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International Atomic Energy Agency

Joint IAEA and OECD/NEA Fuel Incident Notification and Analysis System (FINAS) Guidelines

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IAEA Services Series 14 (Rev. 1)

IAEA SAFETY STANDARDS AND RELATED PUBLICATIONS

IAEA SAFETY STANDARDS

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The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at: Vienna International Centre, PO Box 100, 1400 Vienna, Austria.

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

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JOINT IAEA AND OECD/NEA FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM (FINAS) GUIDELINES

INTERNATIONAL ATOMIC ENERGY AGENCY
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For further information on this publication, please contact:

Research Reactor Safety Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
Email: Official.Mail@iaea.org

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FOREWORD

The Fuel Incident Notification and Analysis System (FINAS) is an international event reporting system for nuclear fuel cycle facilities. The system is jointly operated by the IAEA and the Nuclear Energy Agency. Membership of FINAS is open to Member States that have or are planning to operate nuclear fuel cycle facilities.

FINAS is part of the IAEA's common platform of Incident Reporting Systems for Nuclear Installations, which includes the International Reporting System for nuclear power plants and Incident Reporting System for Research Reactors.

The fundamental objective of FINAS is to contribute to improving the safety of nuclear fuel cycle facilities worldwide. This objective can be achieved by sharing of information on the causal factors and the lessons learned from the events of safety significance that have occurred during the lifetime of the nuclear fuel cycle facilities, including the design, construction, commissioning, operation and decommissioning stages.

The purpose of these guidelines is to describe the system and to give users the background and information to enable them to produce FINAS reports of the necessary quality that effectively communicate the important lessons learned from events in a timely manner. This publication is an update to IAEA Services Series No. 14, IAEA/NEA Fuel Incident Notification and Analysis System (FINAS) Guidelines published in 2006.

These guidelines have been jointly developed by the NEA and IAEA. The IAEA officers responsible for this publication were L. Valiveti and A. Shokr of the Division of Nuclear Installation Safety.

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

The Fuel Incident Notification and Analysis System (FINAS) is an international system through which participating Member States exchange operating experience and lessons learnt to improve the safety of nuclear fuel cycle facilities (NFCFs). FINAS is jointly operated by the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development (OECD).

IAEA Services Series No. 14, IAEA/NEA Fuel Incident Notification and Analysis System (FINAS) Guidelines[1] was published in 2006. These guidelines describe the objectives, scope, and use of the system, reporting and distribution, and system for FINAS operation and management. The guidelines also include the procedure for preparation of reports, and the details of the reporting categories and coding in the system.

The feedback from the use of FINAS indicated the need for inclusion of additional event codes and improved clarity and consistency of the terminology. Furthermore, there was a need to ensure consistency with, and to incorporate the feedback from the experience of operating the IAEA International Reporting System (IRS) for nuclear power plants and Incident Reporting System for Research Reactors (IRSRR) reporting systems.

The information technology (IT) platform of the IAEA incident reporting system was upgraded in 2023. The upgraded system uses a modern IT platform (external web-based interface) for the three operating experience databases (FINAS, IRS, and IRSRR) administered by IAEA. This platform, titled as Incident Reporting Systems for Nuclear Installations (IRSNI), enhances the effectiveness of the systems through improved user interface and providing for better analysis of information.

This publication is a revision of Services Series No. 14; it has been updated to take the above aspects into consideration.

1.2. OBJECTIVE

The purpose of the publication is to describe FINAS, and to give users the necessary background and information to produce reports that would be useful to Member States to prevent the occurrence of similar events at their NFCFs. This publication is intended for use by the FINAS National Coordinators, regulatory bodies, operating organizations, technical support organizations, representatives from the IAEA and NEA, and specialists of the nuclear community from the FINAS Member States.

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA/NEA Fuel Incident Notification and Analysis System (FINAS) Guidelines, IAEA Services Series No. 14, IAEA, Vienna (2006).

1.3. SCOPE

The scope of this publication is to provide the information relevant to the use of FINAS by Member States with FINAS membership, including its operation, and reporting process and procedures.

1.4. STRUCTURE

This publication has four sections and three appendices. Section 2 provides the history, purpose and use of FINAS. It also describes the types of facilities and the methods for collection and distribution of the information of the system. Section 3 describes the process of reporting to the system. The roles and responsibilities of various parties involved in the system are given in Section 4. Appendix I provides explanation of various categories of reporting available in the system. Information on the preparation of FINAS report is given in Appendix II. Appendix III provides the event coding in the system.

2. FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM

In September 1990, the OECD/NEA Committee on the Safety of Nuclear Installations (CSNI) Working Group on Fuel Cycle Safety (WGFCS) proposed instituting a fuel cycle incident reporting system, similar to the IRS used for nuclear power plants. The WGFCS noted the importance and effectiveness of having a database system to share operating experience between Member States. A guideline document [1] was developed, and in 1992 the FINAS was started. By the end of 1994, around 40 incident reports had been compiled and shared. At the Working Group meeting in September 1994, members reviewed the system's status and progress, focusing on event types, report quality, and distribution requirements. Consequently, they proposed forming a task group to address these concerns, a plan endorsed by the CSNI. The results of the review were published in 1995 in FINAS Guidelines [2].

As documented in the proceedings [3], the recommendations from the IAEA International Conference on Topical Issues in Nuclear Safety stated:

> "The IAEA should continue its work of fostering the international exchange of information on regulatory and safety issues for fuel cycle facilities. It is recommended that the IAEA build on its long-standing activities on event information exchange and analysis for NPPs (IRS, NEWS, INES) to fulfil the same role for other installations of the fuel cycle and seek cooperation with the OECD/NEA on its FINAS database. Action should be taken to collect and disseminate to all interested Member States the experience and lessons learnt."

In 2006 the web-based FINAS platform was launched, and joint IAEA and OCED/NEA guidelines were published as the IAEA Services Series No. 14, IAEA/NEA Fuel Incident Notification and Analysis System (FINAS) Guidelines. The web-based platform was created to facilitate efficient data input and easy access to reports. The facility data in FINAS is obtained from the IAEA nuclear fuel cycle facilities database[2]. In 2023, FINAS was integrated into the IRSNI platform.

2.1. PURPOSE OF THE FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM

FINAS was established as a simple and efficient system to exchange important lessons learnt from operating experience gained in NFCFs of the participating Member States. The main objective of the system is to assure proper feedback on events of safety significance on a worldwide basis to help prevent occurrence or recurrence of serious incidents or accidents, or mitigate the potential impacts, if such an event occurs.

Events reported to the system are expected to be of safety significance for the international community in terms of causes and lessons learnt.

FINAS is a system based on the voluntary commitment of participating Member States, who benefit from the exchange of information. Member States are responsible for selecting the events to be reported to the system.

The information is expected to be provided to FINAS in a timely manner. Early information on a significant event in a Member State may assist other Member States in avoiding a similar problem; this is a main objective of the system.

As there are differences in design, construction, and operation of various types of NFCFs, a FINAS report has to provide sufficient details to understand the event and highlight the relevance of the event to the recipient. Therefore, a FINAS report is expected to provide detailed technical, human, and organizational factors' information on the root causes, safety significance, lessons learnt and corrective actions.

Since FINAS focuses on significant events important for the international community, it should neither be viewed as a source for statistical studies nor for component reliability studies. In addition, the system is designed for specialists of the nuclear community as a source of detailed information on analysis and lessons learnt from the events, as opposed to a simple description aimed at the public[3].

2.2. TYPES OF FACILITY WITHIN THE SCOPE OF THE FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM

The types of facility included in the scope of FINAS are those dealing with the nuclear fuel cycle other than nuclear power plants, research reactors and waste disposal facilities. This includes, but is not limited to, facilities such as:

- Uranium and thorium mining and processing facilities;
- Nuclear fuel refining facilities;
- Nuclear fuel conversion facilities;
- Nuclear fuel enrichment facilities;

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[2] https://infcis.iaea.org/NFCFDB/

[3] The International Nuclear and Radiological Event Scale (INES) information service is designed for the media and public information. (see https://www.iaea.org/resources/databases/international-nuclear-and-radiological-event-scale)

- Nuclear fuel fabrication facilities;
- Radioisotope production facilities;
- Radioactive waste processing and storage facilities;
- Nuclear fuel handling and intermediate storage facilities;
- Nuclear fuel reprocessing facilities;
- Nuclear fuel cycle research and development facilities.

Associated activities related to these facilities, such as radioactive waste management and decommissioning, are included in the scope.

FINAS does not address incidents or events related to fuel that occur at nuclear power plants or research reactors, since these are taken into account by the IRS and IRSRR respectively. The reporting system also does not cover incidents related to fuel transportation that occur outside the site of the nuclear fuel cycle facility.

2.3. ACCESS AND USE OF THE FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM

Membership of the system is open to Member States with at least one of the following:

- One or more NFCFs under construction, commissioning or in operation;
- An NFCF that is not in operation but has not been decommissioned;
- A project to build an NFCF.

FINAS is for official use within each participating Member State, by organizations professionally involved in the nuclear industry, that may include the following, with the approval of the participating Member State:

- Regulatory bodies;
- Technical support organizations;
- Operating organizations with planned or ongoing nuclear fuel cycle programmes;
- Vendor companies (design firms, engineering contractors, manufacturers, etc.) associated with NFCFs;
- Research establishments working in the nuclear fuel cycle field.

FINAS had 40 Member States as of June 2024, representing most of the world’s NFCFs. The database covers events at NFCFs dating back to 1992. FINAS reports are collected and disseminated by a designated secure IRSNI-FINAS website (https://irsni.iaea.org/) provided by the IAEA.

FINAS is a restricted information platform. It allows for the submission of reports and access by registered users. There are two types of user roles in FINAS: the ‘National Coordinator’ and the ‘Generic User’. National Coordinators are appointed by the Member States participating in the system (see Section 4.1). National Coordinators can access all the FINAS reports, and upload and edit their national FINAS reports. Generic Users have read-only access to FINAS reports. Generic User access to the system is granted by the Joint IAEA and OECD/NEA FINAS Secretariat on the request of the Member State or the respective National Coordinator. The user manual for FINAS is available on the IRSNI-FINAS website.

FINAS relies upon national reporting systems as the source of information used in the reports and complements these national reporting systems by placing them within the context of the international nuclear safety community. FINAS focuses on safety related events with potential for lessons to be learnt internationally, in particular, precursors, causal analyses and other events with the potential for significant consequences at a facility. Thus, FINAS provides a pre-processed set of data with the intention to be relatable to situations in other Member States, allowing for an efficient feedback process. In addition, the potential exists to include both operating organizations' and regulatory bodies' assessments of events.

FINAS is an important source of information for operating organizations complementing the facility's programmes and national reporting systems. FINAS also provides valuable source of information for regulatory bodies and their technical support organizations in the licensing and oversight of NFCFs, by providing insights on international operational experience for NFCFs. Vendors may be able to improve their design, construction or manufacturing process of structures, systems, and components (SSCs), by utilizing the experience from the lessons learnt that are available in the system. Research establishments may receive additional guidance for establishing new research goals and programmes related to safety of NFCFs.

Member States may also share information on actions they have taken in response to events or information from FINAS reports published by other Member States. This can be done by using the 'Country Actions' feature in the IRSNI-FINAS website.

