No events have been recorded. No fire safety review missions have been hosted.

C.III.3.1.3.3. Overview of actions and implementation status

Also due to the fact that the D2 facility is a new construction no specific upgrades are envisaged in the prevention procedures other than the completion of the conditioning programme of combustible waste.

C.III.3.2 Active fire protection

(Section 01.4 – for Active fire protection)

C.III.3.2.1 Fire detection and alarm

C.III.3.2.1.1. Design approach

The functions of the D-2 fire detection systems are:

- quickly detect a possible fire;
- minimize the risk to workers and the external environment due to releases of radioactivity following fires;

- alert the operator for any manual request for intervention of the sprinkler fire suppression in case of fires in the rooms;
- the detection system is designed to protect all D-2 significant areas;
- remote transmission of alarm signals to predetermined area in an internal emergency operational plan;
- in case of fire detection, or by manual intervention or on automatic signaling of smoke detectors, the ventilation system, if in operation, will be stopped;
- all air ducts are equipped with fire dampers to protect the compartments in the crossings.

C.III.3.2.1.2. Types, main characteristics, and performance expectations

This system consists of:

- automatic fire detectors.
- manual glass break fire call points.
- visual and sound alarm devices.

Automatic fire detectors are installed in all areas of the building, including the service area.

The fire detectors are multicriteria type (smoke detection / temperature detection) installed on the ceiling or in line (storage aisles).

The detectors are equipped with a light indicator for displaying the operating status of the sensor.

The number of detectors in each area is evaluated to ensure the complete coverage of protected areas, as required by current legislation, while guaranteeing normally two detectors for each area.

The detectors are positioned, installed, and possibly adequately protected so that they cannot be subject to mechanical, chemical, or other damage that could affect their correct functioning.

In the presence of a fire, the sensors will send a signal to the control unit, activating the remote alarm.

Within the individual areas, audible and luminous alarm signals are installed.

If the space affected by fire is a space protected by the fire water extinguishing system, the optical-acoustic alarm activated in the space shall also act as a warning alarm for manual activation of the system; a situation overview is provided by direct detection or through the onboard TV cameras of the two transfer cranes of the storage aisles for a safer intervention.

C.III.3.2.1.3. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire detection unavailability the following provision are applied:

- all the handling operation in the waste storage area affected by fire detection unavailability must be stopped and ISIN informed;
- in the waste storage area affected alternative measures must be put in place (e.g., fire watch periodical surveillance).

C.III.3.2.2 Fire suppression

C.III.3.2.2.1. Design approach

Each waste storage fire compartment is equipped with a fire suppression system, that integrates manual intervention by external water hydrants and manual fire extinguishers.

The fire extinguishing system is a water deluge sprinkler and is manually activated by the intervention of the control room operator after having reviewed and checked the signal coming from the detection system or other signaling.
The water used to extinguish the fire, that may be slightly contaminated, is drained to an underground 300 m^3 basin, for a following filtration if necessary.
During the design life of the waste storage facility, the design conditions provided for the power supplies and hydrants dedicated to the fire protection of the site will always be guaranteed.

C.III.3.2.2.2. Types, main characteristics, and performance expectations

The extinguishing intervention will be activated for the deluge intervention only in the damaged room and the design water amount used is adequate for fire extinction.

C.III.3.2.2.3. Management of harmful effects and consequential hazards

Potential harmful effects from the spurious/inadverted activation of the sprinkler extinguishing system are prevented for the fact that the activation is manual. Futhermore, the building is also equipped with a drainage system that can collect water into dedicated tanks.

C.III.3.2.2.4. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire suppression unavailability the following provision are applied:

- all the handling operation in the waste storage area affected by fire suppression unavailability must be stopped and ISIN informed;
- in the waste storage area affected alternative measure must be taken (e.g., additional fire portable fire extinguishers in the area, fire fighters in addition to operational staff).

C.III.3.2.3 Administrative and organizational fire protection issues

C.III.3.2.3.1. Overview of firefighting strategies, administrative arrangements, and assurance

See EUREX D.IV.3.2.3.1.

C.III.3.2.3.2. Firefighting capabilities, responsibilities, organization, and documentation onsite and offsite

See EUREX D.IV.3.2.3.2.

C.III.3.2.3.3. Specific provisions, e.g., loss of access

See EUREX D.IV.3.2.3.3.

C.III.3.3 Passive fire protection

C.III.3.3.1 Prevention of fire spreading (barriers)

C.III.3.3.1.1. Design approach

Fire separation to nearby buildings is guaranteed by adequate distance.
The D-2 waste storage facility itself is divided into a series of compartments to divide the different risk areas, with two main storage aisles, with a transfer crane each, equipped with TV cameras. The partition of the building into fire areas and the consequent division into compartments are based on the principle of preventing a fire that has developed in one area from spreading to other areas of the building with consequent further damage. The fire areas are separated from each other by fire resistant structures.
It is avoided that a possible fire spreads, or that the fumes spread through the ventilation systems. For this purpose, the ventilation ducts, at the crossings of walls that constitute fire compartmentalization, are equipped with fire dampers with fire classification completely identical of the wall crossed. Compartments were defined based on fire load calculations and based on functional and risk fragmentation logics.

Accordingly, with the third level of defence in depth concept is assumed that fire extinguishing systems fail and that fire-fighters do not respond quickly enough to quench fire development. In this scenario the confinement of radioactive spread is guarantee by the fire compartment of each storage area designed to withstand the worst-case scenario.
Some wastes are enclosed in additional fire resistant shelter to avoid their involvement in case of fire.

C.III.3.3.1.2. Description of fire compartments and/or cells design and key features

The D-2 waste storage facility consists of compartments with fire resistance characteristics not less than 2 hours (REI 120). This resistance class is adequate to guarantee what is required by current fire regulations.
Each floor of the building is fire separated respect to the others.
The fire resistance requirements of the structural elements as well as doors and other closing elements, is evaluated and certified in accordance with National regulation.
For all areas the specific design fire load does not exceed 250 MJ/m^2, with an aisle with just 80 MJ/m^2.
From the values of the specific design fire load, the waste storage facility must guarantee a fire resistance class of 30 minutes, according to the level of performance as for national regulation. Nevertheless, the structure and barriers are designed to ensure fire resistance for 120 minutes.
All crossings (electrical installations, ducts, etc.) of walls with fire resistance characteristics are designed to ensure this requirement.
In the ventilation ducts that cross the structures that delimit compartments, at least one damper with fire resistance equal to that of the structure they pass through is installed at the crossings, automatically and directly operated by smoke detectors and thermofusible elements.

C.III.3.3.1.3. Performance assurance through lifetime

No issues are developed for the performance assurance. Maintenance and control are performed accordingly to national law and license technical prescription.

C.III.3.3.2 Ventilation systems

C.III.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The ventilation system of the D-2 storage facility consists of two distinct subsystems for the intake and one of extraction/treatment. On the air extraction line, upstream of the recovery fans, an absolute filtration HEPA system is provided. The air is expelled through a stack and the system is activated when needed (internal atmosphere control or operation in progress), according to Operation Manual and is stopped by a fire detection.
The ventilation system ensures the dynamic confinement of the internal environments of the waste storage while maintaining increasing levels of depression, preventing the flow of air to outdoor.
Fire dampers have been provided for the crossing of all fire compartments. The shutters will be automatically operated by smoke detectors and thermofusible elements.

C.III.3.3.2.2. Performance and management requirements under fire conditions

In case of fire the ventilation system configuration is:

- Supply air switched off
- All fire dampers closed
- Exhaust air switched off.

This configuration is maintained until the fire is extinguished by the suppression system or due to the lack of oxygen to sustain the combustion.
The operator after checking the situation may restart the extraction fan of the ventilation system or the whole system.
The HEPA filter are also designed to be operable at high temperature (250° C).

C.III.3.4 Licensee’s experience of the implementation of fire protection concept

Content of the assessment

The implementation of the fire protection concept is regularly in course for the D-2 storage facility without any particular issue.

C.IV NPS - New Tank Park (EUREX)

C.IV.1 General information

C.IV.1.1 Nuclear installations identification

- Name: **NPS (New Tank Park)**
- Licensee **So.G.I.N. S.p.A**

The liquid waste storage facility (NPS- New Tank Park) is part of the EUREX facility and is hosting the most radioactive fraction of the liquid radioactive waste, while the remaining is in another storage section denominated 800 Area. The total reduction of the risk posed by these waste will be solved with their conditioning in the CEMEX facility, called CEMEX, whose characteristics in terms of prevention, fight and fire resistance are contained in the safety design documentation. The CEMEX design contains a detailed Fire Hazard Analysis and entails Fire Protection Concept compliant to applicable WENRA Safety reference levels.

The Detailed Project of the CEMEX Facility has been approved by the Regulator and is under construction.

New Tank Park (NPS – building 800 B) is a storage facility for highly radioactive liquid waste (ILW). It consists of a storage tanks area, a service/control area and a shielded pipeline that is connected to the existing transfer pipeline connection between Area 800 and Building 200 (which hosts the process cells inside a monolithic block with reinforced concrete and deep walls/plugs for shielding). The building contains three stainless steel storage tanks with pipework and components necessary for transfer, mixing, sampling and plant wash-down. The plan dimensions of the New Tank Park are 16.25 × 23.4 m with the longitudinal axis arranged in the direction SE-NW. The height above ground is approximately 7 m except for one portion to the South reaching 10 m. The main function of the NPS is to accommodate ILW liquid waste to protect it from possible external threats. In the NPS, staff is present only for ordinary testing, maintenance and periodic inspection operations.

C.IV.1.1.3. Key parameters per installation

- Type of facility: **On-site high-activity liquid waste storage facility**
- Year of first operation: **2008**
- Scheduled shutdown date: until the completion of the cementification of the liquid radioactive waste stored in the NPS

C.IV.1.3 Improvements in fire safety as a result of experience feedback

See EUREX D.IV.1.3

C.IV.1.4 Defence in depth principle and its application

The defence in depth principles in the design of NPS waste storage has been applied.

The fire defense was achieved through the development of the following activities:

- minimisation of combustible materials present and the possibility that the fire can start, feeds and spreads rapidly;
- evaluation of the specific fire load taking into account the combustible materials present (electrical equipment and insulation of electrical cables in quantities congruent with the design configuration): the fire load was classified as "zero", in accordance with International Standards when it is less than 100 MJ/sqm:

$$\text{Zero} = q < 100 \text{ MJ/mq}$$

- appropriate fire partition to contain any fire that, despite the fire prevention criteria adopted, should occur;
- installation of a fire detection and alarm system, so that it is possible to promptly detect a fire to face it with the extinguishing systems available; the system is also designed to communicate with the supervision system of the NPS via Ethernet (or via serial or in any case with protocols or drivers);
- installation of manually operated extinguishing equipment, suitable characteristics for a first intervention on a fire principle in all the rooms of the NPS plant, with the exception of normally inaccessible rooms, tank rooms, and process valve racks. Particularly, the tank room is characterized by the absence of ignition sources and combustible materials nearby area. It was decided not to install fire detection devices in the room, because the risk of fire is zero and the radiation fields present extremely high (area radiologically inaccessible when radioactive liquids are present). In the other rooms of the NPS the very low fire load does not require the installation of automatic extinguishing systems (see. Ref. 3.1, 3.2)

The methodology used to carry out the fire hazard assessment is based on the following topics:

a. identification of fire hazards;

Note: For example, the following are assessed: ignition sources, combustible or flammable materials, fire loads, ignition-fuel interaction, any significant quantities of mixtures or hazardous substances, processes that may lead to fires or explosions, possible formation of explosive atmospheres, …

b. description of the context and environment in which the hazards may be found;

Note Examples include accessibility and viability conditions, company layout, distances, separations, isolation, building characteristics, type of construction, geometrical complexity, volume, surface areas, height, underground levels, plan-volumetric articulation, compartmentalisation, ventilation and surface areas available for the extraction of smoke and heat, etc.

c. determination of the quantity and type of occupants exposed to the risk of fire;

d. identification of preventive measures which can remove or reduce the hazards which give rise to significant risks.

e. qualitative or quantitative assessment of the consequences of the fire on occupants, property and the environment;

Where relevant vertical technical regulations are available, the assessment of fire risk by the designer is limited to the peculiar aspects of the specific activity concerned. In areas of activity where inflammable substances are present in the form of combustible gases, vapors, mists or dusts, the fire risk assessment also includes the risk assessment for explosive atmospheres.

As a general assessment for the protection fire, it is important to highlight that in the NPS building the staff is present only during the transfer of liquids (just in 2008 for loading and it will happen for transfer to conditioning) and for ordinary testing, maintenance and periodic inspection operations. The staff is qualified and informed on any action necessary for their own safety. Due to the particular purpose of the storage, the principle of minimizing the presence of people in the building and, especially in the storage tanks area, was followed both for normal activities in the building and for defining the safety control systems. All control and monitoring systems are on site and the signals are coming remotely to the EUREX facility. The building is checked 24 hours a day. The risks to people are very low due to the low crowding.

All the areas of the facility are classified as zero risk because they have a lowest specific fire load (less than 100 MJ/m^2). The only room with a more relevant specific fire load is the batteries room for which a REI 60 requirement has been imposed. This area, moreover, has been equipped with its own ventilation. The battery room is isolated from the other rooms by partition walls with a REI 60 fire resistance.

The lowest specific fire load of all other areas does not require the installation of automatic extinguishing systems.

The structural works have been sized according to the shielding and static and dynamic loads. The vertical concrete structures have a minimum thickness of 50 cm (REI > 180) up to a maximum of 130 cm and floors are 50 cm thick (REI >180). In the NPS the emergency lighting is obtained by autonomous lighting fixtures with flame-resistant self-extinguishing plastic material. Their autonomy is of at least 1 hour and are equipped with sealed Ni-Cd rechargeable accumulators for high temperature with automatic intervention and charging devices.

In order to minimize the presence of hydrogen, the air is forced outside the building by a local fan. It has been installed, moreover, an H_2 gas detector to monitor any build-up at the top of the local.

C.IV.2 Fire Safety Analyses

C.IV.2.1 Fire Safety Analyses for Waste storage facilities on nuclear installations sites

C.IV.2.1.1. Types and scope of the fire safety analyses

A FHA has been developed according to the national legislation and it has been conducted with the aid of the FIREPRO analysis database, developed by Ansaldo, in a simplified version, corrected and integrated for this specific assessment.
The design of the facility was developed with the aim of equipping the installation with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment.

The fire safety design the of the facility was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

a) safety of human life,
b) protection of people (protection of workers and the possible impact on public),
c) protection of property and the environment.

The primary objectives of fire prevention are achieved if the activities have been designed, implemented and managed in such a way as to:

a) minimize the causes of fire and explosion;
b) guarantee the stability of the load-bearing structures for a set period of time;
c) limit the production and propagation of fire within activities;
d) limit the spread of fire to adjacent activities;
e) prevent environmental radiological impact in case of fire;
f) ensure that the occupants can leave the activity safely or that they be rescued in another manner;
g) ensure that the firefighter/rescue squads are able to work under safe conditions.

C.IV.2.1.2. Key assumptions and methodologies

The design of fire safety is an iterative process, consisting of the following steps:

a. scope of the design: the activity and its operation are described qualitatively and quantitatively in order to clarify the scope of the design.

   Note for example, the description of the activity may include location and context, purpose, constraints, organizational structure and responsibilities, type and quantity of occupants, production processes, construction works, facilities, type and quantity of materials stored or used, etc.

b. safety objectives: the safety objectives of the design applicable to the activity, are specified;
c. risk assessment: the fire risk assessment is carried out;
d. risk profiles: risk profiles are determined and assigned;
e. fire prevention strategy: risk mitigation is carried out through preventive, protective and management measures that remove hazards, reduce risks or protect against their consequences:
   i. defining the overall fire prevention strategy,
   ii. attributing performance levels for all fire prevention measures;

iii. identifying the design solutions that guarantee the achievement of the assigned performance levels;

f. if the result of the design is not considered compatible with the purpose defined in point a), the designer iterates the steps referred to in point e) of this methodology.

NPS has been divided into rooms and for each of these the essential components for safety and their specific location have been identified. They were also included in the analysis the separations adopted between redundant active equipment.

The FHA has been conducted assuming some general criteria as follows:

- no ignition fire in areas with zero specific load fire (≤ 100 MJ/m^2);
- no simultaneous combination of fire with:
  - independent individual failures or malfunctions (not due to the fire itself),
  - other independent basic project events
  - external event (such as seismic event and tornado) and EES (reference impact and plane pressure wave);

no fire at the same time in two different areas.

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

The fire hazard analysis has been conducted with the aid of the FIREPRO analysis database, developed by Ansaldo, in a simplified version, corrected and integrated for this specific assessment.

The combustible materials permanently present in the NPS rooms are attributable to the following types:

1. Finishing paints of the rooms walls
2. Coatings/insulators of cables and electrical equipment EPR1 flame retardant material according to CEI 20-22 and reduced gas emission toxic and opaque fumes according to CEI 20-37 and 20-35.
3. Furnishings
4. Paper (docs)
5. Plastic materials (coatings, PC-Case, ABS flame retardant for batteries)

Specific fire loads in the NPS rooms have been calculated: they are in all cases less than 100 MJ/m2 (maximum value 70.9 MJ/m2 for the health physics room) except for the battery room where, due to the plastic material covering the batteries2, the load is 779.4 MJ/m2. The assessment of specific fire loads has been carried out by adding up all contributions except of the electrical coating-insulation of cables. In effect for many rooms the contribution of cables has been revealed predominant and the choice of routing in closed conduits or walkways therefore has rappresented an effective fire preventive action.
Possible risks associated with the transient presence of combustible material due to exceptional maintenance interventions has been minimized through the adoption of technical/administrative procedures aimed at ensuring that operations in the NPS take place in safe conditions and that the restoration of the pre-intervention state is guaranteed to the completion of the work.

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

With the exception of batteries room, the NPS other rooms are therefore to be considered as areas with "Zero Fire Load" or "Areas not subject to Risk". The battery room is instead classifiable, from the point of view of fire, as a “Restricted Risk Area”.

As assessed in the safety documentation, fire scenario for NPS, even severe ones including external aircraft crash (impact effect on structures apart), may not lead to an unacceptable radioactive release to the public and environment.

C.IV 2.1.5. Periodic review and management of changes

C.IV.2.1.5.1. Overview of actions

See EUREX D.IV.2.1.5

C.IV.2.1.5.2 Implementation status of modifications/changes

Not applicable.

C.IV.2.1.6 Licensee's experience of fire safety analyses

C.IV.2.1.6.1. Overview of strengths and weaknesses identified

See EUREX D.IV.2.1.6.1.

C.IV.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

When the fire brigade issues the authorization also gives the prescriptions to be followed:

- Maintain efficient of the systems, devices, equipment and tools aimed at fire safety, aimed to fire safety.
- Carry out checks and controls the systems, devices, equipment and tools, aimed to fire safety, according to programmed time intervals, and in any case not exceeding 6 months, to guarantee adequate levels of reliability.
- Have and update a special register of controls, checks and maintenance carried out on the systems, devices, equipment and tools, aimed at fire safety. This register must be made available for any inspections by the fire brigade.
- Update the training of fire protection and emergency personnel every at least three years.

C.IV.3 Fire Protection Concept and Its Implementation

C.IV.3.1 Fire prevention

C.IV.3.1.1. Design considerations and prevention means

The NPS storage facility is designed to minimize the likelihood of fire through proper system layout and design and, as far as practicable, elimination and/or reduction of ignition hazard by separating ignition sources from flammable materials.

Additional preventive measures during the operation are obtained through administrative procedures.

The compliance of systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards.

The fire prevention measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in accessible areas.
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.

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

See EUREX D.IV.3.1.2.

C.IV.3.1.3 Licensee's experience of the implementation of the fire prevention

See EUREX D.IV.3.1.3.

C.IV.3.1.3.1. Overview of strengths and weaknesses

No weakness or strengths of fire prevention have been identified in the experience of the licensees.

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

No events have been recorded. No fire related missions have been conducted.

C.IV.3.1.3.3. Overview of actions and implementation status

No particular improvements in the fire prevention measures are planned up to now.

C.IV.3.2 Active fire protection

C.IV.3.2.1 Fire detection and alarm

C.IV.3.2.1.1. Design approach

Following the fire risk assessment, the functions of the NPS Fire Detection System have been considered as follows:

- quickly detect a possible fire;
- alert the operator for any manual request;
- the detection system is designed to protect all NPS rooms and allow the automatic activation of one or more of the following actions;
- closure of air outlet dampers (before and after HEPA filters).

C.IV.3.2.1.2. Types, main characteristics, and performance expectations

The fire detection system of NPS consists of:

- linear thermal detectors: in rooms with potential presence of aeriform contamination, detectors are equipped with an addressing module;
- optical smoke detectors: for other rooms; the detectors are equipped with an addressing module
- H_2 gas detector in the battery room.

The linear thermal detector is a thermal fuse with double internal steel cable, equipped with a temperature-sensitive insulation (68°C intervention temperature), wrapped in a protective tape, surrounded by a special vinyl sheath, having a low degree of moisture absorption and resistant to many aggressive chemicals, flexible to low temperatures. The supply voltage is 24 Volts. The area monitored by each hot melt detector can reach approximately 15 m2. The monitored rooms are the filters room (two detectors), shielded filters room (two detectors) and maintenance room. In the battery room it is installed a H_2 gas detector. This detector is calibrated on 2 levels: 15% LEL and 30% LEL (Low Explosion Level: Lower limit of hydrogen gas explosion is equal to 4% of the volume of the room). These two thresholds correspond respectively to a pre-alarm and alarm signal. Tyndall effect analogical optical smoke detectors are installed in the following rooms:
In addition, there are a local optical-acoustic alarm panels system and a local manual alarm system which can be used by an operator qualified. The detection and alert center (to which the detectors will be functionally connected, the manual buttons, optical/acoustic panels) is microprocessor type and equipped with a front panel. This detection center is located in the health physics room, which itself is monitored by an optical smoke detector and is equipped with emergency lighting.
Moreover, the detection center provides:

- a fire alarm signal and a fault signal of the detection system to the supervision system in the control room and to the Protection fire team of the site in order to follow the emergency procedures

- an acoustic / visual signal in the rooms where the fire is detected in order to allow the staff present to move away

The fire detection system is equipped with its own batteries that guarantee operation autonomy in stand-by for 72 hours.

