European Nuclear Safety Regulator's Group

ENSREG

2nd Topical Peer Review Summary Report

"Fire protection"

Draft 0; 31 July 2024 (pre-workshop)

Note: This version is being issued in draft form to serve as input to the workshop discussions, in particular the contents of sections 3 to 8. Some other sections are under development. All text is subject to change in the later versions.

EXECUTIVE SUMMARY AND MAIN RECOMMENDATIONS

Background

In 2014, the Council of the European Union (EU) adopted Directive 2014/87/EURATOM[1] amending Directive 2009/71/EURATOM (Nuclear Safety Directive) in order to incorporate lessons learned from the accident at the Fukushima Daiichi nuclear power plant in 2011 and to take account of the subsequent EU-stress tests findings. Recognising that cooperation between Member States can give added value in terms of nuclear safety, transparency, and openness towards stakeholders, as well as delivering continuous improvements, the revised Nuclear Safety Directive introduced a European system of 'Topical Peer Reviews' (TPR) that commenced in 2017 and which will take place at least every six years thereafter.

The purpose of topical peer reviews is to provide a mechanism for EU Member States to jointly examine topics of importance to nuclear safety, to exchange experience and to identify opportunities to strengthen nuclear safety. The process also provides for participation, on a voluntary basis, of EU neighbouring countries hosting nuclear installations.

In November 2020, at its 41st plenary meeting, ENSREG decided that the topic of the second Topical Peer Review (TPR II) would be "Fire Protection" at nuclear installations.

The Terms of Reference (ToR)[2] and the Technical Specification (TS)[3] of the Topical Peer Review, as well as a Stakeholder Engagement Plan[4], were approved by ENSREG in June 2022 and published on the ENSREG website thereafter.

All nuclear installations covered by the Nuclear Safety Directive are considered in TPR II. Given the large number of nuclear installations that come within the scope of the TPR, and in order to keep the peer review exercise manageable, WENRA proposed a methodology to select the installations to be reported on in the national assessments. This methodology was applied by the national competent authorities of each country to propose a list of installations to report on. Based on ENSREG's request, the list of installations selected at national level together with the rationale for the selection was reviewed by the team leaders in the TPR Board that was set up to oversee the review activities, and reported to ENSREG at its 52nd plenary meeting in April 2023, prior to the completion of the national assessments.

Scope, Objectives and Organisation of the Topical Peer Review

As mentioned in the previous section, the purpose of the topical peer review is to provide a mechanism for EU Member States to jointly examine topics considered important to nuclear safety, to exchange experience and to identify opportunities to strengthen nuclear safety related to such topics. This topical peer review on fire protection is intended to:

- Enable participating countries to review their provisions for fire protection to identify strengths and weaknesses;
- Undertake a European peer review to share operating experience and identify findings: common issues or challenges at EU-level, good practices, areas of good performance and areas for improvement;
- Provide an open and transparent framework for participating countries to develop appropriate follow-up measures to address areas for improvement.

The review process consists of three phases:

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.219.01.0042.01.ENG
[2] https://www.ensreg.eu/sites/default/files/attachments/terms_of_reference.pdf
[3] https://www.ensreg.eu/sites/default/files/attachments/technical_specification.pdf
[4] https://www.ensreg.eu/sites/default/files/attachments/stakeholder_engagement_plan.pdf

In the first phase, national self-assessments were conducted against the WENRA Technical Specification. Results of the self-assessments carried out by the 22 participating countries were documented in the **National Assessment Reports (NARs)**, and published in November 2023.[5]

The second phase started just after the National Assessment Reports were published and made available for questions and comments from all stakeholders. As an indication of the interest and commitment to the TPR II and the importance of the selected topic, this phase resulted in more than 2600 questions and comments from the nominated peer review experts, participating Member States and all stakeholders combined. Subsequently, two workshops were organised to discuss the results of the self-assessments, the questions and comments on the NARs as well as the replies to the questions, as well as the findings from the experts with a view to identifying and discussing both generic and country-specific findings on fire protection. Draft reports (Topical Peer Review Summary Report and country review reports) were issued prior to the relevant workshops as an input for the workshop discussions.

In the third and final phase of the Topical Peer Review, this Topical Peer Review Summary Report has been compiled addressing the generic findings of the review process. The country review reports document country-specific findings that provide input for national action plans.

Eighteen European Union Member States with nuclear installations together with Switzerland, Türkiye, Ukraine, and the United Kingdom participated in the peer review. The regulators of the participating States nominated a total of 48 experts and rapporteurs to carry out the review on the different thematic areas of the NARs as part of the 'TPR team' of reviewers. The entire Peer Review process and activities were overseen by the Topical Peer Review Board, comprised of seven senior regulators from EU Member States, a senior manager from the European Commission (EC) and an EC Technical Secretariat.

[TBC] In the workshops, there were about xxx participants, including experts and observers from non-EU countries (Switzerland, Ukraine, United Kingdom and South Africa) as well as the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development, WANO, and from the nuclear insurance company NEIL.

Main Results of the Topical Peer Review

[TBC](to be completed)

Recommendations to the participating countries and to the European Nuclear Safety Regulators Group (ENSREG)

[TBC] (to be completed)

Transparency

[TBC] (to be completed)

In Conclusion

[TBC] (to be completed)

[5] Ukraine's NAR was made available in March 2024. All national assessment reports are available on the ENSREG website: https://www.ensreg.eu/country-specific-reports-tpr-2

Contents

0. INTRODUCTION

0.1 The Nuclear Safety Directive

Nuclear safety is of the utmost importance to the EU citizens. On 25 June 2009, the Council of the European Union adopted Directive 2009/71/Euratom establishing for the first time a Community framework for the nuclear safety of nuclear installations, which provides binding legal force to the main international nuclear safety principles. The Directive aims to maintain and promote the continuous improvement of nuclear safety.

The Council amended the Nuclear Safety Directive in 2014 (Council Directive 2014/87/Euratom[6]) *"in view of the technical progress achieved through the provisions of the IAEA and by the Western European Nuclear Regulators Association ('WENRA') and responding to the lessons learnt from the stress tests, carried out in 2011 and 2012, and the Fukushima nuclear accident investigations,"* (Directive recital 15).

The amended Directive requires EU Member States to give the highest priority to nuclear safety at all stages of the lifecycle of nuclear installations. This includes carrying out safety assessments regularly, and identifying and implementing reasonably practicable safety improvements in a timely manner.

0.2 General overview of Article 8e – Peer Reviews

Recognising the importance of Peer Reviews in delivering continuous improvement to nuclear safety, the revised Nuclear Safety Directive introduced a European system of topical peer reviews commencing in 2017 and occurring at least every six years thereafter. It notes, *"…peer-reviews have proved to be a good means of building confidence, with the aim of developing and exchanging experience and ensuring the common application of high nuclear safety standards."* (Recital 22).

The amended Directive requires (Recital 23, 2nd paragraph) that "*Member States, through their competent regulatory authorities making relevant use of ENSREG, and building on the expertise of the WENRA, should every six years define a methodology, Terms of Reference and a time frame for Peer Reviews on a common specific technical topic related to the nuclear safety of their nuclear installations. The common specific technical topic to be considered should be identified among the WENRA safety reference levels or on the basis of operating experience feed-back, incidents and accidents and technological and scientific developments. Member States should perform a national self-assessment and make arrangements for common peer reviews by other Member States' competent regulatory authorities of their national self-assessment.*"

The legal provisions regarding the Topical Peer Review mechanism are specified in the Article 8e "Peer Reviews" of the amended Nuclear Safety Directive where it is stated:
"1. ….

2. Member States shall ensure that, on a coordinated basis:

(a) a national assessment is performed, based on a specific topic related to nuclear safety of the relevant nuclear installations on their territory;

(b) all other Member States, and the Commission as observer, are invited to peer review the national assessment referred to in point (a);

(c) appropriate follow-up measures are taken of relevant findings resulting from the peer review process;

(d) relevant reports are published on the above mentioned process and its main outcome when results are available.

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.219.01.0042.01.ENG

3. Member States shall ensure that arrangements are in place to allow for the first topical peer review to start in 2017, and for subsequent topical peer reviews to take place at least every six years thereafter.

According to the Directive (Recital 23, 3rd paragraph) "*Reports on the findings of those peer reviews should be produced. Member States should establish national action plans for addressing any relevant findings and their own national assessment, taking into account the results of those peer review reports. The peer review reports should also form the basis of any summary report of the outcome of the Union-wide topical peer review exercise prepared collectively by the competent regulatory authorities of the Member States. The summary report should not aim to rank the safety of nuclear installations but rather focus on the process and technical findings of the topical peer review so that the knowledge gained from the exercise can be shared*."

The main benefits of the peer reviews are to have a joint in-depth examination of safety significant topics enabling a common understanding on nuclear safety issues and, where appropriate, to identify concrete recommendations to enhance nuclear safety, including appropriate follow-up of actions. Additional benefits are to share knowledge and experience at a European level and to enhance transparency on nuclear safety issues. The TPR terms of reference allows for the participation, on a voluntary basis, of non-EU countries with nuclear installations.

0.3 Objectives of the Topical Peer Review (TPR)

On the basis of proposals made by WENRA, at its 41st meeting[7] in November 2020 ENSREG identified **"Fire Protection"** as the topic for this TPR due to the safety significance of the topic for nuclear installations.

The generic objectives for the Topical Peer Reviews are defined in the Directive (see above). In addition, the TPR terms of reference sets the following objectives:

- Enable participating countries to review their provisions for fire protection to identify strengths and weaknesses;
- Undertake a European peer review to share operating experience and identify findings: common issues or challenges at EU-level, good practices, areas of good performance and areas for improvement;
- Provide an open and transparent framework for participating countries to develop appropriate follow-up measures to address areas for improvement.