Dissemination of event information is expected to also benefit the originating Member State by the increased opportunity for receiving feedback from other Member States. Such dissemination will lead to a wider ranged effort to improve safety, by using operating experience from NFCFs.

Information shared by FINAS may be helpful as an input to decision making on operational safety aspects of the facility.

2.4. COLLECTION AND DISTRIBUTION OF FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM INFORMATION

The FINAS National Coordinators are responsible for the preparation and submission of reports to the FINAS. Once a report is submitted, the IAEA focal point for FINAS[4] undertakes a review to ensure the completeness and quality of the report. Where deficiencies are identifies the IAEA focal point works with the FINAS national coordinator complete the report. Once report is finalised, the IAEA focal point publishes the report on FINAS. Once a new report has been published, all FINAS users are notified.

The FINAS platform provides search and visualization capabilities to help identify important events and trends. For example, events can be searched based on the date of incident, facility type or reported cause of the event.

As a result of the detailed technical character of the information provided by participating Member States, FINAS reports are classified as 'restricted' to enable open and timely exchange of information among members. This condition was accepted when the system was established and remains in force.

[4] IAEA focal point for FINAS is the IAEA staff responsible for the operation of FINAS.

Since the information available in FINAS is restricted to registered FINAS users, any user wishing to share FINAS information with a third-party person or organization needs to obtain the prior consent from the respective FINAS National Coordinator for their own national FINAS reports, and the IAEA (through their FINAS National Coordinator) for all other FINAS reports.

3. FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM REPORTING

3.1. SELECTION OF EVENTS AND INFORMATION FOR FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM REPORTING

Reported event or information[5] is expected to be safety significant or reveal lessons that could help the international nuclear community improve the safety of NFCFs. The information may cover safety related issues, lessons learnt, and good practices. The events or information may be reported to FINAS at any stage of the NFCF lifetime, including siting, design, manufacturing, construction, commissioning, operation, and decommissioning.

In general, an event or information is expected to be reported to FINAS when any of the following criteria are met:

(a) Safety significant events or information are considered reportable if:

- There is an actual or potential significant reduction in the facility's defence in depth;
- They reveal important lessons which may help prevent occurrence, or mitigate the effects of a safety significant event, or to strengthen defence in depth.

For example:

- Releases of radioactive material or exposure to radiation, above the prescribed limits for site personnel or members of the public;
- Release of or exposure to hazardous substances (e.g. toxic, flammable, cryogenic) above the prescribed limits for site personnel or members of the public;
- Failures, degradation or design deficiency of structures, systems, or components, or human errors, that might challenge the fulfilment and maintaining of safety functions;
- Conditions caused by internal and external hazards (e.g. seismic hazards, fire, internal or external flooding, extreme weather) that might damage or impair structures, systems, or components required to fulfil and maintain the safety functions;
- Operating events, typically deviations from normal operations, accompanied by additional equipment failures, human errors or anomalous indications;
- Events with common cause failures;

[5] In context of reporting to FINAS an event is any occurrence unintended by the operator, including operating error, equipment failure or other mishap, and deliberate action on the part of others, the consequences or potential consequences of which are not negligible from the point of view of protection and safety. Information in the context of reporting to FINAS include reports (e.g. summary of operating experience, results of research, regulatory notices) on specific issues which are useful for the FINAS users to review their applicability and formulate appropriate actions to prevent similar issues.

- New degradation mechanism, safety analyses or research results, showing a previously unknown weakness in an item important to safety;
- Organizational or human factor issues such as human error, weaknesses in the safety management system, procedural adherence, inadequate procedures, inadequate training or inadequate control of contractors;
- Major changes to maintenance, periodic testing or inspection programmes, or to regulatory requirements based on events and information;
- Latent weakness or conditions leading to non-compliance with regulatory requirements.

(b) Operating experience often includes precursors or contributors to more significant events. Consequently, the reporting need not be limited only to the criteria listed in (a) above, but also to lower level events, good practices, and corrective actions that contain lessons that may be useful to others. Events that are the repetition of similar events previously reported to FINAS may still convey new lessons to the international community.

3.2. REPORTING CATEGORIES

The events or information may be reported to FINAS in the following reporting categories:

(1) Releases of radioactive material or hazardous material; or exposure to radiation, radioactive material, or hazardous material;
(2) Degradation of safety functions;
(3) Deficiencies in siting, design, construction, commissioning, operation, decommissioning, management systems, or safety assessment;
(4) Generic problems of safety interest;
(5) Consequential actions taken by the regulatory body;
(6) Events of potential safety significance;
(7) Effects of external events of either human or natural origin;
(8) Events which attract public interest;
(9) Non-radiological environmental consequences;
(10) Events affecting the whole site;
(11) Consequential actions taken by the operator.

A detailed explanation of these categories is given in Appendix I.

3.3. CONTENT, REPORTING TIME AND REPORT FORMAT OF FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM -

FINAS reports are intended to be written in clear and understandable plain language. The lessons learnt and actions taken need to be clear and understandable to the international community to facilitate the assessment of the applicability to the situation in other Member States.

The report is expected to cover at least the following:

- Brief facility information and relevant data to enable understanding of the event. The report is not to contain any technical detail or diagram that may disclose security or non-proliferation features;
- A narrative description of the event or information which includes the facility specific technical data necessary to understand the causes and consequences;

- A safety assessment of the event (see section II.3.2.3, Appendix II);
- Results of the cause analysis which details the direct and root causes and contributing factors;
- The lessons learnt and corrective actions taken, including actions taken by the regulatory body.

Additional information on the preparation of FINAS report is given in Appendix II.

The report needs to include an abstract giving the essential characteristics of the event, as well as event codes facilitating the event search in FINAS (see Appendix III).

The report is expected to be submitted as soon as all the required information is available.

For events of high safety significance or important lessons learnt, a preliminary report may be submitted consisting of a brief description of the event and all relevant preliminary findings. The preliminary report needs to be submitted as soon as practicable. This preliminary report needs to be followed by a main report when the findings are finalized.

The format outlined in Appendix II needs to be used for preparing FINAS reports whenever possible. However, flexibility may be applied for practical reasons, such as specific types of reports or different national requirements. The format and content of FINAS reports may be integrated into the national systems for operational experience feedback to link national system and FINAS more efficiently.

FINAS is operated in English. Whilst one of the other official languages of the IAEA may be used, Member States are encouraged to submit FINAS reports in English to reduce the time taken in translation, review and publication of such reports in other official languages. FINAS reports provided in a language other than English may be included in FINAS as an attachment.

4. OPERATION AND MANAGEMENT OF THE FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM

This section describes the role and relationship of the respective parties involved in the operation and management of FINAS. These are the participating Member States, the Joint IAEA and OECD/NEA Technical Committee of FINAS National Coordinators, WGFCS, and the Joint IAEA and OECD/NEA FINAS Secretariat.

4.1. ROLE OF PARTICIPATING MEMBER STATES

Requirement 73 of the IAEA Safety Standards Series No. SSR-4, Safety of Nuclear Fuel Cycle Facilities [4] states:

> **“The operating organization shall establish a programme to learn from events at the facility and events at other nuclear fuel cycle facilities and in the nuclear industry worldwide.”**

Member States need to ensure that relevant and useful operating experience from its nuclear fuel cycle programme is reported to the international community in a timely manner. The effectiveness of this sharing depends on the quality of both the selection and presentation of the information being exchanged among the participating countries. FINAS is a mechanism established by the IAEA and OECD/NEA for capturing of such operating experience. As users of FINAS, the Member States agree on its objectives and decide on the improvements and modifications in reporting, the management of the FINAS database, and the related activities to be performed.

Member States need to designate a primary FINAS National Coordinator to be responsible for the receipt and distribution of information obtained from FINAS and for the transmission of information to FINAS. If necessary, the Member State may also designate alternate National Coordinators to support the primary National Coordinator in their responsibilities. The role of the National Coordinator is tied to the role of the Member State: e.g. promoting exchange, conducting training, and providing feedback on the use of FINAS information within the Member State. The National Coordinator needs to be given the necessary authority and tools to openly communicate to FINAS any information of potential benefit to the international community. The network of National Coordinators can, via direct contacts, supplement the exchange of information. Member States are expected to allocate sufficient resources to make these exchanges effective.

The effectiveness of FINAS largely depends on its regular use. Therefore, the National Coordinators are expected to promote the sharing of relevant operating experience within their country. The National Coordinators are also expected to monitor the usage and effectiveness of operating experience from FINAS within their country to help improve and update the system.

Dissemination of information is more effective if the following approaches are used [5]:

- All Member States are committed to not only use the system but also to report operating experience from their country to the |FINAS;
- FINAS users provide appropriate resources (responsibility of the country and the different operating organizations, vendors, etc.) to ensure proper use of the disseminated information;
- Events and other operating experience information are reported proactively and in a timely manner;
- The information shared is easily understandable.

While the overall responsibility for the use of operating experience lies with the operating organizations, the responsibility and accountability for the effective promotion of the system and its benefits, as well as the training to effectively use the system within their country is the responsibility of the National Coordinator(s).

A National Coordinator is expected to undertake at least the following activities:

- Submit reports on events with useful lessons learnt to the international community to FINAS;
- Submit the requests for addition or modification of NFCF details as necessary in FINAS;
- Demonstrate ownership of the system, by promoting the use of FINAS and showing leadership at the national and international level;

- Ensure report quality such that information is sufficiently comprehensive and commensurate with the timeliness of reporting (e.g. preliminary or main reports, see Appendix II);
- Participate in the biennial technical meeting of FINAS National Coordinators (see Section 4.2), and present the national experience by sharing events, lessons learnt, and corrective actions taken;
- Provide feedback about improvement of effectiveness of the FINAS;
- Share information on actions taken by the Member State, in response to significant events or information from FINAS reports published by other Member States;
- Manage the designation of Generic Users from their country.

Information provided to FINAS needs to be accurate, complete, understandable, user friendly, and easily retrievable. Special efforts are expected to be made by FINAS National Coordinators to ensure information provided is understandable to all the users. This includes the avoidance of abbreviations and jargon and the use of broadly accepted terms.

4.2. ROLE OF THE IAEA AND THE OECD/NEA

The IAEA and OECD/NEA provide the framework, the infrastructure and technical support to operate FINAS. Both agencies coordinate their efforts to ensure activities are not duplicated and meet the expectations of participating Member States.

The primary role of the IAEA is to operate the system and provide support to participating Member States for the efficient operation and management of the system. The role of the IAEA Secretariat includes the following:

- To compile, collate, and disseminate the information related to events reported to the system by participating Member States;
- Translate FINAS reports from the IAEA official languages to English, if necessary;
- Review the submitted reports, check for consistency and give feedback to the National Coordinators, as needed;
- Request follow-up information, as needed;
- Propose FINAS reports to be highlighted for the users and compile periodic reports;
- Compile NFCF operating experience periodic reports from the system;
- Establish, operate, maintain, and update IRSNI-FINAS website;
- Request Member States to provide reports on significant events shared by or available from other sources (e.g. the reports of IAEA peer review missions which are publicly available; the IAEA Unified System for Information Exchange in Incidents and Emergencies (USIE), press information);
- Perform other secretarial services regarding FINAS.