C.IV.3.2.1.3. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire detection unavailability the following provision are applied:

- all the operations in the NPS area affected by fire detection unavailability must be stopped and ISIN informed;
- in operational accessible NPS area affected alternative measures must be put in place (e.g., fire watch periodical surveillance).

C.IV.3.2.2 Fire suppression

C.IV.3.2.2.1. Design approach

Inside the NPS building, because of the very low specific load fire, there are no automatic extinguishing systems and no water hydrants. Only portable fire extinguishers CO_2 are provided.

C.IV.3.2.2.2. Types, main characteristics, and performance expectations

Portable fire extinguishers CO_2 of 5 kg class 113BC are installed in the accessible rooms:

- Fan room (two fire extinguishers)
- Electrical panels room (two fire extinguishers)
- Other rooms (one fire extinguisher)

It is also planned the availability of two external hydrants column UNI 70, connected to the network firefighting of existing site.

C.IV.3.2.2.3. Management of harmful effects and consequential hazards

Not envisaged.

C.IV.3.2.2.4. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire suppression unavailability the following provision are applied:

- all the operations in the NPS area affected by fire detection unavailability must be stopped and ISIN informed;
- in operational accessible NPS area affected alternative measures must be put in place (e.g., fire watch periodical surveillance).

C.IV.3.2.3 Administrative and organizational fire protection issues

C.IV.3.2.3.1. Overview of firefighting strategies, administrative arrangements, and assurance

See EUREX D.IV.3.2.3.1.

C.IV.3.2.3.2. Firefighting capabilities, responsibilities, organization, and documentation onsite and offsite

See EUREX D.IV.3.2.3.2.

C.IV.3.2.3.3. Specific provisions, e.g., loss of access

See EUREX D.IV.3.2.3.3.

C.IV.3.3 Passive fire protection

C.IV.3.3.1 Prevention of fire spreading (barriers)

C.IV.3.3.1.1. Design approach

Following the fire risk assessment, almost all areas have been classified as "zero fire risk area", so the criteria for confinement and separation of the rooms envelop those for fire protection. The battery room, classified as "restricted risk area", is equipped with a separate ventilation system.
Safety-critical redundant components are sufficiently separated so that potential damage is limited to a single redundancy.

C.IV.3.3.1.2. Description of fire compartments and/or cells design and key features

Every tank cell is separated from others; areas where a fire may occur have fire-resistant separation respect to others.

C.IV.3.3.1.3. Performance assurance through lifetime

Maintenance and controls are regularly performed accordingly to national law and license technical prescription to ensure the performance through lifetime.

C.IV.3.3.2 Ventilation systems

C.IV.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The ventilation system in the NPS facility aims to filter both the air from the rooms and the exhaust air from the components; in this case through a double barrier of absolute filters (the first in order to reduce radiation directed to the outside in case of any contaminated releases).
This double barrier of filters (in series) also ensures filtration of the air extracted from the storage tanks and the lines room used for transferring the radioactive liquid ensures the necessary Δp pressures between the most contaminated areas and the less contaminated ones.
The ventilation system guarantees suitable temperatures for the equipment and the staff who occasionally oversee the plant. The intake air is ensured by a forced inlet section which filters and heat-treat the air before entering the rooms. Ventilation is also equipped by a radiological monitoring unit before discharging the air to the chimney.
The emergency ventilation system guarantees the depression and filtration of the storage tanks room and process valves room in which radioactivity may be released in case of an accident.

C.IV.3.3.2.2. Performance and management requirements under fire conditions

The batteries room has the highest specific load fire and it is equipped with its own air extraction system.
Any fire remains contained in the room and does not spread to adjacent rooms or to other plant rooms The safety-essential redundant components are sufficiently separated and the potential damage is limited to a single redundancy. In the adjacent room there is a fire extinguisher to be used for extinguishing the fire. The operations to be planned at the end of the event are only those aimed at repairing any damaged equipment (operation equivalent to any other extraordinary maintenance).

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

See EUREX D.IV.3.4.

C.V - AREA 800 (EUREX)

C.V.1 General information

C.V.1.1 Nuclear installations identification

- Name: **Area 800**
- Licensee: **So.G.I.N. S.p.A**

Area 800 is the original tank storage facility for the liquid wastes generated during the reprocessing activities of the EUREX plant. It consists of groups of cells containing tanks, surrounded by earthworks to provide shielding, and additional structures to enable the transfer of liquids into and between the facility tanks.
It is the old storage facility of the EUREX plant liquid waste, whose fraction of higher activity has been transferred to the NPS new storage facilities. The lower activity liquid waste remained in storage in the Area 800.
The 800 area is located within the Saluggia site in the Sogin area (see D.IV.1.1). The liquid waste characteristics for each tank are different in terms of physical and chemical behavior and total activity depends on the production phase. In particular, the main liquid streams are:

- 1AW first cycle of extraction (currently stored in the New Tank Park, NPS);
- 2AW second cycle of extraction;
- LLW low level waste;
- SW Solvent waste;
- OGW Off-gas waste.

Within the storage area, there are 4 valve pits (designated A, B, DW and 1AW), to allow the transfer of liquids between the various tanks. The valve pits also allow the transfer of liquid wastes outside the Liquid Waste Storage Facility, through the waste transfer tunnel using steam ejectors. Above the tank compartments, a service building contains control systems, valves, alarm systems and the ventilation which is also operational. The tanks are maintained under negative pressure (-25 mm water column compared to atmosphere) through the vessel ventilation lines.

C.V.1.1.3. Key parameters per installation

- Type of facility: **On-site liquid waste storage facility**
- Year of first operation: **1970**
- Scheduled shutdown date: **2037**

C.V.1.2 National regulatory framework

As per §1.2

C.V.2 Fire Safety Analyses

C.V.2.1 Fire Safety Analyses for AREA 800

C.V.2.1.1. Types and scope of the fire safety analyses

The design of the facility was developed with the aim of equipping the installation with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment. Area 800 was made in the 60's, according to law and rules of the period, so the design is compliant with the regulatory frame of the period. The following analysis is then made on a post-construction consideration.
The fire safety design of the facility was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

a. safety of human life,
b. protection of people (protection of workers and the possible impact on public)
c. protection of property and the environment

The primary objectives of fire prevention are achieved if the activities have been designed, implemented and managed in such a way as to:

a. minimize the causes of fire and explosion;
b. guarantee the stability of the load-bearing structures for a set period of time;
c. limit the production and propagation of fire within activities;
d. limit the spread of fire to adjacent activities;
e. prevent environmental radiological impact in case of fire
f. ensure that the occupants can leave the activity safely or that they be rescued in another manner;
g. ensure that the firefighter/rescue squads are able to work under safe conditions.

The fire load in the Area 800 storage facility is very low, taking into account its layout and the characteristics, consisting only in piping and tanks. Three tanks contain the lower activity stream of the liquid waste, non flammable. One tank contains a certain amount of organic waste, that is flammable.

There also some other tanks normally empty that are used in case of accidental conditions, if needed.

C.V.2.1.2. Key assumptions and methodologies

Area 800 was constructed in the 60's and with no significant equipment inside (just the signalling of tank levels, leak alarm and content temperature); it is not possible then identify this point. The assumptions of fire scenarios do not consider malicious actions, prevented by the Physical Protection of the Site and the personnel selection.

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

See EUREX D.IV.2.1.3.

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

No credible fire scenario for Area 800, including external aircraft crash (impact effect on structures apart), leads to an unacceptable radioactive release to the public and environment.

C.V.2.1.5. Periodic review and management of changes

C.V.2.1.5.1. Overview of actions

See EUREX D.IV.2.1.5.1.

C.V.2.1.5.2 Implementation status of modifications/changes

See EUREX D.IV.2.1.5.2.

C.V.2.1.6 Licensee's experience of fire safety analyses

C.V.2.1.6.1. Overview of strengths and weaknesses identified

See EUREX D.IV.2.1.6.1.

C.V.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

See EUREX D.IV.2.1.6.2.

C.V.3 Fire Protection Concept and Its Implementation

C.V.3.1 Fire prevention

C.V.3.1.1. Design considerations and prevention means

The Area 800 storage facility is designed to minimize the likelihood of fire through proper system layout and design and, as far as practicable, elimination and/or reduction of ignition hazard by separating ignition sources from flammable materials. Additional preventive measures during the exercise are obtained through administrative procedures. The facility complies with the Fire Prevention Certificate granted by the national component fire-fighting authority. The compliance of systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards.

The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in accessible areas.
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.
- Adequate fire compartmentation in order to confine a possible fire which, despite the fire prevention criteria adopted, should occur.
- Fire detection and reporting capable of promptly detecting the event.

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

See EUREX D.IV.3.1.2.

C.V.3.1.3 Licensee's experience of the implementation of the fire prevention

See EUREX D.IV.3.1.3.

C.V.3.1.3.1. Overview of strengths and weaknesses

See EUREX D.IV.3.1.3.1.

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

See EUREX D.IV.3.1.3.2.

C.V.3.1.3.3. Overview of actions and implementation status

See EUREX D.IV.3.1.3.3.

C.V.3.2 Active fire protection

(Section 01.4 – for Acive fire protection)

C.V.3.2.1 Fire detection and alarm provisions

C.V.3.2.1.1. Design approach

See EUREX D.IV.3.2.1.1.

C.V.3.2.1.2. Types, main characteristics and performance expectations

See EUREX D.IV.3.2.1.2.

C.V.3.2.1.3. Alternative/temporary provisions

See EUREX D.IV.3.2.1.3.

C.V.3.2.2 Fire suppression provisions

C.V.3.2.2.1. Design approach

See EUREX D.IV.3.2.2.1.

C.V.3.2.2.2. Types, main characteristics and performance expectations

See EUREX D.IV.3.2.2.2

C.V.3.2.2.3. Management of harmful effects and consequential hazards

See EUREX D.IV.3.2.2.3.

C.V.3.2.2.4. Alternative/temporary provisions

Not applicable.

C.V.3.2.3 Administrative and organisational fire protection issues

Administrative and organizational issues adopted for the storage facility are the same of those applied for the decommissioning activites of the EUREX Plant and are described in section D.

C.V.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

See EUREX D.IV.3.2.3.1.

C.V.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

See EUREX D.IV.3.2.3.2.

C.V.3.2.3.3. Specific provisions, e.g. loss of access

See EUREX D.IV.3.2.3.3.

C.V.3.3 Passive fire protection

(Section 01.4 – for Passive fire protection)

C.V.3.3.1 Prevention of fire spreading (barriers)

C.V.3.3.1.1. Design approach

See EUREX D.IV.3.3.1.1

C.V.3.3.1.2. Description of fire compartments and/or cells design and key features

Every tank cell is separated from others. The cells are constructed by reinforced concrete with a wall thickness of 1.2 m which is waterproofed both internally and externally. The external waterproofing consists of two layers of bituminised mineral felt with aluminium foil in between. The internal waterproofing consists of decontaminable paint. All surfaces are painted except those made of AISI 304L stainless steel. Within the storage area, there are 4 valve pits (designated A, B, DW and 1AW), to allow the transfer of liquids between the various tanks. The valve pits also allow the transfer of liquid wastes outside the Liquid Waste Storage Facility, through the waste transfer tunnel using steam ejectors. The ejectors are located in the tanks and several manual valves are located in the valve pits. Above the tank compartments, a building contains control systems, valves, alarm systems and the ventilation which is also operational. The tanks are maintained under negative pressure (-25 mm water column compared to atmosphere) through the vessel ventilation lines connected to the K-8 ventilation system.

C.V.3.3.1.3. Performance assurance through lifetime

See EUREX D.IV.3.3.1.3.

C.V.3.3.2 Ventilation systems

C.V.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The ventilation system of the Area 800 storage consists of a system for extraction/treatment. On the air extraction line, upstream of the recovery fans, an absolute filtration HEPA system, with concrete shielded filters (for irradiation reason) is provided. The air is expelled through a stack. The ventilation system ensures the dynamic confinement of the internal environments of the waste storage while maintaining increasing levels of depression in the tanks, preventing the flow of air to outdoor. There are no fire dampers in the ventilation ducts.

C.V.3.3.2.2. Performance and management requirements under fire conditions

No special configuration is envisaged in case of fire.

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

Content of the assessment

See EUREX D.IV.3.4

C.VI - DEPOSITO OPEC 2

C.VI.1 General information

C.VI.1.1 Nuclear installations identification

- Name: **Waste storage OPEC-2**
- Licensee: **So.G.I.N. S.p.A**

The OPEC-2 temporary storage facility is located within the ENEA Casaccia Research Center, in S. Maria di Galeria (Rome). The site is one of those owned by ENEA entrusted to SOGIN since 2003 for the dismantling of nuclear infrastructures. The waste storage facility OPEC 2 is part of a building that also contains OPEC 1 spent fuel storage facility, laboratories, and administrative office. The site layout ensures that the building is easily accessible and can be approached by the fire brigade from three main sides. The buildings are appropriately spaced from each other and have separate and independent accesses. Fire separation to surrounding buildings is guaranteed by structures with fire resistance characteristics.
Low and intermediate not conditioned waste is stored in the facility.

C.VI.1.1.3. Key parameters per installation

- Type of facility: **On-site temporary waste storage facility for alpha-contaminated solid waste (ILW)**
- Year of construction license: **2011**
- Year of first operation: **2019**
- Scheduled shutdown date: **2029**

C.VI.2 Fire Safety Analyses

C.VI.2.1 Fire Safety Analyses for OPEC-2 Waste storage

C.VI.2.1.1. Types and scope of the fire safety analyses

The fire hazard analysis has been conducted according to the national regulation. The project of the facility was developed with the aim of equipping the installation with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment.
Designing the fire safety of the facility was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

a. safety of human life;

b. protection of people (protection of workers and the possible impact on public);
c. protection of property and the environment

The primary objectives of fire prevention are achieved if the activities have been designed, implemented and managed in such a way as to:

a. minimize the causes of fire and explosion;
b. guarantee the stability of the load-bearing structures for a set period of time;
c. limit the production and propagation of fire within activities;
d. limit the spread of fire to adjacent activities;
e. prevent environmental radiological impact in case of fire
f. ensure that the occupants can leave the activity safely or that they be rescued in another manner;
g. ensure that the firefighter/rescue squads are able to work under safe conditions.

In the fire safety analysis of the OPEC 2 storage facility, it has been assumed a deterministic fire event for each compartment. There is not credible combination of external event such as seismic event and consequent fire because there are no flammable gas line or flammable liquid. All the electrical components are seismic verified to retain their position during the earthquake. For the aircraft impact event it has been assumed a worst-case scenario in which some wastes are directly impacted by the aircraft losing all the material contained into the waste drum and then they are involved into the fire. All the waste drum not impacted directly by the aircraft are involved into the fire consequent to the jet fuel ignition. The fire event during the storage phase is the reference incidental event for environmental release assessments. The fire events during the handling phase of the packages involve minor releases and are therefore enveloped by the event taken as a reference. The fire during storage is caused by ignition sources introduced and mistakenly left in one of the storage compartments. The ignition initially produces the combustion of material left unattended, always in violation of the procedures, within the same room. It is assumed that the fire has the "strength" to involve the waste drums stored into the compartment and to burn part of the contained contaminated combustible material. The assessments carried out refer to "unmitigated" incidental conditions. It has been assumed, conservatively, that no operator action is taken by operating the fire extinguishing system (extinguishing). It was considered realistically that the structure guarantees the required fire resistance; Communication doors to the corridor and to the outside are always closed; they are equipped with a selfclosing device (mechanical spring). On the basis of the accident scenario described, a certain number of drums inside the compartment are assumed to be involved in the fire. The fire of the material contained in the drums involves the release of a certain amount of radioactivity to the environment (source term). The consequences to the environment were evaluated in terms of dose to the population and operators involved in the restoration operations and in terms of soil contamination, considering conservatively a release without filtration. The doses resulting from workers and the population are lower than the objectives assumed in the project in full compliance with the National limits. The assumptions underlying the evaluation of the released source term are very conservative. It has been considered involved into the fire drums with maximum Plutonium content. This condition is highly unlikely given that the percentage of the total of drums with this high Pu content is very low and that the storage loading plan will be optimized to standardize the radiological load as much as possible. It has been considered burnt all the combustible material into the fire area even there's not enough oxygen in the closed compartment to burn all the material.

C.VI.2.1.2. Key assumptions and methodologies

The design of fire safety is an iterative process, consisting of the following steps:

a. scope of the design: the activity and its operation are described qualitatively and quantitatively in order to clarify the scope of the design. For example, the description of the activity may include location and context, purpose, constraints, organizational structure and responsibilities, type and quantity of occupants, production processes, construction works, facilities, type and quantity of materials stored or used, etc;
b. safety objectives: the safety objectives of the design applicable to the activity, are specified;
c. risk assessment: the fire risk assessment is carried out;

d. risk profiles: risk profiles are determined and assigned;
e. fire prevention strategy: risk mitigation is carried out through preventive, protective and management measures that remove hazards, reduce risks or protect against their consequences:
    i. defining the overall fire prevention strategy,
    ii. attributing performance levels for all fire prevention measures;
    iii. identifying the design solutions that guarantee the achievement of the assigned performance levels;
f. if the result of the design is not considered compatible with the purpose defined in point a), the designer iterates the steps referred to in point e) of this methodology.

The assumptions of fire scenarios do not consider malicious actions.

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

The fire phenomena analyses have been studies towards a "Quantitative analysis". Initially a large family of fire scenarios including all the possible outcomes that can take place over the entire life of the activity were evaluated, taking into account the actual operating conditions but also fire events previously occurred in activities and premises having similar characteristics and occupancies. The fire behavior was studied using CFD simulations. The simulations were conducted with Version 5 of Fire Dynamics Simulator (FDS). The purpose of the simulations was to verify that the measures taken at the fire design stage are suitable, and in particular:

1) that the gaseous extinguishing system is suitably sized to ensure that the fire is extinguished (Simulation 1);
2) that even in the event of failure of the extinguishing system, a possible fire is actually suffocated due to lack of oxygen in its initial phase, thus avoiding the achievement of temperatures and thermal flows such as to lead to damage to the metal drums and the consequent direct involvement in the combustion of contaminated materials (Simulation 2);
3) study the evolution of a fire scenario if it is not possible to rely on the REI-120 compartment of the PU3 room, e.g., due to personnel error leaving the door open in contravention of the requirements (Simulation 3);
4) estimate the time required, downstream of the scenario referred to in Simulation 2, so that following the restart of the ventilation system there is the complete washing of the atmosphere of the Room and verify that the temperature with which the extracted fumes impact on the filters is not such as to compromise their efficiency (Simulation 4).

Simulations have shown that:

- The gas-suppressing extinguishing system (to be operated manually) is adequately sized and the distribution points are appropriately distributed.
- In case of failure to operate the extinguishing system by the operator, the fire is also extinguished due to lack of oxygen supply without the radioactive material contained in the drums being involved.
- Downstream of fire scenarios of reasonably conceivable proportions, the ventilation system can be restarted in extraction once the temperature in the compartment has returned below 120°C without compromising the functionality of the filters.

The simulations carried out have also highlighted the importance of the role played by confinement in fire safety.

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

The FHA developed for OPEC 2 demonstrate that any credible fire scenario, including external aircraft crash, don't lead to an unacceptable radioactive release to the public and environment.

The OPEC 2 waste storage is substantially "still", except for loading campaigns of limited duration). In the current configuration, during the lifetime, ignitions and consequent developments of fire are extremely

unlikely. During the loading and/or handling phases of the waste, carried out by electric forklift, accident scenarios are foreseeable that slightly increase the probability of ignition and fire development. The type of radioactive material contained in the waste of the OPEC-2 repository (combustible waste with alpha contamination) provides, as a design criterion for the purposes of nuclear safety and radiation protection, the exclusion of the presence and use of water within the repository itself.
The operations inside the waste storage involve the presence of waste, some of which is combustible, in several successive phases and therefore in different configurations from the point of view of fire risk.

C.VI.2.1.5. Periodic review and management of changes

C.VI.2.1.5.1. Overview of actions

Any change to fire protection system must be prior approved by the Regulator and Fire Authority. Up to now, no need for changes emerged.
Periodical Fire Safety Reviews are performed every 5 years according to National legislation by a professional fire engineer. The last certification of periodic renewal of fire compliance has been recently released on April 16, 2023 by the Fire Department.

C.VI.2.1.5.2 Implementation status of modifications/changes

OPEC-2 is a quite new installation and no need for changes is currently envisaged.

C.VI.2.1.6 Licensee's experience of fire safety analyses

C.VI.2.1.6.1. Overview of strengths and weaknesses identified

No weakness or strengths of fire safety analysis has been identified in the experience of the licensees.

