IAEA

GUIDE ON

INCIDENT REPORTING SYSTEM FOR RESEARCH REACTORS

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January 2000	1	• Initial Version	
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Contents

1. INTRODUCTION

The IAEA has included in its current programme on research reactor safety an Incident Reporting System for Research Reactors (IRSRR) with the objective to improve the safety of research reactors through the exchange of safety-related information on unusual events.

The systematic collection and evaluation of operational experience with unusual events[1] is a very useful way to improve operational safety. A proper analysis of unusual events can identify root causes and provide valuable lessons to be learned by, for example, reactor operators or reactor designers, and regulatory bodies. Reporting of all incidents occurring in the research reactor, as it is defined in the licence for operation, or as otherwise required by the regulatory body, or as described in the safety report, should be considered. Unusual events involving experimental devices and irradiation targets for isotope production should also be considered.

The Incident Reporting System for Research Reactors will collect, maintain and disseminate reports on unusual events which are received from Member States of the IAEA participating in the system. All reports will be stored in a database available for participating IAEA Member States and International Organizations promoting safe operation of research reactors.

The IRSRR will make use of the experience gained through the use of the IAEA/NEA Incident Reporting System for nuclear power plants (NPPs) [1] and of the information stored in the Agency's Research Reactor Database (Directory of IAEA databases).

The IRSRR should not be confused with the International Nuclear Event Scale (INES) reporting system.[2]

This document provides guidance for the IRSRR and the channels of communication within the system. It also describes the format and content of the information that participants should report through the web-system IRSRR, http://irsrr.iaea.org. The reporting criteria (Section 5), the reporting guidelines (Section 6) and the guide words as presented in Appendix II, were approved during the 6th Coordinators Meeting.

2. PARTICIPATION OF MEMBER STATES IN THE IRSRR

Participation in the IRSRR will be voluntary and open to Member States which have embarked on a research reactor programme or which are planning to embark on a research reactor programme.

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[1] The term ‘unusual event’ in this document means safety related unusual event including incident and accidents.

[2] The IRSRR and the INES systems differ from each other fundamentally. The INES reporting system promptly provides the Media and the Public with General Information and an Authoritative Rating on events in Nuclear Facilities, on the basis of a (potential or real) Consequence Analysis. The IRSRR will provide in a timely manner the Technical Nuclear Community with Technical Information and Lessons Learned on events in research reactors, using the method of Cause Analysis.

The IRSRR is intended as an international forum for the sharing of operational experience thus forming a feedback loop in an international context.

The IAEA recommends that each Member State appoint a National Coordinator (preferably from the regulatory body) and a Local Coordinator (from the operating organization). Each coordinator should be a professional, knowledgeable with research reactors or should be assisted by such a professional.

The IRSRR is based on the principle that each participant will provide timely information on its experience with unusual events in research reactors so that the information is available to all other participants. The National Coordinator of a Member State participating in the IRSRR shall therefore submit event reports to the IAEA through the IRSRR web-system in accordance with the arrangements set out in this document.

3. REGISTRATION

Registration and authorization as a National Coordinator will only take place after formal appointment by a Member State through the official channels. Only the National Coordinator of a Member State can decide on access of a Deputy National Coordinator or of Local Coordinators to the IRSRR database. Registration is done by the IAEA administrator upon request of the National Coordinator by which the first name, family name, institution, position and email address of the new user should be supplied.

Before a user can be given access to the IRSRR web-system he/she should be registered in NUCLEUS. NUCLEUS is an IAEA feature enabling users with one username and password to access password restricted IAEA websites. To register for NUCLEUS, go to http://nucleus.iaea.org and select "Register" in the right upper corner.

4. RECEIPT AND DISTRIBUTION OF INFORMATION

Unusual events with safety significance or of general interest to the research reactor community should be identified by the National or Local Coordinators and selected for submission to the IAEA. If a National or Local Coordinator considers an unusual event to be highly significant to safety, a preliminary report should be submitted to the IAEA as soon as practicable. Reports can be prepared by National or Local Coordinators, but to ensure uniform quality the National Coordinator shall submit the report to the IAEA, and should perform a quality check before submitting the information to the IAEA.

The IAEA will nominate a person knowledgeable with research reactors and responsible for the operation of the IRSRR. Before submitting information on incidents and events to participants, the IAEA will carry out a verification and check of the information received. This verification is intended to ensure that all requirements regarding format and content are met in accordance with the checklists given in Section 5 and the Appendices. Where major modifications are proposed by the IAEA, approval of the National Coordinator and the Local Coordinator shall be obtained before the IAEA approves the reports and informs the participants of the IRSRR that a new report is available for viewing.

