GUIDE NO. AERB/NPP/SG/O-13

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GOVERNMENT OF INDIA

AERB SAFETY GUIDE

OPERATIONAL SAFETY EXPERIENCE FEEDBACK ON NUCLEAR POWER PLANTS

ATOMIC ENERGY REGULATORY BOARD

AERB SAFETY GUIDE NO. AERB/NPP/SG/O-13

OPERATIONAL SAFETY EXPERIENCE FEEDBACK ON NUCLEAR POWER PLANTS

Atomic Energy Regulatory Board
Mumbai-400 094
India

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FOREWORD

Activities concerning establishment and utilisation of nuclear facilities and use of radioactive sources are to be carried out in India in accordance with the provisions of the Atomic Energy Act, 1962. In pursuance of the objective of ensureing safety of members of the public and occupational workers as well as protection of environment, the Atomic Energy Regulatory Board has been entrusted with the responsibility of laying down safety standards and framing rules and regulations for such activities. The Board has, therefore, undertaken a programme of developing safety standards, safety codes and related guides, and manuals for the purpose. While some of these documents cover aspects such as siting, design, construction, operation, quality assurance and decommissioning of nuclear and radiation facilities, other documents cover regulation aspects of these facilities.

Safety codes and safety standards are formulated on the basis of internationally accepted safety criteria for design, construction and operation of specific equipment, systems, structures and components of nuclear and radiation facilities. Safety codes establish the objectives and set minimum requirements that shall be fulfilled to provide adequate assurance for safety. Safety guides elaborate various requirements and furnish approaches for their implementation. Safety manuals deal with specific topics and contain detailed scientific and technical information on the subject. These documents are prepared by experts in the relevant fields and are extensively reviewed by advisory committees of the Board before they are published. The documents are revised when necessary, in the light of experience and feedback from users as well as new developments in the field.

The Code of Practice on Safety in Nuclear Power Plant Operation (AERB/SC/O, 1989) lays down the minimum requirements for ensuring adequate safety in plant operation. This safety guide is one of the series of guides, which have been issued or are under preparation, to describe and elaborate on the specific parts of the code. One of the requirements in operation of a nuclear power plant is to establish operational safety experience feedback system to increase the safety based on the information available from different sources (internal and external operating experience). This guide gives essentials for establishing such a system. It also establishes the reporting requirements within a nuclear power plant, operating organisation and to regulatory body. In drafting it, extensive use has been made of the information contained in the relevant documents of the International Atomic Energy Agency issued under its Nuclear Safety Standards Programme.

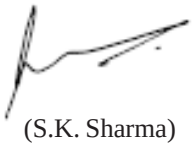
Consistent with the accepted practice, ‘shall’, ‘should’ and ‘may’ are used in the guide to distinguish between a firm requirement, a recommendation and a desirable option respectively. Annexures, bibliography and list of participants are included to provide information that might be helpful to the user. Approaches for implementation different to those set out in the guide may be acceptable, if they provide comparable assurance

against undue risk to the health and safety of the occupational workers and the general public, and protection of the environment.

For aspects not covered in this guide, national and international standards, codes and guides applicable and acceptable to AERB should be followed. Non-radiological aspects of industrial safety and environmental protection are not explicitly considered in this guide. Industrial safety shall be ensured by compliance with the applicable provisions of the Factories Act, 1948 and the Atomic Energy (Factories) Rules, 1996.

This guide has been prepared by specialists in the field drawn from Atomic Energy Regulatory Board, Bhabha Atomic Research Centre, Nuclear Power Corporation of India Limited and other consultants. It has been reviewed by experts and the relevant AERB Advisory Committee on Codes and Guides and the Advisory Committee on Nuclear Safety.

AERB wishes to thank all individuals and organisations who have prepared and reviewed the draft and helped in its finalisation. The list of persons, who have participated in this task, along with their affiliations, is included for information.



(S.K. Sharma)
Chairman, AERB

DEFINITIONS

Acceptable Limits

Limits acceptable to the regulatory body for accident condition or potential exposure.

Accident Conditions

Substantial deviations from operational states, which could lead to release of unacceptable quantities of radioactive materials. They are more severe than anticipated operational occurrences and include design basis accidents as well as beyond design basis accidents.

Ageing

General process in which characteristics of structures, systems or components gradually change with time or use [although the term 'ageing' is defined in a neutral sense - the changes involved in ageing may have no effect on protection or safety, or could even have a beneficial effect-it is commonly used with a connotation of changes that are (or could be) detrimental to protection or safety, i.e. as a synonym of 'ageing degradation'].

Anticipated Operational Occurrences

An operational process deviating from normal operation, which is expected to occur during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety, nor lead to accident conditions.

Approval

A type of regulatory consent issued by the regulatory body to a proposal.

Atomic Energy Regulatory Board (AERB)

A national authority designated by the Government of India having the legal authority for issuing regulatory consent for various activities related to the nuclear and radiation facility and to perform safety and regulatory functions, including their enforcement for the protection of site personnel, the public and the environment against undue radiation hazards.

Audit

A documented activity performed to determine by investigation, examination and evaluation of objective evidence, the adequacy of, and adherence to applicable codes, standards, specifications, established procedures, instructions, administrative or operational programmes and other applicable documents, and the effectiveness of their implementation.

Authorisation

A type of regulatory consent issued by the regulatory body for all sources, practices and uses involving radioactive materials and radiation generating equipment (see also 'consent').