C.VI.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

No fire events are reported or investigated. Spurious actuation of automatic fire suppression system is one of major event reported in licensee experience related to similar facility. For this reason, it has been preferred a manual activation with 24 hours surveillance

C.VI.3 Fire Protection Concept and Its Implementation

C.VI.3.1 Fire prevention

C.VI.3.1.1. Design considerations and prevention means

The OPEC 2 storage facility is designed to minimize the likelihood of fire through proper system layout and design and, as far as practicable, elimination and/or reduction of ignition hazard by separating ignition sources from flammable materials. Additional preventive measures during the exercise are obtained through administrative procedures. The facility complies with the Fire Prevention Certificate granted by the national component fire-fighting authority. The compliance of systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards. The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in storage areas;
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.
- Adequate fire compartmentation in order to confine a possible fire which, despite the fire prevention criteria adopted, should occur;

- Arrangement of contaminated materials (combustible and non-combustible) in the storage rooms so that the consequences of the fire in the storage area are maintained within the objectives of radiation protection for the population even in case of failure of the fire-extinguishing systems.

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

Preventive provisions for the management and control of fire loads and ignition sources are reported in procedures parts of the license documents.

C.VI.3.1.3 Licensee's experience of the implementation of the fire prevention

C.VI.3.1.3.1. Overview of strengths and weaknesses

No weakness or strengths of fire prevention have been identified in the experience of the licensees.

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

No events have been recorded. No review missions have been conducted

C.VI.3.1.3.3. Overview of actions and implementation status

Due to the fact that the facility recently started operation, no need for actions or modifications have been identified.

C.VI.3.2 Active fire protection

C.VI.3.2.1 Fire detection and alarm provisions

C.VI.3.2.1.1. Design approach

The choice to adopt the "Fire detection and alarm" derives from the evaluation of the fire risks in which, for the different environments, it foresees such systems to reduce the risk.
The functions of the OPEC-2 Fire Detection System are:

- quickly detect a possible fire;
- minimize the risk to workers and the external environment due to releases of radioactivity following fires
- alert the operator for any manual request for intervention of the Gaseous Suppression Fire Extinguishing System in case of fires in the protected rooms;

- The detection system is designed to protect all OPEC2 premises and allow the automatic activation of one or more of the following actions:
- automatic closing of any normally open fire doors, belonging to the fire compartment from which the report was received, through the activation of the appropriate closing devices.
- closure of air inlet damper in the compartment affected by fire and all other compartments.
- shut off the air supply section of the ventilation system.
- closing fire dampers for the extraction of air from the storage room affected by fire and all other storage rooms, the air extraction will be operational in the corridor rooms, which have an independent extraction line up to the extraction plenum in the filter room on the first floor, with ducts provided with 2 hours fire resistance; the infiltration air flow depositscorridors will be reversed with respect to the operation under normal conditions, air will leak, through the separation doors, from the deposits to the corridors;
- Remote transmission of alarm signals to predetermined area in an internal emergency operational plan.

C.VI.3.2.1.2. Types, main characteristics and performance expectations

This system consists of:

- automatic fire detectors;
- manual fire calling points;

- visual and sound alarm devices. Automatic fire detectors are installed in all areas of the building, including the office area.

The fire detectors are multicriteria type (smoke detection / temperature detection) installed on the ceiling. They are of the addressable type. The number of detectors in each area is evaluated to ensure the complete coverage of protected areas, as required by current legislation, while guaranteeing a minimum of two detectors for each area. Detectors are also provided in rooms equipped with false ceilings and ventilation channels, where necessary. The detectors are positioned, installed, and possibly adequately protected so that they cannot be subject to mechanical, chemical, or other damage that could affect their correct functioning. In the presence of a fire, the sensors will send a signal to the control center. The fire detection system is integrated by a hydrogen gas detection system, installed inside the UPS battery rooms. In addition to the detectors, manual fire alarm buttons are installed in each storage room and along the escape routes also connected to the control unit. In rooms protected by a suppression system, these buttons will also act as a manual extinguishing control. Within the individual areas, audible and luminous alarm signals are installed. There is a single control center for the fire alarm system. The control unit perform the functions of power supply, self-test, and surveillance of the detectors, will process the signals coming from the field and, in relation to the nature of the signals received, will provide the following signals:

- fire pre-alarm, resulting from the activation of a single detector.
- fire alarm, resulting from the activation of two or more detectors or the activation of a manual fire alarm button;
- anomalies, in case of faults on the detection line.

Following the fire alarm in a room, the control center will activate:

- the emission of an optical-acoustic alarm in the room affected by the fire;
- the emission of an optical-acoustic alarm in all other areas of the building;
- the emission of an optical-acoustic alarm on the main control panel of OPEC2, repeated on a secondary control panel, positioned in a point always manned (H24);
- fire alarm at the automation station.

C.VI.3.2.1.3. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire detection unavailability the following provision are applied:

- o all the handling operation in the waste storage area affected by fire detection unavailability must be stopped
- o in the waste storage area affected alternative measure must be put in place (e.g., Fire watch periodical surveillance)

C.VI.3.2.2 Fire suppression provisions

C.VI.3.2.2.1. Design approach

Each waste storage fire compartment is equipped with a fire suppression system.

The fire extinguishing system is a gaseous suppression type and use, as an extinguishing agent. The system is manually operated by the intervention of the control room operator after having review and checked the signal coming from the detection system or other signaling. It is also possible activate the discharge from one of the local buttons, as required by current legislation. For storage areas, in view of the presence of radioactive waste containing plutonium, it is not intended to use water as an extinguishing. It is international practice to try to minimize the mobilization of alpha contamination using alternative systems to water, for the extinguishing of fires. This choice is supported by the fact that the type of activity (deposit) and storage conditions (waste in double metal drums) do not present risks of ignition and propagation. During the project life of the waste storage, the design conditions provided for the power supplies and hydrants dedicated to the fire protection of the waste storage will always be guaranteed.

C.VI.3.2.2.2. Types, main characteristics and performance expectations

The extinguishing intervention will provide for a discharge of extinguishing material only in the damaged room. The discharge will have the purpose of quickly bringing the concentration of the extinguishing gas in the air to the design value, a necessary condition to ensure the extinguishing of
a possible fire. During the discharge and in the subsequent phases, the corridor rooms are kept in depression by the air extraction system, compared to the other rooms of the depot and the external environment. For technological rooms considering the very low fire load (<100 MJ/m2) portable fire extinguishers are provided. Exclusively for office areas, segregated and separated without communication with the areas of the OPEC 2 plant, protection by UNI 45 hydrants is provided.
The water supply of the hydrants is derived from water main of the site Research Center "ENEA Casaccia". The Research Center "ENEA Casaccia" is characterized by the presence of an external standpipes network that feeds above ground column hydrants to protect the entire site area.

C.VI.3.2.2.3. Management of harmful effects and consequential hazards

The gaseous extinguishing agent is stored inside two separate cylinder packs.
Each cylinder pack serves several rooms according to the procedures detailed below. Each cylinder pack consists of independent and redundant cylinder groups.
To avoid that the rapid discharge of extinguishing agent is undersized during the loading phase of the deposit due to the greater free volume of the damaged room, an additional rapid discharge cylinder group, also redundant, is provided. This additional group will be deactivated once the deposit has been filled.
The use of water for extinguishes fires is foreseen as an exceptional condition (beyond the design bases) following events of such gravity and size (loss of all active and passive systems of the installation). In this case the storage area is equipped with a watertight floor and water barrier in opening on walls to collect the water discharge.

C.VI.3.2.2.4. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire suppression unavailability the following provision are applied:

- all the handling operation in the waste storage area affected by fire suppression unavailability must be stopped;
- in the waste storage area affected alternative measure must be taken (e.g., additional fire portable fire extinguishers in the area).

C.VI.3.2.3 Administrative and organisational fire protection issues

C.VI.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

As regards the administrative and organizational fire protection issues, the OPEC-2 storage facility the involvement of a specific fire-fighting competence is managed by:

- Internal fire-fighting staff (AA);
- On site fire-fighting brigade (SPI);
- National fire brigades (VVF);
- Procedures and other fire prevention and firefighting documentation as for example:
- Internal emergency plan;
- Off-site emergency plan;
- Training plan.

C.VI.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

The firefighting strategies are assured by written procedures reported in the plant documentation.
All the on-site fire-fighting team are trained according to the national law for the higher level of fire risk with final exam certification by the fire department as per the technical prescription an annual fire drill is

performed by all plant personnel also involving the off-site fire brigade. The national fire department and ISIN is informed of the drill. The result of the drill is reported in a register which also indicates the improvement actions for the subsequent phases. Security personnel are trained to handle fire alarm signals and have written procedures for intervening in an emergency.

C.VI.3.2.3.3. Specific provisions, e.g. loss of access

The entrance to the Sogin center and the internal road network allows easy transit and maneuvering to emergency vehicles, within the site the land is flat, and the viability is guaranteed by roads and squares. The layout ensures that the building is easily accessible and can be approached by the fire brigade from three main sides. The buildings are appropriately spaced from each other and have separate and independent accesses.

C.VI.3.3 Passive fire protection

C.VI.3.3.1 Prevention of fire spreading (barriers)

C.VI.3.3.1.1. Design approach

The building is divided into a series of compartments to divide the different risk areas. The partition of the building into fire areas and the consequent division into compartments are based on the principle of preventing a fire that has developed in one area from spreading to other areas of the building with consequent further damage. The fire areas are separated from each other by fire resistant structures. It is avoided that a possible fire spreads, or that the fumes spread through the ventilation systems. For this purpose, the ventilation ducts, at the crossings of walls that constitute fire compartmentalization, are equipped with fire dampers with fire classification completely identical of the wall crossed. Compartments were defined based on fire load calculations and based on functional and risk fragmentation logics. Accordingly with the third level of defence in depth concept is assumed that fire extinguishing systems fail and that firefighters do not respond quickly enough which causes fire development. In this scenario the confinement of radioactive spread is guarantee by the fire compartment of each storage area designed to withstand the worst-case scenario.

C.VI.3.3.1.2. Description of fire compartments and/or cells design and key features

The OPEC 2 waste storage consist of compartments with fire resistance characteristics for not less than 2 hours in case of fire. This resistance class is adequate to guarantee what is required by current fire regulations. Each floor of the building is fire separated respect to the others. The fire resistance requirements of the structural elements as well as doors and other closing elements, is evaluated and certified in accordance with National regulation. For all areas, the specific design fire load does not exceed 900 MJ/m2. From the values of the specific design fire load, the waste storage must guarantee a fire resistance class of 60 minutes (850<900 MJ/m2), according to the level of performance as per National regulation. Therefore, structure is designed to ensure fire resistance for 120 minutes. All crossings (electrical installations, ducts, etc.) of walls with fire resistance characteristics are designed to ensure this requirement. In the ventilation ducts that cross the structures that delimit compartments, at least one damper with fire resistance equal to that of the structure they pass through is installed at the crossings, automatically and directly operated by smoke detectors and thermofusible elements. Two hours fire rating is also extended to the other compartments, normally free of contaminated material and therefore at lower risk in case of fire, even if the specific fire load evaluated for them is less than 1800 MJ/m2.

C.VI.3.3.1.3. Performance assurance through lifetime

Maintenance activities and controls are regularly conducted in order to ensure systems performances during lifetime, in agreement with national legislation and license technical prescription.

C.VI.3.3.2 Ventilation systems

C.VI.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The ventilation system of OPEC 2 consists of two distinct subsystems for the intake and extraction of air from the premises. On the air extraction line, upstream of the recovery fans, an absolute filtration HEPA system is provided. The air is expelled through a new stack, which maintains the position and height of the existing. The system is active H24. The ventilation system will ensure the dynamic confinement of the internal environments of the waste storage while maintaining increasing levels of depression as the passage from the outside to the corridors and from the corridors to the storage rooms. This prevents the flow of air from the premises. Fire dampers have been provided for the crossing of all fire compartments. The shutters will be automatically operated, both with thermal fuse and electric for lack of voltage or for voltage starting.

C.VI.3.3.2.2. Performance and management requirements under fire conditions

In case of fire the ventilation system configuration is:

- supply air off;
- all fire dampers closed;
- exhaust air of the corridor on.

This configuration is maintained until the fire is extinguished or by the suppression system or due to the lack of oxygen to sustain the combustion. The operator, after checking the temperature inside the fire compartment by means of fire-resistant thermocouples installed in each storage area, could restart the extraction fan of the ventilation system. The HEPA filter are also designed to be operable at high temperatures.

C.VI.3.4 Licensee’s experience of the implementation of fire protection concept

Content of the assessment

Sogin experience in the implementation of the fire protection concepts described in this report is limited to the very first years of operation, without any issues. At present, the fire protection features of the OPEC-2 storage facility are working properly.

D. INSTALLATIONS UNDER DECOMMISSIONING

D.I LATINA (NPP)

D.I.1. General information

D.I.1.1 Nuclear installations identification

- Name: Latina Nuclear Power Plant
- Licensee: Sogin S.p.A.

The nuclear power plant of Latina – operated by ENEL and equipped with a gas graphite reactor with an initial gross installed capacity of 210 MWe (subsequently reduced), built by AGIP-Nucleare S.p.A. and by the Nuclear Power Plant Company, reached its first criticality on 27 December 1962 and achieved the first connection to the national grid on 12 May 1963. On 23 Dec. 1987, the CIPE (Inter-ministerial Committee for Economic Planning) resolved on an "immediate closure of the power plant in Foce Verde (Latina) and the performance by ENEL of the necessary operations to place the plant in a condition of safe storage".
In the period following the shutdown, the plant was kept in a safe storage condition until 2003 and after that a pre-decommissioning phase started with the conduct of some preparatory activities, in particular connected to exisiting waste treatment and structure dismantling.

Sogin S.p.A. obtained authorisation to Phase 1 of decommissioning program on 20 May 2020 and its and expected in 2028. Phase 2 of the decommissioning program (not yet submitted to the competent authority) it expected to and in 2043, due to the availability of the National Repository (expected by 2032). Moreover, for the Magnox reactor family, research is being conducted worldwide to identify the best shared practices for the safe management of irradiated graphite and its dismantling.

D.I.1.1.3 Key parameters

- Name/Type of facility: Latina Nuclear Power Plant – Gas Graphite Reactor (Magnox)
- Year of end of operation: 1986
- Year of authorization for decommissioning: 2020
- Scheduled end of decommissioning operations date:2043
- Intended end state (phase 1): 2028
- Decommissioning safe store conditions after end of operation: n.a.
- Dismantling operation: Phase 1: 2020 ÷ 2028; Phase 2: 2032 ÷ 2043
- Waste treatment on the site: 2020 ÷ 2043

D.I.1.3 Improvements in fire safety as a result of experience feedback

During operation of the plant, safety maintenance and decommissioning, improvement of fire safety is due to revamping of systems in case of new technology available, compliance to new lowand in case of new installations, prescriptions from Authorities. Improvement in fire safety could result from experience feedback of other Sogin nuclear installation.

D.I.1.4 Defence in depth principle and its application

To ensure first level of defence in depth (ref. 3.1) Latina Plant works under prescriptions and evaluation coming from the follow documents:

- *Fire Protection Certificate (CPI)*, release from National Fire Brigades (VV.FF.). It certificated if prevention and protection measures for any place or activity in the site are conformed with the National Technical Low.
- *Technical evaluation of fire risk -LT MS 10890*, that release an evaluation regarding the reliability of fire firefighting measures token for any activity.
- *Evaluation of fire load – LT MS 10891*.

After Ministerial Decree 20 May 2020 *"Authorization of the Decommissioning Activity -Phase 1"*, any aspect of fire fighting is reported in the document LT MS 11272 *"Prevention and protection firefighting program".* This document is updated based on an article of the Decree, that is:

"before start of activity, send to the Regulator (ISIN) updating of *Prevention and protection firefighting program,* with evaluation of reliability of firefighting measure"

This document reports all procedures use on site to ensure reliability of any firefighting system (check, frequency, etc), training procedures of employees, procedures for radiological emergency.

The document is approved by ISIN.

To ensure second level of defence in depth (ref.3.2) there is a firefighting system in all building of the site, with detectors and alarm buttons. Alarms from system are displayed on the Control Panel in the Control Room of the Site (h24).
To ensure third level of defence in depth (ref.3.3) there is a manual water extinguish fire system (design on level 3 of risk) and portable extinguish fire device in any building of the site. For new building or plant, fire spreading is guaranteed through the presence of structures design with fire resistance characteristics. Ventilation ducts and electrical penetration are fire resistance qualified.

For every activity of decommissioning program (dismantling or build of new building or plant, construction build and management of repository) there is a specific Evaluation of Fire Risk, about fire load and way to do activity to minimize likelihood of fire. For any activity involved radioactive material (

In material treatment facility, activity with risk of fire (thermos cuts, flammable liquids, etc) are performed under national technical low criteria. Any systems of treatment facility or radioactive waste repository (electrical, ventilation, technical gases, etc.) are design whit firefighting criteria. Detection fire system and extinguish fire system are always present. Where necessary, detection gas system is supplied. Fire spreading is avoided trough the presence of structures (walls and doors) with fire resistance characteristics. Ventilation systems are designed with fire compartmentalization, to avoid fire or fumes spreads to closed areas with different risk of fire.
In the plant a water manual fire extinguish system with column hydrants, wall hydrants and hose reel hydrants is installed. System is always in pressure and starts automatically when water is requested. In any area (inside and outside buildings) are available portable fire extinguish device. At the repository of magnox wastes is available a gaseous fire extinguishing system (argon).

D.I.2 Fire Safety Analyses

D.I.2.1 Fire Safety Analyses for Installations under decommissioning

D.I.2.1.1. Types and scope of the fire safety analyses

The project of any activity of decommissioning was developed with the aim of equipping the installation (worksite, facility, repository) with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment.

Designing the fire safety of the activity was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

a) safety of human life,
b) protection of people (protection of workers and the possible impact on public)
c) protection of property and the environment

The primary objectives of fire prevention are achieved if the activities have been designed, implemented and managed in such a way as to:

a) minimize the causes of fire and explosion;
b) guarantee the stability of the load-bearing structures for a set period of time;
c) limit the production and propagation of fire within activities;
d) limit the spread of fire to adjacent activities;
e) prevent environmental radiological impact in case of fire
f) ensure that the occupants can leave the activity safely or that they be rescued in another manner;
g) ensure that the firefighter/rescue squads are able to work under safe conditions.

Fire Safety Analysis has been prepared taking into account the basic criteria of DM 10/03/1998 and the guidelines reported in LT MS 11272 (coherent with the recommendations of Technical Guide n. 31 of ISIN); in particular, risk assessment and computation methodologies have been implemented on the basis of dedicated mathematical models and the actual configuration of the plant. Mathematical risk assessment is basically based on the following parameters: fire loads, risk weighting factors, risk mitigation factors.

The Fire Safety Analysis concerns the ordinary operation conditions of the main buildings of the Site; for any further activity scheduled in the decommissioning programme, a specific Fire Hazard Analysis is developed on the basis of updated criteria with the purpose to integrate the FSA.

D.I.2.1.2. Key assumptions and methodologies

The design of fire safety is an iterative process, consisting of the following steps:

a. scope of the design: the activity and its operation are described qualitatively and quantitatively in order to clarify the scope of the design.

Note. For example, the description of the activity may include location and context, purpose, constraints, organizational structure and responsibilities, type and quantity of occupants, production processes, construction works, facilities, type and quantity of materials stored or used, etc.

b. safety objectives: the safety objectives of the design applicable to the activity, are specified;
c. risk assessment: the fire risk assessment is carried out;
d. risk profiles: risk profiles are determined and assigned;
e. fire prevention strategy: risk mitigation is carried out through preventive, protective and management measures that remove hazards, reduce risks or protect against their consequences:
i. defining the overall fire prevention strategy,
ii. attributing performance levels for all fire prevention measures;
iii. identifying the design solutions that guarantee the achievement of the assigned performance levels;
f. if the result of the design is not considered compatible with the purpose defined in point a), the designer iterates the steps referred to in point e) of this methodology.

The assumptions of fire scenarios do not consider malicious actions.

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

For fire risk analysis (doc. LT MS 10890), evaluation of residual fire risk has been determined under Ministerial Decree 10/03/1998 criteria, by use of three factors:

- fire load
- factor that increases risk of fire (risk weighting factors)
- factor that decreases risk of fire (risk mitigation factors)

Factor that increases risk of fire are:

- combustion speed

- toxicity of combustion product
- ignition probability
- people damage probability

Factor that decreases risk of fire are determined like answer to question concerning following aspects: building, safety procedures, ignition probability, flight of workers, maintenance aspects, alarm systems, firefighting aspects, emergency aspects, training of workers.

Using numerical parameter for any factor, the result of the multiplication provides the risk of fire for any activity: low, medium, high.

Two software has been used: ***CPI win Evaluation Risk Activity*** and ***CPI win Fire Load Activity*** (Namirial s.p.a.).