After the verification, and if appropriate with consent of the changes obtained from the National Coordinator, the event report will be approved and a notification will be submitted to all IRSRR coordinators that the event report is available for viewing. If a participant requests the IAEA for additional information to supplement a report which is already approved, or the Agency itself makes such a request, then the IAEA will pass this request on to the appropriate National Coordinator. All information sent to the IAEA under the IRSRR should be distributed through the National Coordinators only.

A web-system has been made available, in which the event reports are achieved, for easy retrieval and search options.

The information stored in the IRSRR web-system will be made available to the participants in accordance with the confidentiality requirements of the National Coordinator who supplied the reports. Without specific requirements, all event reports are restricted, i.e. for official use only within the research reactor community.

Besides receiving, archiving and distributing information, the IAEA will prepare periodic reports on IRSRR activities and will organize periodic meetings to review and evaluate the material available on unusual events. The proceedings of such meetings will be posted on the IRSRR web-system.

5. REPORTING

5.1. EVENTS TO BE REPORTED

Unusual events that meet one or more of the following criteria could be considered as appropriate for reporting to the IRSRR:

(a) The unusual event identifies important lessons learned that allow the international research reactor community to prevent a recurrence of a similar event or to avoid the occurrence of a more serious unusual event in terms of safety; or
(b) The unusual event is itself (potentially) important or serious in terms of its safety implications or whether it (potentially) reduces the defense in depth significantly; or
(c) The unusual event is a repercussion of similar events previously reported to IRSRR, but which identifies new lessons learned.

5.2. REPORTING CATEGORIES

Unusual events caused by any of the following categories should be reported to the IRSRR:

(a) Unanticipated releases of radioactive material or exposure to radiation
(b) Degradation of barriers and safety related systems
(c) Deficiencies in design, construction, operation (including maintenance and periodic testing), quality assurance or safety evaluation, including experimental devices and isotope production facilities
(d) Generic problems of safety interest
(e) Consequential actions
(f) Events of potential safety significance
(g) Effects of unusual external events of either man-made or natural origin

More details of the above reporting categories are given in Appendix I.

6. REPORTING GUIDELINES

6.1. GENERAL REQUIREMENTS

The reports should be submitted to the IAEA through the IRSRR web-system by the National Coordinator. The National Coordinator is responsible to perform a quality check and to discuss any outstanding questions with the involved Local Coordinator and/or the involved operator. The IRSRR report should consist of the following six parts:

(a) Facility data, date and title of the incident
(b) Abstract
(c) Description of the event
(d) Investigation of the unusual event and safety assessment
(d) Observed causes and corrective actions
(e) Lessons learned
(f) Guide words

The reports should be written in English. Each report should be precise and "stand alone". If necessary, clear drawings may be incorporated. The use of abbreviations and symbols should be avoided. The use of SI units is recommended.

Some guidelines for the preparation of the report are given in the next sections and a detailed description is given in the user manual, which is available at the IRSRR website.

6.2. GENERAL ASPECTS TO BE CONSIDERED

The following aspects or considerations should be included in the description of the incident, when relevant:

(a) Status of the research reactor prior to the incident;
(b) How the operators became aware of the incident;
(c) Operator actions related to the incident;

(d) Systems, components or experimental devices involved in the incident;
(e) Direct consequences of the incident, including information on the affected reactor equipment;
(f) Pertinent diagrams or drawings which may help the understanding of the incident; and
(g) Other occurrences which may be related to the incident.

Because of the great variation in design and configuration of research reactors around the world, it may be useful to provide a brief description of and/or background information on the affected systems.

When a safety-related deficiency is reported, the description should indicate how this was detected.

6.3. INVESTIGATION OF THE UNUSUAL EVENT AND SAFETY ASSESSMENT

This section should describe the investigation performed to determine the causes of the incident and the assessment of the safety consequences and implications of the event. In particular, the following aspects and observations should be addressed, if relevant:

(a) Any violation of safety limits, safety system settings or limiting conditions for safe Operation;
(b) Any violation of periodic inspection requirements or administrative requirements;
(c) Analysis, including calculations, to determine the causes of the event;
(d) Review of procedures;
(e) Assessment of the status of the affected items and systems important to safety;
(f) Assessment of the safety significance of the event and whether the event would have been more severe under reasonable and credible alternative conditions;
(g) Assessment of the contribution of human factors to the event;
(h) The methods used for the investigation and analysis, such as ASSET, TRIPOD, Change, or the own procedures; and
(i) Summary of conclusions and recommendations.