0.4 Purpose of the Summary Report

[TBC] The purpose of this report is to provide Member States with the outcome of the peer review process, particularly by presenting the main findings in terms of good practices and challenges. These findings were identified by the TPR II experts and were discussed during the thematic sessions of the workshops. The sessions chaired by the thematic team leaders led to thorough discussions on topics of interest whose conclusions are reported in this document.

The generic results of the peer review on fire protection are summarised in this report. The specific ones are documented in the country review reports.

[7] https://www.ensreg.eu/sites/default/files/attachments/minutes_of_the_41st_meeting_of_ensreg.pdf

1. DESCRIPTION OF THE PEER REVIEW PROCESS

1.0. Topic and scope of the TPR

As mentioned above, ENSREG identified "fire protection" at nuclear installations as the topic for this TPR.

Fire is among the significant risks for many nuclear installations. Fires can occur at many locations in an installation and may be capable of challenging multiple structures, systems and components (SSC) simultaneously and affect signalling and power supply of multiple systems, being a possible cause of common cause failures. A fire could also involve nuclear and/or radioactive materials and lead to the release and dispersion of these. In addition to being an independent event itself, fire can be induced by other hazards or events. It can also itself induce other internal hazards (e.g., flooding, explosion).

None of the previous evaluations and benchmarks initiated after Fukushima at the European level covered fire safety, thus it is a subject that can lead to new insights. It is also a topic that is relevant for each nuclear installation, subject to a graded approach. Aspects other than nuclear safety are not in the scope of the TPR.

1.0.1. Scope of the nuclear installations

All nuclear installations within the scope of the Nuclear Safety Directive are considered within the TPR II. Given the large number of nuclear installations that come within the scope of the TPR, and to keep the Peer Review exercise manageable, a selection was performed by the national competent authorities of each participating State of those installations to be reported on in the national assessments. The selection is based the methodology proposed by WENRA.

At the 47th ENSREG plenary meeting, ENSREG *"agreed to a review process of the national proposals of the nuclear installations to be reported on involving the team-leaders (TL) in the TPR-II Board; however, the final selection of installations would be a national decision".*

Based on this decision, the list of installations selected at national level together with the rationale for the selection was reviewed by the team leaders and reported to ENSREG (52nd ENSREG plenary meeting, April 2023) prior to the start of the national assessments. In their report[8], the Board gives the conclusions of the review, in particular with recommendations for providing further justification or inclusion of some complementary installations. ENSREG underlined that the final selection of installations would be made by the national competent regulatory authorities, and that the outcome of the Board's review should be considered as recommendations for the authorities to follow.

1.1. Project Organisation

1.1.1. Topical Peer Review Board

The TPR Board was established at the 41st meeting[9] of ENSREG in November 2020, to provide leadership and to supervise the peer review process. For this TPR, the TPR Board also coordinated the preparatory activities for the TPR process. The composition of the Board is as follows:

Position	Organisation	Name
Chair	ASN (FR)	Sylvie Cadet-Mercier
Vice- Chair	ISIN (IT)	Lamberto Matteocci
European Commission Official	DG ENER	Michael Huebel

[8] https://www.ensreg.eu/sites/default/files/attachments/tpr_ii_boards_review_of_national_selections.pdf
[9] https://www.ensreg.eu/sites/default/files/attachments/minutes_of_the_41st_meeting_of_ensreg.pdf

Thematic Team Leaders Fire prevention and passive fire protection Active fire protection Fire safety analyses	 ANVS (NL) BMUV (DE) CSN (ES)	 Robert Jansen Gisela Stoppa Miguel Ángel Jiménez Garcia
Country Team Leaders Group 1 Group 2	 BEL V (BE) VATESI (LT)	 François Henry Dainius Brandišauskas
Technical Secretariat	DG ENER	Bharat Patel

1.1.2. Review Teams

In December 2020, the TPR Board on behalf of ENSREG asked ENSREG members and observer countries to nominate suitable experts that could perform an in-depth technical (peer) review of the participating countries' NARs according to the following:

- Each EU Member State and other participating country had the right to nominate one or more experts for each of the different topics.
- The required qualifications and experience of the experts were decided by the nominating countries; information on the experts´ background was provided to facilitate the composition of balanced teams.
- In nominating their experts, countries also indicated whether they could serve as Team Leaders or Rapporteurs.
- The appointment of Team Leaders and Rapporteurs was agreed jointly by ENSREG and the TPR Board.

Based on the nominations, three teams of experts were created according to the following thematic groups in fire protection:

- Fire safety analyses
- Fire prevention and passive fire protection
- Active fire protection

The experts reviewed the NARs under the guidance of their respective Thematic Team Leaders. The experts, rapporteurs and Board Members represented altogether a 'TPR team' of 57 persons (42 experts, 6 rapporteurs, and 9 Board members) experts from 22 different countries (EU and non-EU)[10].

1.1.3. European Commission Support

According to Directive 2014/87/Euratom, the European Commission has the role of observer in the Topical Peer Reviews. It also has the role of facilitator in providing a secretariat support for all phases of the process. In this TPR, the European Commission was represented in the TPR Board and Commission experts from the JRC participated in the team of experts.

1.2. Project Implementation

1.2.1. Technical Specification, Terms of Reference and Stakeholder Engagement Plan

The Technical Specification was drafted by WENRA; the Terms of Reference (ToR) and the Stakeholder Engagement Plan were drafted by ENSREG working groups. After making draft versions of these documents available for consultation by stakeholders, including the public, (between 13 April and 27

[10] These numbers include substitutions of team members during the period of the review

May 2022[11], final versions of these three documents were approved by ENSREG and published on its website in June 2022[12], thereby launching the TPR II process.

1.2.2. Preparation of National Assessment Reports (NARs)

The Peer Review exercise is a requirement under Article 8e of the Nuclear Safety Directive for EU Member States, but several non-EU countries also participated on a voluntary basis.

The NARs were prepared by the national nuclear safety regulators based on the WENRA Technical Specification. The reports were published on the ENSREG website in November 2023[13] [14].

1.2.3. Desktop Review

The review by the TPR experts was organised by thematic areas.

The thematic team leaders and other TPR Board members provided guidance to experts throughout the review stages, and to ensure consistency of the peer review. Each expert was therefore responsible for the review of several installations for a given thematic. Based on their review, the experts identified specific ‘topics of interest’ for further in-depth discussion in the thematic sessions of the workshops (described in in Sections 03 to 08 of this report) and to propose country-specific findings for discussion in the country review workshop.

The Country Team Leaders were responsible for steering the discussions from the different experts involved in the three thematic areas to arrive at a consensus on proposed country-specific findings.

As an additional element to complement the desktop review, it was decided that inclusion of a limited number of site visits would be beneficial to the TPR II process as an additional means for sharing experience and national practices on specific fire protection issues and directly involving licensees and regulators. These site visits were focused on research reactors, since fire protection is not covered to the same extent by the international review missions to which they are subject.

1.2.4. Peer Review Workshops

[TBC] The thematic workshop took place in Luxembourg from 9 to 12 September 2024 with more than [xxx] representatives from the participating countries, including licensees. Participants also attended from the European Commission, IAEA, OECD/NEA, WENRA, WANO and non-EU Regulatory Authorities´ (representatives from South Africa), as well as a representative from the nuclear insurance field. All the sessions were webstreamed on a secured network to allow additional representatives from regulatory authorities, TSOs, utilities, and other subject experts to follow the discussions.

[TBC] Each session of the workshop…(to be completed).

The conclusions of the thematic workshop are documented in this report, as described in the ToR.

[TBC] Furthermore, the Country Group workshop took place in Luxembourg from 30 September to 3 October 2024. The conclusions of this workshop are documented in the country review reports, as per the ToR.

1.3. Public information and interaction

[11] https://www.ensreg.eu/tpr-2-public-engagement
[12] https://www.ensreg.eu/tpr-2-background
[13] https://www.ensreg.eu/country-specific-reports/EU-Member-States-tpr2
[14] https://www.ensreg.eu/country-specific-reports/other-countries-tpr2

In accordance with the ToR and the ENSREG 'Guidance for National Regulatory Organisations — Principles for Openness and Transparency'[15], a TPR II Stakeholder Engagement Plan was developed[16], to strengthen engagement with all stakeholders including the public, industry, regulatory authorities, government bodies and other interested parties, such as NGOs identifying activities to ensure the peer review process and outcomes are visible, e.g. publication of national assessment reports on the ENSREG website, organisation of public meetings.

1.3.1. Information on the ENSREG website

Dedicated webpages were created on the ENSREG website for public information. These were updated throughout the Peer Review process.

The NARs were published by the national regulators on their websites and were also made available through the ENSREG website from November 2023[17]. In addition, the questions and answers on the NARs were published on the ENSREG website[18].

[TBC] The TPR Summary Report, after approval by ENSREG Members, was published on the ENSREG website.

[TBC] ENSREG and participating countries will prepare National Action Plans that will also be published on the ENSREG website.

1.3.2. Public Events

As a prelude to the TPR activities, on 22 June 2021, the first stakeholder meeting took place online to inform interested parties about the different European peer reviews and specifically about the TPR II process, timeline and the technical basis for the choice topic of fire protection. Opportunities for public participation were also highlighted. The event was web-streamed and more than 140 stakeholders coming from industry, regulatory authorities, NGOs and TSOs participated. The agenda and presentations are available on the ENSREG website [19].