Activity	**Fire dangers**	**Fire Load (MJ/m²)**	**REI Classification**	**Residual Risk**
Guardianship	Solid Combustible materials (paper)	26,43	0	0,3534
Office	Solid combustible materials (paper), electrical ignition probability	504,00	30	14,675
New Archives	Solid combustible materials (paper), electrical ignition probability	2263,35	90	36,84
Infirmary	Solid combustible materials (paper), oxidizing (oxygen), electrical ignition probability	204,00	15	3,7098
Laboratory	Solid combustible materials (paper), oxidizing (oxygen), flammable liquids, flammable gas, use of stove, electrical ignition probability,	612,00	30	20,283
Chemical and Radio Chemical Laboratory	Solid combustible materials (paper), oxidizing (oxygen), flammable liquids, flammable gas, use of stove, electrical ignition probability,	612,00	30	37,446
Liquid fuel dispenser		1046,48	45	7,877
New dosimetry laboratory	Solid combustible materials (paper), oxidizing (oxygen), flammable liquids, flammable gas, use of stove, electrical ignition probability,	21,56	0	0,4134
New radioactive repository	electrical ignition probability	7,76	0	0,0589
Magnox repository	Special solid combustible materials (powder), electrical ignition probability	5815,43	240	22,73
Low activity radioactive repository	Special solid combustible materials (powder), solid combustible materials (paper), electrical ignition probability	1371,50	90	18,75
Reactor building ground floor	Special solid combustible materials (powder), solid combustible materials (paper), oxidizing (oxygen), electrical ignition probability, open flame, electrostatic/atmospheric charge	44,09	0	5,5185
Generator set building	High heated machine	839,73	60	7,2984
Generator set	flammable liquids, electrical ignition probability	225,97	20	3,3388
Oxiacetylen repository	open flame	1591,63	90	21,64
Archives (5000 ÷ 50000) kg	Solid combustible materials (paper), electrical ignition probability	3849,95	180	34,813
Flammable materials repository	Solid combustible materials (paper, other), electrical ignition probability	952,80	90	21,10
GPL Tank	Methane gas, atmospheric discharge, electrical ignition probability, use of stove,	765,00	60	22,43

Activity	Fire dangers	Fire Load (MJ/m²)	REI Classification	Residual Risk
Canteen	Methane gas, flammable liquids, solid combustible materials, electrical ignition probability, open flame	408,00	30	15,188
Parking	flammable liquids, open flame, atmospheric discharge, electrostatic charge, electrical ignition probability	103,94	0	3,8371
Dangerous materials repository	solid combustible materials	289,65	15	1,8125
Ex Parson radioactive repository	flammable liquids, electrical ignition probability, solid combustible materials	348,17	20	3,799
Control room	solid combustible, electrostatic charge, electrical ignition probability	64,17	0	1,4338
Pump station	electrostatic charge, atmospheric discharge, electrical ignition probability	121,82	0	2,199
Radioactive liquid treatment building	solid combustible, high heated machine	86,43	0	1,363
Electric cabinet room	solid combustible, electrostatic charge	364,30	15	2,2672
Radioactive sludge tank	electrical ignition probability	360,00	15	0,9064

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

In fire risk analysis (doc. LT MS 10890) there are n.26 activities with related residual fire risk: n.19 activities “Low” risk and n.7 “Medium” risk. Highest fire load (5815 MJ/m^2) is for Magnox Repository. Highest residual risk is for Radiochemical Laboratory, the Archive and the main Warehouse. Fire analysis provides a globally risk for Latina NPP as “Medium”.

The prevention and protection measures to be furtherly adopted to the different decommissioning activities according to the results of the fire hazard analysis include:

- keeping good levels of training for the emergency and firefighting teams, by means of six months-based exercises,
- updating the fire detection systems of the plant,
- improving the selection, design and location of portable fire extinguishing systems.

D.I.2.1.5. Periodic review and management of changes

Periodic review of safety assessment follows the periodic update of reference Regulations, Guidelines and specific Laws (e.g. DM 03/09/2021).

D.I.2.1.5.1. Overview of actions

The management of changes of fire hazard analysis is conducted in its periodic review as required by legislation. In addition, for specific activities, an assessment is conducted when detailed Operational Plans are submitted to the Regulator.

D.I.2.1.5.2 Implementation status of modifications/changes

No relevant modification or changes are currently in progress.

D.I.2.1.6 Licensee’s experience of fire safety analyses

Describe its experience of fire safety analyses.

D.I.2.1.6.1. Overview of strengths and weaknesses identified

A strength point of Fire Safety Analysis results from the fact that the assessment criteria follow the DM 10/03/1998 and the mathematical methodologies are direct, well established and strictly based on the actual configuration of the plant.

On the other hand, safety analysis requires to be updated, following the progressive evolution of the configuration of the plant during the decommissioning period.

D.I.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

Document LT MS 11272 *"Prevention and protection firefighting program"*, approved by National Authority (ISIN), is updates after every modification regarding firefighting issues (removed built or plants during decommissioning, new system installed, etc.) or request from National Authority.

Fire Safety Analysis documents (LT MS 10870 and LT MS 10871) are periodically updates following the evolution of site configuration. For any new installation, we submit to competent authorities (VV.F) the design to remarks about firefighting. Provisions generally had highlighted the following points:

- Use of uninflammable materials and coatings for critical installations,
- Use of fire adequate compartments (REI),
- Functional design of fire detection systems for new installations

D.I.3 Fire Protection Concept and Its Implementation

D.I.3.1 Fire prevention

D.I.3.1.1. Design considerations and prevention means

Facility and related activity are complying with the *Technical Evaluation of Fire Risk - LT MS 10890*, that release an evaluation regarding the reliability of fire firefighting measures token for any activity. *Technical evaluation of fire risk* is based on Fire Prevention Certificate, granted by the national component fire-fighting authority (VVF).
For new building (repository, implant or treatment facility), prevention measures (minimize the likelihood of fire end ignition sources) are considered through proper system layout and design and, as far as practicable, elimination and/or reduction of ignition hazard by separating ignition sources from flammable materials.The compliance of systems with a specific fire-fighting function mainly complies with the national standards of good practice and, where this is not technically possible for justified reasons, with the international reference standards.

The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in storage areas.
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.
- Adequate fire compartmentation to confine a possible fire which, despite the fire prevention criteria adopted, should occur.
- Fire detection and reporting capable of promptly detecting the event.
- Fire suppression through the adoption of at least two independent systems, each characterized by high service availability.
- Arrangement of contaminated materials (combustible and non-combustible) in the storage rooms so that the consequences of the fire in the storage area are maintained within the objectives of radiation protection for the population even in case of failure of the fire-extinguishing systems.

The nature and characteristics of ignition sources are taken into account in designing the prevention means implemented for fire safety purposes; for instance, the possible hydrogen generation in magnox splitters waste implies the implementation of a hydrogen detection system in controlling the venting system of Splitters Pits.

it is important to highlight that as a Magnox type reactor, Latina NPP is equipped with a nuclear reactor core made of about 2000 tons of graphite. Graphite, used as the moderator and reflector of the reactor, is confined inside a steel spherical vessel (20 m in diameter and 11 cm thickness) fully isolated from the external environment by sealed plugs.
Thus, no ignition source can currently be introduced within the graphite core environment.
Until the dismantling of the reactor building will get started (after the availability of the National Repository), no operational activity is expected to concern graphite, except for periodic monitoring instrumental surveys.
From a fire safety point of view, it must be remarked that the presence of graphite dust inside the reactor vessel, is not of particular concern.
In fact, many experimental investigations internationally carried out (e.g. doc. Electric Power Research Institute, "*Graphite Dust Deflagration. A review of international data with particular reference to the decommissioning of graphite moderated reactor*", final Report March 2007) have proved that of a dust explosion involving graphite dust is extremely low under decommissioning conditions and negligeable under current safe storage conditions.

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

Arrangements on fire loads in every area or building of the site is established on the results of doc. LT MS 10891 *"Evaluation of fire load" Fire Protection Certificate (CPI)*, release from National Fire Brigades (VV.FF.). It certificated if prevention and protection measures for any place or activity in the site are conformed with the National Technical Low.

- *Technical evaluation of fire risk -LT MS 10890*, that release an evaluation regarding the reliability of fire firefighting measures token for any activity.
- *Prevention and protection firefighting program – LT MS 11272"*, approved by National Authority (ISIN). It's a prescription of the Authorization of Decommissioning Activity – Phase 1 of Ministerial Decree 20 May 2020.

the Fire Protection Certificate (CPI) document and Technical Evaluation of Fire Risk document. For any new activity, minimization of fire load is taken on design (rules materials storage, use of fireproof materials, etc.)

A minimization of ignition sources is a key objective assumed in the project of decommissioning operations (use of explosion-proof lamps, sismic-proof electrical cabinet etc). If the activity involves use of open flame, this use is done without combustible material and whit safety prescriptions.

Any work activity is strictly regulated by authorization and operation procedures (working permits) through wich safety provisions are decided and applied (rif. Procedure LT MO 00005).

The fire prevention measures adopted in the main building of the plant are as follows:

Reactor building: Restricted access to contaminated areas, based on procedures (LT MO 00010 "Health Physics Regulation) and Radioprotection Expert prescription, minimization of fire loads;

Interim Storage Facility: Exclusion of combustible radioactive waste or other materials inside the storage area, how established by Ministerial Decree n.4056 of 25/02/2015;

Splitters Pits: Isolation of the storage pits by plugs, implementation of a venting system controlled by a hydrogen detection system.

D.I.3.1.3 Licensee's experience of the implementation of the fire prevention

D.I.3.1.3.1. Overview of strengths and weaknesses

No particular strength and weaknesses have been identified

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

No events are reported. No international review regarding fire safety have been conducted.

D.I.3.1.3.3. Overview of actions and implementation status

Fire Safety Analysis and fire load assessment are under update.

D.I.3.1.4. Regulator's assessment of the fire prevention

D.I.3.1.4.1. Overview of strengths and weaknesses in the fire prevention

D.I.3.1.4.2. Lessons learned from inspection and assessment on the fire prevention as part of its regulatory oversight

D.I.3.2 Active fire protection

D.I.3.2.1 Fire detection and alarm

D.I.3.2.1.1. Design approach

The functions of Fire Detection System are:

- quickly detect a possible fire.
- minimize the risk to workers and the external environment due to releases of radioactivity following fires.

  The detection system is designed to protect any area of the site (premises or implants) and allow the automatic activation of the following actions:
- closure of air inlet damper in the compartment affected by fire and all other compartments.
- shut off the air supply section of the ventilation system.
- closing fire dampers for the extraction of air from the storage room affected by fire and all other storage rooms, the air extraction will be operational in the corridor rooms, which have an independent extraction line up to the extraction plenum in the filter room on the first floor, with ducts provided with 2 hours fire resistance; the infiltration air flow deposits-corridors will be reversed with respect to the operation under normal conditions, air will leak, through the separation doors, from the deposits to the corridors;
- remote transmission of alarm signals to predetermined area in the Control Room of the site. Alarms are trasmitted also to the security room at the entrance.

D.I.3.2.1.2. Types, main characteristics and performance expectations

This system consists of:

- automatic fire detectors (smoke and temperature detectors, optical detectors).
- manual fire calling points.
- visual and sound alarm devices.

Automatic fire detectors are installed in any areas of the site where there are decommissioning activities, facilities, storage facilities, or workers (offices, workshop, laboratories, etc).
The fire detectors are multicriteria type (smoke detection/temperature detection) installed on the ceiling.
The detectors are equipped with a light indicator for displaying the operating status of the sensor. They are of the addressable type. The number of detectors in each area is in according with the current legislation.
Detectors are also provided in rooms equipped with false ceilings and ventilation channels, where necessary.
The detectors are positioned, installed, and possibly adequately protected so that they cannot be subject to mechanical, chemical, or other damage that could affect their correct functioning. In building with ceiling above 8 mt, are installed also optical detector.

All the detector, depending on the building, are referred to n.21 control unit. Are installed also n.3 detection systems for hydrogen gas (UPS battery room, repository of magnox waste, forklift charge station). Hydrogen gas detectors systems are interfaced, through a special module, to the fire detection control unit.
In the presence of smoke, the sensors will send a signal, by the relative control unit, to the control center of the fire detection system in the Control Room of the site and furthermore in the Guardianship. In both, there is presence of employs continuously.
In addition to the detectors, manual fire alarm buttons are installed, also connected to the control unit. These buttons are installed in a clearly accessible position, along the escape routes, distinguishable from any other manual buttons.
Within the individual areas, audible and luminous alarm signals are installed.
There is a single control center for the fire alarm system. It is interconnected directly to the automation station of the control system and the power supply is derived from redundant UPS units.
The control unit perform the functions of power supply, self-test, and surveillance of the detectors, will process the signals coming from the field and, in relation to the nature of the signals received, will provide the following signals:

- fire alarm, resulting from the activation of one or more detectors or the activation of a manual fire alarm button;
- anomalies, in case of faults on the detection line, due to:
- interruptions or short circuit on the line;
- faults or lack of power supply to the processing and alarm signaling circuits.

Following the fire alarm in a building, the control center will activate the emission of an optical-acoustic alarm on the main control panel of the Control Room (H24), repeated on a secondary control panel, positioned in the Guardianship (H24).
The control unit is equipped with an emergency battery, sized to guarantee power for 72 hours; After this period, it is possible to maintain an alarm condition for at least 15 minutes.
If the space affected by fire is a space protected by the extinguishing system, the optical-acoustic alarm activated in the space shall also act as a warning alarm of the extinguishing discharge, to allow, with an appropriate delay, the evacuation by any personnel present, before the extinguishing discharge begins.

D.I.3.2.1.3. Alternative/temporary provisions

In case of unavailability of the fire detection system are require, notification to Regulator is mandatory, with alternative arrangements supply (usually, increase of control by emploies or guardian).

D.I.3.2.2 Fire suppression

D.I.3.2.2.1. Design approach

Fire suppression systems are design for a timely fire extinguish. To ensure this statement, there is a fixed water manual fire extinguish system, and, furthermore, there are in any buildings of the site portable fire extinguishers. Inside the pump station room of the system (FIREBOX) is installed an automatic fire extinguish system (SPRINKLER).
Design criteria for the detection fire systems and fire extinguishing systems (hydrant systems) implemented on the plant follow national technical guidances (guidances UNI 9795, UNI 10779, UNI EN 12845, UNI 11224 and subsequent updates).

D.I.3.2.2.2. Types, main characteristics and performance expectations

Fixed water fire extinguish system is design according to the national technical law, with level 3 regarding power plant criteria. The system (underground pipes) has n.40 column hydrants (type C), near or around any building of the site, n.10 wall hydrants (n.8 inside New Temporary Repository and n.2 inside LECO Plant). N.2 hose reel hydrants are installed in the Radiochemical Laboratory.
System is maintained at a pressure of 0,9 MPa by a pilot pump. A main pump provide water in case of start of the system. Pilot and main pump take water from charge canal of the former thermal condenser of the

plant. In case of failure of the main pump, an emergency pump provide water from a 1000 m^3 accumulation basin. All the pumps are installed in a Firebox with the electrical cabinet for the management of the system. Firebox has an automatic fire extinguish system (SPRINKLER) starting by temperature.
To ensure a timely action against fire, or for areas isn't allowed to use water (electrical cabinet room, electrical transformer cabinet, etc.) there are portable fire extinguishers. Three types are available: powder extinguishers (6 kg), CO_2 extinguishers (5 kg) and roundup extinguishers (50 kg) outside building.

The fire protection measures adopted in the main building of the plant are as follows:

Reactor building: Implementation of fire detection system in occupied areas, redundant portable extinguishing devices, using REI classified compartments;

Interim Storage Facility: Implementation of fire detection system, hydrant systems inside the storage area installed with a water collecting system, compartmentalized ventilation system controlled by fire detection system (authomatic shut down), portable extinguishing devices; the storage area is divided in two compartmentalized sections.

Splitters Pits: Implementation of an authomatic argon suppression system controlled by the fire detection system, implementation of fire detection system inside the covering building; portable extinguishing devices;

D.I.3.2.2.3. Management of harmful effects and consequential hazards

Fire harmful effect are analysed, for any activity, in the Failure Mode and Effects Analysis, to ensure reliability of design, implant or complex activity.

D.I.3.2.2.4. Alternative/temporary provisions

If a column hydrant is inaccessible due to the presence of worksite or other reasons (maintenance operation, failure), alternative measures are adopted:

- appropriate device able to reach areas from other columns;
- increase of portable devices;
- specific procedure for workers.

D.I.3.2.3 Administrative and organisational fire protection issues

D.I.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

As regards the administrative and organizational fire protection issues, the involvement of a specific fire-fighting competence is managed by:

- Internal fire-fighting staff (AA)
- On site fire-fighting brigade (SPI)
- National fire brigades (VVF)
- Procedures and other fire prevention and firefighting documentation as for example:
- Internal emergency plan;
- Off-site emergency plan;
- Training plan

D.I.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

To allow decommissioning program, Latina Site has the document *"Prevention and protection firefighting program – LT 11272"*, approved by National Authority (ISIN). In this document, every firefighting aspect is treated. In this document, are reported reference procedures, responsibility, frequency of check and training, etc. A Physical Protection and Security Technician (TSPF), appointed by Head of Site, take care the implementation of the program.

On site there is a firefighting of n.21 employees, trained according to the national law for the higher level of fire risk with final exam certification by the fire department. As per the technical prescription, n.2 drill per year is performed for firefighting team. The national fire department and ISIN is informed of the drill. Firefighting team are available, in group of three, beyond worker's hours.
There are n.2 documents for firefighting team:

- *Firefighting team intervention – LT MO 00008;*
- *Firefighting team exercise – LT MO 00011.*

Emergency drill is performed annually, involving all employees of the site. It starts from a hypothetical fire occurs in a repository with a radiological release out of the site. This drill verifies organization and management of the people directly and not directly involved. National Authority (ISIN) directly verifies every step of drill. There are n.3 general documents available, where are defined instruction to firefighting teams:

- *Off-site emergency Plan for the Latina NPP;*
- *Instructions for Internal Emergency Plan – LT MO 00016;*
- *Instructions to employees in case of emergency – LT MO 00017.*

D.I.3.2.3.3. Specific provisions, e.g. loss of access

D.I.3.3 Passive fire protection

D.I.3.3.1 Prevention of fire spreading (barriers)

D.I.3.3.1.1. Design approach

Fire separation to adjoin building is guaranteed through the presence of structures with fire resistance characteristics.
New buildings (facility, repository, etc.) are divided into a series of compartments to divide the different risk areas. The partition of the buildings into fire areas and the consequent division into compartments are based on the principle of preventing a fire that has developed in one area from spreading to other areas of the buildings with consequent further damage. The fire areas are separated from each other by fire resistant structures.
It is avoided that a possible fire spreads, or that the fumes spread through the ventilation systems. For this purpose, the ventilation ducts, at the crossings of walls that constitute fire compartmentalization, are equipped with fire dampers with fire classification completely identical of the wall crossed. Compartments were defined based on fire load calculations and based on functional and risk fragmentation logics.
Accordingly with the third level of defence in depth concept is assumed that fire extinguishing systems fail and that firefighters do not respond quickly enough which causes fire development. In this scenario the confinement of radioactive spread is guarantee by the fire compartment of each storage area designed to withstand the worst-case scenario.
In the repository, wastes can be enclosed in fire resistant shell to avoid their participation in case of fire

Compartimentation is designed following the recommendations of national guidances (UNI guidances on REI criteria), based upon the assessment of fire load for every activity (rif. DM 10/03/1998, *Evaluation of fire load – LT MS 10891*).
The same criteria are used for every new decommissioning activity.

D.I.3.3.1.2. Description of fire compartments and/or cells design and key features

Compartments features and characteristics are verified and approved by Fire Authority and, by issuing the Fire Prevention Certificate (CPI). Performances are verified by means of periodic controls, as established by national Laws, regulations and internal procedures (*Prevention and protection firefighting program – LT MS 11272*).

REI classification of compartments is reported in § D.2.1.3.

D.I.3.3.1.3. Performance assurance through lifetime

Functional conditions and performances of compartments are verified and tested through time by periodic checking (six month-based), carried out following the provisions of the Decommissiong Authorization or reference national legislation.

D.I.3.3.2 Ventilation systems

D.I.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

Ventilation system is design to separate areas with radiological potential contamination from area without contamination, and the system maintains a low pressure inside the building respect outside, to avoid release of contamination. Ventilation and filtration systems have important function in case of accident, so specific criteria are adopted:

- two air extractors are installed, to ensure ventilation control in case of single failure;
- two air injection system, to maintenance right pressure inside building in case of failure;
- injection filters are installed (G4 e F7 type) to avoid injection of powder or sand;
- Ventilation shutters has the same REI classification of the wall.

Ventilation systems are currently located in the following building:

- Splitters Pits storage building, The system is automatically controlled by the hydrogen detection system;
- New Interim Storage Facility. The system is used during operating phases (waste management activities within the storage areas) in order to produce the dynamical confinement of the building;
- Radiochemical laboratories venting systems;

The following facilities, which are about to start their operation, are equipped with dynamical confinement system, automatically controlled by the fire detection system.

- Material Treatment Facility,
- Supercompacting and grouting station,
- New treatment facility for radioactive liquid effluents.

D.I.3.3.2.2. Performance and management requirements under fire conditions

In case of fire, ventilation system is shut down by authomatically ventilators turning off. The ventilation shut down is controlled by the detection system starting (alarm signal);
In addition, to ensure compartmentalization, ventilation dampers installed in the junction points of adjacent rooms, automatically close down as the effect of the detection system alarm signalling.

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

The operation experience under the decommissioning regime provided the base for implementation of procedures concerning every aspect of firefighting organization.
The prevention and protection program (LT MS 11272) has been approved by Regulatory Authority prior to any decommissioning activity. This program sums up the approach criteria of fire prevention and protection: training of emergency and firefighting teams, periodic exercises, maintenance and periodic controls of systems and equipment, periodic controls of compartments integrity.
Fire Authority has checked and approved the compliance of the fire preventing and protecting systems for recently commissioned installations (e.g. waste treatment on the site).
Even if no event has occurred so far, fire protection features are improved by ensuring the technological update of the systems and procedures with respect to the current standards (e.g. revamping of the fire detection system, revamping of the fire hydrant extinguishing system).

D.II TRINO NUCLEAR POWER PLANT decommissioning

D.II.1 General information

D.II.1.1 Nuclear installations identification

- Name: **Enrico Fermi NPP**
- Licensee: **Sogin S.p.A.**

The Enrico Fermi NPP is located in Trino (VC), near the Po river. The NPP is in decommissioning phase. It was an PWR, its power load was 270 MWe. The Site is owned by Sogin, except for the electrical station, owned by the electric power provider (Terna S.p.A.). Two waste storage facilities were realized in the site to host the waste produced during the plant lifetime.

The site is surronded by river and canals, on the nothern side is located an abandoned factory.