6.4. OBSERVED CAUSES AND CORRECTIVE ACTIONS

The following points, if relevant, should be included in this section:

(a) Results of the observed cause investigation;
(b) Corrective actions regarding the failed/affected equipment;
(c) Actions to prevent occurrence of similar future events (e.g. modification of design, procedures or periodic testing programme, training of personnel, change of Operational Limits and Conditions); and
(d) Regulatory actions.

6.5. LESSONS LEARNED

This section should identify the lessons learned. It is recommended that the lessons learned be presented according to the following classification:

(a) Design and construction
(b) Safety analysis
(c) Operational Limits and Conditions
(d) Maintenance and Periodic Testing
(e) Procedures
(f) Utilization
(g) Radiation protection
(h) Emergency planning
(I) Quality Assurance
(j) Personnel training and qualification
(k) Equipment

6.6. GUIDE WORDS

The IRSRR guide words are a simplified means to search and retrieve the information on events. This is achieved by assigning numerical codes to the typical systems, root causes, consequences, etc., which generally characterize research reactor incidents. The National Coordinator should select the guide words on the web-system.

The following groups of guide words are available. See Appendix II for the complete set.

(1)Reporting category
This field identifies the category (or categories) into which the event falls:

- Unanticipated releases of radioactive material or exposure to radiation
- Degradation of barriers and safety related systems
- Deficiencies in design, construction, operation (including maintenance and periodic testing), quality assurance or safety evaluation, including experimental devices and isotope production facilities
- Generic problems of safety interest

(2)Reactor status prior to the event
This field identifies the reactor status prior to the event. Sometimes this has no relation to the incident. Even in such cases, the appropriate code(s) should be indicated as precisely as possible.

(3)Failed/affected systems
This field identifies:

- The systems which failed or lost their normal function, thereby initiating or triggering further steps of the event
- The systems which functioned as designed but induced further steps in the development of the event
- The systems which were damaged as a result of the event
- The important systems which lost their normal function as a result of the event
- Other systems that played a role in the development of the event

The codes of this field are based on the mechanical/physical constitution of the research reactor. However, sometimes one part/component of a system has two or more functions. In such cases both should be indicated.

(4)Failed/affected components
This field should identify which component failed or was affected. If multiple components are affected then they should also be indicated.

(5)Cause of the event
This field identifies the observed or direct cause of the event. For a sequential event, all the observed causes of each stage should be selected. 'Observed cause' is a cause that is the direct initiator of the event or is the direct trigger of the next steps.

(6)Effects on operation
This field will indicate which effect on the operation of the reactor has been observed.

(7) Characteristics of the incident
This field identifies the nature of the event. In comparison with 'reporting category', this field describes the type of event that started the incident, or its triggering mechanism, whereas 'reporting category' is more related to the outcome of the event. There will typically be only one or a small number of characteristics of the event.

(8)Nature of failure or error
This field identifies the type of event. 'Failure' includes both physical impairment and function loss. In this coding system, 'common cause failure' means the multiple failures that are the result of one common cause (not limited only to the failure of redundant equipment).

(9)Nature of recovery actions
This field identifies the "first" observed recovery action of the incident.

APPENDIX I: UNUSUAL EVENT REPORTING CATEGORIES

This appendix identifies categories for reporting unusual events, giving some background information on their establishment and examples of events that may fall into them. The categories provide a basis for identifying safety-related unusual events that are expected to be reported through the IRSRR. It is important to note that a report may be prepared not only because an event has occurred, but also because a significant safety-related action has been taken as a result of findings during maintenance, periodic testing, in-service inspection, safety audits, etc. The examples given here are expected to be useful for an understanding of the categories, but do not necessarily cover every aspect of them.