[TBC] Further public engagement activities …(to be completed)

[15] http://www.ensreg.eu/document/guidance-nro-principles-openness-and-transparency
[16] https://www.ensreg.eu/sites/default/files/attachments/stakeholder_engagement_plan.pdf
[17] https://www.ensreg.eu/country-specific-reports-tpr-2
[18] Available by following the country reports section on https://www.ensreg.eu/country-specific-reports-tpr-2
[19] https://www.ensreg.eu/eu-topical-peer-reviews

2. REGULATORY FRAMEWORK

[TBC] [Inputs to be added based on the answers from the TPR team question:

"*The NAR in §1.2 presents the regulatory framework. If not yet clearly mentioned in the NAR, could you indicate whether the WENRA SRLs for NPPs, and RRs (if relevant for your country), which are used as reference for this topical peer review on 'fire protection' (as per the Technical specification) are binding or not in your country? If they are not binding, what is the status of the SRLs (non-binding, guidance, advisory..*)?"]

3. USE OF EXPERIENCE FEEDBACK

Type of installations mainly concerned

Applicable to all installation types.

Background and justification

The analysis and exchange of information about fire events is an important element to improve fire protection. Lessons learned from fire events can reveal weaknesses that could be resolved with adequate provisions (either technical or organisational provisions).

Fire events and their reporting

Analysis and consideration of nuclear installations' internal and external (national and international) operating experience regarding fire events (including smouldering fires), events resulting from spurious actuations with potential associated harmful effects, and events with a deterioration or failure of active and/or passive fire protection means, is essential for ensuring nuclear (including radiation) safety. It is necessary that fires are categorised and reported immediately. Without categorisation, fires cannot be compared or well understood. Categorisation of fires from low to medium, moderate or high energy is essential for determining measures in the area of fire prevention and passive/active fire protection.

The information related to the fire events categorisation provided by the NARs and the answers to the generic questions vary in depth. However, it can be concluded that fire events are generally recorded by the operators. Nevertheless, their categorisation seems different across participating countries and there are differences in the processes and criteria for analysing and reporting the events. Indeed, fire related events and incidents are reported to the regulatory authorities in every country. However, in some countries every event is to be reported while in others the reporting is based on a safety related categorisation of the events. Moreover, in some countries, in addition to the reporting to the competent nuclear authority there is also a reporting to fire safety authorities. Additionally, some countries reported that fire related incidents are submitted to the OECD NEA FIRE Database.

Developments in fire protection resulting from operating experience feedback

The feedback from the operating experience from the installations and, where relevant, from other installations (similar or not) is a key mean for enhancing safety.

The TPR II Technical specifications requested to describe "*how fire safety has developed and improved in the installations based on lessons learned from internal and external events and other sources such as Periodic Safety Review, Safety Review Missions, maintenance, fire safety research and regulatory supervision*."

Generally, the NARs did not provide concrete examples of how fire protection has been improved as a result of the operating experience, in particular from other installations. The feedback from fire events on fire safety analyses (FHA/fire PSA) is also generally not addressed by the participating countries although most of them participate to OECD Fire Database Project.

Information sharing on feedback from fire events

The TPR II Technical specifications requested to describe "*how operational feedback of experience is shared amongst all relevant stakeholders*."

Generally, the NARs did not detail how and to what extent the information on fire events is shared and/or discussed at the national and/or international level. Therefore, a generic question was raised. A national or international exchange of information on fire events and the knowledge gained from them can make a significant contribution to improving fire safety. Processes can be adapted in a targeted manner, particularly in the organisational area of fire protection. It would be of particular interest to discuss the sources of external operating experience available to licensees and regulators and the procedures to make such information available, notably for countries with a small number of certain types of nuclear installations, in order to extend the base of fire events knowledge.

As fire is a risk for any industry, exchanging information with conventional industry is also a mean to learn from their events and to identify any existing weaknesses. Some countries reported in their NAR specific analysis for their nuclear installations after a fire event in non-nuclear installations.

Aspects to be discussed during the workshop:

- Fire events and their reporting
- Developments in fire protection resulting from operating experience feedback
- Information sharing on feedback from fire events

Expected outcomes of the workshop

- Overview of approaches regarding fire events categorisation and the use of experience feedback for improvements
- Better insights from national approaches to share experience and identify potential good practices or challenges

4. FIRE SAFETY ANALYSES

4.0. General methodologies for deterministic FSA

Type of installations mainly concerned

In general applicable to all types of installations.

Background and justification

Objectives and scope of the deterministic fire safety analyses

Ensuring the fulfilment of the safety functions under the conditions of a postulated fire has been the main objective of the fire safety analyses in nuclear installations. The TPR technical specification requested to detail the type and scope of fire safety analyses, key assumptions and methodologies, phenomena and main results.

Deterministic fire safety analyses: Types, methodologies, standards, guidelines, and assumptions

Understanding the different approaches to fire safety analysis, from conservative to realistic, during the different operational conditions of the installation, (e.g. in NPPs under power or shutdown conditions), the phenomena that are considered in the analysis, the assumptions made, etc. is crucial for developing effective strategies that balance safety and operational efficiency.

Furthermore, it is relevant to have an overview of general methodologies for the understanding of how the various methods interact and support the overall objectives with deterministic safety analysis. Depending on the facility type, the type and amount of nuclear material in the facility, the spectrum of initiating events, etc., different methodologies can be applied for the Fire Safety Analyses. The different objectives and scope of those methodologies and their respective application can be shared and discussed.

State-of-the-art understanding of fire-induced phenomena

Deterministic fire safety analyses typically postulate failure of equipment. State-of-the-art understanding of fire-induced phenomena has revealed potential failures resulting from different fire phenomena. Some more detailed models and methods allow exploring the degree of deterioration/failure/malfunction of safety components, including pressure effects due to fire impairing fire-barriers, effects of smoke and soot onto equipment, spurious actuation/signals of electric and electronic components, high-energy arcing faults (HEAF), smouldering fires, etc.

Aspects to be discussed at the workshop

- Objectives and scope of the deterministic fire safety analyses
- Deterministic fire safety analyses
  - Types (fire hazard analysis, fire safe shutdown analysis, etc)
  - Methodologies,
  - Standards and guidelines used
  - Assumptions (postulated fires, including fires occurring in parallel at different locations, application of the single-failure criterion, credit given to the actuation of fire protection systems and consideration of potential unavailabilities, credit given to intervention teams)
- State-of-the-art understanding of fire-induced phenomena

Expected outcomes of the workshop

- Overview and a broad understanding of different approaches for deterministic fire safety analysis, in particular objectives, assumptions, regulatory requirements, standards, and their interactions.

- Better insights from national approaches to share experience and identify potential good practices or challenges

4.1. Analysis of radiological consequences

Type of installations mainly concerned

Fuel fabrication and other fuel cycle facilities, waste facilities, facilities in decommissioning.

Background and justification

As mentioned in the TPR technical specification, the fire protection means aim at mitigating secondary fire effects and maintaining safety functions identified as necessary in case of fire, including mitigation of the radiological consequences of the fire. In the presence of radioactive materials, a fire can disperse the materials and thereby lead to radioactive releases to the environment.

State of knowledge on the different phenomena to be analysed

Countries have followed different approaches on the methodologies applicable to carry out the radiological consequences analysis of a postulated fire (due to the release and airborne dispersion of radioactive materials or due to a criticality accident in case of fire). Variability in the depth and extent of the analysis of the radiological consequences of a fire was also noted in the NARs for the installations.

Specific provisions to limit radiological releases in the event of fire and associated qualifications

Specific measures are necessary to deal with the effluents produced by the fire extinguishing systems and equipment for firefighting, which could lead to contamination (dispersion of radioactive materials) or to criticality accidents. Undesirable effects of firefighting water, like flooding, are addressed in section 7.1.2 ‘Harmful effects of firefighting water’.

Facilities in which radioactive materials are handled (waste management and storage, facilities under decommissioning) as well as fuel fabrication facilities seem the most sensitive to these consequences. Since the purpose, processes and risks are very different amongst these types of facilities, the fire safety analyses may have to consider different sets of phenomena, assumptions and scenarios, as well as of the measures to be taken to limit the radiological consequences in the case of a fire, like the combined use of static and dynamic confinement, ventilation management, etc.
Sharing experience about such analyses based on examples of fire scenarios to be analysed amongst the countries hosting such facilities is expected to illustrate potential issues and noteworthy practices.

Aspects to be discussed at the workshop

- State of knowledge on the different phenomena to be analysed (i.e. failure mechanisms of waste packages due to fire, airborne release fractions and respirable fraction, deposition/redeposition in structures, filtration efficiency, filter clogging by soot, etc.)
- Specific provisions to limit radiological releases in the event of fire and associated qualifications (static containment, ventilation management, filtration systems, etc.)

Expected outcomes of the workshop

- Overview of analysis practices (combination between static and dynamic containment, ventilation management during the fire) and sharing data/needs of R&D (proportion of radioactive materials involved in the fire, airborne release factors of the radioactive material(s) involved, effectiveness of the ventilation systems despite the fire, filters clogging by soot, examples of fire scenarios to study)
- Better insights from national approaches to share experience and identify potential good practices or challenges

4.2. Approach to updating the FSA (methodologies and data)

Type of installations mainly concerned

All types of nuclear installations.

Background and justification

The TPR technical specification requested to detail the approach followed for updating the fire safety analyses.

Sources to derive the need for fire safety analyses updates

Updates of the fire safety analysis may be required or needed due to e.g., a changing regulatory framework, changes in the operating status of the plant, plant modifications, operational feedback, safety reviews, feedback from regulatory oversight, developments in the modelling tools, or simply due to the evolving state of science and technology.

The non-nuclear regulatory framework for fire safety, involving different stakeholders and authorities in fire protection, may also lead to the need for fire protection updates.