The IAEA and OECD/NEA organize the meeting of the Technical Committee of the FINAS National Coordinators on a biennial basis (see also Section 4.3). The location of the meeting alternates between the IAEA and OECD/NEA headquarters.

Any change in FINAS requires approval by both IAEA and OECD/NEA.

4.2.1. Role of the working group on fuel cycle safety

The WGFCS is an international forum to exchange information on matters relevant to NFCFs, including licensing systems, safety philosophy and safety standards to improve mutual understanding, and to review the information from FINAS and other databases.

The role of WGFCS related to FINAS is the following:

- Encourage and support WGFCS member countries to participant as a FINAS member and report their events in the FINAS;
- Organize a specific forum to share lessons learnt and promote their implementation, in the case of an event of common interest;
- Assess the lessons learnt and good practices in the operation of NFCFs, in order to reach mutual understanding of design philosophy and principles, licensing systems and safety requirements related to NFCFs;
- Organize the development of topical studies (e.g. based on the information reported in FINAS);
- Optimize the benefits of cooperation with other existing NEA working groups and other international organizations (e.g. IAEA, World Association of Nuclear Operators (WANO)).

The WGFCS membership is managed by the OECD/NEA. The IAEA participates in the WGFCS as an observer. The WGFCS annual meeting is organized by the OECD/NEA and follows the meeting of the Technical Committee of FINAS National Coordinators (see Section 4.3). The WGFCS provides feedback, if necessary, on FINAS improvements in the context of the WGFCS objectives[6].

4.2.2. Role of the IAEA event review group

All reports submitted to FINAS are reviewed internally by the IAEA Event Review Group for their completeness and quality. In general, the review occurs within 30 days of the receipt of the FINAS report. The safety significance, root cause analysis, corrective actions implemented and overall compliance with the FINAS guidelines are discussed.

Members of the IAEA Event Review Group include the staff from various sections of Division of Nuclear Installation Safety and the IAEA focal point for FINAS. After the review meeting, any suggestions or comments intended to clarify the content of a report are sent to the respective FINAS National Coordinator for review and action as appropriate. If the IAEA does not receive a response to the suggestions or comments within 30 days, the original version of the report that was submitted to the system is published.

4.3. ROLE OF THE TECHNICAL COMMITTEE OF FINAS NATIONAL COORDINATORS

The Technical Committee of FINAS National Coordinators is restricted to the National Coordinators and their alternates and the focal points or technical officers from IAEA and OECD/NEA.

[6] https://www.oecd-nea.org/jcms/pl_25487/working-group-on-fuel-cycle-safety-wgfcs

The Technical Committee meets biennially to undertake the following activities:

- Review the status of FINAS operation and management;
- Discuss important operating experience or information presented during the meeting;
- Present the current IAEA and OECD/ NEA activities in this area.

The participants review and analyse the activities performed within the framework of FINAS and the Technical Committee provides recommendations to IAEA and NEA on the relevant aspects.

The Technical Committee meeting is usually followed by the WGFCS meeting to review the information received and to exchange information on recent events that have occurred in participating member countries of the WGFCS.

APPENDIX I.

FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM REPORTING CATEGORIES

This appendix discusses the categories of operating experience (events and information) to be reported. It provides background information on the reasons for their selection as well as a general description and examples of relevant events and information. A report may be prepared not only because an event has occurred, but also because a significant lesson learnt has been identified. The categories are intended to provide a basis to characterize the events and information to be reported to FINAS.

The examples given here are not exhaustive and are intended to illustrate typical events to be reported to the system under each category (see Section 3.2). Certain complex events may fall into more than one category.

I.1. CATEGORY 1: RELEASES OF RADIOACTIVE MATERIAL OR HAZARDOUS MATERIAL; OR EXPOSURE TO RADIATION, RADIOACTIVE MATERIAL, OR HAZARDOUS MATERIAL

Releases of radioactive or hazardous materials at the facility directly impacts facility personnel and the environment. The design and operation of an NFCF incorporates features that prevent undue releases and exposures. Due to weaknesses in operational controls, design, etc., unanticipated releases or exposures might occur. This category is intended to report events addressing actual or potential serious weaknesses in the provisions implemented, even if the prescribed dose limits or exposure limits have not been exceeded.

I.1.1. Category 1.1: Unanticipated or unexpected releases of radioactive material or hazardous material

This category comprises unanticipated or unexpected releases to the environment or within the site of the facility, not exceeding the authorization limits. Unanticipated releases confined to the site may pose problems to safety of personnel or render access to on-site areas difficult, resulting in items important to safety that cannot be adequately controlled, tested or maintained.

Examples:

(a) Routine airborne activity monitoring of a ventilation discharge stack indicated a significant increase in alpha activity in the airborne discharges. The increased activity recorded in the airborne discharge continued into the next day before falling back to slightly above normal levels. No on-site personnel were affected and the potential dose to the most highly exposed member of the general public was assessed as less than 1 micro (μ)-Sievert (Sv).

An investigation revealed the origin of the activity as a redundant building being decommissioned. No single cause was identified but it is clear that the ventilation system was partly unfiltered and did not meet modern standards. This had been recognized by the operating organization who, as part of the decommissioning operations, was in the process of installing a new filtered ventilation system. The programme for this work was brought forward and a temporary filtered extraction system was made available for connection if needed.

(b) Significant quantities of Iodine-129 were released over a two-week period from a chimney which ventilates the cells within a chemical reprocessing plant. The amounts released were less than 10% of the authorized discharge. The analysis for the bulked daily samples is done weekly and the result was not available until four days after the end of the second week, thus causing a delay in reporting the event. No on-site personnel were affected and the potential dose to the most highly exposed member of the general public was assessed as less than 1µSv.

An investigation determined that there was a change in operating conditions in the plant dissolver. During this change, the radioactive Iodine that is normally retained in the upstream stages of the system, passed into subsequent downstream stages, and volatilised, thus escaping via the cell ventilation system.

(c) During commissioning of a new plant for the treatment of waste solvents, it was noticed that a valve on a line carrying 13 molar nitric acid was leaking and needed replacement of the internal parts. Before the repairs could begin, a double isolation of the line was specified including one isolation in a building under the control of a different plant manager. Due to inadequate arrangements for the control of cross boundary isolations, inadequate training of the people involved and inadequate verification before work began, the wrong line was isolated. The second isolation also failed because the valve had been incorrectly assembled, allowing nitric acid to pass when the valve was nominally in the closed position. About seven cubic meters (m^3) of nitric acid was released to the plant operating area when the bonnet of the faulty valve was lifted. The maintenance personnel involved suffered minor acid burns and a member of the emergency response team was affected by NO_X fumes. Prompt action by the site fire brigade to neutralize the acid and cover surface drains prevented any significant release of acid to the environment.

I.1.2. Category 1.2: Exposure to radiation, radioactive material or hazardous materials that exceeds prescribed limits for members of the public

An event resulting in exposure to radiation, radioactive material or hazardous material that exceeds prescribed limits for members of the public is the consequence of a serious breakdown of the barriers protecting the public. Therefore, all such events are expected to be reported to FINAS.[7]

I.1.3. Category 1.3: Unanticipated or unexpected exposure to radiation, radioactive material, or hazardous material for facility personnel

The protection of facility personnel is a major safety objective for facility operation. Therefore, events dealing with unanticipated exposure of personnel are usually due to degradation of barriers or operational controls. This category comprises events addressing serious potential or actual weaknesses in the provisions implemented leading to external irradiation or internal contamination through airborne dispersion.

[7] Unanticipated or unexpected exposure to the public which does not exceed the limits is categorized in 1.1.

Examples:

(a) A mixed oxide fuel pin was blocked in the loading machine. The automatic sequence failed to interrupt, and the fuel pin was chopped. This resulted in the dispersion of an estimated amount of 1g mixed oxide in the form of a fine powder and grains. The ventilation air exhausted from the affected hall passed through an adjacent hall for the fabrication of uranium pellets and mounting into pins. As a consequence, plutonium contamination was spread into both halls. Monitoring and decontamination started immediately after installing a triple entrance lock to the contaminated zone and an additional ventilation system. The internal contamination of eight workers involved in the incident was monitored by analysis of faeces and urine. All doses were below the prescribed limits.

(b) An apparently empty shipping container was sent to the decontamination area, where decontamination personnel established that the dose rate from the container had been underestimated. Their personal dosimeters alarmed, indicating higher than expected radiation fields. It was discovered that a small piece of metallic wire, probably from a neutron flux detector assembly, having a contact dose rate in excess of 10 Sv/hour (h), was responsible for the unexpectedly high activity from the container. The event draws attention to inadequacies of administrative controls.

I.2. CATEGORY 2: DEGRADATION OF SAFETY FUNCTIONS

The safety functions that need to be met for safe operation of NFCFs include the confinement and cooling of the radioactive material and associated harmful materials, protection against radiation exposure, and maintaining subcriticality of fissile material. Additionally, confinement of other hazardous substances, and prevention and control of hazardous chemical reactions are also the safety functions that need to be met in some NFCFs. This category is intended to include events where actual or potential serious degradation has occurred in the safety systems that are designed to maintain the availability of safety functions. Degradation of related SSCs resulting in actual or potential loss of the safety functions are also to be reported under this category.

I.2.1. Category 2.1: Degradation of confinement

The confinement represents a system of multiple barriers that prevent the escape of radioactive or hazardous material to the environment and prevents or limit the exposure of facility personnel and the public. Confinement structures include passive structures and components (e.g. vessels, gloveboxes, cells, tanks) as well as active components (e.g. valves, cooling systems, ventilation systems). In shutdown conditions confinement integrity may also be needed when performing material handling operations or movement of radioactive materials or when cooling of the radioactive material could be threatened.

During the normal operation of NFCFs, the potential exists for leaks to develop in process vessels and cells and associated equipment, despite the care with which they are fabricated and operated. Small and anticipated leaks that do not prevent continued operation of the plant are in themselves not reportable. However, breaches of confinement caused by unexpected factors and other unexpected failure mechanisms are to be reported, especially when generic implications ensue. Reportable confinement failures are not limited to operation of NFCF systems. Incidents which occur during ancillary operations (e.g. waste handling and flasking or casking operations), which can result in actual or potential loss of confinement and can give rise to important lessons learnt, are also to be included in this category.

Example:

In the course of a fuel shearing operation, monitoring showed a variation in the fuel dissolution parameters and the shearing was halted. After investigating, the operator found that a fuel element nozzle had damaged the channelling system which diverts fuel elements to an acid decontamination vat[8] and sheared fuel sections to the dissolver. Sheared fuel sections, containing fissile material, had consequently been directed to a nozzle decontamination vat instead of to the dissolver. An estimated 1060 kg of fuel had accidently been sent to the decontamination vat. The incident had no radiological consequences for staff or the environment. Improvements were subsequently introduced to ensure early detection of similar incidents.

Note: For such an event, Category 2.2.1, degradation of criticality control is also to be considered if the vat is not geometrically safe.