REPORTING CATEGORIES

The categories are:

1.1 Unanticipated releases of radioactive material or exposure to radiation
1.1.1 Unanticipated releases of radioactive material
1.1.2 Exposure to radiation that exceeds prescribed dose limits for members of the public
1.1.3 Unanticipated exposure to radiation for site personnel
1.2 Degradation of barriers and safety related systems (including experimental devices and isotope production facilities important to safety)
1.2.1 Fuel cladding failure or fuel damage
1.2.2 Degradation of primary coolant boundary
1.2.3 Degradation of containment/confinement function or integrity
1.2.4 Degradation of systems required to control reactivity and shutdown
1.2.5 Degradation of systems required to assure primary coolant inventory and core cooling
1.2.6 Degradation of essential support systems
1.2.7 Degradation of experimental devices or isotope production facilities
1.3 Deficiencies in design, construction, operation (including maintenance and periodic testing), quality assurance or safety evaluation, including experimental devices and isotope production facilities
1.3.1 Deficiencies in design
1.3.2 Deficiencies in construction
1.3.3 Deficiencies in operation (including maintenance and periodic testing)
1.3.4 Deficiencies in quality assurance
1.3.5 Deficiencies in safety evaluation
1.4 Generic problems of safety interest
1.5 Consequential actions
1.6 Events of potential safety significance
1.7 Effects of unusual external events of either man-made or natural origin

DISCUSSION AND EXAMPLES

Category 1.1: Unanticipated releases of radioactive material or exposure to radiation.

1.1.1. Unanticipated releases of radioactive material

Discussion: Unanticipated releases of radioactive material may occur as a result of design deficiencies, exceeding safety limits or deficiencies in conduct of operations.

Examples:

(a) Release from a damaged fuel element in the core or in spent fuel storage
(b) Release from liquid or solid waste storage facility
(c) Release from irradiated capsules or from experimental devices
(d) Release of irradiated gas from beam tubes or other experimental facilities

1.1.2. Exposure to radiation that exceeds prescribed dose limits for members of the public
1.1.3. Unanticipated exposure to radiation for site personnel

Examples:

(a) Exposure of personnel due to poor planning of maintenance tasks or fuel management or manipulation of experimental devices
(b) Exposure due to non-compliance with operating procedures (e.g. access control procedure)
(c) Exposure following failure of fuel cladding, irradiation capsule, transfer container, etc.

Category 1.2: Degradation of barriers and safety related systems (including experimental devices and isotope production facilities important to safety)

1.2.1. Fuel cladding failure or fuel damage
1.2.2. Degradation of the primary coolant boundary
1.2.3. Degradation of confinement/containment function or integrity

Discussion: The objective is to collect information on degradation of any of the three barriers against release of radioactive materials.

Examples:

(a) An unacceptable rate or level of fuel cladding failure in the reactor or in the storage pool that is caused by exceeding safety limits, poor water quality or design and manufacturing deficiencies. Mechanical damage of fuel elements during fuel handling should be taken into account.
(b) Cracks and breaks in piping, in the reactor vessel or in major components of the primary coolant circuit that have safety relevance (e.g. reactor coolant pumps, valves, pool)
(c) Significant defects in welds or materials used in the primary coolant system
(d) Loss of coolant
(e) Loss of coolant flow
(f) Unavailability of residual heat removal system on demand

(g) Degradation of coolant quality (significant change in pH, conductivity, cleanliness, concentration of impurities)
(h) Loss of containment/confinement function or integrity, including leakage rates exceeding authorized limits

1.2.4. Degradation of systems required to control reactivity and shutdown

Examples:

(a) Failure of the reactor protection system to produce a signal
(b) Bypass or incorrect safety system setting
(c) Failure of the reactivity control mechanism
(d) Reduction of the shut-down margin
(e) Failure of manual scram

1.2.5. Degradation of systems required to assure primary coolant inventory and core cooling

Discussion: The objective is to collect information on anomalies in systems which assure in normal and transient operations sufficient means to remove core power and decay heat

Examples:

(a) Degradation or failure of the emergency core cooling system
(b) Degradation or failure of the emergency ventilation or clean-up system
(c) Degradation or failure of containment isolation system
(d) Degradation or failure of flap valves

1.2.6. Degradation of essential support system

Discussion: The objective is to collect information on anomalies in safety related systems that could lead to degradation of principle barriers.

Examples:

(a) Degradation of the reactor power regulation system
(b) Failure of the radiation monitoring system
(c) Loss of electrical power associated with safety-related systems (e.g. loss of emergency power (Diesel generator), or DC power to instrumentation)
(d) Degradation of the water treatment systems
(e) Loss of compressed-air for safety-related systems

1.2.7. Degradation of experimental devices or isotope production facilities.

Examples:

(a) Degradation of experimental devices' components or their protective system
(b) Any degradation of the integrity of experimental devices leading to significant contamination or affecting the safety of the reactor

Category 1.3: Deficiencies in design, construction, operation (including maintenance and periodic testing), quality assurance, or safety evaluation of reactor systems, experimental devices and radioisotope production facilities

1.3.1. Deficiencies in design

1.3.2. Deficiencies in construction

Discussion: The aim is to collect information on deficiencies in design or construction, including experimental devices, that, if uncorrected, could result in loss of a required safety function.