Fire safety analyses (deterministic and probabilistic) and their updates: methodology, periodicity, codes and tools

The principles and practices for updating safety analyses, considering new data and assumptions related to changes in either the physical configuration of the installation, its operating conditions, the methodology or the codes applied, etc., are likely to have many common aspects between countries. However, the review has also identified areas where differences exist. These may be related to the differences in regulation and also to national practices. Knowledge about differences and similarities and the reasons behind are important in identifying examples of noteworthy practices.

Updates in the fire safety analyses and the data should also take into account any evolution in the codes and tools used for fire modelling, as well as their validation, sensitivity and uncertainties. The criteria for their selection/adoption and use of results are other important aspects.

The periodicity to conduct the update may be established in specific regulatory requirements or it can be derived based upon the relevance of changes in reference data, information and adopted tools.

The country- or plant-specific underlying procedures and processes in terms of scoping, the periodicity of updates and the involvement of the different stakeholders would be of particular interest to other countries and experts.

Aspects to be discussed at the workshop

- Sources to derive the need for fire safety analyses updates: level of fire risk, PSR results, new regulations, national and international reviews of the Fire Safety Analysis, insights from fire safety related R&D activities, state of practices.
- Fire safety analyses (deterministic and probabilistic) and their updates: approaches on the methodology and periodicity for their update:
    - Codes/tools for fire modelling and data used for fire safety analyses, including their validation, sensitivity and uncertainties
    - Criteria for their selection/adoption and use of results

Expected outcomes of the workshop

- Overview of different approaches, periodicities, and practices for updating the FSA and PSA including the underlying tools and models; modifications of the plant and the involvement of different stakeholders

- Better insights from national approaches to share experience and identify potential good practices or challenges

4.3. Fire PSA in NPPs: Scope, criteria, and level of conservatism

Type of installations mainly concerned

Installations in which Fire PSA are conducted (NPPs, maybe RRs or others).

Background and justification

According to international standards, PSA for internal hazards, in particular Fire PSA, is required as part of the PSA that is mandatory for NPPs in most countries as a complement of deterministic FHA. Fire risk assessment aims at analysing fires as one of the most risk-significant internal hazards.
Moreover, Fire PSA plays an important role in identifying spatial dependencies and the need for separation/segregation of redundant trains.
PSAs are an important tool to identify strengths and weaknesses and to assess the overall safety and risk profile of a nuclear installation, indicating the need of realism for their use in practical applications.

<u>Scope of the Fire PSA in the different countries</u>

According to descriptions in the NARs the scope of Fire PSA is different from one country to another. Level 1 Fire PSA has at least been performed for the “full power operation” plant operational state. The number of countries carrying out Fire PSAs for low-power and shutdown plant operational states is much lower. Level 2 Fire PSA, if performed, has mainly been conducted for full-power operation.

In exceptional cases, a full scope Fire PSA up to Level 2 or even Level 3 for all plant operational states, including also a systematic and comprehensive analysis of combinations of fires and further anticipated events (mainly associated with external and internal hazards) has been conducted.

Extensions of the Fire PSA scope (to at least Level 2 for all plant operational states) and application (from a single reactor unit up to a whole site with multiple installations of the same or different types) could show the added value of this tool for fire safety assessment.

<u>Screening criteria applied for event combinations and fire scenarios</u>

Additionally, the application of screening criteria – in terms of threshold values for the fire-induced core damage frequency or for the fire load density - may extend or reduce the set of scenarios and events to be considered in the analyses, thereby affecting the interpretation of the scenarios with a very low probability.
In this matter, the consideration of a threshold number of coincident electrical events caused by a fire in electrical circuits or cables (open circuit, short circuit, or short to ground) may also affect the input of the probability of failure of electrical equipment in case of a fire.

<u>Level of conservatism in a Fire PSA</u>

Understanding the different approaches and assumptions to probabilistic Fire PSA, from highly conservative to realistic, is essential for developing effective strategies that balance safety and operational efficiency.
To this purpose, the use of conservative (instantaneous failure of equipment, conservative time of failure of FP features, etc.) vs more realistic assumptions within Fire PSA may have an impact on the potential results of Fire PSAs and their potential applications, such as corrective actions to be taken or prioritisation of modifications.

Sensitivity/uncertainty analyses

Utilising robust analytical tools such as fire simulation codes and performing sensitivity and uncertainty analyses enhances the accuracy and reliability of Fire PSA. Moreover, the use of plant specific data as far as possible increases the level of confidence in the results of the assessment and supports the choice of the most suitable modifications. This also increases the level of confidence of the Fire PSA as a means to analyse the risk from fires in a traceable way.

Based on information in the NARs, improvements of the Fire PSA, particularly a better consideration of available operating experience with credible fire events and events with deterioration and/or failure of fire protection means from nuclear installations and other industries as far as applicable, are needed in several countries.

The results from Fire PSA and the resulting improvements in the fire protection systems of nuclear installations should be shared between different installations of each country and could be shared internationally.

Contribution of fire events to the overall PSA results

There is a large variation in the contribution of fire to the overall damage (core, and in several countries also fuel damage frequencies in line with IAEA SSG-3, Rev. 1) and to the radioactive release frequencies (large and/or large early release frequencies, in line with IAEA SSG-4, Rev. 1) estimated within PSA.

Aspects to be discussed at the workshop

- Scope of the Fire PSA in the different countries
- Screening criteria for event combinations and fire scenarios
- Level of conservatism in a Fire PSA.
    - Use of conservative vs more realistic assumptions within Fire PSA (instantaneous failure of equipment, conservative time of failure of FP features, etc.).
    - Impact of conservative assumptions on the potential results of Fire PSAs and their potential applications, such as corrective actions to be taken or prioritisation of modifications.
- Sensitivity/uncertainty analyses
- Contribution of fire events to the overall PSA results

Expected outcomes of the workshop

- Overview of different approaches and practices regarding the scope of Fire PSA; results from Fire PSA and the consequent improvements in the fire protection systems; practices to carry out uncertainty and sensitivity analysis considering fire simulations and Fire PSA; reducing the level of conservatism
- Better insights from national approaches to share experience and identify potential good practices or challenges

4.4. Use and application of FSA results

Type of installations mainly concerned

In general applicable to all types of installations.

Background and justification

Fire safety analyses are an important part of a nuclear installation's overall safety demonstration. The WENRA safety reference level WENRA SV 6.1 requires that *"A fire hazard analysis shall be developed on a deterministic basis. The deterministic analysis shall be complemented by PSA to evaluate the fire protection arrangements and to identify risks caused by fires."*

Fire safety analyses can help to identify the need for plant modifications (in design and/or operation) and can support to prioritize improvements.

<u>Use of FHA and fire PSA to identify plant modifications to increase fire safety</u>

Fire PSA complements deterministic fire safety analyses in achieving a balanced design by enabling the analyst to identify and assess the strengths and weaknesses of a particular design and/or operation to ensure that no fire or specific feature of the facility provides a disproportionate contribution to the overall fire risk.

PSA is therefore an input for the identification of plant modifications to increase fire safety under the ALARP principle of reducing risks.

<u>Approaches used to identify and prioritise plant modifications and/or procedures for enhancing fire safety</u>

PSA also allows to identify and analyse complex interactions in more detail than through a deterministic assessment, aiding safety-informed decision making and therefore is an input for the assessment of plant modifications and prioritisation of improvements.

Specific issues related to this topic are:

- the use of installation Fire Safety Analysis (FSA) by the licensee and by the regulator for the prioritisation of either technical plant modifications or improvements procedures to prevent human errors and to enhance fire safety,
- the use of probabilistic fire risk assessment (Fire PSA) for risk-informed decision-making (RIDM).

<u>Monitoring of the FHA and fire PSA input elements to detect deviations</u>

Fire Safety Analysis (both deterministic and probabilistic) are based on assumptions about plant layout, fire barriers, fire loads, availability of fire detection and protection systems, human actions (plant operators' actions, fire brigade etc.) etc. All the above aspects need to be and monitored to ensure the continuous validity of the FSAs and their results and conclusions.

Deviations from these assumptions alter the results of these FSA and need to be detected and analysed to determine if compensatory measures (temporary or permanent) are needed to ensure the level of defence in-depth in fire safety. For that purpose, adequate maintenance, control, and in-service inspections of SSC need to be in place.

Aspects to be discussed at the workshop

- Use of FHA and fire PSA to identify plant modifications to increase fire safety
- Approaches used to identify and prioritise technical plant modifications and/or procedures for enhancing fire safety.
- Monitoring of the FHA and fire PSA input elements to detect deviations
  - Tools/procedures to identify disconformities in fire plant design, lay-out, and operation including fire barriers, fire loads and their spatial distribution, etc.
  - Procedure and responsibilities to analyse and implement compensatory measures or corrective actions, monitor their usefulness and effectiveness

Expected outcomes of the workshop

- Overview of different approaches and practices for using proactively the FSA and PSA results to improve nuclear fire safety based on the ALARP principle and the related regulatory processes; monitoring the FHA and PSA inputs and to identify the need for compensatory measures when deviations are detected

- Better insights from national approaches to share experience and identify potential good practices or challenges

5. FIRE PREVENTION

5.0. Management of fire loads

Type of installations mainly concerned

Applicable to all installation types.

<u>Background and justification</u>

The management of fire loads in nuclear installation is a measure to minimise the likelihood of fires and their consequences. The management of fire loads is related to the admissible fire loads. It is considered in the fire safety analysis and in the design of fire protection measures. Their control in nuclear installation is key to ensure safety.

<u>Fire load inventory documentation and management (transient and permanent)</u>

Minimisation of fire loads and consideration of the limits for permanent and transient fire loads is an important part of fire management.