D.II.1.1.3. Key parameters per installation

- Name/Type of facility: Enrico Fermi PWR NPP under decommissioning.
- Year of end of operation: 1987.
- Year of authorization for decommissioning: 2012.
- Scheduled end of decommissioning operations date: 2035.
- Intended end state: green field.
- Decommissioning safe store conditions after end of operation: the plant was in safe store condition from 1990 to 2012
- Dismantling operation: since 2001, decommissioning activity were performed in order to dismantle the system not required for the following activities (e.g. cooling towers, Diesel Generators, Turbine, etc.).

Waste treatment on site: an incinerator is used to reduce the dimenions of the combustible material; an evaporator system performs boron concentration reduction and a lower radioactivity reduction on water collected on the plant.

D.II.2 Fire Safety Analyses

D.II.2.1 Fire Safety Analyses for EUREX plant under decommissioning

D.II.2.1.1. Types and scope of the fire safety analyses

The fire hazard analysis of the Trino NPP is based on the Ministerial Decree 10th March 1998: through a previous fire hazard assessment, the legislator established rules and norms in order to provide minimal safety requirements whose observance guarantees the minimization of the fire risk.

It is a qualitative fire hazard assessment: the main fire and explosion hazards have been identified, considering the combustible materials displacement, then an estimation of the probability of occurrence and of the magnitude of the consequences has been associated with each fire or explosion scenario. The analysis is part of a legal procedure, aimed at the issuing of a fire protection certificate by a specific (conventional) regulator.

A following analysis, aimed at the fire protection system sizing, has been conducted: it took into account not only the combustible material contained in the areas, but also the importance by a safety point of view of the systems contained in an area, the possible radioactive source term due to the fire accident in the specified area and the possibilities of contemporaneity between events. This is an application of the defence in depth that will be better discussed in the following paragraph.

Since decommissioning activities could change the routinary configuration of combustible materials and extinguishing systems, Specific fire hazard assessment are requested by the authority for each decommissioning activity.

D.II.2.1.2. Key assumptions and methodologies

The key assumptions are:

- the most important fire events are related with the main masses of combustible materials;
- the magnitude of the events is related with the risk of exposition to radioactive materials;
- safety related systems shall be protected against fire events;
- the fire safety assessment is related only to the normal conditions, additional analysis shall be performed for decommissioning activities that could change the plant configuration;
- the fire extinguishing system shall be sized taken into account contemporaneity of fire events.

The methodology used for the fire safety assessment is mainly qualitative, is compliant with the national legislation and, considering the combustible materials contained and the activity normally performed, is commensurate with the scenarios.

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

The fire hazard analysis has been performed in accompliance with the Ministerial Decree 10th March 1998. This methodology is based on the following steps:

- identification of the main scope fo the analysis: the waste storage facilities are included in the main analysis regarding the Nuclear Power Plant, considered as plant for the peaceful use of nuclear energy;
- identification of the main "vertical" norms to be applied (activity): the waste storage facilities are considered in the activity "plants in which nuclear fuel are detained or produced or radioactive waste are stored".
- identification of the risk sources: combustible material are listed, in the specific case of the waste storage facilities, the ammount of combustible materiali is neglegible. In this phase of the analysis, also other kind of dangerous substances or compounds are considered: the radioactive waste stored in the storage facilities is taken into account.
- identification of the main characteristics of each building: structural characteristics, system and functional characteristics; compartimentation; combustible materials; maximum conceivable personnel presence; emergency exits; ventilation; fixed extinguishing plants and mobile extinguishing tools; fire detection system; signage.
- qualitative fire hazard assessment: the result of this analysis concerning the whole Trino NPP is that the fire hazard is low. The same is applied to the waste storage facilities.
- reduction of residual fire hazard:
    - fixed fire extinguishing system and mobile fire extinguishing tools are reported.
    - radioactive containment measures are reported;
    - emergency management: the emergency plan concerns the whole Trino NPP, but the waste storage facilities are mainly considered, containing the maximum source term in case of a radioactive spreading due, for instance, by a fire. The Trino Emergency Plan involves all the local authorities, for instance fire brigades, local sanitary system, etc.
    - information and training about the fire extinguishing procedures are reported;
    - controls and maintenance of the fire prevenction measures are reported.

The complexity of a fire event Trino NPP is managed through the flexibility of the fire fighting team and procedures: Nuclear Emergency procedures contains guidelines for radiological survey team that give radiological data about possible radioactive spreading outside the plant boundaries, following instruction of an Emergency Manager. The Emergency Manager is in an isolated position and has access to meteorological data.

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

The fire safety analysis shows that the normal activities represent a low fire hazard risk, indeed all the combustible substances have a high flash point, electric cables are subject to specific legislation, the heating and cooling systems are compliant with nationale laws, fire detection and extinguishing systems are located according to the fire hazard.

D.II.2.1.5. Periodic review and management of changes

D.II.2.1.5.1. Overview of actions

The assessments carried out are fully re-evaluated every 5 years (as per legislation) and also in the occasion of regulatory updates or if requested by the competent Authorities, for example when the OP (Operational Plan) for decommissioning actrivites have to be submitted for approval.

D.II.2.1.5.2 Implementation status of modifications/changes

In the case of changes in the ammount of combustible materials, each decommissioning activity is ruled by a procedure that foresees also a specific fire hazard assessment. This fire hazard assessment is performed by an expert and is supervised by the Regulator for approval.

Relevant changes in the fire detection and extinguishing systems are not permitted on the existing systems if not specifically approved by the NRA: even during normal manutentive activities, any component can not be replaced with other having lesser characteristics. System changes can be proposed by the licensee through a specific procedure involving safety related roles, the issued documentation is submitted to the Regulator for approval.

D.II.2.1.6 Licensee's experience of fire safety analyses

D.II.2.1.6.1. Overview of strengths and weaknesses identified

The fire safety analysis is based on a methodology (complaint with the DM 10/03/1998) that has the following strenght:

- It is based on an analysis performed by the legislator: it is based on the experience grown by experts;
- It is based on a well known approach, therefore it is well codified and then it is easy for the issuer to compile and the authorities to evaluate.

D.II.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

No relevant events happened on site.

Some minor reviews of the fire safety analysis have been: following a spurious event, a release of extinguishing gas took place in the Site main archive. Due to changes in norms and regulation mainly about greenhouse gas, the extinguishing gas had to be changed, therefore a review of the fire safety analysis had to be performed to consider the different extinguishing power of the new gas. The review was coordinated by a project that was evaluated by the Firebrigades technical office, then, when the change was implemented, the firebrigades checked that what has been realized was compliant with the project. A specific authorization was then achieved.

No international review have been conducted.

D.II.3 Fire Protection Concept and Its Implementation

D.II.3.1 Fire prevention

D.II.3.1.1. Design considerations and prevention means

Combustible materials are not allowed, especcially in the classified area, if not strictly needed.

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

For the management and control of fire loads and ignition sources, the principles of defense in depth and appropriate management and maintenance procedures were applied.
The defence in depth principles applied to decommissioning activities have been implemented following these different successive levels.

With reference to the First level of defence in depth (preventing fires from starting) the following prevention measures can be highlighted.
Each dismantling activity is detailed in specific licensing documentation, including a fire hazard evaluation.
In general, the thermal cutting of steel and concrete is not allowed.
In general, for decommissioning purposes, the use of combustible material is reduced as much as possible (e.g. wood or paper shall not be introduced in radio-hazardous areas).
Whenever an ignition source shall be used (e.g. tools for mechanical cutting producing hot swarfs), combustible material are not allowed in the surrounding or, if possible, are segregated.

In case of combustible gases to be ammitted in work areas, e.g. in case of hot cutting, procedures establish that the gases must be taken out of closed environment and the end of the working day and must be sealed.

D.II.3.1.3 Licensee's experience of the implementation of the fire prevention

D.II.3.1.3.1. Overview of strengths and weaknesses

The fire prevention has been implemented following Italian norms and regulation. This approach is well known and derives from a general fire risk assessment performed by the regulator with the assistance of competent authorities (for instance Firebrigades). Due to this, the approach can ensure that the minimal requirements are fullfilled. Since the approach is strictly regulated, its application is easily performed.

Due to the restriction of the admittance of combustible material in the classified area, a significant reduction about the produced waste volume has been performed.

The reduction of combustible material is a principle that is well understood by employees and it is part of the safety culture.

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

No relevant events happened on site. No international review mission have been conducted.

D.II.3.1.3.3. Overview of actions and implementation status

Pocedures for implementing fire prevention are continuously verified and updated.

D.II.3.2 Active fire protection

D.II.3.2.1 Fire detection and alarm provisions

D.II.3.2.1.1. Design approach

The fire detection and alarm system has been designed in compliance with the Italian law (especially D.M. march 10th 1998): in consequence of the individuation of the residual fire risk, fire detection and alarm are located in the areas with the aim to reduce that risk.

The fire alarms are collected in the Main Control Room and give the possibility to recognize the zone where the fire event is happening. New installations are provided with their own fire detection and alarm system. The alarm system is also equipped with local acustic and lighting signals.

A fire detection system is located both in the area containing combustible material and in the most radio-hazardous areas.

D.II.3.2.1.2. Types, main characteristics and performance expectations

Any fire zone is equipped with a separated branch of the fire detection system. The fire resistance of the structures ensures that the detection system is not involved in a fire event happening in an adjacent area.

The fire detection system consists of the following control units:

- Coe Clerici: this control unit collects data from smoke detectors, light detectors and thermal detectors. These detectors are located in classified and not classified areas, near engines, cables (considered as combustible material) or high voltage features;
- Cerberus: this control unit collects data from smoke detectors from classified and not classified areas;
- Notifier-archive: this control uniti collects data from smoke detectors from the Site main archive;
- Notifier-TT: this control unit collects data from smoke detectors from the Temporary Buffer Area.

D.II.3.2.1.3. Alternative/temporary provisions

In case the fire detection or alarm systems is disabled due to temporary works, periodic inspections are established.

D.II.3.2.2 Fire suppression

The NPP fire suppression system is installed and maintained operable.

D.II.3.2.2.1. Design approach

The fire suppression system has been created during the operational life of the nuclear powre plant. The fire extinguishing system is distributed all over the NPP, in order to mitigate the spreading of fire.
The main change introduced along the time has been related to the primary water supply: in the early years, the fire suppression system water supply came from the Po river. It was subsequently replaced by the acquifer through the adoption of dedicated wells.

The fire suppression system actually used was designed to overcome worst fire event, related to the presence of wood and other combustible material in the plant. At the present time, many of the combustible materials have been removed from the plant and the general nuclear risk has been reduced by the nuclear fuel removal.

The fire extinguishing system covers all the classified and not-classified areas. The type of fire extinguishing feature is established through a fire hazard assessment.

The key characteristics of the fire suppression plant are complaint with D.M. march the 10th 1998:

- the use of water is avoided where power supply distribution is located;

- the better fire extinguishing system for the archive is a gas suppression system;
- the fire water system can provide more than 20 hours at minimum water extinguishing flow.

D.II.3.2.2.2. Types, main characteristics and performance expectations

Loss of Off-Site Energy Supply is taken into account as main secondary hazard: the water is supplied by different and redundant systems. A motorized pump and an electric pump can supply water to the High Pressure Extinguishing System after the emptying of the autoclave. Also a Low Pressure Extinguishing system is provided and its functioning is ensured by a water head.

The fire fighting team is provided with manual firefighting equipment, established by the site fire expert. Since the equipment is provided with wheels, accessibility features have been built in the main exit and entrances.

D.II.3.2.2.3. Management of harmful effects and consequential hazards

Employes are trained to avoid any needed interaction with the safety features, fire extinguishing features included. Human error is reduced by internal procedures: any maintenance or not-routinary activity is planned and is supervised by expert personnel.

The location and manual use of fire estinguishing systems exclude flooding of safety relevant parts due to spurius actuation.

D.II.3.2.2.4. Alternative/temporary provisions

Important change in system configuration or temporary fire extinguishing provisions are communicated to all the employes. The alternative and temporary provisions are established by the site fire expert.

D.II.3.2.3 Administrative and organisational fire protection issues

D.II.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

The operability of the fire protection systems and organization is required by the technical prescription issued by the Regulator regarding the E. Fermi NPP. Therefore, technical and organizational procedures are issued by Sogin to ensure the operability through periodical inspections, maintenance and testing.

D.II.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

The general firefighting strategy is mainly established by the law and is revised together with the local fire brigades autorithies. In general, a common plan is established in order to coordinate action in front of any kind of major accident (including fire hazard in the waste storage facilities) with the offsite resources. The plan is reported in a specific document revised whenever the NPP conditions should change.

Since the fire fighting team must possess a specific training certificate, the training is provided in accompliance with the law. It includes a general training about fire scenarios, a specific training about fire hazard in the NPP and a practical simulation to be arranged on site. The training takes place every six months, a fire emergency simulation takes place once a year, a coordinated fire emergency simulation (including nuclear aspects and involving offsite resources) takes place once a year.

During the emergency simulations, the procedures are tested and subsequently changed, if needed. Through the years, procedures changes have been needed by changes in the SSC or in the disponition or use of the areas, or to better establish the action sequence in order to minimize the intervention time.

Any role involved in the fire emergency management is taken into account by a specific procedure. These procedures are usually revised after each emergency simulation, if needed.

Firefighting resources are established through an evaluation of the scenarios and the following minimum staff number.

Coordination is achieved through the following consideration:

- procedures are discussed with the fire brigades technicians;
- in case of fire emergency, up to the fire brigades arrival, the fire fighting direction is in charge of the Plant Supervisor (trained in fire fighting procedures). After the fire brigades arrival, information are given to the fire brigade's team head and he gets in charge of the fire fighting direction.

In case of fire emergency and fire brigades intervention, one of four path is communicated to the fire brigade tank driver: it ensure the safer path in order to avoid contamination due to smoke spreading. Even if the resources are trained about the specific hazards of the plant, the Plant Supervisor (as former Fire fighting team head) gives information about the scenario.

During an Emergency, security controls are bypassed, but only emergency machine can access to the site.

Every six-month training is performed by the fire fighting team. Emergency testing is performed two times a year. All the personnel and the suppliers are involved in the emergency testing, in order to spread safety culture.

Access routes for firefighting are yearly tested and, in case of need, maintained.

A Nuclear Emergency Plan has been issued by Sogin and local authorities and it also takes into consideration a fire emergency scenario.

D.II.3.2.3.3. Specific provisions, e.g. loss of access

Every facility is surrounded by internal roads; therefore, their accessibility is always ensured. Some route could be avoided due to contamination release in its direction. This is considered by the Nuclear Emergency Director that decides the best route to reach the facilities.

Four main alternative access routes are available for reaching the NPP. In case of a contemporaneous loss of each of the four access routes, thanks to the site fire extinguishing systems reliability and the fire fighting team readiness and competence, the Plant can manage a fire emergency independently from firebrigades in case of a severe loss of access routes. In any case, four main access routes are available for reaching the Plant.

D.II.3.3 Passive fire protection

D.II.3.3.1 Prevention of fire spreading (barriers)

D.II.3.3.1.1. Design approach

In the fire hazard analysis, the fire barriers are evaluated. It is mainly considered that the thickness of the facility walls is sufficient to prevent the fire spreading. This is due minly to the fact that the thickness needed by the radiation protection point of view is normally bigger than the thickness needed for fire protection.

The spreading of secondary fire is also avoided through the use of anti-fire-spreading cables, walls and doors.

Whenever a new system is installed in a building, the fire barriers are re-assessed through a fire hazard assessment. Italian norms and standards provide instructions about minimal requirements to be followed.

Fire resistance and stability is ensured through product requirements (accompliance with specific norms and standards). The facilities are maintained to ensure the expected fire resistance and stability ratings.

D.II.3.3.1.2. Description of fire compartments and/or cells design and key features

The fire safety analysis is performed taking into account every area of the NPP. For each area the presence of combustible material and the characteristics of fire prevention are listed. The fire compartimentation characteristics are listed and evaluated by the firebrigades.

New barriers are designed depending on the fire combustible material in a certain area.

The compartimentation is mainly achieved through walls material and thickness and fire resistant components (cables and duct insulation).

Material and component certifications ensure the required fire resistance and stability ratings.

Fire barriers are provided by: walls, doors, HVAC automatic or manual segregation features, electrical insulations, etc.

The Reactor Building is divided by the rest of the NPP by a steel liner and a thick concrete layer ensuring REI 120. This building is provided with a specific ventilation system, provided with fire segregation features.

The Auxiliary building is provided with specific segregation for the Motor Control Center (anti-propagation duct and cables). The Building walls have a relevant thickness due to radioprotection requirements, ensuring REI 120.

The waste storage facilities are provided with 50 cm thick walls (evalued sufficient for compartimentation) and metallic doors.

Areas where combustible material are stored due to specific activity are the following:

- Emergency Diesel Generator: compartimentation through thick walls (ensuring REI 120), impermeabilization of the floor;
- Turbine Hall, containing 3kV electric distribution center: 25 to 60 cm thick walls ensure adequate compartimentation;
- Control Room and cable room: compartimentation realized through adequate walls, anti-propagation duct and cables. The ventilation system is a closed one, provided with smoke extraction mode.
- The Plant Main Archive is compartimented by walls and doors ensuring REI 90. The specific ventilation system is provided with automatic segregation, combined with the inlet of the extinguishing gas.

D.II.3.3.1.3. Performance assurance through lifetime

Inspections on specific compartimentation (as waste storage facilities walls or Reactor Building walls and doors) are periodically performed. In case of malfunctioning or visible deterioration of their characteristics, maintenance is provided.

The NPP walls provide an efficient fire barrier, therefore, the Reactor building is sealed by the rest of the NPP. The Auxiliary building and the turbine building are divided in several areas, many of which is equipped with fire resistant doors.

The areas where SSC important to safety are located, are equipped with fire barriers (e.g. main control room, diesel generator area, DC battery area, etc.).

D.II.3.3.2 Ventilation systems

D.II.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

The ventilation system is designed to be automatically or manually closed in order to seal zones. Since it is located on vertical walls or ceiling, it does not interfere with firefighting routes.

During fire events, the ventilation system in hazardous areas is designed to shut down automatically. In the other cases, it is shut down manually.

The ventilation serving an area can be sealed through fire dampers in order to avoid the spreading of fire by-product or other hazardous substances.

D.II.3.3.2.2. Performance and management requirements under fire conditions

The ventilation system in hazardous areas is provided with automatic fire damper in order to avoid the spreading of fire. The fire resistance rating of the ventilation system is not taken into account in the fire safety analysis. Means available to prevent the spread of fire are fire damper and compartimentation.

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

The actual fire protection system is mainly based on the original NPP fire protection system. Implementation has been performed any time a new system or specific activity required a new evaluation. The new systems are in accompliance with actual norms and regulations. This approach ensure that the new fire protection features are justified.

Besides, the whole fire protection system is periodically assessed by the authorities (fire brigades) and its availability and rating are evalutated. If the system does not ensure minimal requests, it must be renewed.

By the organizational point of view, the firefighting team and the procedures regarding its staff requirements (minimum number of people, training, testing, etc.) have proved to ensure a ready and effective response. The tests performed two times a year enable the acquisition of information about lesser changes occurred on the plant which could be neglected and possible improvements.

D.III ESSOR-D-C (RR)

D.III.1 General information

D.III.1.1 Nuclear installations identification

- Name: **ESSOR**
- Licensee: **European Commission**

The ESSOR reactor is a 42.6 MW reactor. The original design envisaged heavy water as moderator and as organic fluid coolant, but from the beginning of its operating life it was cooled with heavy water. ESSOR was used as a neutron emitter, the first irradiation cycle started in February 1969. ESSOR was finally shut down in 1983.

ESSOR reactor is located within the INE (Isola Nucleare ESSOR), which is a complex of nuclear installations including a Research Reactor (RR) and a series of Research Laboratories, some in decommissioning and others in regularly authorized activities based on suitable and specific operating licenses. The management status of the ESSOR RR is that of the SAFE STORE, i.e., safe storage conditions before Decommissioning, not yet begun. Therefore, the status is pre-decommissioning.

Inside the INE there are two significant storages of spent nuclear fuel material (SPENT FUEL STORAGE) which are the "ADECO Pool" and the "TSA".

INE complex belongs to the Joint Research Centre of Ispra (JRC-Ispra), which is located in the Province of Varese, on the eastern shore of Lake Maggiore, at the foot of the Lombardy Alps, about 22 km from the nearest Swiss border crossing.

Within the JRC, in another nuclear installation separate from INE, i.e., in an area called "AREA40" there is a nuclear waste storage facility, currently in operation with a regular operating license called "ISF" – Interim Storage Facility.

D.III.1.1.3. Key parameters per installation

- Name/Type of facility: ESSOR nuclear plant
- Year of end of operation (reactor): 04/07/1983
- Year of authorization for decommissioning: Application submitted in March 2023
- Scheduled end of decommissioning operations date: 30 years after decommissioning license
- Intended end state: 2046 (pre-decommissioning)
- Decommissioning safe store conditions after end of operation:
- Dismantling operation: safe storage coditions before decommissoning

D.III.2 Fire Safety Analyses

D.III.2.1 Fire Safety Analyses for EUREX plant under decommissioning

D.III.2.1.1. Types and scope of the fire safety analyses

The risk assessment was conducted with deterministic methods without Fire Safety Engineering criteria.

In compliance with the specific VRI Procedure operating within the JRC-Ispra, the analysis of possible adjustment interventions, for the purposes of Fire Prevention and of general fire safety criteria, was carried out.

The JRC-Ispra site is not subject to the control of the competent fire brigade Command for the operation of its activities. However, in accordance with the self-regulation (extra-territory site) that has been given, the JRC-Ispra provides a final assessment of the adaptation of the existing building or the construction of new buildings, which is "equivalent" to the requirements of Article 4 of the Fire Prevention Controls of Presidential Decree 151/2011. This assessment verifies the completeness of the documentation acquired during the construction or fire adaptation works and finally expresses a judgment of substantial authorization to carry out the activities inside the building.