I.2.2. Category 2.2: Degradation of reactivity control

I.2.2.1. Category 2.2.1: Criticality control

Various SSCs are provided in an NFCF for criticality control. They include systems for control of mass, concentration or enrichment of fissile material, and control of neutron absorbers, reflectors and moderating materials. Criticality control may be affected by failing administrative and operational controls (e.g. undetected changes in geometry and mass balance, removal of neutron absorbing material, changes in chemical conditions). Degradation of such systems and controls may lead to reactivity excursions and high radiation levels accompanied by release of fission products. Observed degradation or failures of such systems and controls may have generic implications and are expected to be reported.

Example:

A failure occurred in a pipe connected to a plutonium evaporation system in a reprocessing facility. This resulted in a leak of plutonium nitrate into the secondary containment cell and an accumulation of plutonium containing material at the base of the evaporator. The accumulated material remained subcritical. On discovering the leak, the operating organization shut down the reprocessing facility. The operating organization subsequently modified the facility to prevent similar occurrences and made improvements to the systems for leak detection. In addition, operating procedures have been reviewed and strengthened. There was no unauthorized discharge of radioactivity to the environment during the incident or as a result of any of the remedial actions. There was no additional radiation exposure to workers on site at the time of the incident.

I.2.2.2. Category 2.2.2: Chemical reactivity

Degradation of the control of chemical reactivity may lead to chemical reactions such as explosions, exothermal reactions due to non-compatible substances or unstable reagents or compounds, uncontrolled kinetics, or auto catalytic reactions. Radiolysis and hydrogen generation can induce such events.

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[8] A vat is a large container, vessel or a tank which is generally used to store or hold liquids.

Example:

An uncontrolled exothermic reaction occurred during a routine operation to dissolve uranium–zirconium alloy swarf in a mixture of hydrofluoric acid and nitric acid. This heat generating reaction resulted in the burning of a small quantity of uranium–zirconium alloy swarf. The swarf fire quickly extinguished itself, but the heat given off was sufficient to cause a secondary fire by igniting plastic components within the facility. This secondary fire was in turn quickly extinguished by the on-site fire brigade. No on-site personnel were affected by the incident. Although the fire resulted in a higher than normal discharge from a ventilation stack on the day of the incident. This was significantly below the levels that would involve notification to the regulatory body, and the overall monthly discharge was consistent with that which would have been expected from routine operations alone. An investigation identified the cause to be a modification to the plant which allowed undiluted acid to drip directly onto exposed swarf resulting in the uncontrolled exothermic reaction. The modification was carried out to overcome a conventional hazard found during the commissioning of a new acid feed system fitted to the plant, and was categorized as having only a 'minor, if any' nuclear safety significance. The incident demonstrated that there was a weakness in the safety categorization system used by the operating organization.

I.2.3. Category 2.3: Degradation of cooling

In some NFCFs, cooling systems are provided to remove heat from radioactive decay and chemical reactions. Failure to remove the heat may result in temperature excursions that can challenge the confinement of radioactive or hazardous materials. Actual failures and existence of significant potential failures in these systems are expected to be reported under this category.

Example:

The vitrification facility of a spent fuel reprocessing plant experienced an interim loss of the safe cooling function for a high level liquid waste (HLLW) feed tank. The safe cooling system comprises two independent cooling loops (A and B) to assure heat removal from the HLLW in the tanks. An operator noticed that the cooling water flow rate at the pump discharge on the B-loop had decreased, while the A-loop was isolated due to modification work. A field investigation was initiated, and a gate valve (B-valve) on the B-loop was found to be closed. The valve was immediately opened manually, and the safe cooling system flow was restored. The operating organization determined that the safe cooling function of the facility had been lost for approximately 8 hours. The HLLW temperature in the feed tank increased to 32°C, but it was well below the alarm setpoint. The operating organization has taken corrective actions in the areas of operations, equipment, and modification work management to prevent the reoccurrence of similar events.

Note: This event can also be categorized under 3.3 Deficiencies in operation including maintenance and surveillance and 3.4 Deficiencies in management system.

I.2.4. Category 2.4: Degradation of support functions

Many support functions contribute to maintaining the safety of facilities, as their failure can lead to damages to the facility or personnel. Typical examples of these support functions considered in this category include:

- Radiological protection monitoring systems;
- Process monitoring (e.g. chemical analysis);
- Electrical power supply;
- Control systems;
- Vacuum, fluids and gases;
- Measurement systems;
- Reagents;
- Fire protection.

Degradations of such support systems may be of generic interest and are expected to be reported if important lessons can be learnt.

Example:

Loss of electrical power supply resulted in unavailability of the air extraction systems in the high activity cells, the effluent treatment station, and the radiation protection measurement and monitoring systems for a period of six minutes. This incident also caused the onset of flooding in the low and intermediate activity laboratories. The cause of this incident was that all circuit breakers in the electrical circuits of these systems opened when a technician attempted to open a single circuit breaker during a maintenance operation. This malfunction caused by an installation design fault was familiar to the operator since it had given rise to a similar incident a year earlier. Moreover, no formal procedure existed for the particular task to be carried out. In accordance with the operating instructions, the personnel evacuated the areas affected by the shutdown of the ventilation system. The flooding of the area was due to poor design of the liquid effluent collection system. A valve in this system remained open following the loss of electrical power supply.

I.3. CATEGORY 3: DEFICIENCIES IN SITING, DESIGN, CONSTRUCTION, COMMISSIONING, OPERATION, DECOMMISSIONING, MANAGEMENT SYSTEMS, OR SAFETY ASSESSMENT

Adherence to requirements and standards during the lifetime of the facility assures the overall safety of NFCFs. Effective management systems and comprehensive safety assessment are necessary in all stages of the lifetime of a facility.

I.3.1. Category 3.1: Deficiencies in design

The main objective of plant and equipment design is to ensure overall facility safety with sufficient margins. Deficiencies in the design could result in loss of a safety function, loss of safety system or unexpected event sequences. Further, design deficiencies may cause common mode failures that affect the facility safety. All such cases including material compatibility, degradation due to environmental or operating conditions, computational errors, etc. are to be reported under this category.

Example:

Annual scheduled maintenance was being carried out in a reprocessing facility during which the ventilation for part of the facility ventilation needed to be switched from normal mode to reduced mode which meant fewer fans working than during normal ventilation system operation. During one of the start-up sequences of the fans in reduced mode, the electrical protection system caused the one of the ventilation fans to trip due to an electrical fault. caused the fan to trip by electrical protection settings. A sequence of automatic actions then caused several fans powered by the same power supply to start up simultaneously. This generated a high demand for electrical current, which tripped the thermal overload protection switches and caused the unexpected shutdown of part of the facility's ventilation systems. The event was caused due to inadequate design of the power supply to the fans and of the instrumentation and controls.

Note: This event can also be categorized under Category 3.5, Deficiencies in safety assessment.

I.3.2. Category 3.2: Deficiencies in construction, manufacturing, procurement, installation, or commissioning

Deficiencies in construction, manufacturing, procurement, installation, or commissioning may cause significant deviations from the desired facility status. These deficiencies can occur during initial installation of the facility and during modification of the facility. If these deficiencies cannot be detected by testing or maintenance, they may cause latent failures that degrade facility safety. Events are expected be reported if these deficiencies affect facility safety and show significant lessons to be learnt.

Examples:

(a) While performing work addressing a small coolant leak on enrichment cascades, it was noted that the outer (secondary) rupture disk had a significant accumulation of tar-like material, presumably due to leakage into the assembly from the facility's roof. The amount of tar in the rupture disk was such that the disk was determined to be inoperable, and the system operation was placed into a mode that took this into account. Inspections were commenced to identify if there were any other locations where tar dripping from the roof might have entered rupture disk assemblies. Further locations were identified and, as each was discovered, the associated coolant system pressure relief system was declared inoperable, and an appropriate mode of operation was established. During the inspections, an additional failure mode was discovered: a foreign material exclusion cap had been left installed in the outlet port of some rupture disk assemblies. Although this flexible plastic cap would not have impacted the rupture disk blowing at rated pressure, there was concern that the cap could become lodged in the rupture disk outlet diffuser nozzle. Systems with this condition were also declared inoperable and an appropriate mode of operation was established.

(b) In a uranium enrichment plant, 140 litres of acidic liquid with a total radioactivity of 2.3×10^8 Becquerel (Bq) uranium leaked from a collecting tank into a sealed concrete pit. The tank, made of ferritic steel with an inner plastic coating, had corroded around the welding seam of an outlet pipe which allowed acidic rinsing liquid to come into direct contact with the tank material. Routine inspection of the interior of the tank had not detected the damage and partial detachment of the inner coating had not been recognized. Four further tanks of similar construction were exchanged for tanks made of acid-resistant steel.

Note*:* Such incidents could be relevant to Categories 3.1, 3.2 or 3.3 and have to be carefully assessed as the leakage can be related to:

- The design (e.g. error in material selection or inappropriate analysis of process conditions).
- The construction (e.g. the defect analysis revealed an inadequate assembly during construction.
- The operation conditions such as, insufficient analysis of corrective maintenance conditions (e.g. specific reagents) or insufficient periodic monitoring.

I.3.3. Category 3.3: Deficiencies in operation including maintenance and surveillance

Safe operation and effective maintenance (including inspection and surveillance activities) are the result of qualified and well-trained facility staff, adequate procedures and tools, and good management. Deficiencies in human performance by operating personnel, other facility personnel or contractor personnel may degrade defence in depth. These deficiencies may result in the degradation or loss of safety systems or loss of operational control.

Example:

A plant operator observed that a small amount of plutonium-bearing solvent liquor had leaked from a sample cabinet onto the floor beneath it. An investigation indicated that the initial cause was a restriction in the overflow line from an instrument feed tank located within the sample cabinet which serves as the secondary containment. The restriction led to the liquor overflowing into the base of the cabinet. The overflown liquor passed into a process vessel as intended, via a drain line in the cabinet. However, due to a defect in the cabinet seal, small quantity of liquor leaked out of the cabinet onto the floor.

Note*:* This incident can be categorized as Category 3.3, as the incident was due to insufficient monitoring (detection of the reagent flow disturbance or of the leakage in the cabinet) of process equipment. This event may also be relevant to Category 2.1, Degradation of confinement.

I.3.4. Category 3.4: Deficiencies in management system

IAEA Safety Standards Series No. GSR Part 2, Leadership and Management for Safety [6] requires the operating organizations establish, apply, sustain, and continuously improve a management system to ensure the safety of NFCFs.

Requirement 6 of GSR Part 2 [6] states:

> **"The management system shall integrate its elements, including safety, health, environmental, security, quality, human-and-organizational-factor, societal and economic elements, so that safety is not compromised."**

The events reported in this category may include the following deficiencies in the management system:

- Part(s) of the management system (e.g. organizational structure, procedures, interfaces between interested parties, safety culture, etc.) are not complying with the related requirements and standards;
- Inconsistency(s) within the management system;
- Non-conformities with the management system (e.g. non-compliance of products or activities with the procedures);
- Missing or insufficient documentation of the management system, missing or insufficient records.

Examples:

(a) During a walkdown of a uranic waste storage facility on an enrichment plant, several non-compliant radioactive residue storage arrays were identified. The walkdown identified that several arrays had been manufactured incorrectly and did not meet the spacing requirements defined in the extant safety case. Further inspection revealed that compliance with the storage container volume criteria could not be confirmed in all cases. The operating organization immediately prohibited all movement of containers and personnel into the facility. A criticality safety assessment of the non-compliant storage arrays was completed which concluded that the current non-compliant state was demonstrated to remain adequately subcritical provided the storage arrays remained in place as they were.