The information from the NARs and the answers to the generic questions vary in depth and extent to which the management of fire loads was documented and demonstrate that across installation types, there are different approaches to the management of fire loads (permanent and transient). Some are more qualitative (concepts), others are more quantitative (tools such as fire load indexes, fire load spreadsheets etc): they are defined by parameters which are not generally provided or described, in particular regarding the limits for permanent and transient fire loads, the consideration of new types of fire sources (e.g lithium-ion batteries) or the items that may be excluded. Sharing these different approaches would be beneficial for all countries.

<u>Roles, responsibilities and frequency of inspections</u>

It is important to regularly verify by inspection the actual permanent and transient fire loads and the functioning of its management. The roles and responsibilities of personnel in defining, controlling and verifying fire loads or detailed procedures are generally not available for comparison. Expectations in this area can for instance be found in IAEA SSG-77 para 10.7, I.10 and I.16c.

<u>Fire load input for the design and safety analysis of fire protection systems</u>

The expected linkage between fire analysis, management of the fire load and design of passive fire protection measures is often not detailed in the NARs. It is therefore important to get a global view in particular on the following issues:

- whether the fire resistance of the compartments was taken into account when allowing temporary and/or fixed storage;
- whether there are claims on the presence of non-combustible materials (e.g. in cables with fire resistance) and if they are accounted for in the fire analysis and the design of fire protection measures including barriers/ compartmentation;
- practices used in the determination of the fire resistance rating of fire compartments including penetrations, as well as other safety measures and design features e.g. ventilation ducts, in accordance with the combustible inventories and fire load density (MJ/m²).

Valuable reference in this respect is IAEA SSG-64 paragraphs 4.6 to 4.12: recommendations on fire load minimisation and use of fire resisting materials

<u>Aspects to be discussed at the workshop</u>

- Fire load inventory documentation and management (transient and permanent)
- Roles, responsibilities and frequency of fire load inspections
- Fire load input for the design and safety analysis of fire protection systems

Expected outcome of the workshop

- Overview/benchmarking of approaches regarding the management of fire loads (inventory, inspections and consideration into the design of fire protection measures and safety analyses)
- Better insights from national approaches to share experience and identify potential good practices or challenges

5.1. Management of ignition sources

Type of installations mainly concerned

Applicable to all installation types.

Background and justification

The management of ignition sources in nuclear installations is a measure to minimise the likelihood of fires and their consequences. The management of ignition sources is related to the design of passive fire protection measures and fire safety analysis. Their control in nuclear installations is key to ensure safety.

It was expected the NARs describe the process in the installation´s design and the administrative process in place for minimising the likelihood of fire. This was to cover, in accordance with fire analysis considerations, management and control of ignition sources (including "hot work") to handle maintenance or other operations (e.g., experiments in research reactors, daily start and stoppage of dismantling works in installations under decommissioning). As these aspects have been differently covered in the NARs, and considering their relevance for a properly implemented fire safety concept, it is important that they are addressed as a specific topic in the workshop.

An important learning from the OECD Fire Database project, as presented in the SMiRT25 summary paper, is that hot work is a dominant, major cause of fire events (PWR, PHWR, BWR). The role of hot work as a cause of fires in other installation types is described in the NARs only by some participant countries. In this respect the identification of ignition sources from hot work, inspection and verification policy and temporary measures during hot work are key issues.

Approaches for systematic identification and management of ignition sources

For a systematic identification of ignition sources from hot work, chemicals reactions, high energy arcing fault (HEAF), hot spots, hot gas, overheating or failure of electrical or mechanical SSC, human actions/ factors and ATEX during operation, maintenance and modifications, it is helpful to refer to IAEA SSG-77 paragraphs 9.7, 10.7 and Appendix I, paras I.23–I.41.and, specifically, hot work.

Roles and responsibilities for the management of hot work

There are varying levels of coverage on the roles and responsibilities for the management of hot work at the installations. Only a few countries identify the permit duration, the inspection activities and roles associated with 'independent verification'. Expectations in this area are described for example, in IAEA SSG-77 paras I.34, I.37 and I.38.

Temporary or compensatory fire prevention, protection and suppression measures during hot work

Some countries generally refer to the introduction of temporary or compensatory fire prevention and protection measures during hot works. When provided, the process to identify the appropriate mitigation measures is not available. IAEA SSG-77 para 10.7(a), I.36, I.38 and I40-41 are a helpful reminder of some of the provisions that could be expected.

Aspects to be discussed at the workshop

- Approaches for systematic identification and management of ignition sources
- Roles and responsibilities for the management of hot work
- Temporary or compensatory fire prevention, protection and suppression measures during hot work

Expected outcome of the workshop

- Overview/benchmarking of approaches regarding the management of ignition sources and in particular hot works, including the graded application
- Better insights from national approaches to share experience and identify potential good practices or challenges

6. PASSIVE FIRE PROTECTION

6.0. Ageing management of passive and active fire protection SSC

Type of installations mainly concerned

Applicable to all installation types.

Background and justification

As a key element for nuclear safety, ageing management is implemented to ensure that the effects of ageing will not prevent structures, systems and components (SSCs), important to safety or others SSCs whose failure may prevent SSCs important to safety from fulfilling their intended functions, from being able to accomplish their required safety functions reliably throughout the lifetime of the installation (including its decommissioning) and it takes account of changes that occur with time and use. This requires addressing both the effects of physical ageing of SSCs, resulting in degradation of their performance characteristics, and the non-physical ageing (obsolescence) of SSCs. This is reflected in the WENRA safety reference level WENRA I1.1 to I1.3.

Ageing Management of reactors was the main topic of the first Topical Peer Review (TPR1). In TPR1, the participating countries described implementation of the overall ageing management programme and specific ageing management programmes for the following SSCs: electrical cables, concealed pipework, reactor pressure vessels, concrete containment structures. Fire protection systems were not specifically addressed at that time.

During the review of the NARs, it was found that information on the ageing management of SSCs of the fire protection systems was very limited. Therefore, generic questions were raised to address this topic.

Preventive actions for ageing management

The review of answers shows that only one country answered questions in detail on the preventive actions performed within the ageing management programme for NPPs. The majority of countries answered only partly the questions. Therefore, it doesn't allow to compare the approach of the different operators. It would be beneficial to share the preventive actions (inspection, test procedures (methods used, frequency…) implemented for the ageing management of some SSCs of the fire protection system, in particular the penetrations seals, fire doors and firewater distribution networks.

Lessons learned from the preventive actions

Preventive actions may lead to the identification of issues that were resolved by the operators by maintenance or repair, equipment modification or replacement, or update of the ageing management programme. Consideration of relevant operating experience is essential for the operators.

Aspects to be discussed at the workshop

- Preventive actions for ageing management
- Lessons learnt from the preventive actions

Expected outcome of the workshop

- Overview of practices regarding the preventive actions for ageing management
- Better insights from national approaches to share experience and identify potential good practices or challenges

6.1. Inspection and functionality testing of fire dampers

Type of installations mainly concerned

Applicable to all installation types.

Background and justification

Correct and effective functioning of the closure of fire dampers is essential to prevent the spreading of a fire to other areas. To ensure this, inspections and tests (as part of the maintenance programme of the installation) are carried out to verify the state of the fire dampers and their functionality, including their triggering and closing mechanisms.

Approaches and methods used (such as actuation, verification, visual, camera)

Based on the information from the NARs and answers, it can be concluded that in general there are different approaches among countries and types of installations, with regard to the inspection and functionality testing of fire dampers.
Some fire dampers or their triggering mechanisms are, e.g. due to practical constraints, located in places which are difficult to access. Consequently, inspection hatches have often been placed at some distance from the fire dampers, their closing mechanisms, and the detectors and systems intended to trigger them. This may make it difficult to carry out inspections in general and specifically visual verifications during functionality tests. Important issues are lack of visual verification in general, and lack of access to certain dampers.

Frequencies and associated justification for dampers' inspections and tests

The type and frequency of inspection and testing are defined based on the technical requirements of the installation, which take into account the location of the systems to be checked.

Approach for design modifications/replacement of dampers

During operation, testing and inspections, inadequate functionality or failure may have been registered. Instead of simply replacing the failing parts, a solution may sometimes be to redesign parts of the system or replacing some parts with more suitable or new type of components (e.g. a new damper). When the damper is not easily accessible or cannot be accessed (e.g. due to radiological hazards), modifications of the area where the damper is located may also be necessary to allow adequate inspection and testing.

Findings from inspection or testing of dampers

Inspection or testing of dampers may have led to maintenance, repair, equipment modification or replacement. Consideration of such operating experience is essential for the operators.

Aspects to be discussed at the workshop

- Approaches and methods used (such as actuation, verification, visual, camera)
- Frequencies and associated justification for dampers' inspections and tests
- Approach for design modifications/replacement of dampers
- Findings from inspection or testing of dampers

Expected outcome of the workshop

- Overview of practices regarding dampers testing, dampers modification or replacement, approach for non-accessible dampers
- Better insights from national approaches to share experience and identify potential good practices or challenges

6.2. Ventilation management in case of fire

Type of installations mainly concerned

Applicable to all types of installations

Background and justification

In the event of fire, changes in pressure and temperature can disrupt the circulation of air and give rise to uncontrolled transfers of a medium (smoke, pyrolytic gases, radioactive material) within the installation and eventually to the environment. Furthermore, a fire can damage filters and ventilation ducts and facilitate the transport of radioactive aerosols within the installation and/or to the environment. The management of ventilation systems in case of fire therefore requires consideration.

The objectives are to avoid the spreading of the fire and the risks associated with pyrolytic gases, smoke and other unburned material, and to facilitate intervention and control of fire consequences in the concerned areas, especially in terms of confinement. These objectives should be analysed in some specific areas to demonstrate that they do not unacceptably conflict with other safety requirements (e.g., keeping depressurisation, atmosphere circulation patterns, radiological confinement (filters), etc.). These issues are also crucial for personnel and rescue teams routes and working areas habitability analysis.