The radiological impact assessment on the operators concerned and on the external population has been carried out, verifying that dose rate is always lower than the maximum required by the legislation. The INE plant is subject to the ISIN oversight.

D.III.2.1.2. Key assumptions and methodologies

In order to accurately identify the fire risks and the preventive and protective measures for fire protection purposes, the activity has been completely re-evaluated, also in consideration of the recent regulations issued by the competent bodies (Legislative Decree 151/2011, Legislative Decree 81/08 and Ministerial Decree 10.03.98).

The VPI document is the update of the ESSOR Nuclear Plant (INE) safety report, with the aim of providing an overview of the installations, taking into account the changes that have occurred to date.

The document describes the ESSOR Nuclear Plant (INE), with reference to:

° The environmental framework of the area where INE is located.
° A description of the buildings and systems which INE is composed of.
° The overview of the installations, the management methods and the conditions limiting the operation.
° Previous operating experience.
° The plant characterization including radioactive material and radiation levels.

The document identifies the reference configuration to be taken for future uses of the plant, future activities and relevant authorization activities.

The dimensional and performance data relating to the systems and installations are deduced from the ESSOR safety report, from the safety reports relating to plant modifications and from the project documents. The data refer to the situation at the date of drafting the report.

The INE safety plan is available, describing the interventions carried out or nearing completion on buildings and installations, in order to obtain the best safety conditions for workers. The plan describes the routes to lead personnel to a safe place in the event of an accident. The safety plan shall be integrated with the nuclear emergency plan.

Inside some laboratories there are radioactive waste materials stored inside metal drums or special containers. They are in a temporary storage position waiting to be delivered to specific permanent storage areas. In these cases, the analysis of fire loads is carried out and the requirements for the correct use of the affected areas are given.
The fire brigade within the JRC-Ispra operate autonomously with limited intervention times.

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

No special codified procedures were used for the assessment of fire phenomena. The identification of fire hazards is performed, taking into account the following aspects:

- The complex is separated from other buildings by open space.
- The complex will be divided into different fire compartments depending on the intended use, on the fire load and on the danger of the area. The individual fire compartments shall be separated from each other by fire-resistant structures.
- The fire resistance of the separating structures was determined based on the results of the partitioning work carried out in 2014, and on the basis of the related Documentation, the REI 2018 CERTs were issued as an annex to the Fire Documentation useful for the Fire Certification and relative SIA (Studio di Impatto Ambientale – Environmental Impact Study).

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

Following the outcome of the risk assessment, one or more of the following measures to reduce the likelihood of fire outbreaks shall be taken (in cases where this has not yet been done):

C) TECHNICAL MEASURES.

D) ORGANIZATIONAL-MANAGERIAL MEASURES.

To adopt appropriate fire safety measures, the most common causes and dangers that may lead to the occurrence and spread of a fire have been considered.

In order to prepare the necessary measures to prevent fires, particular attention was paid to:

- Storage and use of easily combustible materials.
- Use of heat sources.
- Electrical systems and components.
- Maintenance and renovation work.
- Alarm procedures
- Training and information for workers

The main results of deterministic Fire Hazards Analysis (FHA) are attached to the ESSOR DVR.

D.III.2.1.5. Periodic review and management of changes

D.III.2.1.5.1. Overview of actions

In relation to the operational procedure adopted within the JRC-Ispra, the VPI document and its SIA should be updated within 5 years. Within this period, the requirements that have been completely/partially fulfilled must be verified and the forecast documents updated.

The assessments carried out are fully evaluated not only every 5 years (as per legislation) but also on the occasion of regulatory updates (e.g. Ministerial Decree 09/2021), or if requested by the competent Authorities following inspections, or when the OP (Operational Plan)/DP (Detailed Project) are presented.

Some actions are currently underway to comply with Fire Regulations:

EMERGENCY DIESEL GENERATOR building 84a

In order to eliminate the emergency generator and related diesel storage tanks ~~located in building 84a~~, a new dedicated power supply is being developed, deriving from INE complex, which already has an emergency power supply from generators.

WATER NETWORK

Some renovations have recently been carried out on the outer ring of the hydrant network.

REMOVAL OF ELECTRICAL CABLES

The removal of electrical cables and components within the Controlled Zones has begun.

D.III.2.1.5.2 Implementation status of modifications/changes

Fire prevention adaptation activities are currently underway, as listed in the VPI document.

D.III.2.1.6 Licensee's experience of fire safety analyses

The safety status of ESSOR in the field of Fire Prevention has been subject to assessment during the VPI procedure and adaptation requirements have been issued, which are being fulfilled.

D.III.2.1.6.1. Overview of strengths and weaknesses identified

The ESSOR Nuclear Plant (INE), which includes irradiated fuel storage, is located at the Joint Research Centre of the European Commission in Ispra (VA) and is part of an extraterritorial context. In order to acquire the autonomy towards the territory and the neighbouring administrations, the site has organized itself with a rapid intervention barracks dedicated to emergency support for research activities and for the management of nuclear installations.

The barracks of the Emergency and Response Support Service (ERSS) is therefore one of the main strengths for fire prevention, as:

- The garrison is guaranteed continuously, 24 hours a day, 7 days a week.
- Interventions are carried out within a timing that does not exceed 5 minutes.
- In the off-work hours, the relevant nuclear alarms are transferred to the ERSS barracks, which is also responsible for convening (pursuant to Art.91, Legislative Decree 101/2020) the plant technical personnel on call.
- emergency personnel have specialized training for nuclear safety and health protection of workers, the population, and the environment.
- The volunteers of the ERSS Service include ESSOR Plant internal staff, ensuring a greater dissemination of specific skills.
- ERSS Service is equipped with means dedicated to deal with technical, firefighting, NBCR (Nuclear, Bacteriological, Chemical and Radioactive), health emergencies, as well as suitable for environmental prospecting.
- Other STRENGHTS include:
- The adoption of policy, procedures and training programmes, which continuously improve the safety culture, both for management and employees.
- Among the most significant WEAKNESSES:
- Being extraterritorial, a National Authorization Process is not adopted at the JRC-Ispra, with the consequence that there is no written evidence of authorizations by the competent Authorities, pursuant to Ministerial Decree 151/2011 (SCIA or CPI). This Process would have ensured a further evaluation of Third Party.
- The management of turnover of retired employees, because usually, the availability of new personnel is subsequent to the retirement process and can lead to a PLANT know-how loss

D.III.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

- The current good technique provides for the prohibition of any gas fire extinguishing system in case of presence of personnel.
- The provision of portable auxiliary fire extinguishers to be available on the basis of the ERSS Service assessment.
- The disposal by protocol of gas no longer in accordance with the rules.
- the reassessment of future operational needs taking into account the obligations arising from the Safety Report.
- Notes/observations and inspection reports with requirements from the competent authorities.
- The constant interactions with the Italian Nuclear Safety Authority (ISIN), even on site and the possibility of direct comparisons with this Authority (e.g. Joint Committee provided in accordance with Law 901/1960) have made it possible to constantly improve the infrastructure and procedures relating to fire protection on site, ensuring greater attention to personnel safety.

D.III.3 Fire Protection Concept and Its Implementation

The applicable WENRA Safety Levels are those related to Facilities under decommissioning. Nevertheless, the ESSOR plant and its related laboratories are currently in a SAFE STORAGE phase while the decommissioning authorisation has not been granted yet since the application was submitted only in 2023.

D.III.3.1 Fire prevention

D.III.3.1.1. Design considerations and prevention means

The INE plant management regulation requires that the fire system is suitable for the protection of the INE complex and that it is always in operation. The INE Complex has a fire detection system, consisting of thermovelocimetric and smoke detectors, which control the containment structure and the exterior of the buildings, with the exception of some buildings, controlled by an independent system. The fire detection system will be kept in operation with all the components currently installed.
The quantities of combustible materials present are reduced to the minimum necessary for the normal conduct of work. In all working departments it is forbidden to smoke and use open flames.

The quantities of combustible materials present are reduced to the minimum necessary for the normal conduct of work. In all working departments it will be forbidden to smoke and use open flames.

Ignition sources
The ignition sources are reduced to a minimum through the adoption of electrical systems suitable for the place of installation, and of specific work procedures.

Training and information
Workers will be trained and informed about the fire risks present in the activity, the procedures to be adopted to limit these risks, to prevent fires and in case of fire.
Overall assessment of hazardous substances for fire-fighting purposes with quantities and types
This paragraph briefly describes the main substances dangerous for protection purposes, with quantities and types, and the main fire protection devices of the whole activity.

Dangerous substances
Within the areas concerned there are no combustible substances relevant for fire prevention purposes, apart from electrical systems currently in disuse and without voltage. To date, the work activities within the controlled zones are limited to the scheduled maintenance of the facilities, performed by external companies, to environmental monitoring with radiation protection systems, to instrumental surveys of various types preparatory to the executive design of the decommissioning phases, to cleaning works of the rooms.

Crowding of areas
The total number of people employed within the activity is about 38, distributed in the various areas. The abovementioned number of people is indicative and subject to excursions depending on the needs of the technological cycle and, therefore, the maximum declared continuous presences per environment may be subject to variations in the order of 2 or 3 units, considering the global number of people. In work areas where there is no continuous presence of personnel, the number of people will be occasional and limited to the time needed to perform the necessary work operations.

Fire Load Assessment
As for the calculation of the fire load, it was conducted exclusively for rooms where there are combustible materials in significant quantities; this calculation was carried out according to the Ministerial Decree 16/02/2007. The fire load values found, compared with the fire resistance classes attributed to the different rooms, show a considerable margin of safety of the buildings against fire, although these values are extremely variable considering the amount of electrical equipment in disuse.

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

We proceeded as follows:

- Fire risk mitigation procedures are undertaken by reducing the fire load
- Action was taken by reducing the fire load in the classified area by eliminating the electric cables and the parts of the electrical installation without power supply (out of service).

The fire prevention system has been designed and, over time, implemented according to the criteria:

- Minimize the likelihood of fires
- Eliminate combustible material and potential sources of ignition to the practicable extent.
- Strict control of these sources of ignition by limiting their number and location, for example separate ignition sources from combustible material.
- Fire control and mitigation by early fire detection and extinguishing.
- Prevent the spread of fires.

The presence of the Fire Brigades inside the JRC, whose intervention is in a short time, is an added value by implementing for most systems the extinction by firefighters and not automatic extinguishing systems

FIRE PROTECTION

It includes the measures:

- to prevent fires from starting (nature and quantity of combustible material, fire permit);
- to detect and extinguish quickly any fires that start (detectors, alarms, extinguishing systems);
- to prevent the spread of fires and their effects that may affect safety (fire compartment, redundancy).

D.III.3.1.3 Licensee’s experience of the implementation of the fire prevention

D.III.3.1.3.1. Overview of strengths and weaknesses

The ESSOR Nuclear Plant (INE), is located at the Joint Research Center of the European Commission in Ispra (VA) and is part of an extraterritorial context. In order to acquire the autonomy towards the territory and the neighboring administrations, the site has organized itself with a rapid intervention barracks dedicated to emergency support for research activities and for the management of nuclear installations. The barracks of the Emergency and Response Support Service (ERSS) is therefore one of the main strengths for fire prevention, as:

- The garrison is guaranteed continuously, 24 hours a day, 7 days a week.
- In the off-work hours, the relevant nuclear alarms are transferred to the ERSS barracks, which is also responsible for convening (pursuant to Art.91, Legislative Decree 101/2020) the plant technical personnel on call.
- emergency personnel have specialized training for nuclear safety and health protection of workers, the population, and the environment.
- ERSS Service is equipped with means dedicated to deal with technical, firefighting, NBCR (Nuclear, Bacteriological, Chemical and Radioactive), health emergencies, as well as suitable for environmental prospecting.
- Possibility of additional intervention, in case of need, of the vehicles of the Provincial Fire Brigade Command of Varese, which operates in collaboration with the Internal Fire Brigade Command of the JRC-Ispra site.
- Cooperation with national emergency management agencies is being organised. This approach aims to improve the relationship with other stakeholders (such as fire and rescue services and national fire supervision, etc.).

In the perspective of decommissioning, the investment commitment for the renewal of the fire systems is difficult, although strategic. Extraterritoriality implies the lack of jurisdiction for the Italian non-nuclear bodies in charge (such as the Italian Fire Brigade) and consequently the inapplicability of the procedure for obtaining the Fire Prevention Certificate (CPI).

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

The gas system of some cells, has recently undergone an unexpected degradation of the extinguishing charge. Analysis of this situation led to the following conclusions:

- the extinguishing gas is NAF S III, no longer in compliance and therefore not reintegrable.
- the current good technique provides for the prohibition of any gas fire extinguishing system in the event of the presence of personnel.
- the provision of portable auxiliary fire extinguishers available based on the ERSS assessment.
- the disposal by protocol of the gas no longer in accordance with the rules.
- the reassessment of future operational needs due to the obligations arising from the Safety Report.

D.III.3.1.3.3. Overview of actions and implementation status

In order to know in real time the presence of the staff in the various technical areas of the plant, for a better management of the activities, the physical subdivision of the accesses, now granted through personal identification card, has recently been completed. This system allows the INE Control Room staff as well as the security service to identify the personnel in the various areas of the plant also for the purposes of fire safety and in general emergency management. The fire load is being decreased through the removal campaign of obsolete cables and not relevant systems. Regular inspections by the Control Authority represent an added value.

An internal procedure is operational to verify the status of ongoing and planned actions in the field of safety in general and fire prevention in particular:

- Reduction of the existing fire load in the premises inside the controlled zone and supervised area by removing the electrical cables and electrical system components no longer live;
- Replace, where necessary, all the general release switches, manually activated, at the entrance of the premises, and position them in a clearly visible way to facilitate their operation;
- Inside rooms, avoid hot maintenance work with the use of emery and equipment that may develop ignition sparks (M.D. March 1998), or if necessary adopt specific processing procedures, possibly in the presence of fire brigade. For hot working, always follow the Site Procedures;
- Use, where possible, non-electric, portable battery-powered users and processing tools with accumulators and small battery-powered G.E., whenever possible;
- Insertion of barrier type smoke detectors or other suitable type one per floor, to acquire a smoke presence control as precise as possible;
- Insertion of smoke detection sensors specific for pipelines, inside the air extraction channels in the controlled zone environments, to automatically dissect the supply / return ducts, allowing the blocking of the supplies and the management of only the return of the air conveyed to the chimney and expelled after filtration;

D.III.3.2 Active fire protection

(Section 01.4 – for Acive fire protection)

Based on the FHA, the principles of defence in depth were applied, operating in the order according to the following procedure:

- reduction of combustible material masses;
- reduction of possible ignition sources;
- Active protection with smoke detection systems;
- Passive protection with ventilation systems and compartments;
- extinction delegated as much as possible to the intervention of the fire brigade inside the JRC.

D.III.3.2.1 Fire detection and alarm provisions

D.III.3.2.1.1. Design approach

The decision to adopt "Fire detection and alarm" derives from the fire risk assessment that provides for these systems to reduce the risk. Therefore, they are operated because of the fire risk analysis and the application of current technical regulations. The detection systems consist of a network of fire detectors and a network of smoke detectors. The detectors are distributed in the different rooms, are collected in groups and each refer to a power, signalling and alarm control unit. The alarms are reported in the main manoeuvring room and to the JRC fire brigade. In particular, the alarms are:

- FIRE (from the fire detector control unit);
- SMOKE DETECTORS (from the smoke detector control unit),
- PETRA FIRE (groups the ADECO hot cell systems, the control unit is located in the front-cell room).

D.III.3.2.1.2. Types, main characteristics and performance expectations

This system consi The smoke detection systems are independent for each environment. The control centre and the Fire Station know exactly in real time which sensors are affected by the alarm. The lines are equipped with differential protection from the generator panel. The INE Complex fire extinguishing system consists of:

- prevention systems;
- detection systems.

Prevention systems

Prevention is entrusted to risk reduction activities, such as the electrical cables removal of disconnected equipment, and to procedures that prevent the accumulation of flammable materials in unprotected areas

Detection systems

INE buildings and premises are generally equipped with fire detectors and manual fire alarm buttons. The buttons are protected from accidental actuations and clearly indicate the use which they are intended for. Each detector and button refer to a power, signalling and alarm control unit. The alarms of the control unit, both in case of failure and in case of fire, are reported in the main control room and at the SRST station. The connection between the control unit and the SRST barracks is via a double line system, one main and one reserve; the system is powered not only by mains electricity, but also by a subsidiary energy source. In case of failure the main line stops, signalling the non-functioning and the reserve line intervenes. In the event of an alarm, SRST personnel intervene within 3 minutes. Manual fire alarm buttons will be available at the positions provided in the fire load assessment project; they will be appropriately reported.

Distribution of emergency exits

At the service of the activities there is a system of escape routes, compliant with the parameters set by Legislative Decree 81/08 and subsequent amendments and additions and with the parameters set by the D.M. March 10, 1998. This system is an integral part of the DVR and the Evacuation Plan and is constantly updated by the RSPP office. However, in some laboratories, it is not possible to comply with the parameters set by the D.M. March 1998 as the nuclear emergency prevents the opening of openings in the sealed containers. In any case, the presence of personnel inside the laboratories is limited or occasional.

Electrical

The electrical systems of the buildings will be adapted, where possible, with the nuclear nature of the site, both in the Safely Conservation phase and in the upcoming decommissioning phase, in compliance with the regulations stated by the ITALIAN ELECTROTECHNICAL COMMITTEE or even other legislation that may be adequate to the provisions of Law 186 of 1 March 1968.

D.III.3.2.1.3. Alternative/temporary provisions

When it is needed to disable temporary the fire detection system locally or globally, alternative arrangements are provided (e.g. increase of control by staff in radio contact with the control room and in the presence of the internal JRC fire brigades' personnel).

D.III.3.2.2 Fire suppression

Fire extinguishing can be carried out by:

- fire extinguishers (powder and/or CO2).
- Hydrants.
- internal JRC fire brigades' personnel means of extinction.

The fire extinguishers are appropriately marked and fixed to the wall with the possibility of easy and quick release, without resorting to the use of keys, ladders or other; the choice of the type and quantity of fire extinguishers is made with regard to fire risk and fire load.

The maintenance and verification of fire-fighting equipment are carried out by qualified personnel, according to the deadlines established by current legislation.

The emergency signalling systems in INE consist of several signalling devices, according to the category of danger:

- optical/acoustic signals;
- sirens, through standard sound.

Extinguishing systems

The fire extinguishing systems of the INE consist of a network of hydrants with UNI 45 connection and equipped with hose and lance. CO2 and powder fire extinguishers are distributed on the plant and in the rooms; they are assigned, in quantity and type, in relation to the specific risk. Within the JRC there is always a team of firefighters, specially trained in relation to the ESSOR nuclear plant. In ESSOR there is a single halon automatic fire suppression system (in ADECO cells). The plant is being phased out for safety reasons. All the systems are under periodic review as indicated by national norms and standards.

Fire-fighting water distribution network

The fire-fighting water distribution system in the ESSOR complex is supplied by 3 tanks located inside the INE area. The basins are located outside the INE and are managed by the JRC's Technical Services Unit. The ventilation and air conditioning system ensures adequate temperature conditions and the necessary air changes. Currently, with the plant in permanent shutdown, the specific risks deriving from the operation of the various process circuits (for example the elimination of organic refrigerants) have disappeared and the sprinkler systems and the general sprinkler network are taken out of service or removed. This is to reduce the extension of the network, with advantages in terms of reliability and lower management costs. The network of water supply points is operable and in service. They are equipped with UNI 45 connections, hose and lance. The same network has been modified to protect the new installations and laboratories that have been included in the ESSOR complex. An extraordinary maintenance intervention on some sections of the outer ring of the INE buildings was completed, which made it possible to replace some damaged sections and close the ring distribution system. The internal hydrants of the INE buildings in the Controlled Zone have been decommissioned. The fire safety adaptation project includes strategies to improve the performance of the hydrant network inside the INE buildings. In particular, the removal of the internal hydrants in the Controlled Zone and Supervised Areas and the deactivation by emptying the existing water ring were carried out. This is because the aging pipe network does not offer guarantees of tightness and is subject to probable leaks. Furthermore, in the presence of fire, the Fire Brigades prefer as far as possible to avoid the use of hydrant networks supplied with the building and directly connect their vehicles to the UNI 70 connection. In addition, the presence of water in the Controlled Area constitutes a further danger from the point of view of disposal as it is difficult to see in the undercurrent sections. The elimination of hydrants does not compromise fire safety equipment if compensatory procedures are implemented by adding to the endowment, in the immediate vicinity, 2 powder and CO_2 hydrants for each hydrant eliminated.

Portable first-aid firefighting equipment

The choice of portable and wheeled fire extinguishers was determined according to the fire class and the level of risk of the workplace, according to the indications of the Ministerial Decree of 10 March 1998. The mobile extinguishing equipment supplied consists of portable fire extinguishers, mainly powder, located at different points, along the exit routes, near the exits and hung on the wall by means of appropriate supports. Extinguishing agents are compatible with substances being processed and/or stored.

D.III.3.2.2.1. Design approach

The presence of Fire Brigades on site is an important factor to be considered in the design approach for every JRC facility.

Considering future activities in the TSA dry storage facility, JRC is evaluating to use a new fire suppression systems updated to the latest technical standard in order to avoid automatic discharge of gas during the presence of personnel in the premises concerned. For the spent fuel pool, some actions are envisaged such as the installation of smoke detection sensors inside the ventilation channels, the installation of additional fire dampers and the replacement of existing channels with others suitably classified REI.

D.III.3.2.2.2. Types, main characteristics and performance expectations

The fire extinguish system is designed according to the national technical law considering also the presence of Fire Brigades on site.