Note: This event can also be categorized under Category 3.2, Deficiencies in construction, manufacturing, procurement, installation, or commissioning.

(b) In one of the manufacturing workshops producing nuclear fuel assemblies for pressurized water reactors, an operator discovered the presence of wet products (scrap containing fissile materials) in a drum identified as containing dry products. This situation indicated non-compliance with the criticality risk prevention rules applicable to the storage and internal transfer of this type of containers. The operating organization suspended production operations in the pellet grinding units as well as the transfer of drums and launched a check of all drums that could potentially contain wet products. This check revealed six other anomalies concerning the procedures for management of drums.

(c) Cleanup operations were performed in a MOX fuel fabrication facility that had been shut down. These operations were performed according to a specific authorization with adapted operating limits and conditions, and by implementing internal operating procedures. An incident occurred after a milling operation and led to the overload of the milling equipment in reference to the authorized mass limit. The resulting fissile mass due to the overload of the mill was low compared to the mass considered in the criticality safety assessments This was due to the safety margins that were considered in the design of the equipment and in the administrative controls. Nevertheless, the incident revealed an accumulation of deficiencies in the safety culture of the operating shifts. Consequently, cleanup operations were stopped, and an extensive review of the operating procedures and equipment was undertaken.

Note: This event can also be categorized under Category 3.3 Deficiencies in operation including maintenance and surveillance.

I.3.5. Category 3.5: Deficiencies in safety assessment

Safety assessment is carried out throughout all stages in the lifetime of an NFCF, including siting, design, operation, and decommissioning. The safety assessment covers the analysis of postulated initiating events in all facility states including operational states and accident conditions, and the related safety measures.

This category addresses deficiencies in the safety assessment of systems, event sequences and operating conditions considered in the design analysis, as well as deficiencies in the original scope of the safety assessment (i.e. event sequences or conditions not identified or analysed). Typical examples in this category are environmental conditions not adequately considered in the design of the facility, unforeseen system interactions, non-conservative calculations, and deficiencies in the safety evaluation of maintenance procedures. This category addresses deficiencies in the safety assessment during all stages in the lifetime of an NFCF.

Example:

Several radiation monitors alarmed in a fuel encapsulation plant resulting in the evacuation of the building. The cause was identified as a flask containing swarf from the de-canning of fuel elements. Pressurization of the flask resulted in a leak of radioactive material into the building. A small amount of activity was released to atmosphere before the building ventilation system was shut down. The release did not breach any authorized discharge limits. The operating organization has produced a revised safety case covering swarf flask transfers and introduced additional measures to monitor swarf behaviour within the flask, in particular the evolution of potentially explosive or flammable gases.

Note: This event can also be categorized under Category 1.1, Unanticipated or unexpected releases of radioactive material or hazardous material, and Category 2.1, Degradation of confinement.

I.3.6. Category 3.6: Deficiencies in decommissioning

Deficiencies in decommissioning could result in generation of large quantities of radioactive wastes, nonconforming[9] radioactive waste, unacceptable quantities of non-radioactive pollutants and/or hazardous wastes, breach of safety barriers leading to spread of contamination, and unacceptable radiation exposure to workers, the public and the environment [5]. All such events and/or issues are expected to be reported under this category.

Examples:

(a) During the transfer of a redundant glovebox to a storage facility on site, contamination in the form of discrete spots was released onto the floor of the plant. The personal protective equipment worn by a health physics surveyor (shoe) and an operator (shoe and coverall leg) were found to be contaminated with alpha activity. All samples collected via nose-blows, personal air samplers and air samplers showed no significant activity. A recovery operation was undertaken to identify and clean-up the contamination that had been released. The operating organization has improved the methods of sealing for all penetrations of the bulk items including glove boxes, during preparation for their movement.

(b) A fire broke out in the filtration system located in a decontamination room. The filtration system was used to extract smoke, gases, and dust from the plasma cutting block used for dismantling contaminated metallic materials. The fire was caused by the generation of particles of flammable materials that can be extracted by air flow. These small and light particles can ignite during cutting and cannot be stopped by the "Spark Arrester". In addition, when cutting greased/lubricated materials, there is a possible formation of oil vapour which is extracted and deposited on the filters. The filtration system was destroyed but there was no significant impact on staff and environment. After the event, the operating organization decided to move from the plasma burning technique to cold cutting techniques.

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[9] not meeting the acceptance criteria for disposal or storage.

I.3.7. Category 3.7: Deficiencies in siting

This category is expected to include deficiencies in planning and preparation of site that result in a negative impact on the construction, operation or decommissioning of an NFCF, or result in negative environmental, economic, health, and social effects from the proposed facility.

I.4. CATEGORY 4: GENERIC PROBLEMS OF SAFETY INTEREST

Events that reveal deficiencies, which affect or might affect several facility systems or components, or might have implications for other facilities, may be reported in this category. Reoccurrences of events, which indicate the existence of generic problems of safety significance are also be reported under this category. These generic problems might not have been adequately addressed by operation experience feedback, research, and regulation. The purpose of reporting such events is to draw attention to such problems and enable initiation of corrective action to prevent events with serious consequences.

Example:

A vehicle carrying 12 Type A transport packages (with fresh fuel assemblies) was involved in a collision with a car, resulting in a fire. The outer wooden packaging burned away, and there was extensive damage to the gaskets and pressure relief valves of nearly all of the metal inners. There was also physical deformation of the metal inner containers. the inner metal packaging was damaged. There was no release of radioactive material.

I.5. CATEGORY 5: CONSEQUENTIAL ACTIONS TAKEN BY THE REGULATORY BODY

This category is intended to include significant consequential actions taken by the regulatory body resulting from lessons learnt of reported events. Such actions could be changes to regulatory requirements related to the licensing process, the design or operation of NFCFs, or enforcement actions. They may also include important changes to the requirements for design, construction, commissioning, safety assessment, modifications, surveillance or decommissioning of facility systems; changes to requirements on facility staff or changes in requirements related to emergency preparedness and response. Reports on consequential actions identify important lessons learnt related to the regulatory process dealing with significant problems or events.

Example:

A criticality accident occurred at the conversion test building of a uranium conversion facility. Introduction of a uranyl nitrate solution (enrichment of 18.8 %) into a precipitation tank was intended to be restricted by procedure to ensure that one batch (2.4 kg uranium) was added at a time from buffer tanks. However, workers bypassed the buffer tanks using a 5-liter stainless steel bucket and a funnel, feeding in seven batches of the uranyl nitrate solution. This resulted in 16.6 kg uranium in the precipitation tank. As a result, the uranyl nitrate solution in the precipitation tank reached criticality. Three workers were exposed to radiation. The maximum measured dose and the maximum estimated dose to a member of the public were 16 mSv and 21 mSv, respectively. The public doses were dominated by direct irradiation, therefore local residents within about 350 m of the facility were requested to evacuate, and people within 10 km of the facility were recommended to stay indoors.

The government took several measures, such as the "Law for the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors" was revised to include periodic inspections, introducing a system to check the compliance of operating organizations with safety preservation rules, the assignment of "Administration of the Nuclear Safety Inspectors" to the major sites and stipulation of licensees' duty to train their employees. "Special Law on Emergency Preparedness for Nuclear Disaster" was legislated. The Nuclear Safety Commission established the "Safety Examination Guide for the Specific Uranium Fabrication Facilities" for facilities that process uranium enriched to 5% to 20%.

I.6. CATEGORY 6: EVENTS OF POTENTIAL SAFETY SIGNIFICANCE AND OTHER OPERATING EXPERIENCE INFORMATION

This category is intended to include events that did not have any actual significant safety consequences, but which nonetheless are of potential safety significance. It covers events where protective systems were actuated to mitigate consequences of an event or where these systems had been challenged unnecessarily. It includes especially near-miss situations that may also be precursors to more serious events. It may include events that lead to potential loss of a safety function.

This category is also intended to include new perspectives; industry initiatives; information gained from the results of analysis, research, benchmarking, or review of events; and issues in other industries. Reporting in this category may include the effects of changes in technology, safety standards, or new regulatory requirements that may impact NFCF systems.

Example:

The failure of a spent fuel supply conveyer in a reprocessing plant caused the shearing operation of spent fuel to be suspended due to lack of spent fuel transfers from the storage pond to the shearing cell. Detailed investigation revealed that the drive shaft for the supply conveyer had detached from the joint of the driving shaft and drive motor unit. The setscrew of the driving shaft had loosened and had not acted as expected. As a countermeasure, spot welding of the setscrew used to fix the drive shaft was improved. Subsequently, a new drive shaft and insert shaft were assembled and placed into the shearing cell. Failure of the conveyor during the spent fuel transfer might have resulted in higher than expected exposure to workers. As a result of the event, checking of the connection at the drive shaft was included in the facility's periodic inspection programme.

I.7. CATEGORY 7: EFFECTS OF EXTERNAL EVENTS OF EITHER HUMAN OR NATURAL ORIGIN

This category is intended to include those events caused by an external act or condition which might challenge the ability of the facility to continue to operate, or to shut down, or to maintain shutdown conditions in a safe manner. The category includes external events such as natural events (e.g. high winds, earthquake, flood, ice formation, pollution of river water or sea water, lightning strikes, heavy rain, or snow fall) and human induced events (e.g. explosion, fire, industrial transportation accident, aircraft crash).

Example:

Heavy snow and high winds hit the area of a multi facility site which included a NFCFs. Overhead electrical lines on the main grid system clashed due to icing. Furthermore, a broken electrical earth line on one of the 132kV double circuits feeding the facility caused short term voltage dips. Voltage dips caused by faults affected the electrical systems and this caused multiple tripping of electrical equipment in many facilities at the site. Some of the equipment that tripped included the systems vital for safe operation, such as active area ventilation fans and radiological detection equipment. As a result, facilities at the site including the reprocessing facilities, were immediately shut down in a fully loaded condition, buildings were evacuated, and a site incident was declared.

In addition, the voltage dips caused the tripping of important utility supplies. Steam, water, and compressed air were all adversely affected. Staff were despatched from site to remote locations, in challenging weather, to restart equipment and safeguard water supplies.

Despite multiple individual facility faults, evacuations and site wide utility disruption, no-one was injured and there was no release of radioactivity from the site. The emergency response organization was successfully deployed and effectively managed the situation which was brought back into full control within a few days. However, this response occurred amidst severe weather to the south of the site. If this weather had directly impacted the site, recovery operations would have been more challenging.

I.8. CATEGORY 8: EVENTS WHICH ATTRACT PUBLIC INTEREST

This category covers events that attract significant public interest, even if the safety significance of the event is limited. Events reported in this category may also be reported under other categories as applicable.

Example:

During preparations for the startup of a vitrification plant, a release of ruthenium-106 occurred. The release is understood to have arisen during work within a sealed and ventilated cell in which a glass product container was heated whilst containing some liquor. The volatile ruthenium is believed to have been released into the cell and then to the atmosphere via the cell extract system and stack. The filters in this extraction system which are designed to trap particulate material, are ineffective against volatile ruthenium.