Issue of ventilation system and fire dampers automatization (approach, solutions)

Based on the information from the NARs and answers to the generic questions, different approaches for research reactors (RR) concerning the ventilation management were noted:

- In most of the RRs equipped with fire dampers, the closure of the fire dampers is automatically generated. For some RRs, a manual closure of the fire dampers by the operator is required;
- The shutdown of a certain (part of) ventilation system is mainly performed manually. In most of the research reactors under review, the ventilation is kept in service as long as deemed safe in case of fire in order to maintain the pressure gradients throughout the installation. However, for one Triga Mark II reactor, there is an automatic shutdown of the ventilation in case of fire detection.

For the other installations, the level of detail provided in the NARs for ventilation management in case of fire does not allow to compare the approach of the different operators. For this reason it would be beneficial to share practices.

Operators’ action on certain ventilation systems in case of fire

Criteria for certain parameters (for example the temperature, filter clogging, fire or smoke detection…) can lead to stop partially or totally the ventilation system. Criteria, availability of these key parameters in the control room and availability of procedures for ventilation management in case of fire for fast decision-making are not always specified in the NARs. The way operators address these issues could be shared during the workshop.

Aspects to be discussed at the workshop

- Issue of ventilation system and fire dampers automatization (approach, solutions)
- Operators’ action on certain ventilation systems in case of fire

Expected outcome of the workshop

- Overview of practices regarding the management of the ventilation (automatic actions, manual actions)
- Better insights from national approaches to share experience and identify potential good practices or challenges

7. ACTIVE FIRE PROTECTION

7.0. Fire detection

7.0.1. Adequate strategies for the installation of fire detectors and failure tolerance of fire detection

Type of installations mainly concerned

In general, applicable to all types of installations

Background and Justification

There are different approaches for the number, location, and type of fire detector in rooms, which may depend on the presence of SSCs, fire load, ignition sources, type of the room, etc.

As mentioned in the Topical Peer Review 2023 Fire Protection Technical Specification (TS), the requirement *WENRA SV 6.8* for NPPs WENRA SRLs on Fire Detection and Alarm Systems (FDAS) can be applied for other installations according to a graded approach.

> *(WENRA SV 6.8) Fire detection and alarm features, with detailed annunciation of the location of a fire to the control room personnel, shall be installed at the plant and their adequacy shall be supported by results of the fire hazard assessment. These features shall be provided with non-interruptible emergency power supplies and failures of the cable connections shall be announced to the main control room.*

The TPR II technical specification specifically requests with regard to FDAS for "...*the provisions (including subordinate systems to the extent applicable) to identify and notify occupants and fire emergency responders of any fire as needed according to the fire safety analysis (for reactor installations also including information to the control room, including systems' key features / technology and locations covered*, ….).

<u>Strategies for the installation of fire detectors</u>

From the information reported in the NARs and the answers, the TPR team notes that the strategy for the installation of fire detectors is different from one country to another or depending on the installations:

- some countries claim "full coverage", whilst allowing certain areas to be left out, like lavatories etc., according to national requirements;
- many installations report about having a complete coverage by fire detectors only in the controlled areas or only in safety relevant rooms or having different criteria. Rooms/areas that were by some installations intentionally left out from fire detection were rooms without fire loads/ignition sources and rooms with high radioactivity which would not allow the deployment of fire detectors;
- In some facilities or locations, no fire detectors are installed either because an automatic fire suppression system with own detector capacity is present, or a waste storage facility is in 'outside areas'.

However, in the case of presence of dangerous goods, or if the fire could spread to sensitive facilities nearby, the safety analysis may indicate the need for separate and dedicated detectors in these outside areas.

<u>Adequate measures for FDAS with no addressable detectors</u>

The ability to announce the location of the fire on the detector level is given by addressable detectors. Older systems locate a fire at a less detailed level and may be supported by additional measures.
The related chapters of the NARs and the responses to the questions show that addressable fire detectors are installed at the majority of installations, especially the newer installations, or by an

upgrade of the FDAS. Some installations report to have a standard equivalent to addressable detectors allowing for single detector identification without giving further details. Other installations report to allow for fire location based on a zone or room level by using distinct loops. Sometimes it is reported that detector annunciation is followed by detailed location by staff, e.g. fire fighters.

<u>Failure tolerance of FDAS regarding a single failure</u>

The failure tolerance of the FDAS (single failure of a component of the FDAS, e.g. a subsidiary fire-alarm board) should not lead to a failure of fire detection in more than one redundant safety train. There are different means to achieve failure tolerance of FDAS: for example, a high failure tolerance may be achieved by providing that the transmission of a fire detection signal runs over redundant components.

Aspects to be discussed at the workshop

- Strategies for the installation of fire detectors
- Adequate measures for FDAS with no addressable detectors
- Failure tolerance of FDAS regarding a single failure

<u>Expected outcome of the workshop</u>

- Overview/benchmarking of approaches regarding the strategy for fire detectors installation and failure tolerance
- Better insights from national approaches to share experience and identify potential good practices or challenges

7.1. Fire suppression

7.1.1. Issues for the installation of extinguishing systems

Type of installations mainly concerned

In general, applicable to all types of installations

Background and Justification

In accordance with IAEA Safety Guide NS-G-1.7 the availability, efficiency and adequate choice of fire extinguishing system for specific plant areas/rooms is key to ensuring fire safety not only of the plant, but also the safety of personnel.

The use of automatic fire extinguishing systems, such as water, foam, gas or dry chemical systems should be handled carefully to ensure they respond properly and effectively in the event of a fire. It should also be taken into account that the activation of fire extinguishing systems can lead to negative effects of the extinguishing agent on people and on components important to safety (for example, flooding of nuclear fuel storage areas with water or foam, dangerous exposure of personnel to carbon dioxide or other toxic gases, local harmful overpressure due to spurious injection of gas extinguishing agent, use of ozone-depleting substances, local cooling of safety-important components, etc.).

<u>Strategy and criteria for selecting plant areas/rooms for installing fire extinguishing systems (gas, foam, water, etc.)</u>

The choice of an automatic fire extinguishing system in specific plant areas/rooms leads to a number of issues that require clear criteria for their implementation such as selection of the type of extinguishing agent (their comparative assessment) as well as taking account of the potential damage caused by fire extinguishing agents on the protected equipment, and negative impact on service personnel.

Based on the information reported in the NARs and the answers, the TPR team notes that the strategy for selecting plant areas/rooms for installing automatic fire extinguishing systems (gas, foam, water, etc.) is not clearly described.

Introduction of gas/foam fire extinguishing systems for specific rooms or plant areas and equipment

A potential issue in the field of fire detection and extinguishing is the lack of permanent fire extinguishing systems in the main control panel, backup control panel and other electrical and electronic equipment rooms. A gas fire extinguishing system (GFES) could be introduced for these purposes. The implementation of the GFES leads to a number of issues that are not clearly described or in most cases are absent, namely:

- The number of premises at the power unit to be equipped with GFES is determined based on the specific fire load (calculation approaches).
- List of specific premises with electrical and electronic equipment to be equipped with GFES.
- Justification for the use of gas fire extinguishing agent (GFEA).
- Damage GFEA provisions for protected equipment.
- Justification for the safety of exposure of service personnel to GFEA in case of emergency situations.

Automatic fire extinguishing systems for plant areas with diesel generators

In the premises where diesel power systems (DPS) are installed, diesel fuel poses the greatest fire hazard. In order to protect against fires, explosions, and prevent threats to human life, the premises of DPS should be equipped with automatic fire extinguishing systems. However, some of these premises are not equipped with an automatic fire extinguishing system and only fire alarm systems are installed. As a compensatory measure, the above premises are equipped with mobile carbon dioxide fire extinguishers with manual start.

The implementation of automatic fire extinguishing systems for DPS leads to a number of issues that are not clearly described or in most cases are absent, namely:

- Justification for the use of fire extinguishing agent (FEA).
- Damage FEA provisions for protected equipment.
- Justification for the safety of exposure to FEA on service personnel in case of emergency situations.

Aspects to be discussed at the workshop

- Strategy and criteria for selecting plant areas/rooms for installing fire extinguishing systems (gas, foam, water, etc.)
- Introduction of gas fire extinguishing systems for specific rooms or plant areas and equipment
- Automatic fire extinguishing systems for plant areas with diesel generators

Expected outcome of the workshop

- Overview/benchmarking of approaches regarding the strategy for fire extinguishing systems (gas, foam, water, etc.), installation and failure tolerance
- Better insights from national approaches to share experience and identify potential good practices or challenges

7.1.2. Harmful effects of firefighting water

Type of installations mainly concerned

In general, applicable to all types of installations

Background and Justification

The consequences of flooding from the operation or failure of water fire suppression systems should be assessed as appropriate, and it should be shown that active fire suppression systems are designed and located so that any spurious operation does not impair the functional capability of SSCs or compromise life safety.

The TPR II Technical Specification for the NARs specifically asks in regard to suppression systems:

- *how harmful effects of inadvertent operation are taken into account and system reliability is assured;*
- *how secondary hazards from actuation or rupture of fire extinguishing systems (flooding, challenges to radiological containment, criticality, stored waste etc.) have been considered in the safety demonstration and operational arrangements*.

Approaches for systematic identification of harmful water effects on equipment and structures as a result of pipe breaks (or inadvertent operation) and spray and their consideration

Harmful water effects on equipment and structures as a result of pipe breaks (or inadvertent operation) and spray should be identified to ensure that SSCs are still able to perform their safety functions required to achieve the safe shutdown.

In the NARs or the answers to the generic questions, some countries reported on harmful effects (flooding, spraying, short-circuiting of electrical connections) and how they are considered to design the protection of the SSCs important to ensure the safe shutdown.