D.III.3.2.2.3. Management of harmful effects and consequential hazards

Fire harmful effects and hazards are managed for the Spent Fuel Pool (1) and TSA (2), in the following way:

- ✓ On site fire-fighting brigade (24hr/7days) that can perform also an on-site inspection/patrol on demand;
- ✓ Nuclear technical experts available outside normal working hours, based on needs;
- ✓ National fire brigades (VVF) located in the vicinity of the JRC site that can intervene using their means and vehicles to face the effects/hazards;
- ✓ Video Surveillance Systems that can be used to monitor the effects/hazards;
- ✓ control and monitoring systems of staff presences in each specific area;
- ✓ continuously downgrading the fire loads with appropriated dedicated measures;
- ✓ continuous updating of procedures/documentation as for example:
    - Emergency plans;
    - List of prohibited flammable materials introduced based on activities;
    - Training plan.

D.III.3.2.2.4. Alternative/temporary provisions

If a fire extinguish system is inaccessible, alternative measures are adopted:

- appropriate device able to reach the needed area;
- increase of portable devices;
- specific procedure for workers.

D.III.3.2.3 Administrative and organisational fire protection issues

Each fire alarm situation is managed directly by the Fire Brigades on site. The procedure is activated by the security staff who work 24/7.

A suitable VPI procedure within the JRC is active for the verification of fire loads within each room. The procedure of verification, control and scheduled maintenance is active as per current laws on active and passive detection/extinction systems.

Periodic training procedures for fire-fighting personnel are active for the first interventions. Then, the internal garrison of the Fire Brigades intervenes immediately.

The internal personnel of the Fire Brigades are trained and equipped to operate in the nuclear field.

D.III.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

Scheduled maintenance procedures are underway approved, according to legal regulations. This procedure involves the drafting of work sheets, risk assessment documents and joint inspections. Avoid hot processing, use cables and extension cords as short as possible. Activate Safety Procedures for the execution of works within the Centre (free flame works, interventions on machines and plants, etc.). Prevent isolated access to service personnel within the Controlled Zones, allowing it only to a minimum of two people. Special processes will be carried out in the presence of Fire Brigades.

Emergency Management System - Existence of an effective emergency management system (INE general emergency plan, trained fire rescue team available 24 hours a day, etc.).

Maintenance of significant systems for the purposes of Fire Prevention - Scheduled Control of the plants:

- electric
- atmospheric discharges
- Fire detection
- Signalling and alarm
- emergency lighting
- fire extinguishing (automatic and manual)
- controlled zone and supervised areas ventilation
- HVAC

Change Management – Applying the procedure for authorizing changes to plants, structures, lay-outs, materials and equipment. Fully comply with the INE Procedures (specific document for Improvement-Variant procedures) also computerized.

Presence of flammable substances and materials - prohibition of introducing flammable liquids into the INE (this provision is already referred to for laboratories within the technical requirements of the Operating Licences).

C**ontrol and monitoring systems of presences in CZs and SAs** – intensified the level of control and monitoring of attendance in controlled zone and supervised areas to identify, in the event of fire, the people present within certain areas of the building and their exact location.

Video Surveillance Systems
Intensify the control of presences inside the C.Z. and S.A. by intensifying the number of video surveillance terminals connected to the internal CCTV.

Maintenance Materials Management
Activate appropriate strategies and actions for the Management of Materials of small Maintenance or Warehouse residues, to reduce Fire Loads inside the premises by removing useless material and manage separate collection and storage in protected areas.

D.III.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

Fire fighters, who activate the JRC's internal emergency procedures for conventional and/or nuclear alarms if necessary, are constantly present in the Control Room. There are codified written procedures of intervention that define the actions of the internal ESSOR fire fighters. The employees are constantly trained.

Periodic fire evacuation exercises are activated. All those present within ESSOR are informed about the procedures to be adopted in the event of a fire alarm with orderly movement towards the Meeting Points. The teams of the Fire Brigades operating 24 hrs/day, based within the JRC Ispra site, have intervention times of about 5 minutes, in case of detection of anomalies and alarms by the INE detection systems. They are perfectly trained for any type of intervention. It is envisaged a fixed garrison, or verification patrol (vehicle and first intervention team), of the Fire Brigades within INE, in permanent preparation in case of activities with significant risk or failure of the fire protection systems. It is envisaged that, in the intervention procedures, the FB can operate immediately and autonomously within the various areas even without the presence of internal INE staff, on remote availability at night and during holidays or weekends. This allows a drastic reduction in time and consequent increase in the effectiveness of interventions.

D.III.3.2.3.3. Specific provisions, e.g. loss of access

The Internal Emergency Plan of the JRC is active, which plans to alarm the Civil Protection, Prefecture, neighbouring municipalities, etc.

D.III.3.3 Passive fire protection

The interventions are aimed at reducing fire loads and the risk of ignition, to detect any anomalies with suitable automatic systems and to activate intervention procedures.

D.III.3.3.1 Prevention of fire spreading (barriers)

REI 120 minimum level fire compartments are designed to ensure the isolation of areas of specific sensitivity. Fire doors and hole seals are provided.

Partitioning components (walls, ceilings, false ceilings, doors, handles, sealing, etc.) are subject to periodic maintenance in accordance with the law.

D.III.3.3.1.1. Design approach

All building structures shall ensure fire resistance appropriate to the fire load provided therein. The compartments have a fire resistance class compatible with the expected fire loads and are calculated according to Italian regulations. The last partitioning carried out in 2015-16 was certified **for fire resistance purposes by a Firefighting Technician during the VPI Procedure drafting phase through CERT REI. <u>It should be noted that the structures of each part of the INE building will guarantee a fire resistance adequate to the fire load calculated as per the regulatory procedure.</u>**

D.III.3.3.1.2. Description of fire compartments and/or cells design and key features

REI classification of equipment (e.g., doors) is derived from the classification of respective structural compartment.

D.III.3.3.1.3. Performance assurance through lifetime

It should be noted that the structures of each part of the INE building will guarantee adequate fire resistance to the fire load calculated as per the regulatory procedure. The following prescribed compartments are to be carried out: All source storages inside INE must be encapsulated in security safes, specifically made, and possibly, if not commercially available of the necessary dimensions, tailored to specific needs. The resistance must be REI 60/120. Among activities, the partitioning of specific risk areas has been envisaged. The various partitions will be separated from each other by structures with fire resistance characteristics not lower than REI 60.

D.III.3.3.2 Ventilation systems

Existing ventilation systems guarantee the same continuity class as the compartments in terms of segregation and smoke detection systems. Some ventilation channels are equipped internally with smoke detection sensors.

All ventilation systems are equipped with fire dampers.

D.III.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

Fire systems have the same REI class as wall compartments. The ventilation systems that pass through adjacent compartments are equipped with fire dampers controlled by a smoke detection system. The damper closes the air circulation. The operating logic foresees that in case of fire the smoke detection system automatically blocks the air flow in the supply and return channels.

D.III.3.3.2.2. Performance and management requirements under fire conditions

The main ventilation system will be kept in its normal configuration to ensure negative pressures and air changes. During the decommissioning phase the confinement of the work areas, where the ventilation system is not present or no longer functional, will be built temporary confinement structures, equipped with SAS and a portable ventilation system. For future cutting operations portable fume extraction units will be installed on site. Once the decommissioning of an intervention unit is complete, and once the premises or areas have been cleaned and decontaminated, the ventilation will be rebalanced gradually. In this phase improvement interventions envisaged will concern the installation of smoke detectors on the extraction ducts for the activation of automatic shutters for closing the air inlet/extraction ducts.

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

The strengths and weaknesses of protection systems are briefly listed below. Among the strengths, the extreme attention paid to the assessment of fire risks according to the VPI internal procedure is highlighted. The risks have been well defined and analyzed with a conservative approach considering the applicable legislation, the basic safety standards for similar plants and the state of the places. Actions are underway to comply with the stated fire safety requirements. The fire risk assessment has identified the functional requirements and performance criteria of fire protection systems to be adopted in the various buildings; Since there have been no events such as to ascertain the actual efficiency of fire protection systems, their required capacity/performance is verified in a documentary manner (e.g. REI certifications, plant declarations of conformity). A possible criticality is connected to the transformation of the Site due to evolving decommissioning activities. The procedures will have to be verified and adapted to the different phases of the decommissioning procedure. Some actions envisaged as VPI requirements are being activated, such as the installation of smoke detection sensors inside the channels (ventilation system), the installation of additional fire dampers and the replacement of existing channels with others suitably classified REI.

D.IV EUREX (FCF)

D.IV.1 General information

D.IV.1.1 Nuclear installations identification

- Name: **EUREX reprocessing facility in the Sogin Saluggia Site**
- Licensee: **Sogin SpA**

The Sogin Saluggia Site is located in northern Italy, in western Pianura Padana, 45 km from Turin, in the province of Vercelli, approximately 2 km south-east of Saluggia town. The Site managed by Sogin since 2003 is located in a part of the ENEA Research & Development Centre, centre where only conventional activities are run. Contacts and sharing of information with the National Fire Brigades (VVF), whose headquarters and main fire fighting equipment and vehicles are located in Vercelli city (40 km away), are continuous. The Centre covers approximately 100.000 m2 of ground, which Sogin Site covering approximately 70.000 m2 of. The Sogin Site in inside the Saluggia industrial area, where about 1000 people work and which hosts bio-medical factories and the spent fuel storage Deposito Avogadro Plant (managed by another licensee), where spent Sogin fuel is stored. The plant was built in the 60's, in the frame of the Italian R&D plan for spent fuel reprocessing and consists in a block of shielded cells, hosting the reprocessing equipment (tanks, steam-jets, piping, mixer-settlers, evaporators…).

D.IV.1.1.3. Key parameters per installation

- Name/Type of facility: **EUREX Spent Fuel Reprocessing**
- Year of end of operation: 1983
- Year of authorization for decommissioning: overall authorization requested – decommissioning activities performed under specific authorization
- Scheduled end of decommissioning operations date: 2037
- Intended end state: release for unrestricted use
- Decommissioning safe store conditions after end of operation: not applicable
- Dismantling operation: in progress
- Waste treatment on the site: in progress

D.IV.2 Fire Safety Analyses

D.IV.2.1 Fire Safety Analyses for EUREX plant under decommissioning

D.IV.2.1.1. Types and scope of the fire safety analyses

For the facility the Fire safety analyses is referred to a deterministic fire safety analyses such as a Fire Hazard Analysis (FHA).
The project of the facility was developed with the aim of equipping the installation with all the systems necessary to prevent fire risk and all those necessary to mitigate any consequences, with reference to the protection of workers and the possible impact on the external environment.
Designing the fire safety of the facility was developed identifying the technical and management solutions aimed at achieving the primary objectives of fire prevention, which are:

a) safety of human life,
b) protection of people (protection of workers and the possible impact on public)
c) protection of property and the environment

The primary objectives of fire prevention are achieved if the activities have been designed, implemented and managed in such a way as to:

a) minimize the causes of fire and explosion;
b) guarantee the stability of the load-bearing structures for a set period of time;

c) limit the production and propagation of fire within activities;
d) limit the spread of fire to adjacent activities;
e) prevent environmental radiological impact in case of fire
f) ensure that the occupants can leave the activity safely or that they be rescued in another manner;
g) ensure that the firefighter/rescue squads are able to work under safe conditions.

Fire risk analysis has been performed according to following input, suggesting a fire event as very remote:

- Process cells has negligible fire load;
- Waste is all contained within metal casings;
- No significant ignition sources are considered;
- No other combustible materials are present.

On the basis of the accident scenario described, the release of a certain amount of radioactivity to the environment (source term) has been conservatively evaluated.

The consequences to the environment were evaluated in terms of dose to the population and operators involved in the restoration operations and in terms of soil contamination, considering conservatively a release without filtration.

The doses resulting from workers and the population are lower than the objectives assumed in the project in full compliance with the National limits.

In detail, for all the nuclear installations in the EUREX facility prior operation, a fire safety analysis is made as a part of the overall one, item of the Detailed Design Report that – according to Italian law – as to be approved by the Regulator for Nuclear Safety before the operation.

Since 2000's the analysis is made through definite steps, which detail may vary according to radiological risk of the installation and are:

- Individuation of the accident events (earthquake, crash, fire, flooding…) where fire is one of the internals one
- Definition of safety and radioprotection objectives (dose to workers and population in case of event)
- Identification of safety relevant systems, structures and components and descending classification
- Safety analysis, with associated impacts and definition of the radioactive source term and related dose
- Check of the results

The analysis is done when in case of the event, the design countermeasures allow the respect of safety and radioprotection objectives.

D.IV.2.1.2. Key assumptions and methodologies

The design of fire safety is an iterative process, consisting of the following steps:

a. scope of the design: the activity and its operation are described qualitatively and quantitatively in order to clarify the scope of the design.
b. safety objectives: the safety objectives of the design applicable to the activity, are specified;
c. risk assessment: the fire risk assessment is carried out;
d. risk profiles: risk profiles are determined and assigned;
e. fire prevention strategy: risk mitigation is carried out through preventive, protective and management measures that remove hazards, reduce risks or protect against their consequences:
    i. defining the overall fire prevention strategy,
    ii. attributing performance levels for all fire prevention measures;
    iii. identifying the design solutions that guarantee the achievement of the assigned performance levels;
f. if the result of the design is not considered compatible with the purpose defined in point a), the designer iterates the steps referred to in point e) of this methodology.

The assumptions of fire scenarios do not consider malicious actions, prevented by the Physical Protection of the Site and the personnel selection.

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

The identification of the characterizing fire risk elements is carried out in accordance with the provisions of the Decree of the Minister of the Interior of 4 May 1998 and amendments of 2nd and 3rd September 2021. Ten activities have been identified, according to the law, to be checked by the national Brigade Fire, as reported in the planimetry. A qualified technician before issuing the technical report to submit to the National Fire Brigade, has carried out an inspection to verify the current situation of the activities subject to control, the efficiency of the fire protection systems and the compliance with the requirements included in the authorizations. On the basis of this report, the National Fire Brigade issued the authorization.

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

The FHA developed for EUREX facility demonstrates that any credible fire scenario doesn't lead to an unacceptable radioactive release to the public and environment.
In the Impact Analysis for the Off-site emergency Plan, approved by Inspectorate for Nuclear Safety and Radiation Protection, all the EUREX Facility events leading to radioactive release (fire included) have been analyzed. Where the radioactive impact is exceeding acceptable levels (i.e. no need for people evacuation or sheltering), actions are taken to reduce the risk or the impact, as solid waste conditioning or transfer to more suitable repository.

D.IV.2.1.5. Periodic review and management of changes

D.IV.2.1.5.1. Overview of actions

Any change to fire protection/fighting systems must be prior authorized by the Inspectorate for Nuclear Safety and Radiation Protection (ISIN) and National Fire Brigade. In any case, the Fire Safety Analyses are carried out and re-evaluated when the OPs (Operational Plan) or DPs (Detailed project), related to new installations or decommissioning activites, are submitted to the Authority, for approval.

D.IV.2.1.5.2 Implementation status of modifications/changes

At present there are no modifications/changes in progress

D.IV.2.1.6 Licensee's experience of fire safety analyses

D.IV.2.1.6.1. Overview of strengths and weaknesses identified

No weakness or strengths of fire safety analysis has been identified in the experience of the licensees.
From a general point of view, it must be considered that the Italian law for fire protection indicates in a prescriptive manner preventive and protection measures to apply, on the basis of a general assessment made by fire authority.
This approach is well defined and easy to apply. Only compliance with prescritions has to be achieved without specific computation to be performed by the operator.
On the other hand, this prescriptive approach, for complex installations as nuclear facilities, cannot handle specific aspects, mainly the interaction between fire and radiological risk. This is however taken into account in the safety analysis requirements established by nuclear regulators.

D.IV.2.1.6.2. Lessons learned from events, reviews, fire safety related missions, etc.

To comply with the requirements included in the authorization, the licensee has adopted technical/management procedures aimed as follows:

- Controls, verifications and maintenance interventions on fire-fighting systems are carried out in compliance with the mandatory reference standards.
- The personnel of the fire-fighting team are trained on the actions to be taken in the event of a fire on the plant, both in the Classified Area and in the No Controlled Area;
- The staff of the EUREX Facility is trained and informed of the behaviour to be taken in case of fire.

Specific prescriptions are issued by the Inspectorate for Nuclear Safety and Radiation Protection (ISIN) when OPs (Operational Plan) or DPs (Detailed project) are submitted to the Authority, for approval

D.IV.3 Fire Protection Concept and Its Implementation

D.IV.3.1 Fire prevention

D.IV.3.1.1. Design considerations and prevention means

The EUREX facility is designed to minimize the likelihood of fire through proper system layout and design and, as far as practicable, elimination and/or reduction of ignition hazard by separating ignition sources from flammable materials.

Additional preventive measures during the exercise are obtained through administrative procedures.

The fire prevention and protection measures are defined according to the fire risk assessment (Fire Hazard Analysis) and based on the general criterion of Defense in Depth:

- Minimization of additional combustible materials present in storage areas.
- Minimization of the possibility that the fire can start, grow, and spread rapidly by adequate disposition of contaminated combustible materials, equipment and, where possible, by separating the causes of fire from flammable materials.
- Arrangement of contaminated materials (combustible and non-combustible) in the operational accessible rooms so that the consequences of the fire in the storage area are maintained within the objectives of radiation protection for the population even in case of failure of the fire suppression systems.

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

Each dismantling activity is detailed in specific licensing documentation, including a fire hazard evaluation.

In general, the thermal cutting of steel and concrete is not allowed.

In general, for decommissioning purposes, the use of combustible material is reduced as much as possible (e.g. wood or paper shall not be introduced in radio-hazardous areas).

Whenever an ignition source shall be used (e.g. tools for mechanical cutting producing hot swarfs), combustible material are not allowed in the surrounding or, if possible, are segregated.

D.IV.3.1.3 Licensee's experience of the implementation of the fire prevention

Fire prevention and protection measures are in compliance with law and they are easy to be applied. On the other hand, situations that deviate from the planned path need a precise ad hoc regulatory and management interpretation with a risk assessment according to a performance approach.

D.IV.3.1.3.1. Overview of strengths and weaknesses

No weakness or strengths of fire prevention have been identified in the experience of the licensees.

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

No events have been recorded.

D.IV.3.1.3.3. Overview of actions and implementation status

No technological upgrade of some components of the fire detection circuits is due up to now.

D.IV.3.2 Active fire protection

(Section 01.4 – for Acive fire protection)

D.IV.3.2.1 Fire detection and alarm provisions

D.IV.3.2.1.1. Design approach

EUREX fire detection system has been chosen on the basis of the fire risk assessment. Its functions are:

- quickly detect a possible fire.
- minimize the risk to workers and the external environment due to releases of radioactivity following fires.
- alert the operator for any manual request for intervention of the CO2 fire suppression in case of fires in the equipped cells or elsewhere.
- he detection systems are designed to protect all EUREX significant areas
- remote transmission of alarm signals to predetermined area, according to the Internal Emergency Plan.

D.IV.3.2.1.2. Types, main characteristics and performance expectations

This system consists of:

- optic flame detectors.
- visual and sound alarm devices.
- the detectors are positioned, installed, and possibly adequately protected so that they cannot be subject to mechanical, chemical, or other damage that could affect their correct functioning.
- in the presence of a fire, the sensors will send a signal to the control unit, activating the remote alarm.

If the space affected by fire is a space protected by the CO2 extinguishing system, the optical-acoustic alarm activated shall also act as a warning alarm for manual activation of the system.

D.IV.3.2.1.3. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire detection unavailability thefollowing provision are applied:

- All the operations covered by specific fire detection unavailability must be stopped and the Authority has to be informed
- In operational accessible areas, alternative measures must be put in place (e.g., fire watch periodical surveillance).

D.IV.3.2.2 Fire suppression

D.IV.3.2.2.1. Design approach

With reference to the Ministerial Decree 10 Marzo 1998, the fire extinguishing system is ensured by fixed and mobile systems as follows:

- water hydrant network;
- fixed CO2 installation;
- fixed extinguishing gas system;
- fixed foam system;
- powder fire extinguishers (twin agents or CO2).

There are also emergency devices such as fireproof blankets and dampers.

All the EUREX facility is covered by a water hydrant network, serving the facility and the other site buildings.

D.IV.3.2.2.2. Types, main characteristics and performance expectations

The extinguishing CO2 intervention will provide for a discharge of extinguishing material only in the affected area. The discharge will have the purpose of quickly bringing the concentration of the extinguishing gas in the air to the design value, a necessary condition to ensure the extinguishing of a possible fire. During the discharge and in the subsequent phases, the plant is kept in depression by the air extraction system, compared to the the external environment. For areas with a low fire risk portable fire extinguishers are

provided. Exclusively for office areas, segregated and separated without communication with the areas of the EUREX plant, protection by water hydrants is provided.
The water supply of the hydrants is derived from water main of the Site, characterized by the presence of an external standpipes network that feeds above ground column hydrants to protect the entire Site area.

D.IV.3.2.2.3. Management of harmful effects and consequential hazards

Prior manual activation of CO2 discharge, working staff will be warned to leave the plant.

D.IV.3.2.2.4. Alternative/temporary provisions

Pursuant with Technical Specification for the operation in case of fire extinguishing system unavailability the following measures are applied:

- All operations in the area affected by fire extinguishing system unavailability must be stopped and the Authority has to be informed
- Alternative measures have to be put in place: fire watch periodical surveillance, additional fire extinguishers…

D.IV.3.2.3 Administrative and organisational fire protection issues

D.IV.3.2.3.1. Overview of firefighting strategies, administrative arrangements and assurance

As regards the administrative and organizational fire protection issues, in the Saluggia Site, where EUREX plant is located, the involvement of a specific fire-fighting competence is managed by:

- On site Fire-Fighting Brigade (FFB);
- National Fire Brigades (VVF).
- Procedures and other fire prevention and firefighting documentation as for example:
  - Fire-fighting Operational Manual;
  - Internal emergency plan;
  - Off-site emergency plan;
  - Training plan.