Off-site monitoring in the environment was conducted by the facility, the Environment Agency and the Ministry of Agriculture, Fisheries and Food in the two weeks following the event. The Environment Agency recorded the results of all monitoring data in its public registers. The ministry posted its monitoring results on its website. Doses to members of the public were considered to be small. The incident was classified as Level 1 on the INES scale.

I.9. CATEGORY 9: NON-RADIOLOGICAL ENVIRONMENTAL CONSEQUENCES

This category is intended to include those events which may result in a non-radiological consequence to the environment. Non-radiological consequences may be caused by hazardous materials found in NFCFs (e.g. beryllium, ammonia, arsenic, organic solvents) that might result in soil, groundwater and surface water contamination above prescribed limits as well as contaminants that result in air quality degradation (e.g. release of particulates and toxic gases such as fluorine, hydrogen fluoride and NOx).

Events reported in this category may also be reported under other categories as applicable.

I.10. CATEGORY 10: EVENTS AFFECTING THE WHOLE SITE

This category covers events that affect the whole site in which an NFCF is located, even if the safety significance of the event is limited. Events reported in this category may also be reported under other categories as applicable.

Example:

A loss of electric power supply occurred at the site of a fuel fabrication facility, affecting all administrative offices buildings, laboratories, and the installations. The emergency plan was activated, and a non-usual event situation was declared. The operations of all facilities at the site were interrupted. The electrical maintenance team investigated and located a short circuit that damaged a power cable The circuit breaker of the line was disarmed, and the circuit breakers of the other lines were also disarmed. The repair was concluded, and the emergency was declared terminated.

Subsequently, during a routine verification of the radiological conditions of the facility, it was noted that an operator had performed screening activities with UO_2 powder to restart production of pellets before the termination of the emergency. The analysis of the filters of the fixed air sampling device in the screening room, and of the gaseous effluent flow at the chimney of the exhaust ventilation system showed that the activity registered was below the investigation level. The event had no radiological consequences to operating personnel, personnel at other plants on the site, and off-site.

I.11. CATEGORY 11: CONSEQUENTIAL ACTIONS TAKEN BY THE OPERATOR

This category is intended to include significant consequential actions taken by the operating organization resulting from lessons learnt from the events that occurred within the facility or elsewhere. Such actions could be significant changes to operating procedures, operational limits and conditions, or safety assessment; modification (including replacement, modernization) of the facility based on the feedback of operating experience; revision of the maintenance, periodic testing, and inspection programme. Reports on consequential actions identify important lessons learnt related to dealing with significant problems or events.

Example:

A laboratory glovebox inventory check identified a partly filled bottle of non-radioactive tetrahydrofuran, an industrial solvent, which over time may have become chemically unstable. The operating organization judged that the bottle of tetrahydrofuran presented an increased potential for a release of energy which could have resulted in the loss of containment provided by the glovebox. The glovebox held radioactive material, so loss of containment carried with it the potential for release or spread of radioactivity. The operating organization disposed of the bottle safely and in accordance with the country's standard protocol. The event did not result in loss of containment or personal injury.

The operating organization followed the country's standard protocol, which included informing the explosive ordnance disposal team within the Ministry of Defence. The team advised that the tetrahydrofuran and some other chemicals (nine bottles in total) at the facility should be disposed of using controlled explosive techniques. The chemicals were safely recovered and disposed of via this method. The corrective actions arising from this event, that were identified by the operating organization include:

- Setting up of a ‘Chemical Recovery Project Team’ with the mandate to validate, categorize and safely dispose chemicals via a risk-based approach;
- Undertaking external benchmarking for the management of complex chemical inventories throughout their storage;
- Establishment of a ‘Chemical Safety Competency’ baseline at the facility;
- Ensuring the correct tailoring of competent resources to effectively address the conventional safety risk profiles and hazards of the different facilities on the site.

APPENDIX II.

PROCEDURE FOR PREPARATION OF FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM REPORTS

II.1. INTRODUCTION

The purpose of this procedure is to help the user to prepare a FINAS report of an event or information, so that important lessons learnt are effectively transferred to the international nuclear community. This procedure focuses on the content of the information to be provided in the report rather than on its format. The IRSNI-FINAS website is designed to assist the National Coordinators in sending FINAS reports and it provides the structure for the preparation of a report. Events or information to be reported to FINAS are expected to be selected according to the general criteria provided in Section 3.1 of this publication.

The types of reports that may be submitted to FINAS are as follows:

- Preliminary report: A preliminary report is expected to be prepared for an event with actual and significant safety consequences, or for an event with an actual or potentially significant reduction in defence in depth. The purpose of preliminary reporting is to make the nuclear community aware of the risks related to the event as soon as possible and to allow the other Member States to promptly respond to the situation, as appropriate.
- Main report: The main report may be the first report if a preliminary report was not needed or may supplement a preliminary report. There are two types of main reports:
  - A specific main report associated with a single event or information;
  - A generic main report, associated with a set of events or information related to each other, and produced to focus on common lessons learnt from the events or information.
- Follow-up report: A follow-up report is expected to be prepared when new or different information is identified that may improve understanding of the event or information and the effectiveness of its associated corrective and preventive actions. The responsibility for identifying the need for a follow-up report lies with the National Coordinator.

The suggested methodology for preparation of these reports is detailed in the next sections.

II.2. PRELIMINARY REPORT

The preliminary report is expected to summarize the information available at the time the report is prepared. It includes a short description of the event or information; initial consequences of the event if there are any (e.g. radiological impacts to people and the environment), the preliminary safety evaluation and the short term actions taken, and lessons learnt; if available. Depending on the significance of the event or information, a preliminary report may be useful, otherwise a main report is to be provided. As soon as the necessary information is available, a main report is expected to be prepared to supplement the preliminary report.

II.3. MAIN REPORT

The following sub-sections provide suggested methodology for the preparations of the main report according to the reporting template.

II.3.1. Identification of the necessary information

From the available information, extract and sort the following (as available):

- General data, such as site and facility name, and date and time of the event.
- Facility conditions before the event, and methods of event discovery.
- The factual event sequence as observed, including any observed degradations or malfunctions of systems and the reasoning or reactions of personnel at the time.
- The observed cause–consequence relationships.
- Assessment of impact of event sequence on safety and defence in depth.
- A consequence analysis to determine whether or not some aspects of the event are indicators of indirect problems or weaknesses, which under other circumstances, could also lead to a safety significant event or a serious accident.
- An analysis of the event, identifying the root causes and causal factors, the impact(s) on safety, and the investigative and corrective actions taken. The causes and corrective actions are expected to address technical as well as human and organizational factors or deficiencies and how each given deficiency has been corrected.
- Assessment by the regulatory body, to the extent possible.
- If the event description or analysis need additional facility-related information to be made available to readers to facilitate understanding, then the necessary information on facility features.

II.3.2. Formalization of the collected information into the event report

After the collection of all the necessary information, the report needs to be prepared in accordance with the FINAS report template. The information provided in the FINAS report includes the following:

- Basic data including incident date, country, facility and the site name; title of the event; and abstract of the event;
- Narrative description of the event;
- Safety assessment of the event;
- Cause analysis of the event;
- Lessons learnt and actions taken after the incident, including the actions taken by the regulatory body;
- Event coding.

A suggested process for preparation of the various sections of a FINAS report is provided below:

II.3.2.1. Basic data

Incident date:

The incident date could be the date of actual occurrence of the incident or the date of discovery of the condition in the facility. In cases where the date of incident could not be conclusively determined (e.g. intake of radionuclides detected during routine monitoring), an informed estimate of the possible date of event may be made. For information notices that summarize the experiences or lessons learnt from multiple events, the date of release of the information notice may be considered as the incident date.

Title:

The title is to be a short characterization of the event, emphasizing its most significant features.

Abstract:

The purpose of the abstract is to convey the main messages contained in the report, essential for the understanding of the relevance of the event or conditions. The abstract needs to include in a concise form, a brief description of the event, its safety relevance, its causes, the lessons learnt, and the corrective actions taken.

II.3.2.2. Narrative description

Facility features:

- Provide the technical and organizational data necessary to understand the event, including a brief description of the systems and diagrams or flowsheets as applicable, practices, procedures or organizational characteristics that influenced the event, that would be helpful for understanding the event. Facility systems and terminology may not be the same in all the Member States. Descriptive names for equipment need to be used rather than internal identification codes.
- Provide additional facility specific data (e.g. factors, aspects, deficiencies) necessary to understand the event.

Event sequence and personnel reactions:

- Provide all relevant information on what happened during the event and on the general context of the event. The following information is expected to be provided:
  - Situational aspects:
    - Facility conditions prior to the event;
    - Operating modes or testing conditions;
    - Equipment status.
  - For events where human performance plays a significant role, the following information is expected to be provided where available:
    - Facility personnel involvement (see codes in Appendix III-5.2);
    - Type of activity at the time of the event (see codes in Appendix III-5.3);
    - Characterization of the personnel and individual task related work practices (see codes in Appendix III-5.4.2);
    - Characterization of the working conditions (see codes in 5.4.4 and 5.4.5 of Appendix III);
    - Any other relevant organizational aspects (see codes in 5.4.3 and 5.4.6 to 5.4.9 of Appendix III).

- Chronological information:
  - Chronological information indicating relevant timescales;
  - Identification of failures and successes in responding to the event, including any that occurs during the recovery actions phase.

- For events where human performance plays a significant role, the following information is expected to be provided where available:
  - Information on the nature and timing of recovery actions (see codes in Appendix III-9). Such information may provide additional insight into the complexity of the situation and the difficulties for the operating personnel to detect and diagnose the problem. Lessons may also be learnt from the positive role of facility personnel involved in the event. If relevant, include a discussion of the recovery actions, providing information on how and when the recovery was achieved.
  - Identify the types of personnel involved in the recovery actions.
  - Detection and diagnosis activities, including delays encountered.
  - More specific information on any time delays encountered in detection and diagnosis activities is useful for the evaluation of human errors, system failures, and the safety problem presented by the event. Indicate, if applicable, any factor leading to a lengthy delay before a problem was detected or diagnosed.
  - Any human or organizational errors involved. This includes errors of commission as well as omission, and what would have been the correct action(s), if known;
  - Intra- and extra-team communication aspects.

– This description does not need to focus too much on causes, in order not to duplicate the cause analysis.
– Previously related events or precursors are expected to be indicated.
– If available, add figures, including layouts, photographs, or drawings, to facilitate a better understanding of the environment in which the event occurred.

II.3.2.3. Safety assessment

– Address the actual and potential consequences of the observed events(s). In particular, a discussion of the barriers and defence in depth, and the effective barrier that terminated the event is expected to be included.
– When relevant, safety aspects related to human performance are expected to be included.
– If the assessments by the operating organization and by the regulatory body are different, this needs to be indicated.
– If an event and/or information is recurrent, the analysis is expected to include an explanation why the already implemented corrective action(s) has not been effective.

II.3.2.4. Cause analysis

– Indicate clearly here, when relevant, the direct causes as well as the root causes and the contributing factors from the results of cause analysis, as follows:

- The presentation and discussion of the direct or observed causes (i.e. the failures, actions, omissions, or conditions which immediately produced the event) needs to answer the question ‘how did it happen?’, identifying the technical or human deficiencies.
- To the extent possible, the results of the analysis identifying the failure mode including the nature of failures or errors (see codes in Appendix III- 8) need to be provided.
- When human factor plays a significant role, the information that needs to be provided (where available) includes the type of observed inadequate human actions (see codes in Appendix III, 5.1.8.) which contributed to the initiation of the event or affected in a direct way the operator or system response to the event.