Consideration of consequences of water effects and measures taken to protect or mitigate the risks

Since pipes carrying fire-fighting water are very often large bore pipes with the potential to quickly inundate a facility, water discharge these pipes can result in significant damage to the facility and potentially result in radiological consequences.

IAEA Safety guide SSG-64 identifies guidance for the types of pipe failure which should be considered, such that good practice would consider both high and low energy pipes, including an assessment of the consequences, assuming a full pipe break to demonstrate the robustness of the design. This analysis should consider instantaneous local and global effects of pipe breaks such as pipe whip, jet impingement and flooding to inform the design for the supports, protection and to identify the affected SSCs important to safety. All these possible effects should be analysed and considered in the plant design, in particular for protective and mitigating measures. From the descriptions reported in the NARs and the answers, the TPR team notes the information provided varies in depth of coverage and clarity across the highlighted subtopics. For example, information related to Almaraz and Cofrentes NPP (Spain) provide information on the analysis of water depths as a result of pipe failure considered in the scope of the flooding analysis, identification where the flooding depths exceed the deterministic analysis, the potential consequences which may arise and the measures taken to mitigate the risk.

Measures taken to deal with the fire water run-off and to ensure its treatment so as to prevent the spread of radiological contamination

The possible consequences of firefighting water run-off from water-based fire suppression systems should also be considered in the design. The measures adopted to control firewater run-off (such as the use of drains and collection structures) should ensure that contaminated water is not released into the environment or to areas in which it may pose a hazard to people or the facilities.

Aspects to be discussed at the workshop

- Approaches for systematic identification of harmful water effects on equipment and structures as a result of pipe breaks (or inadvertent operation) and spray and their consideration
- Consideration of consequences of water effects and measures taken to protect or mitigate the risks
- Measures taken to deal with the fire water run-off and to ensure its treatment so as to prevent the spread of radiological contamination

Expected outcome of the workshop

- Overview/benchmarking of approaches regarding the consideration of harmful effects of firefighting water
- Better insights from national approaches to share experience and identify potential good practices or challenges

7.2. Administrative and organisational fire protection issues

7.2.1. Firefighting - different responsibilities - distribution of tasks across licensee, on-site and off-site fire brigades

Type of installations mainly concerned

In general, applicable to all types of installations

Background and justifications

When a fire breaks out in a facility, a rapid and coordinated response must be provided to control its spread and extinguish it.

Upon activation of the fire detection system in the nuclear facility, there are provisions for alerting of fire teams starting from the internal fire brigade and escalating to the external fire units.

Establishing the strategy regarding on-site and off-site fire safety units is the responsibility of the licensee. It includes agreement about responsibilities. Depending on the safety issues, the licensee has an organisation and emergency resources. There may be more or less equipped internal teams, internal teams specialised in fighting fire outbreaks or external resources such as teams shared between operators or public emergency services.

Different levels of firefighting operations

Firefighting operations can be divided into several tasks from the moment the fire is detected. It may be detected by humans (operator or witness) and/or detected by an automatic fire detection system. These tasks can be allocated to different levels associated with increasing timescale as follows:

- Detection (automatic or by witnesses): Presence of automatic extinguishing means or use of a manual extinguisher by local workers.
- Action of the first intervention team with light equipment: Generally, specialised operators who are working in the vicinity without specific gear or equipment.
- Action by the second intervention team with heavy equipment: as specific protective clothing, water jets or vehicles [can be onsite fire-brigade].
- Action by external intervention team from the neighbourhood: like private firefighters from neighbouring installations [can be mutualised “on-site” fire-brigade].
- Action by public firefighters. [Off-site fire-brigade].

Depending on the issues identified, the licensee implements all or part of these different levels or means, depending on their organisation, local arrangements and the assessment of the issues. The objective to be achieved is of course the rapid extinction of the fire before it becomes uncontrollable or fully developed. If this sequence fails, the third level of defence in depth, sectorization, must make it possible to contain the fire and its effects.

The NARs describe these different organisations retained by the operators. The review of this subject in the different NARs gives different approaches and information.

The objective of this topic of interest is to compare practices between different families of operators with comparable activity (like NPP, fuel cycle facilities, research reactors, waste storage facilities). This information aims to provide a comprehensive understanding of the different levels of firefighting intervention, including personnel, equipment, procedures, and additional responsibilities. It helps ensure clarity and consistency in the description and implementation of firefighting protocols across various facilities.

<u>Coordination of on-site and off-site brigades</u>

The NARs indicate that joint exercises involving teams from external and internal fire services are performed to provide adequate coordination and interaction between them. However, the NARs don't provide much information on the criteria for calling or not calling an off-site fire brigade/intervention team in case of a fire event.

Aspects to be discussed at the workshop

- The different levels of firefighting operations the operators rely on, and their related means and responsibilities:
  - Their resources (number of personnel or team members involved at each level (e.g. composition of the team 24/24), their protective gear and equipment); the means utilised to control the fire (considering seismic qualification of on-site fire brigade building in case of fire induced by earthquake, the timescale for intervention(s) etc).
  - Their responsibilities (including identification of additional responsibilities or tasks assigned to the firefighting team or other operators at each level, such as common rescue of people, security duties, operating function, number of installations covered, training, etc).
- The coordination of on-site and off-site brigades, including the definition of criteria for calling or not calling an off-site fire brigade/intervention team.

<u>Expected outcome of the workshop</u>

- Overview of operational organisation between actors from the detection of the fire until its extinction
- Better insights from national approaches to share experience and identify potential good practices or challenges

7.2.2. Availability of the off-site fire brigade and other services in case of simultaneous events (on-site fire and off-site emergency) in the strategy for active fire protection

Type of installations mainly concerned

In general, applicable to all types of installations

Background and justification

The description of the off-site firefighting services in the NARs frequently refer to situations in which, apart from a fire on the facility site, no other emergency seems considered. In case of another emergency, an important issue is that off-site firefighting teams will give the highest priority in responding to a fire at a nuclear facility even if they have commitments to other activities.

From the NARs, it can be noticed that there are installations that take only the external fire brigade into account for any firefighting activities, but they seem not to consider the occurrence of events that simultaneously need the external fire brigades, for example:

- off-site aircraft crash with flying debris and/or (burning) fuel across the plant site (on-/off-site),
- wildland fire (off-site) with entry of smoke and/or sparks across the plant site,
- large regional events like earthquakes, floods, blizzard which bind the capacities from all emergency organisations.

The above examples are intended to illustrate that there is a realistic and everyday possibility that certain external events may lead to incidents or events on the nuclear site, e.g. a fire.

Aspects to be discussed at the workshop

- Availability off-site personnel with equipment and technical resources familiar with the site and agreements in case of simultaneous events (fire in the installation together with off-site emergency).
- Organisational arrangements for an adequate replacement of a professional off-site fire brigade.
- Involvement of a volunteer fire brigade in case of non-availability of the professional fire brigade, if relevant.

Expected outcome of the workshop

- Better insights from national approaches to share experience

8. TRANSVERSAL TOPICS

8.0. Compartmentation

Type of installations mainly concerned

In general, applicable to all installation types

Background and justification

A proper compartmentation combined with a fire hazard analysis is fundamental for preventing the spread of fires and for mitigating their impact on the nuclear installations. This issue is essential as the results of the analysis carried out directly affect the means for fire prevention and the passive fire protection features to be implemented and maintained.

Use of suitably qualified fire-resistant rated barriers is regular practice for preventing fire spreading. This practice is applied in most areas of civil engineering, including nuclear installations.

Threats from internal hazards shall be eliminated or minimized as far as reasonably practicable for all plant operational states. In the analysis of plant internal hazards fires play a key role and have been put at the first place of the list in WENRA SRL SV2.2.

Methods for determining and re-assessing suitable fire barriers

Fire resistance ratings typically consider fire load and fire load density threshold values.

According to WENRA SRL SV6.5 the use of a fire compartment approach is preferred. The fire resistance rating of the fire barriers of the fire compartment shall be sufficiently high so that the total combustion of the fire load in the compartment can occur without breaching the barriers taking into account the fire hazard analysis. If a fire compartment approach is not practicable, fire cells shall be used and duly justified by the fire hazard analysis, including compensatory measures. For fire barrier resistance assessment, oxygen availability within and oxygen supply to the fire compartment shall be conservatively considered and justified. Thus, the approaches to compartmentation and physical separation for prevention of fire propagation and spreading to other compartments, are crucial for the understanding of the proposed solutions and the adequacy of measures taken.

Effects of fire-related compartmentation on the level of conservatism/realism of Fire PSA (comparison)

The approaches for a proper fire hazard analysis (FHA) and, as an important part of that, for the analysis of the fire-related building compartmentation by suitable and reliable fire compartment (and fire cell, where applicable) boundaries rating vary between the countries participating in the TPR II.

The results of the FHA provide an important input for the Fire PSA. Where an adequate fire compartmentation with appropriate fire compartment boundaries by suitably qualified fire barriers is present (as part of a typically conservative design approach), a conservative Fire PSA can pessimistically assume a failure of the whole fire compartment. For a realistic Fire PSA, the fire compartments can be further subdivided in virtual units (often called fire influence zones where it can more realistically assumed that a fire in a pre-defined time period cannot spread to all zones in the whole compartment and thus a failure of all components in the compartment does not have to be assumed. This may (not in all cases) significantly affect the Fire PSA results.

Cases when the use of a ‘state-of-the art’ compartmentation is not fully possible and compensatory measures are needed

Most participating countries proceed with modifications (including expansion of the facility) according to similar approaches, involving a fire safety analysis.