Examples:

(a) Degradation of materials under environmental conditions not sufficiently considered in the design stage or because in the design stage the influence was not yet known or not clearly understood.
(b) Despite proper design, errors were made during construction or installation that could influence the performance of the systems or components if not detected during testing, maintenance or otherwise.

1.3.3. Deficiencies in operation (including maintenance and periodic testing)

Discussion: The safe operation of a research reactor or its experimental devices relies to a large extent upon the skill and proper actions of the reactor personnel. As a result of deficiencies in this area, a simple event could escalate into an incident. Information in this area is important for the feedback of operational experience.

Examples:

(a) Inadvertent criticality, e.g., during in-core fuel management
(b) Personnel errors or procedural deficiencies or shortcomings in man-machine interface resulting in loss of reactor capability to perform safety functions
(c) Violation of licence conditions, such as operational limits and conditions, periodic testing requirements or administrative requirements

1.3.4. Deficiencies in quality assurance

Discussion: A quality assurance programme provides a disciplined approach to all activities affecting quality, including verification of task performance and implementation or corrective actions where required. Quality assurance is an aspect of good management and related to design and construction as well as to operation. Deficiencies in the quality assurance programme might influence the safe operation of research reactors.
Examples:

(a) Incorrect or outdated drawings are used for maintenance
(b) A component was not constructed as intended in the design
(c) Insufficient verification of accomplished work owing to deficiency in task description or indicated responsibility

1.3.5. Deficiencies in safety evaluation

Discussion: Unanalyzed or insufficiently analyzed events might confront the operators with unexpected situations should such events arise.

Examples:

(a) Any event caused by a failure, condition or action that demonstrates an insufficient independence of safety systems and components. Safety systems and components are those needed to:
  - shut down the reactor and maintain it in a safe shutdown condition, or
  - remove residual heat, or
  - control release of radioactive material.

(b) Any event that results in the reactor not being in a controlled condition or that results in an unanalyzed condition that significantly compromises reactor safety
(c) Any incorrect analyses of possible chemical reaction of irradiated materials

Category 1.4: Generic problems of safety interest.

Discussion: This category is intended to include those events that individually seem not to be significant, but after recurrence indicate that a problem of safety significance could exist.

Examples:

(a) Recurring events
(b) Events with implications for similar reactor designs

Category 1.5: Consequential actions

Discussion: This category is intended to include significant consequential actions resulting from reported events. This includes actions taken by organizations on the basis of lessons learned from elsewhere.
Examples:

(a) Important modifications to the design basis
(b) Changes to emergency planning
(c) Changes to design assessment requirements
(d) Changes to accidents analysis and evaluation
(e) Important changes to the requirements for construction, commissioning and operation

Category 1.6: Events of potential safety significance

Discussion: This category is intended to include events that, under different circumstances or of greater intensity, could have had safety significance.

Examples:

(a) Any event that occurs at shutdown or low power operation that would become significant for safety if it occurred at full power
(b) Events that have no significant consequences but are considered to approach a near miss situation or are precursors of more serious events
(c) An event that identifies a significant common cause failure

Category 1.7: Effects of unusual external events of either man-made or natural origin

Discussion: This category includes those events (acts or conditions) which might challenge the safety of the reactor.

Examples:

(a) A tornado or cyclone that affects the site
(b) An earthquake that approaches design basis limits
(c) Chemical explosion, fire, aircraft crash or other man-made event that affects the site