– The report also needs to provide the identified ‘causal factors’ relevant to the message to be conveyed. These causal factors are causes that, if corrected, would not by themselves have prevented the event, but are important enough to implement worthwhile corrective actions in order to improve the quality of the process or product.
– A presentation and discussion of root causes needs to be included. These causes are fundamental causes that, if corrected, are intended to prevent recurrence of the event or of its adverse environment. Both causal factors and root causes provide the answers to the question, ‘why did it happen?’
– When human factor plays a significant role, the following information that needs to be provided (where available) includes the human performance related causal factors and root causes (see codes in 5.4. and 5.5. of Appendix III).
– If possible, include an event and causal factor chart to illustrate the analysis results.

II.3.2.5. Lessons learnt and corrective actions

– Describe the set of corrective actions taken by the operating organization to address the observed technical, human, and organizational deficiencies. The priority of the various corrective measures is also expected to be provided if it improves understanding of the significance of the various causes. Corrective actions may cover administrative measures as well as engineering measures that address the technical, human, and organizational deficiencies. Corrective actions can be divided into three types:
  - Immediate corrective actions taken promptly to restore normal conditions or eliminate problems, for example, equipment is repaired, procedures are updated.
  - Interim corrective actions that are short term actions to reduce risk of recurrence while awaiting long term corrective actions. They can be accompanied by compensatory corrective actions.
  - Corrective actions to prevent reoccurrence. These actions are most important to prevent events from happening again.

– For events where human performance plays a significant role, include (when available):
  - Changes in behaviours, attitudes or habits of persons or groups.
  - Changes to the initial and continuing training programmes. Indicate what was lacking in terms of knowledge or proficiency.
  - Changes to procedures, or new procedures.
  - Organizational changes.
  - Improvement in ergonomics.
  - Hardware modifications which affect the human–machine interface.
  - Conduct of re-training to correct specific knowledge deficiencies.

- Describe also any specific or enforcement actions taken by the regulatory body in response to the event.
- An indication of the generic character of the actions taken or of difficulties in designing or implementing the corrective actions may be useful.
- The content and formulation of the lessons learnt need to be practical and applicable to other NFCFs and be consistent with the basic safety message to be conveyed.

II.3.2.6. Codes

The event codes are provided in FINAS for classification of events considering the following aspects:

1. Reporting categories;
2. Facility status prior to the event;
3. Failed or affected systems;
4. Failed or affected components;
5. Cause of the event;
6. Effects on operation;
7. Characteristics of the incident;
8. Nature of failure or error;
9. Nature of recovery actions.

As the codes are provided for facilitating the searching of the FINAS database and supporting the event analysis, they need to reflect the event conditions, the observed phenomena and the problems encountered. More than one code can be selected under each category. Appendix III provides a list of the events codes provided in FINAS.

II.4. FOLLOW-UP REPORT

A follow-up report may be submitted when additional corrective actions have been taken to assure effective resolution of the event or relevant new information is available after the main report has been submitted.

APPENDIX III.

FUEL INCIDENT NOTIFICATION AND ANALYSIS SYSTEM EVENT CODING

1. REPORTING CATEGORIES

1.1. Releases of radioactive material or hazardous material; or exposure to radiation, radioactive material, or hazardous material

1.1.1 Unanticipated or unexpected releases of radioactive material or hazardous material

1.1.2 Exposure to radiation, radioactive material or hazardous materials that exceeds prescribed limits for members of the public

1.1.3 Unanticipated or unexpected exposure to radiation or hazardous chemicals for site personnel

1.2. Degradation of safety functions

1.2.1. Degradation of radiological protection (confinement, shielding) or chemical confinement

1.2.1.1. Static barriers

1.2.1.2. Ventilation hierarchy

1.2.2. Degradation of reactivity control

1.2.2.1. Criticality control

1.2.2.2. Chemical reactivity control

1.2.3. Degradation of cooling

1.2.4. Degradation of support functions

1.2.4.1. Radiological protection monitoring systems

1.2.4.2. Process monitoring (e.g. chemical analysis)

1.2.4.3. Electrical power supply

1.2.4.4. Control systems

1.2.4.5. Vacuum, fluids, and gases

1.2.4.6. Measurement systems

1.2.4.7. Reagents

1.2.4.8. Fire protection

1.2.4.9. Fuel handling

1.3. Deficiencies in siting, design, construction, commissioning, operation, decommissioning, management systems or safety assessment