Particularly in installations designed to earlier standards, a nearly complete compartmentation with fire resistance ratings determined according to the state-of-the art and practice - not only from nuclear industry but as defined also in non-nuclear building codes applied widely over Europe - is not always possible (for example due to designs with lower wall/floor/ceiling qualifications or limited space).

It can be in particular the case that for older installations, compromises and slight adjustments may sometimes be justified on the basis of reasonable practicability, if for example newer regulations cannot be fully complied with due to operational reasons. In these cases, improvements of fire barriers are therefore often not possible.

In order to ensure the same fire protection level, credit is typically given to additional compensatory means. These can be encapsulations of unprotected fire loads to physically separate them from potential ignition sources, protective intumescent/ablative coatings of cables (which do not need much space/volume). Although they do not represent a qualified fire barrier, with additional active protection means they can represent an effective upgrade to the original design. An example of the additional active protection could be the use of suitable fire suppression means, either for successfully extinguishing a fire in an early stage, when it is not fully developed, or cooling the potential target to prevent its failure. This implies that, where a full compartmentation is not possible a comparable protection level can be reached by appropriate compensatory means (e.g. separation/segregation of fire compartments and, as far as applicable, of fire cells).

Aspects to be discussed at the workshop:

- Methods for determining and re-assessing suitable fire barriers
- Effects of fire related compartmentation on the level conservatism/realism of Fire PSA (comparison)
- Cases where the use of 'state-of-the art' compartmentation is not fully possible and compensatory fire protection means are needed.

Expected outcomes of the workshop

- Overview/benchmarking of approaches regarding the analysis of the fire related building compartmentation and their application for installations design with older standards related regulations, corresponding FHAs/Fire PSAs, existing fire protection concepts
- Better insights from national approaches to share experience and identify potential good practices or challenges

8.1. Decommissioning

Type of installations mainly concerned

Applicable to NPPs, research reactors and fuel cycle facilities in decommissioning.

Background and justification

Facilities in decommissioning usually face specific challenges due to the constant transformation of the site related to the changing decommissioning activities. Therefore, the fire protection strategy and fire protection systems need to be adapted and modified during the different phases of decommissioning or removed when no longer needed. The fire hazard analysis is as well consequently updated to reflect the changing configuration of the installation.

<u>Criteria and process to identify and implement modifications on fire protection measures, administrative controls, organisation and training</u>

During decommissioning, there is a constant evolution of several factors:

- Changes in the radiological environment, including the presence or not of fresh/spent fuel in the installation. and changes in the radiological inventories, in particular related to the presence of generated radioactive waste that could be affected in case of a fire at any given location.
- Changes in fire loads (removal of high fire loads such as turbines, generators, transformers or emergency power generators) and possible introduction of new combustible materials and/or ignition sources (associated to an increased frequency of hot works).
- Conduct of dismantling operations such as disassembly of equipment, systems and components as well as the demolition and decontamination of structures.

These factors could lead to:

- Changes in the number of workers carrying out activities and updating of their training on fire safety
- Adaptation or refurbishment, if needed, of existing fire protection systems (e.g detection and suppression systems, fire barriers etc)
- Regular adaptation of administrative controls and procedures commensurate with the risks present at different stages of decommissioning.

<u>The process to update the fire hazard analysis and fire protection programme in order to reflect the changing situation of the plant</u>

In relation to the evolutions and changes in the fire and radiological hazards, there is a need to periodically update the fire protection programme and the fire hazard analysis. It can be also required that a specific fire hazard analysis is conducted for certain “safety relevant” decommissioning operations according to their particular characteristics. Updated fire hazard analysis can also be used to base decisions on the removal of fire protection systems if considered to be no longer necessary for the subsequent steps of decommissioning.

Aspects to be discussed at the workshop

- Criteria and the process carried out to identify and implement modifications on fire protection measures, administrative controls, the organisation and training.
- The process carried out to update the fire hazard analysis and fire protection programme in order to reflect the changing situation of the plant.

Expected outcomes of the workshop

- Overview/benchmarking of approaches regarding adaptation of fire protection provisions to the conduct of decommissioning operations
- Better insights from national approaches to share experience and identify potential good practices or challenges

8.2. Combinations of fires with other hazards

Types of installations mainly concerned

All types of nuclear installations, particularly NPPs and RRs

Background and justification

There is relevant national and international operating experience of event combinations involving plant internal fires, coming from both from nuclear and non-nuclear installations.

Combinations of fires and other hazards represent a non-negligible share of more than 12 % of all fire events reported to the OECD NEA FIRE Database [20].

Combinations of hazards to be addressed in the safety analyses and criteria for their identification

The WENRA SRLs require an analysis of credible combinations of events that may occur, for different types of nuclear installations. In addition, the need to detail the combinations of events considered in fire safety analysis and the rules/criteria applied to consider such event combinations was included in the most recent IAEA Safety Guides for the design and operation of nuclear power plants and partly also other nuclear installations (IAEA SSG-64, SSG-68, SSG-77) as well as in the PSA Safety Guides (IAEA SSG-3, Rev. 1, SSG-4) require the consideration of credible hazard combinations, including combinations of fires and other hazards.

The TPR experts' review of the NARs identified that considering combinations of the internal hazard fire with other external and/or internal hazards clearly enhances the overall level of safety.

Particular consideration may be given to the following site specifically applicable event combinations of fires and other external and internal hazards in deterministic analyses and Fire PSA:

- Earthquake and consequential or coincidental plant internal fire;
- Transportation accident such as aircraft crash, truck crash on roads or ship collision on rivers, etc. and consequential internal fire;
- Plant internal fire and consequential internal flooding.

Design, qualification and performance of fire protection systems (passive[21] and active[22]) against combined hazards

According to IAEA SSG-64, the fire protection features must be designed to fulfil their required functions in the event of combinations of fires and other anticipated events, particularly earthquakes as the most well-known combination, and considered in some regulations for more than 40 years. High intensity earthquakes have a low probability of occurrence during a nuclear installation´s lifetime but their effects can be significant. They may damage both the SSCs of the installation and the surrounding infrastructure, making it difficult to operate on-site resources or to provide external support in a timely manner.

In addition, seismically induced fires may occur simultaneously at different locations inside the installation. Nuclear fire safety management principles are generally designed considering one single fire event at a time (rarely two or more), which may not be fully adapted to seismically induced fires.

History shows the complexity of facing fire events induced by earthquakes and the need to ensure the availability and reliability of the relevant parts of the fire detection and alarm features as well as the fire extinguishing provisions and their robustness in case of seismic hazards. If the active fire protection means fail to fulfil their required function, a fire consequential to a seismic hazard may grow without being detected and/or suppressed in a timely manner, and safety functions could ultimately be inadmissibly impaired.

Aspects to be discussed at the workshop

- Combinations of hazards to be addressed in the safety analyses and criteria for their identification
- Design, qualification and performance of fire protection systems against combined hazards

Expected outcomes of the workshop

[20] https://www.oecd-nea.org/jcms/pl_24954/fire-incidents-records-exchange-fire-project
[21] Fire barriers and their elements
[22] Fire extinction systems (FES) and fire detection and alarm systems (FDAS)

- Overview/benchmarking of approaches regarding event combinations of fires and other hazards to be considered in the different installations
- Better insights from national approaches to share experience and identify potential good practices or challenges

9. [TBC]Conclusions and Recommendations

9.0. Summary of review process compliance with Topical Peer review Terms of Reference and Technical Specifications

9.1. Summary of the results regarding the fire safety analyses

9.2. Summary of results regarding fire prevention

9.3. Summary of results regarding fire passive protection

9.4. Summary of results regarding fire active protection

The review identified a n umber of areas where actions taken by the countries would enhance …

The review highlighted an industry-wide challenge where further work at the European level is warranted. This challenge is …. Addressing this challenge would improve the effectiveness of ….

9.5. Main results regarding Nuclear Power Plants

9.6. Main results regarding Research Reactors

9.7. Main results regarding Fuel Cycle Facilities (enrichment, fabrication, reprocessing)

9.8. Main results regarding Waste Facilities

9.9. Main results regarding Spent fuel storage facilities

9.10. Main results regarding facilities in decommissioning

9.11. Recommendations to the European Nuclear Safety Regulators Group and Countries for future positions and actions

10. [TBC]References

[TBC]Annex I: Glossary

Annex II: Definition of Good Practice, National Area of Good Performance, National Area for Improvement and Challenge

<u>The findings of the peer review are categorized according to the following definitions:</u>

- ***Good Practice*** *which should be understood as an aspect of fire protection, which is considered by the TPR review Team to go beyond what is required in meeting the appropriate national or international standards. It is identified in recognition of an arrangement, practice, policy or programme significantly superior to those generally observed in participating countries and having a clear safety benefit. It is likely to be applicable to other participating countries with similar programmes and it is for each country to review and decide on its implementation in relevant nuclear installations to improve safety.*

- *A* ***National area of good performance*** *which should be understood as an arrangement, practice, policy or programme related to fire protection that is recognized by the TPR review Team as a significant accomplishment for the country, and has been undertaken and implemented effectively in the country and is worthwhile to commend.*

- *A* ***National area for improvemen****t which should be understood as an aspect of fire protection identified by the TPR Peer Review Team where improvement is expected, considering the arrangement, practice, policy or programme generally observed in other participating countries. It may also be self-identified by the country itself (i.e. self-assessment) where improvement is appropriate.*

- ***Challenge (EU wide****) EU wide Challenges which should be understood as aspects in the implementation of fire protection that are considered by the TPR Peer Review Team to be common to many or all countries and are areas where action at a European level, in addition to action at national level, would help to increase available knowledge, drive consistency or produce beneficial new techniques or technology to assist in enhancing fire protection at nuclear installations or the fire safety case.*

[TBC]Annex III: Compilation of Good Practices and Challenges

[TBC]Annex IV: Statistics about Questions