APPENDIX II: GLOSSARY OF CODES FOR THE CODED WATCHLIST

CODE	DESCRIPTION
1.	**REPORTING CATEGORIES**
1.1	**Unanticipated releases of radioactive material or exposure to radiation**
1.1.1	Unanticipated releases of radioactive material
1.1.2	Exposure to radiation that exceeds prescribed dose limits for members of the public
1.1.3	Unanticipated exposure to radiation for site personnel
1.2	**Degradation of barriers and safety related systems (including experimental devices and isotope production facilities important to safety)**
1.2.1	Fuel cladding failure or fuel damage
1.2.2	Degradation of primary coolant boundary
1.2.3	Degradation of containment/confinement function or integrity
1.2.4	Degradation of systems required to control reactivity and shutdown
1.2.5	Degradation of systems required to assure primary coolant inventory and core cooling
1.2.6	Degradation of essential support systems
1.2.7	Degradation of experimental devices or isotope production facilities
1.3	**Deficiencies in design, construction, operation (including maintenance and periodic testing), quality assurance or safety evaluation, including experimental devices and isotope production facilities**
1.3.1	Deficiencies in design
1.3.2	Deficiencies in construction
1.3.3	Deficiencies in operation (including maintenance and periodic testing)
1.3.4	Deficiencies in quality assurance
1.3.5	Deficiencies in safety evaluation
1.4	**Generic problems of safety interest**
1.5	**Consequential actions**
1.6	**Events of potential safety significance (potential unsafe situation)**
1.7	**Effects of unusual external or internal events**
2.	**REACTOR STATUS PRIOR TO THE EVENT**
2.0	Not applicable
2.1	**On power**
2.1.1	Full power
2.1.2	Reduced power (including zero power)
2.1.3	Raising power or starting up
2.1.4	Reducing power
2.1.5	Refueling on power
2.1.6	Pulse operation
2.1.7	Handling of experimental devices with reactor on power
2.2	**Subcritical**
2.2.1	Reactor in subcritical state
2.2.2	Handling of experimental devices during the subcritical state

2.3 **Shutdown**
2.3.1 Normal shutdown
2.3.2 Shutdown and refuelling
2.3.3 Handling of experimental devices during shutdown
2.3.4 Extended shutdown
2.4 **Pre-operational**
2.4.1 Construction
2.4.2 Commissioning
2.5 **Testing or maintenance was being performed**
2.6 **Decommissioning**

3. **FAILED/AFFECTED SYSTEMS**
3.1 **Primary reactor systems**
3.1.1 Reactor core/fuel assemblies/control and shutdown rods/guide thimbles
3.1.2 Control and shut down system components (rod drive mechanism, motor, power supply, hydraulic system)
3.1.3 Reflector
3.1.4 Reactor vessel
3.1.5 Moderator
3.1.6 Core support structure
3.2 **Reactor and pool coolant systems**
3.2.1 Primary coolant system
3.2.2 Secondary cooling system (pumps and associated system components), piping,…)
3.2.3 Emergency core cooling system
3.2.4 Residual heat removal system (including natural convection system)
3.2.5 Pool cooling
3.2.6 Pool liner integrity
3.3 **Containment/confinement systems**
3.3.0 Other
3.3.1 Containment/confinement integrity
3.3.2 Containment ventilation system
3.3.3 Emergency ventilation system
3.4 **Instrumentation and control systems**
3.4.1 Other monitoring and control systems
3.4.2 Reactor shut down system
3.4.3 Reactor control system
3.4.4 Neutron flux monitoring channels
3.4.5 Process monitoring (temperature, flow, pressure, level, leak detection, ….)
3.4.6 Plant/process computer
3.4.7 Radiation monitoring systems
3.4.8 Environmental monitoring
3.4.9 Communication and alarm systems
3.4.10 Fire detection
3.5 **Electrical systems**
3.5.0 Other
3.5.1 AC supply system
3.5.2 DC supply system
3.5.3 Emergency power supply system
3.6 **Auxiliary systems**
3.6.0 Other

3.6.1 Water purification (including coolant)
3.6.2 Compressed air
3.6.3 Demineralized water supply/make-up
3.6.4 Fuel handling and storage
3.6.5 Fire Protection
3.6.6 Sampling system
3.6.7 Spent fuel pool and/or refuelling pool cooling, including clean-up system
3.6.8 Cranes and lifting devices
3.7 Waste management
3.7.0 Other
3.7.1 Liquid radwaste
3.7.2 Solid radwaste
3.7.3 Gaseous radwaste
3.7.4 Non-radioactive waste (solid, liquid, gaseous)
3.8 Heating, ventilation and air-conditioning systems (HVAC)
3.8.0 Other
3.8.1 Containment/confinement (HVAC)
3.8.2 Control room (HVAC)
3.8.3 Spent fuel building (HVAC)
3.8.4 Waste management building (HVAC)
3.9 Structural systems
3.9.0 Other
3.9.1 Fuel storage building
3.9.2 Waste management building
3.9.3 Cooling tower
3.9.4 Pump building
3.9.5 Plant stack
3.10 Experimental facilities, devices and isotope production facilities
3.10.0 Other
3.10.1 Experimental devices
3.10.2 Isotope production facilities
3.10.3 Beam tubes
3.10.4 Hot cells/ shielded boxes
3.10.5 Rabbit/conveyer systems
3.10.6 Cold sources
3.10.7 Hot sources