Periodic fire emergency drills are performed and some of them with the participation of the local VVF.

D.IV.3.2.3.2. Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

The firefighting strategies are assured by written. In these procedures, tasks and responsabilities are described in detail. The EUREX staff is divided in general staff, internal Firefightfers Brigade and the Technical Guard (on duty 24/24 7/7). Each of them is trained on what to do in fire emergency.

D.IV.3.2.3.3. Specific provisions, e.g. loss of access

The entrance to the Sogin Site and the internal road network allows easy transit and maneuvering to emergency vehicles, within the site the land is flat, and the viability is guaranteed by roads and squares. The layout ensures that the building is easily accessible and can be approached by the Fire Brigade (internal and external). The buildings are appropriately spaced from each other and have separate and independent accesses. Due to a Flood Defense Wall surrounding the site, a flood resistant emergency entrance is present, so no specific provisions for firefighting situations with loss of access routes are provided (public road network availability during flood cannot be guaranteed).

D.IV.3.3 Passive fire protection

D.IV.3.3.1 Prevention of fire spreading (barriers)

D.IV.3.3.1.1. Design approach

The EUREX facility was built in the 60's, according to existing rules and law so no compliance with 1998 Decreee is declared in the design or applied in the construction nor qualification for fire resistance is present.

D.IV.3.3.1.2. Description of fire compartments and/or cells design and key features

Shielding from radiation and separation in different reprocessing cycles, ensure that process cells are completely separated from each others by thick concrete walls and – after the reprocessing exercise was arrested – there is no more combustible material inside; operation areas are separated by thick airtight metal doors with pneumatic interlock.

D.IV.3.3.1.3. Performance assurance through lifetime

No issues specific issues are foreseen for the performance assurance. Maintenance and control are performed accordingly to national law and license technical prescription.

D.IV.3.3.2 Ventilation systems

D.IV.3.3.2.1. Ventilation system design: segregation and isolation provisions (as applicable)

No segregation of ventilation or fire dampers are present, due to design and construction time (60's); in any case the filtering unit is very far from eventual fire (long ventilation ducts).

D.IV.3.3.2.2. Performance and management requirements under fire conditions

Filters before stack expulsion are designed to be operable at high temperature (250° C).

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

The fire risk assessment is updated in compliance with the applicable legislation. The fire protection systems are kept under control trough procedures and personnel training. The current efficiency of fire protection systems is verified in a documentary manner (eg. fire certifications, plant declarations of conformity where existing). Critical issues can be found in the updating and modification of the protection measures considering that most EUREX systems date back to the time of construction of the plant. In the case of a new facility aimed to EUREX decommissioning or any decommissioning activity, the fire protection is designed according to the applicable legislation and the documentation is submitted to the Authority for approval.

National Inspectorate
for nuclear safety
and radiation protection

Appendix to the NAR - Final national list of “candidate installations”and “represented installations”, Italy

January 2023

Introduction

The present report provides information on the final selection of national installations of Italy for the TPR II, taking into account the conclusion of the Board Review and the final version of Technical Specifications. *Candidate* installations, which will be reported in the NAR, and *Represented* installations are indicated in the following table. A short description of the installations is also provided.

TPR II – Final Selection of National Candidate and Represented Installations for ITALY

Installation category	Candidate installations (To be reported in the NAR)	Represented installations
Nuclear power plant		
Research reactor	Lena Triga Mark II Tapiro Fast neutron	RC-1 Triga Mark II
Fuel reprocessing facility		
Fuel fabrication facility		
Fuel enrichment facility		
Dedicated spent fuel storage	In ITREC FCF under decommissioning site (Wet in operation and Dry under construction) In ESSOR reactor under decommissioning site (Wet and Dry, both into operation) Avogadro (Wet, into operation)	OPEC 1 (Dry Storage Facility)
Installations in Decommissioning	Latina NPP (Magnox Reactor) Trino NPP (PWR) EUREX FCF (Reprocessing) ESSOR - RR (now in Safe Store)	Caorso (NPP-BWR) Garigliano (NPP-BWR) ITREC (FCF - Reprocessing) IPU (FCF - Fabrication)
On-site radioactive waste storage	T1 – T2 (on Trino NPP site) E1, E2, E3 (on EUREX FCF site) OPEC2 (on IPU FCF site)	C1, C2, C3 (on Caorso NPP site) G1, G2, G3 (on Garigliano NPP site) L1, L2, L3 (on Latina NPP site) I1, I2, I3, I4 (on ITREC FCF site)
Total	17	19

Short description of Italian Candidate Installations for the TPR II

1. Research Reactors in operation

TRIGA Mark II Pavia

The reactor is a TRIGA Mark II open tank reactor operating at a maximum power of 250 KW, owned and operated by LENA, University of Pavia, and located in the city centre of Pavia.

The spent fuel is stored in special pits in the reactor building. There are 5 pits, two of them respectively contain 9 spent fuel assemblies.

Moreover, on the edges of the reactor pool, there are fuel racks where partially burned fuel assemblies, to be possibly inserted in the reactor, are stored.

As for other Italian Research reactors a periodic review is foreseen every 5 years addressed to review the operating experience and the status of reactor systems and components. The limited amount of radioactive waste (a few m^3 of VLLW and LLW), typically technological waste and ion exchange resins coming from clean-up water system, is stored in a dedicated building.

The limited amount of produced radioactive waste is managed on the site.

RSV TAPIRO

The RSV TAPIRO (fast reactor), operating at a maximum power of 5 KW, is owned and operated by ENEA and located in the Casaccia Research Centre.

The reactor is characterized by a neutron flux near the core centre having a spectrum very close to that of nuclear fission, with an average energy spectrum equal to 1 MeV.

The key feature of the reactor is the high enrichment of the fuel.

The reactor refrigeration plant consists of a circuit made of steel which allows the circulation of helium.

The limited amount of radioactive waste produced is sent for storage to an external facility located in the same centre. As for other Italian Research reactors a periodic review is foreseen every 5 years addressed to review the operating experience and the status of reactor systems and components.

The limited amount of produced radioactive waste is managed in installations of Casaccia Research Centre.

2. Dedicated spent fuel storage facilities

Avogadro spent fuel storage facility

Avogadro is a spent fuel wet storage facility away from reactors.

The storage building is focused on its storage pool, where the spent fuel lays in several racks.

The fuel temporary storage service is presently supplied to SOGIN S.p.A., the owner of the spent fuel unloaded from Trino and Garigliano nuclear power plants.

The facility is operated by the Deposito Avogadro Company.

Several transports have been arranged in recent years to transfer the fuel assemblies to UK and to France for reprocessing. At present only 63 fuel elements remain to be transferred to France in the framework of the in place service agreement. To prevent chemical corrosion of the structural materials of the fuel storage racks and of the bottles containing Garigliano fuel elements, the storage pool is filled with demineralised water and periodical controls of the chemical composition of pool water are imposed by the operative technical requirements.

Once the transfer abroad of the remained spent fuel will be completed the facility will enter into the decommissioning phase.

Spent Fuel Storage in ITREC Plant

ITREC, a pilot reprocessing facility operated in the '70ies (uranium-thorium cycle fuels from the US Elk River reactor). After having reprocessed 20 Elk River spent fuel elements, during the commissioning tests (1975-78), the operation was stopped. 64 U-Th spent fuel assemblies are still stored in the pool (10,7m x 3m x 7m).

The plant is managed by SO.G.I.N.

Preliminary decommissioning activities are ongoing according to a licence granted in 2006. Most of activities conducted up to now are related to treatment and conditioning of existing waste.

Radioactive waste generated during past operation are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
882,4	1928,2 (520)	219,5	136,8 (196)	163,4	31,4 (140)	**3362 (2121)**

The waste present on the site is stored in six different storage facilities. Some additional buffer areas are also available for a part of the VLLW.

All the liquid waste (LLW, ILW) produced by the plant operation has been conditioned and is stored in two of them.The conditioning process for the 3,3 m^3 of U-Th solution final product will be conducted in a dedicated cementation facility under construction on the site.

In the ITREC installation there is the a spent fuel pool with 64 elements still stored in the pool for dry storage. The construction of the dry storage facility is in progress to accommodate the spent fuel elements into dual purpose casks.

Spent Fuel Storage in ESSOR Reactor

See ESSOR Reactor description below.

3. Installations under Decommissioning

3 a) NPPs

LATINA NPP

The Latina NPP is a 153 MWe GCR and was operated since 1962 until 1987 currently under decommissioning.

The plant is managed by SO.G.I.N. and the decommissioning authorization was issued in 2020.

The decommissioning strategy foresees two-phase, with the first one aimed dismantling of structures, system and components of the plant but not of reactor building (with radioactive graphite inside) which will be put in safe conservation. This phase is also addressed to treat and condition existing waste and waste resulting from performed decommissioning activities. The second one, to be implemented only after the siting and construction of the National repository, foresees the dismantling of all plant structures with the purpose to reach the green field end state (this second phase will be subject to specific authorization).

All spent fuel has been removed from the plant; the primary circuit has been filled with dry air, and blowers and portions of the primary circuit outside the reactor building have been dismantled.

Radioactive waste generated during past operation and from already completed decommissioning activities are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
17,9	849,9 (418)	0,9	488,2 (732)	89,1	348,5 (690)	**1794 (1948)**

Part of the exiting waste is made of radioactive sludges whose conditioning is in progress in a dedicated facility on the site.

At present, the radioactive waste is stored in three storage facilities on the NPP site. In one of these facilities only conditioned waste is present. In the others both VLLW and LLW are stored.

TRINO NPP

The "Enrico Fermi" NPP is located in the municipality of Trino (VC), is a 870 MWt (272 MWe) PWR and was in operation from 1965 until 1987 when it was shut down in the aftermath of the Chernobyl accident.
The plant is managed by SO.G.I.N. and the decommissioning authorization was issued in 2012.
The most important decommissioning activities carried in recent years are:

- modification of the ventilation system of the reactor building;
- construction of a temporary storage station for radioactive waste, in order to allow the refurbishment of the storage facilities on the site;
- qualification of the Wet Oxidation Treatment process of ion exchange resins;
- treatment VLLW and LLW deriving from past plant operation;
- transfer abroad of the spent fuel for reprocessing.

The main activities currently underway are:

- construction of the new liquid waste treatment system;
- removal of the activated components from the purifier pool;
- adaptation of the systems in the reactor cavity for the subsequent internals and vessel dismantling activities;
- realization of the facility for the treatment of ion exchange resins.

The following projects are under regulatory assessment:

- conditioning facility for ion exchange resins.

Radioactive waste generated during past operation and from already completed decommissioning activities are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
48,4	825,9 (568)	56	145,5 (406)	3,5	61,6 (137)	**1141 (1219)**

They are stored in 2 dedicated facilities in the site. All ILW are stored in one of the two facilities.

3b) FCFs under decommissioning

EUREX Reprocessing Plant

The EUREX plant operated from 1970 to 1983 on reprocessing of spent fuel irradiated in Italian and European Community research reactors as well as power reactors.

The plant is managed by SO.G.I.N.

Since 2004 many activities related to waste treatment, conditioning and improvement of storage conditions have been conducted as well as preparatory activities for decommissioning.

Radioactive waste generated during past operation and from already completed decommissioning activities are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
275,6	1258 (658)	79,1	811,8 (740)	33,7	484,4 (1095)	**2943 (2881)**

The main activities in progress at EUREX facility are related to the treatment and conditioning of liquid wastes generated from the reprocessing of MTR and CANDU fuel (some 120 m^3 ILW and some 100 m^3 LLW). For this aim a dedicated cementation facility is under construction. This liquid waste is currently stored in a dedicated storage facility located in a bunkered building in the site.

Solid radioactive waste is stored in the two main Waste Storage Facilities, the second of which has entered into operation in 2019. Activities are in progress to transfer wastes from the old facility to the new one.

3c) Research Reactors under decommissioning

ESSOR Reactor

ESSOR is a research reactor with thermal power of 42 MW cooled by heavy water.

In the past it was used as neutron irradiator and it was put in final shutdown in 1983. It is currently in safe conservation (Safe Store) and will be decommissioned in the coming future.

The reactor buildings include also the pool for spent fuel and a dedicated hot cell refurbished to store under dry conditions all spent fuel present in the JRC Ispra site (TSA Depot).

The spent fuel still present and stored in the pool comes from different nuclear plants; this fuel will in the near future be placed in dry storage in TSA Depot.

All radioactive waste is stored in an external dedicated facility, located in site of the research centre devoted to the storage of all the radioactive waste generated in the centre.

4) On site radioactive waste storage facilities

4a) RW Storage Facilities at TRINO NPP Site

There are two RW storage facilities on the TRINO NPP site that will be addressed in the NAR: Storage facility D1 (T1) and Storage Facility D2 (T2). T1 is currently in operation while T2 is under a process of upgrading of structures and auxiliary systems. After the refurbishment of the T2 storage facility also the T1 will follow the same upgrading process.

4b) RW Storage facilities on EUREX FCF site

There are three main RW storage facilities at EUREX FCFs Site that will be addressed in the NAR: 1) Storage facility D2 (E1), recently built; 2) Storage Facility 2300 (E2), whose waste is being transferred to E1 and which will be refurbished in the coming future for being upgraded; 3) Liquid Waste storage facility NPS/800 zone (E£), dedicated to the storage of IL liquid waste, which will be conditioned by cementation in the CEMEX facility under construction.

4c) OPEC 2 storage facility

OPEC 2 storage facility is a new facility for the storage of waste coming from past operation and decommissioning of IPU FCF.

Short description of Represented Installations

1. Research Reactors

TRIGA RC-1

TRIGA RC-1 is a Mark II open tank reactor operating at a maximum power of 1-MW, owned and operated by ENEA and located in a research nuclear centre. The core is cooled by light-water with an annular graphite reflector. The core has a cylindrical configuration and is placed at the bottom of an open tank.

On the inner edges of the reactor tank, there are racks where partially burned fuel assemblies can be stored in a sub critical configuration. At present there are some partially burned fuel assemblies located in the racks. Spent fuel is stored in dedicated pits.

The limited amount of radioactive waste produced is sent for storage to an external facility located in the same centre. As for other Italian Research reactors a periodic review is foreseen every 5 years addressed to review the operating experience and the status of reactor systems and components.

The limited amount of produced radioactive waste is managed in installations of Casaccia Research Centre.

For the purpose of the TPR II TRIGA RC-1 Rector is represented by Tapiro Reactor.

2. Dedicated spent fuel storage facilities

2a) OPEC 1

OPEC 1 is a spent fuel dry storage facility dedicated to pieces of irradiated fuel elements (pins and fragments) used in the past to conduct post irradiation research activities. They are lodged into dedicated containers located in two storage areas of the installation. The facility is located in the ENEA Research Centre of Casaccia and is managed by SO.G.I.N..

For the purpose of the TPR II OPEC 1 is represented by ITREC dry storage facility.

3. Installations under decommissioning

3a) NPPs under decommissioning

CAORSO NPP

The Caorso NPP is located in the municipality of Caorso (PC), is a 2651 MWt (860 MWe) BWR and was in operation from 1981 until 1987 when it was shut down in the aftermath of the Chernobyl accident.
The plant is managed by SO.G.I.N. and the decommissioning authorization was issued in 2014.
The most important decommissioning activities carried in recent years are:

- transfer abroad of all spent fuel for reprocessing;
- dismantling of the Off-Gas building;
- treatment of VLLW and LLW deriving from past plant operation;

The main activities currently underway are:

- realization of the waste management facility and temporary storage station in the turbine building;
- transfer abroad for treatment and conditioning of resins and sludge coming from past operation;
- realization of the waste route from reactor building to turbine building;

- refurbishment of one of existing VLLW/LLW interim storage facility;

The following projects are under regulatory assessment:

- refurbishment of two existing VLLW/LLW and ILW interim storage facilities.

Radioactive waste generated during past operation and from already completed decommissioning activities are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
102,5	678,5 (768)	8,3	1576,6 (294)	-	-	**2366 (1173)**

There are 3 waste storage facilities in the site for which a refurbishment programme is ongoing. At present one facility is under reconstruction and wastes are temporarily stored in buffer zones. For the second facility the stored waste is currently being transferred abroad for treatment and conditioning. In each facility there are both VLLW and LLW.

GARIGLIANO NPP

The Garigliano NPP is located in the municipality of Sessa Aurunca (CE), is a 506 MWt (160 MWe) BWR and was in operation from 1964 until 1978 when was shut down due to structural problems in the steam generators, too expansive to solve given the short residual plant life.

The plant is managed by SO.G.I.N. and the decommissioning authorization was issued in 2012.

The most important decommissioning activities carried on in recent years are:

- treatment of resins and sludges deriving from past plant operation;
- transfer of all spent fuel for reprocessing;
- refurbishment of some existing interim storage facilities;
- realization of a new interim storage facility;
- remediation of underground trenches used for storage of VLLW during operation;
- demolition of the old stack and commissioning of the new one;
- dismantling of part of big components in turbine building;

The main activities currently underway are:

- realization of the new system for the treatment of liquid waste;
- refurbishment/realization of systems necessary to conduct dismantling operations of systems and components in the Turbine building and Reactor building and construction of a waste management facility;
- shipment abroad of metal waste for treatment and conditioning;
- refurbishment and realization of interim storage facilities.

The following projects are under regulatory assessment:

- realization of the waste route from reactor building to turbine building.

Radioactive waste generated during past operation and from already completed decommissioning activities are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
54,8	1673,2 (1510)	921,2	228,4 (510)	90	54,8	**2968 (3086)**

They are stored in 5 dedicated facilities. In two facilities there are only conditioned waste. In the other they are distributed in a mixed manner. One of these facilities is under refurbishment to be upgraded at the current standards.

For the purpose of the TPR II CAORSO and GARIGLIANO NPPs are represented by TRINO NPP.

3b) FCF s under decommissioning

ITREC Reprocessing Plant

ITREC, a pilot reprocessing facility operated in the ‘70ies (uranium-thorium cycle fuels from the US Elk River reactor). After having reprocessed 20 Elk River spent fuel elements, during the commissioning tests (1975-78), the operation was stopped. 64 U-Th spent fuel assemblies are still stored in the pool (10,7m x 3m x 7m).

The plant is managed by SO.G.I.N.

Preliminary decommissioning activities are ongoing according to a licence granted in 2006. Most of activities conducted up to now are related to treatment and conditioning of existing waste.

Radioactive waste generated during past operation are classified as reported in the following table. Volume data are in m^3. In brackets volume data after conditioning.

VLLW		LLW		ILW		TOTAL
Conditioned	Not Conditioned	Conditioned	Not Conditioned	Conditioned	Not Conditioned	
882,4	1928,2 (520)	219,5	136,8 (196)	163,4	31,4 (140)	**3362 (2121)**

The waste present on the site is stored in six different storage facilities. Some additional buffer areas are also available for a part of the VLLW.

All the liquid waste (LLW, ILW) produced by the plant operation has been conditioned and is stored in two of them. The conditioning process for the 3,3 m^3 of U-Th solution final product will be conducted in a dedicated cementation facility under construction on the site.

An additional important task is to manage the transfer the 64 spent fuel elements still stored in the pool into dual purpose casks for dry storage. Construction of the dry storage facility is in progress.

Plutonium fuel fabrication plant (IPU)

IPU plant is a MOX fabrication laboratory, in the Casaccia research nuclear centre, operated by ENEA from 1968 to 1974 (process development) and from 1977 to early eighties (MOX fuel fabrication experimental campaigns). Since 2003, the plant is managed by SOGIN .

At the end of 2010 the first glove box (SaG) of the plutonium plant (IPU) was dismantled, as a hot test of the dismantling project of the remaining 55 SaG's, started in 2012; the dismantling has been completed in 2021. The SaG were used in the past operation for manipulating uranium and plutonium during the manufacture of MOX fuel. In the near future, the treatment of radioactive waste streams will be carried out.

The waste coming from past operation and from decommissioning is expected to be stored in an external facility located in the same site. This facility started operation in 2019. The transfer of waste to this new facility is ongoing.

For the purpose of the TPR II ITREC and IPU FCFs are represented by EUREX facility.

4. On-site waste storage facilities

4a) Storage facilities on NPPs under decommissioning sites

GARIGLIANO NPP

There are three main storage facilities in the Garigliano NPP site, containing waste above VLLW category, in part not conditioned yet: 1) Storage facility D1 (G1); Storage facility ex-ECCS (G2); Storage facility D2 (G3), currently under construction.

LATINA NPP

There are three main storage facilities in the Latina NPP site containing waste above VLLW category, in part not conditioned yet: 1) Low level activity storage facility (L1); Ex Parson Storage Facility (L2); "Splitters" storage facility (L3).

CAORSO NPP

There are three main storage facilities in the Latina NPP site containing waste above VLLW category, in part not conditioned yet: 1) ERSBA 1 (C1) into operation; 2) ERSBA 2 (C2) and ERSMA (C3) under refurbishment.

For the purpose of the TPR II storage facilities on GARIGLIANO, LATINA and CAORSO sites are represented by storage facilities on TRINO sites.

4a) Storage facilities on FCFs under decommissioning sites

ITREC FCF

There are four main storage facilities in the ITREC FCF site containing waste above VLLW category, in part not conditioned yet: 1) Storage Facility 9.1 (I1), Storage Facility 9.4 (I2); Storage Facility 9.4 (I3); Storage facility for reprocessing final product (I4).

For the purpose of the TPR II storage facilities on ITREC site are represented by storage facilities on EUREX site.