1.3.1. Deficiencies in design

1.3.2. Deficiencies in construction, manufacturing, procurement, installation, or commissioning

1.3.3. Deficiencies in operation including maintenance and surveillance

1.3.4. Deficiencies in management systems

1.3.5. Deficiencies in safety assessment

1.3.6. Deficiencies in decommissioning

1.3.7. Deficiencies in siting

1.4. Generic problems of safety interest

1.5. Consequential actions taken by the regulatory body

1.6. Events of potential safety significance and other operating experience information

1.7. Effects of external events of either human or natural origin

1.8. Events which attract public interest

1.9. Non-radiological environmental consequences

1.9.1. Soil

1.9.2. Water

1.9.2.1. Surface Water

1.9.2.2. Sub-surface or Ground water

1.9.3. Air

1.10. Events affecting the whole site

1.11. Consequential actions taken by the operator

2. FACILITY/WORKSHOP STATUS PRIOR TO THE EVENT

2.0. Other

2.1. Commissioning

2.2. Operation

2.2.1. Normal operation

2.2.2. Stand-by or partial shutdown

2.2.3. Maintenance

2.2.4. Testing

2.2.5. Modifications

2.3. Shutdown

2.3.1. Maintenance

2.3.2. Testing

2.3.3. Modifications

2.3.4. Mothball with maintenance

2.4. Decommissioning

2.5. Refurbishments (Major upgrades or modifications)

2.6. Siting and site survey

2.7. Construction

3. FAILED/AFFECTED SYSTEMS

3.0 Other

3.1. Primary process systems

3.1.0. Other primary process systems

3.1.1. Handling and transport systems

3.1.2. Feed and delivery systems

3.1.3. Dissolving systems

3.1.4. Liquid / liquid or gas / liquid extraction systems

3.1.5. Calciner / fluidized bed / furnace systems

3.1.6. Separators

3.1.7. Storage systems

3.2. Other process systems

3.2.0. Other

3.2.1. Off-gas treatment systems

3.3. Essential auxiliary systems

3.3.0. Other

3.3.1. Criticality control (detector, absorber, or other physical system)

3.3.2. Chemical control (including sampling and analytical control)

3.3.3. Cooling systems

3.3.4. Reagents feed systems

3.3.5. Instrumentation and control systems

3.3.6. Electrical power supply

3.3.7. Radiological protection controls

3.4. Other auxiliary systems

3.4.0. Other

3.4.1. Fire protection systems

3.4.2. Service air, compressed gas, breathing air

3.5. Structural systems

3.5.0. Other

3.5.1. Building

3.5.2. Concrete (Including material properties)

3.5.3. Rebar, Reinforcement, Steel Work, embedded parts

3.5.4. Pool Liners

3.5.5. Pre/Post Stressing Cables (including associated instrumentation and equipment)

3.5.6. Welds

3.5.7. Coatings, Paints etc.

3.5.8. Building Penetrations, Sealants (including gaskets etc.)

3.5.9. Casings, joints and liners for wells, mines, and boreholes

3.5.10. Stack, Chimney, ducts

3.6. Containment and shielding systems

3.6.1. Static containment

3.6.1.0. Other static containment

3.6.1.1. Building containment

3.6.1.2. Pond and pool containments

3.6.1.3. Dry chambers

3.6.1.4. Casks (wet and dry)

3.6.1.5. Process pipework and fittings

3.6.1.6. Pressure boundaries

3.6.2. Ventilation and air cleaning systems

3.6.3. Shielding

3.7. Waste management systems

3.7.0. Other

3.7.1. Waste storage

3.7.2. Liquid treatment systems

3.7.3. Compaction systems

3.7.4. Incineration systems

3.7.5. Waste encapsulation and vitrification

3.8. Transport systems

3.8.1. On-site

3.8.2. Off-site

3.9. Civil, mine and ore extraction

3.9.1. Civil (e.g. foundations)

3.9.2. Mine

3.9.3. Borehole

3.10. Engineered safety features

4. FAILED/AFFECTED COMPONENTS

4.1. Instrumentation (e.g. gauges, transmitters, sensors, etc.)

4.1.0. Other

4.1.1. Pressure

4.1.2. Temperature

4.1.3. Level

4.1.4. Flow

4.1.5. Radiation

4.1.6. Contamination

4.1.7. Concentration including pH

4.1.8. Position

4.1.9. Humidity

4.1.10. Neutron flux (detectors, ion chambers and associated components)

4.1.11. Criticality monitors

4.1.12. Speed measuring

4.1.13. Fire detectors

4.1.14. Hydrogen detectors

4.1.15. Hazardous gas monitoring (e.g. NH_3, NOx)

4.1.16. Electrical (current, voltage, power, etc.)

4.1.17. Supervisory control systems

4.2. Mechanical

4.2.0. Other

4.2.1. Racks

4.2.2. Tanks, vessels

4.2.3. Containers

4.2.4. Retention structures

4.2.5. Valves/diverters

4.2.6. Tubes, pipes, ducts, pipe-joints

4.2.7. Pumps and ejectors

4.2.8. Compressors, fans

4.2.9. Turbines, engines

4.2.10. Heat exchangers

4.2.11. Evaporators

4.2.12. Condensers and scrubbers

4.2.13. Filters

4.2.14. Furnaces

4.2.15. Penetrations

4.2.16. Fittings, couplings, hangers, supports, bearings, thermal sleeves, snubbers

4.2.17. Ladders and scaffoldings

4.2.18. Protective shielding

4.2.19. Glove boxes

4.2.20. Conveyor/rabbit

4.2.21. Process vessels

4.2.22. Packaging (waste drums etc.)

4.2.23. Ion exchange columns

4.2.24. Centrifuge

4.2.25. Lifting equipment (includes fuel transfer systems, cranes)

4.2.26. Bearings, rails, brakes & stops

4.2.27. Sample transfer systems

4.3. Electrical

4.3.0. Other

4.3.1. Switchyard equipment (switchgear, transformers, buses, etc)

4.3.2. Inverters, rectifiers, batteries, power supplies, battery chargers, discharging device for static charge etc.

4.3.3. Circuit breakers or fuses

4.3.4. Motors

4.3.5. Emergency or standby generators

4.3.6. Relays, connectors, hand switches, pushbuttons, contacts, etc.

4.3.7. Wiring, logic circuitry, controllers, starters, cables, etc.

4.3.8. Alarms

4.4. Information technology

4.4.1. Hardware (for processing, storing, or transmitting data)

4.4.2. Software (including viruses etc.)

4.4.3. Artificial Intelligence

5. CAUSE OF EVENT

5.1. Type of technological failure

5.1.0. Unknown or other

5.1.1. Mechanical failure

5.1.1.0. Other

5.1.1.1. Corrosion, erosion, fouling

5.1.1.2. Wear, fretting, lubrication problem

5.1.1.3. Fatigue

5.1.1.4. Overloading (including mechanical stress and overspeed)

5.1.1.5. Vibration

5.1.1.6. Leak

5.1.1.7. Break, rupture, crack, weld failure

5.1.1.8. Blockage, restriction, obstruction, binding, foreign material

5.1.1.9. Deformation, distortion, displacement, spurious movement, loosening, loose parts

5.1.1.10. Material properties

5.1.1.11. Ageing and obsolescence

5.1.1.12. Collision (e.g. dropped load)

5.1.2. Electrical failure

5.1.2.0. Other

5.1.2.1. Short-circuit, arcing

5.1.2.2. Overheating

5.1.2.3. Overvoltage

5.1.2.4. Bad contact, disconnection

5.1.2.5. Circuit failure, open circuit

5.1.2.6. Ground fault

5.1.2.7. Undervoltage, voltage breakdown

5.1.2.8. Faulty insulation

5.1.2.9. Failure to change state

5.1.2.10. Voltage fluctuations/phase instability

5.1.3. Chemical or physics failure

5.1.3.0. Other

5.1.3.1. Impurities in chemicals used

5.1.3.2. Fire burning, smoke, explosion

5.1.3.3. Uncontrolled chemical reaction

5.1.3.4. Inadequate chemical control

5.1.3.5. Blockage, fouling, corrosion caused by chemical reactions

5.1.3.6. Pyrophoricity

5.1.4. Hydraulic failure

5.1.4.0. Other

5.1.4.1. Water hammer, abnormal pressure

5.1.4.2. Loss of fluid flow

5.1.4.3. Loss of pressure

5.1.4.4. Cavitation

5.1.4.5. Gas binding

5.1.5. Instrumentation and control failure

5.1.5.0. Other

5.1.5.1. False response, loss of signal, spurious signal

5.1.5.2. Set point drift, parameter drift

5.1.5.3. Computer hardware deficiency

5.1.5.4. Computer software deficiency

5.1.5.5. Commercial software

5.1.5.6. Bespoke software

5.1.6. Environmental (abnormal conditions inside plant)

5.1.6.0. Other

5.1.6.1. Temperature

5.1.6.2. Pressure

5.1.6.3. Humidity

5.1.6.4. Flooding

5.1.6.5. Freezing

5.1.6.6. Irradiation, contamination, irradiation of parts

5.1.6.7. Dropped loads, missiles, high energy impacts

5.1.6.8. Fire, burning, smoke, explosion

5.1.7. Environmental (external to the plant)

5.1.7.0. Other

5.1.7.1. Lightning strikes

5.1.7.2. Flooding

5.1.7.3. Storm, wind loading

5.1.7.4. Earthquake

5.1.7.5. Freezing

5.1.7.6. Aircraft crash

5.1.7.7. Heavy rain or snow

5.1.7.8. Sandstorm

5.1.8. Human inadequate actions

5.1.8.1. Slip or lapse

5.1.8.2. Mistake

5.1.8.3. Violation

5.1.8.4. Sabotage (including tampering)

5.2. Inadequate human action - plant staff involved

5.2.1. Maintenance

5.2.2. Operations

5.2.3. Technical and engineering

5.2.4. Management and administration

5.2.5. Control of contractor/subcontractor/vendor

5.3. Inadequate human action - type of activity

5.3.0. Other activity

5.3.1. Not relevant

5.3.2. Normal operations

5.3.3. Shutdown operations

5.3.4. Equipment start-up

5.3.5. Planned/preventive maintenance

5.3.6. Isolating/de-isolating

5.3.7. Repair (unplanned/breakdown maintenance)

5.3.8. Routine testing with existing procedures/documents

5.3.9. Special testing with one-off special procedure

5.3.10. Post-modification testing

5.3.11. Post-maintenance testing

5.3.12. Fault finding

5.3.13. Commissioning (of new equipment)

5.3.14. Recommissioning (of existing equipment)

5.3.15. Decommissioning

5.3.16. Nuclear material handling

5.3.17. Inspection

5.3.18. Abnormal operation (due to external or internal constraints)

5.3.19. Engineering review

5.3.20. Modification implementation

5.3.21. Training

5.3.22. Actions taken under emergency conditions

5.4. Human performance related causal factors and root causes

5.4.0. Other

5.4.1. Verbal communications

5.4.2. Personnel work practices

5.4.2.0. Other

5.4.2.1. Control of task/independent verification

5.4.2.2. Complacency/lack of motivation/inappropriate habits

5.4.2.3. Use of improper tools and equipment

5.4.3. Personnel work scheduling

5.4.4. Environmental conditions

5.4.5. Human–machine interface

5.4.6. Training/qualification

5.4.7. Written procedures and documents

5.4.7.1. Procedure availability

5.4.7.2. Procedure completeness/accuracy

5.4.7.3. Procedure compliance

5.4.7.4. Documentation management (including archiving and retention)

5.4.7.5. Inadequate/inaccurate safety documentation

5.4.8. Supervisory methods

5.4.9. Work organization

5.4.9.0. Other

5.4.9.1. Shift/team size or composition

5.4.9.2. Planning/preparation of work

5.4.10. Personal factors

5.4.10.0. Other

5.4.10.1. Fatigue

5.4.10.2. Stress/perceived lack of time/boredom

5.4.10.3. Skill of the craft less than adequate/not familiar with job performance standards

5.5. Management related causal factors and root causes

5.5.0. Other

5.5.1. Management direction

5.5.2. Communication or coordination

5.5.3. Management monitoring and assessment

5.5.4. Decision process

5.5.5. Allocation of resources

5.5.6. Change management

5.5.7. Organizational/safety culture

5.5.8. Management of contingencies

5.5.9. Management of contracted work (e.g. qualification, training, supervision, and guidance)

5.5.10. Management of staff training and qualification

5.5.11. Knowledge management

5.5.12. Communication failure

5.6. Equipment related causal factors and root causes

5.6.0. Other

5.6.1. Design configuration and analysis

5.6.1.1. Design analysis quality

5.6.1.2. Materials selection

5.6.1.3. Modifications engineering quality

5.6.1.4. Modifications engineering review process

5.6.2. Equipment specification, manufacture, and construction

5.6.3. Maintenance, testing or surveillance

5.6.4. Equipment aging

5.6.5. CSFI - counterfeit, suspect, fraudulent items

6. EFFECTS ON OPERATION

6.0. Other

6.1. Load or capacity decrease reduction

6.2. Activation of engineered safety features

6.3. Unplanned or significant radiation or toxic exposure

6.3.1. Public

6.3.2. Facility personnel

6.3.3. Environment

6.4. Significant injuries

6.4.1. Public

6.4.2. Facility personnel

6.5. Outage extension

6.6. Exceeding technical specification limits

6.7. Actual or potential delay in initial startup

6.8. Actual or potential impact on lifetime of NFCF

6.9. Actual or potential impact on existing nuclear facilities nearby

6.10. Worsening of operational conditions

6.11. Reduction of safety margin

6.12. None

7. CHARACTERISTICS OF THE INCIDENT

7.0. Others

7.1. Unexpected or potential criticality

7.2. Degraded containment

7.3. Loss or significant degradation of safety function

7.4. Loss of power

7.4.1. On-site

7.4.2. Off-site

7.5. Discovery of major condition not previously considered or analysed

7.6. Fuel handling incident

7.7. Radioactive waste incident

7.8. Radiation exposure

7.9. Release of radioactive materials

7.10. Significant injuries

7.11. Hazardous material release

7.12. Security, safeguards, sabotage, or tampering event

7.13. Construction/Manufacturing Deficiencies

8. NATURE OF FAILURE OR ERROR

8.0. Others

8.1. Single failure or single error

8.2. Multiple failures or multiple errors

8.2.1. Independent multiple failures or errors

8.2.2. Dependent multiple failures or errors

8.2.3. Recurrent failure or error

8.3. Common cause failure

8.4. Significant or unforeseen interaction between systems

9. NATURE OF RECOVERY ACTIONS

9.0. Not relevant

9.1. Recovery by human action

9.1.1. Recovery by foreseen human action

9.1.2. Recovery by unforeseen human action

9.2. Recovery by automatic plant action or by design

9.3. No recovery

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GLOSSARY

The technical terms used in the IAEA safety standards and other safety related IAEA publications are defined and explained in the IAEA Nuclear Safety and Security Glossary, 2022 (Interim) Edition[1]. The following definitions are specific to this publication and are not provided in the Glossary.

causal factor. A cause that, if corrected, would not in itself have prevented the event, but is important enough to be recognized as needing corrective action to improve the quality of the process or product. Also, a factor that influences the outcome of a situation. The reasons for an action that was taken or an event that occurred in the sequence of events that led to the grounds for an investigation.

dependent failures. A failure which occurs due to interactions or failures of SSCs within a system or due to interactions with, or failures of SSCs among other systems or equipment, or due to human error. The following three types of dependent failures may be distinguished:

1. Functional dependencies;
2. Physical interaction failures;
3. Human interaction.

human errors. Groups and/or families of attributes to characterize wrong human behaviour (understanding, intention, and action). Examples of such groups are:

- Violation (the person has a good understanding, but develops an intention not in compliance with that understanding);
- Mistake (the intention of the person is wrong because the person's understanding is not in compliance with the prescribed task);
- Slip (the intention was good, but the action is wrong).

human factors. A general term summarizing the various aspects of human behaviours in working conditions, including the behaviour itself and the factors important to understand the behaviour. This includes cognitive, ergonomic, technical, and organizational factors.

human performance. The capabilities and characteristic behaviours of human beings in complex or stressful task environments such as engineering, operation, and maintenance. Deficiencies in human performance (including operating personnel, other plant personnel, and contractor personnel) may degrade the defence in depth.

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[1] INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Nuclear Safety and Security Glossary: Terminology Used in Nuclear Safety, Nuclear Security, Radiation Protection and Emergency Preparedness and Response, 2022 (Interim) Edition, IAEA, Vienna (2022), https://doi.org/10.61092/iaea.rrxi-t56z

mistake. A mistake is an intended action resulting in an undesired outcome in a problem-solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc.

operating experience. A valuable source of information for learning about and improving the safety and reliability of nuclear installations. It is essential to collect such information in a systematic way that conforms with agreed to reporting thresholds for events occurring during the design, construction, commissioning, operating, and decommissioning phases of the facilities to enhance safety. This includes information on deviations from normal performance by systems and by personnel, which could be precursors of events.

recovery action. An activity which is performed to correct the progression of an event, aiming at bringing the facility to a safe state.

CONTRIBUTORS TO DRAFTING AND REVIEW

Agarwal, K.	International Atomic Energy Agency
Amalraj, J.	Canadian Nuclear Safety Commission, Canada
Davis J. K.	Sellafield Ltd., United Kingdom
Kataoka, K.	Nuclear Regulation Authority, Japan
Nakoski, J	Nuclear Energy Agency, Organization for Economic Co-operation and Development
Shokr, A.	International Atomic Energy Agency
Tomka, P.	Hungarian Atomic Energy Agency, Hungary
Valiveti, L. N.	International Atomic Energy Agency

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