4. FAILED/AFFECTED COMPONENTS
4.0 No specific component involved
4.1 Instrumentation (gauges, transmitters, sensors)
4.1.0 Other
4.1.1 Pressure
4.1.2 Temperature
4.1.4 Flow
4.1.5 Radiation/Contamination
4.1.9 Neutron flux (detectors, ion chambers and associated components)
4.1.11 Fire detectors
4.1.12 Hydrogen detectors
4.1.13 Power supply (current, voltage, power)
4.2 Mechanical

4.2.0	Other
4.2.1	Pumps, compressors, fans
4.2.2	Generators (diesel, gasoline, ...)
4.2.3	Valves (including safety/relief/check/solenoid/natural convection valves) , valve operators, controllers, dampers and fire breakers, seals and packing
4.2.4	Heat exchangers (heaters, coolers, condensers, boilers, air dryer, ...), heat exchanger tube plugs
4.2.5	Tanks, pressure vessels (e.g. reactor vessel and internals, accumulators)
4.2.6	Tubes, pipes, ducts
4.2.7	Fittings, couplings (including transmissions and gear boxes), hangers, supports, bearings
4.2.8	Strainers, screens, filters, ion exchange columns
4.2.9	Penetration (e.g., hot cells, reactor building, fuel handling, etc.)
4.2.10	Control or protective rods and associated components or mechanisms, fuel elements
4.2.11	Fuel storage racks, fuel storage casks and fuel transport containers
4.3	**Electrical**
4.3.0	Other
4.3.1	Switchyard equipment (switchgear, transformers, buses, substations)
4.3.2	Circuit breakers, power breakers, fuses
4.3.4.	Motors (for pumps, fans, compressors, valves, motor generators, ...)
4.3.5	Generators of emergency and stand-by power
4.3.6.	(coding not to be used)
4.3.8	Wiring, logic circuitry, controllers, starters, electrical cables
4.4	**Computers**
4.4.1	Computer hardware
4.4.2	Computer software

5.	**CAUSE OF THE EVENT**
5.1	**Cause**
5.1.0	Unknown or other
5.1.1	Mechanical failure
5.1.1.0	Other mechanical failure
5.1.1.1	Corrosion, erosion, fouling
5.1.1.2	Wear, fretting, lubrication problem
5.1.1.3	Fatigue
5.1.1.4	Over-loading (including mechanical stress)
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
5.1.2	Electrical failure
5.1.2.0	Other electrical failure
5.1.2.1	Short-circuit, arcing
5.1.2.2	Overheating
5.1.2.3	Overvoltage
5.1.2.8	Faulty insulation
5.1.3	Chemical or core physics failure
5.1.3.0	Other chemical or core physics failure

5.1.3.1 Chemical contamination, deposition
5.1.3.2 Uncontrolled chemical reaction
5.1.3.3 Core physics problems
5.1.3.4 Poor chemistry or inadequate chemical control
5.1.3.5 Fuel metallurgy problems
5.1.3.6 Unexpected material behaviour
5.1.4 Hydraulic/pneumatic failure
5.1.5 Instrumentation and control failure
5.1.6 Internal (abnormal) environmental conditions
5.1.6.0 Other internal environmental cause
5.1.6.1 High temperature
5.1.6.2 Pressure
5.1.6.3 Humidity
5.1.6.4 Flooding, water ingress
5.1.6.5 Low temperature, freezing
5.1.6.6 Radiation, 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 Externa (abnormal) environmental conditions
5.1.7.0 Other external environmental cause (fire, toxic/explosive gases, ...)
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 High ambient temperature/high humidity
5.1.7.7 Heavy rain or snow
5.1.7.8 Heavy sand storms
5.1.8 (coding not to be used)
5.1.9 (coding not to be used)
5.1.10 Human factors
5.1.10.1 Error of commission or error omission.
5.1.10.2 Not used
5.1.10.3 Not used
5.1.10.4 Sabotage
5.2 (coding not to be used)
5.3 Inadequate human action – plant staff/contractor/experimenter involved
5.3.1 Maintenance
5.3.2 Operations
5.3.3 Technical and engineering
5.3.4 Management and administration
5.3.5 Experiments
5.4 Inadequate human action - type of activity
5.4.1 Other
5.4.2 Reactor start-up
5.4.3 Normal reactor operations
5.4.4 Reactor shutdown operations
5.4.5 Planned/preventive maintenance
5.4.6 Repair (unplanned/breakdown maintenance)
5.4.7 Routine testing/ inspection with existing procedures/documents

5.4.8 Special testing with one-off special procedure
5.4.9 Commissioning (of new equipment)
5.4.10 Recommissioning (of existing equipment)
5.4.11 Decommissioning
5.4.12 Fuel handling/refueling operations
5.4.13 Abnormal operation (due to external or internal constraints)
5.4.14 Training
5.4.15 Actions taken under emergency conditions
5.4.16 Routine operation of experimental devices
5.4.17 Non-routine operation of experimental devices
5.4.18 Handling of experimental devices
5.5 Human performance related causal factors and root causes
5.5.1 Verbal communications
5.5.2 Personnel work practices
5.5.2.0 Others
5.5.2.1 Lack of control of task/independent verification
5.5.2.2 Complacency/lack of motivation/inappropriate habits
5.5.2.3 Use of improper tools and equipment
5.5.3 Personnel work scheduling
5.5.4 Environmental conditions
5.5.5 Man-machine interface
5.5.6 Training/qualification
5.5.7 Written procedures and documents
5.5.8 Supervisory methods
5.5.9 Work organization
5.5.9.0 Others
5.5.9.1 Shift/team size or composition
5.5.9.2 Planning/preparation of work
5.5.10 Personal factors
5.5.10.0 Others
5.5.10.1 Fatigue
5.5.10.2 Stress/perceived lack of time/boredom
5.5.10.3 Skill of the craft less than adequate/not familiar with job performance standards
5.6 Management related causal factors and root causes
5.6.0 Others
5.6.1 Management direction
5.6.2 Communication or co-ordination
5.6.3 Management monitoring and assessment
5.6.4 Decision process
5.6.5 Allocation of resources
5.6.6 Change management
5.6.7 Organizational/safety culture
5.6.8 Management of contingencies
5.7 Equipment related causal factors and root causes
5.7.0 Others
5.7.1 Design configuration and analysis
5.7.2 Equipment specification, manufacture and construction
5.7.3 Maintenance, testing or surveillance
5.7.4 Ageing

6. **EFFECTS ON OPERATION**
6.0 Unidentified or no significant effect on operation or not relevant
6.1 Reactor scram
6.1.1 Automatic reactor scram
6.1.2 Manual reactor scram
6.2 Controlled shutdown
6.4 Activation of engineered safety features
6.5 Challenge to safety or relief valve
6.6 Unanticipated or significant release of radioactive materials
6.6.1 Unanticipated or significant release of radioactive materials outside the plant
6.6.2 Unanticipated or significant release of radioactive materials inside the plant
6.7 Unplanned or significant radiation exposure of personnel or public
6.7.1 Radiation exposure to the workers within the annual limit
6.7.2 Radiation exposure to the workers exceeding the annual limit
6.7.3 Radiation exposure to the public within the annual limit
6.7.4 Radiation exposure to the public exceeding the annual limit
6.8 Personnel or public injuries
6.8.1 Work absence of workers
6.8.2 Hospitalization of workers
6.8.3 Hospitalization of public
6.9 Outage extension
6.10 Exceeding technical specification limits

7. **CHARACTERISTICS OF THE INCIDENT**
7.0 Other characteristics
7.1 Degraded fuel
7.2 Degraded reactor coolant boundary
7.3 Degraded reactor containment/confinement
7.4 Loss of safety function
7.5 Significant degradation of safety function
7.6 Failure or significant degradation of reactivity control
7.7 Failure or significant degradation of reactor control
7.8 Failure or significant degradation of heat removal capability
7.9 Loss of off-site power
7.10 Loss of on-site power or emergency power
7.11 Transient
7.11.0 Other transient
7.11.1 Power transient
7.11.2 Temperature transient
7.11.3 Pressure transient
7.11.4 Flow transient
7.12 Physical hazards (internal or external to the plant)
7.13 Discovery of major condition not previously considered or analysed
7.14 Fuel handling incident
7.15 Radwaste incident
7.16 Security, safeguards, sabotage or tampering incident
7.17 Degradation or malfunctioning of experimental devices

8. NATURE OF FAILURE OR ERROR

8.0 Not relevant

8.1 Single failure or single error

8.2 Multiple failure or multiple error

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 (including potential for CCF)

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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