Commencement of Operation of Nuclear Power Plant

The specific activity/activities in the commissioning phase of a nuclear power plant towards first approach to criticality, starting from fuel loading.

Commissioning

The process during which structures, systems and components of a nuclear or radiation facility, on being constructed, are made functional and verified in accordance with design specifications and found to have met the performance criteria.

Competent Authority

Any official or authority appointed, approved or recognised by the Government of India for the purpose of the Rules promulgated under the Atomic Energy Act, 1962.

Consent

A written permission, issued to the 'consentee' by the regulatory body to perform specified activities related to nuclear and radiation facilities. The types of consents are 'license', 'authorisation', 'registration' and 'approval', and will apply according to the category of the facility, the particular activity and radiation source involved.

Construction

The process of manufacturing, testing and assembling the components of a nuclear or radiation facility, the erection of civil works and structures, the installation of components and equipment and the performance of associated tests.

Decommissioning

The process by which a nuclear or radiation facility is finally taken out of operation in a manner that provides adequate protection to the health and safety of the workers, the public and the environment.

Defence-in-Depth

Provision of multiple levels of protection for ensuring safety of workers, the public or the environment.

Emergency

A situation, which endangers or is likely to endanger safety of the site personnel, the nuclear/radiation facility or the public and the environment.

Event

Occurrence of an unplanned activity or deviations from normalcy. It may be an occurrence or a sequence of related occurrences. Depending on the severity in deviations and consequences, the event may be classified as an anomaly, incident or accident in ascending order.

Examination

An element of inspection consisting of investigation of materials, components, supplies or services, to determine conformance with those specified requirements which can be determined by such investigation.

Full Power

The rated thermal power of the reactor, i.e. the gross fission power as established by the station heat balance, using approved methodology.

Inspection

Quality control actions, which by means of examination, observation or measurement, determine the conformance of materials, parts, components, systems, structures as well as processes and procedures with predetermined quality requirements.

Item

A general term covering structures, systems, components, parts or materials.

Licence

A type of regulatory consent, granted by the regulatory body for all sources, practices and uses for nuclear facilities involving the nuclear fuel cycle and also certain categories of radiation facilities. It also means authority given by the regulatory body to a person to operate the above said facilities.

Normal Operation

Operation of a plant or equipment within specified operational limits and conditions. In case of nuclear power plant, this includes, start-up, power operation, shutting down, shutdown state, maintenance, testing and refuelling.

Nuclear Power Plant (NPP)

A nuclear reactor or a group of reactors together with all the associated structures, systems, equipment and components necessary for safe generation of electricity.

Nuclear Safety

The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of site personnel, the public and the environment from undue radiation hazards.

Operating Organisation

The organisation so designated by responsible organisation and authorised by the regulatory body to operate the facility.

Operation

All activities following and prior to commissioning performed to achieve, in a safe manner, the purpose for which a nuclear/radiation facility is constructed, including maintenance.

Operational Limits and Conditions (OLC)

Limits on plant parameters and a set of rules on the functional capability and the performance level of equipment and personnel, approved by the regulatory body, for safe operation of the nuclear/radiation facility (see also 'Technical Specifications for Operation').

Operational States

The states defined under 'normal operation' and 'anticipated operational occurrences'.

Plant Management

Members of the site personnel who have been delegated responsibility and authority by the operating organisation for directing the operation of the plant.

Prescribed Limits

Limits established or accepted by the regulatory body.

Protection System

A part of safety system which encompasses all those electrical, mechanical devices and circuitry, from and (including the sensors) up to the input terminals of the safety actuation system and the safety support features, involved in generating the signals associated with the safety tasks.

Qualified Person

An individual who, by virtue of certification by appropriate authorities and through experience, is duly recognised as having expertise in a relevant field of specialisation like quality assurance, radiation protection, plant operation, fire safety or any relevant engineering or safety speciality.

Quality Assurance (QA)

Planned and systematic actions necessary to provide the confidence that an item or service will satisfy given requirements for quality.

Records

Documents which furnish objective evidence of the quality of items and activities affecting quality. They include logging of events and other measurements.

Regulatory Body

(See 'Atomic Energy Regulatory Board').

Regulatory Consent

(See 'Consent').

Reliability

The probability that a structure, system, component or facility will perform its intended (specified) function satisfactorily for a specified period under specified conditions.

Responsible Organisation

An organisation having overall responsibility for siting, design, construction, commissioning, operation and decommissioning of a facility.

Safety Actuation System

A part of safety system, which encompasses all the equipment, required to accomplish the required safety action when initiated by the protection system.

Safety Analysis Report (SAR)

A document, provided by the applicant/consentee to the regulatory body, containing information concerning the nuclear or radiation facility, its design, accident analysis and provisions to minimise the risk to the public, the site personnel and the environment.

Safety Support System

Part of safety systems which encompasses all equipment that provide services, such as cooling, lubrication and energy supply (pneumatic or electric) required by the protection system and safety actuation systems.

Safety System

System important to safety and provided to assure that under anticipated operational occurrences and accident conditions, the safe shutdown of the reactor followed by heat removal from the core and containment of any radioactivity, is satisfactorily achieved. (Examples of such systems are shutdown systems, emergency core cooling system and containment isolation system).

Severe Accident

Nuclear facility conditions beyond those of the design basis accidents causing significant core degradation.

Site Personnel

All persons working at the site, either permanently or temporarily.

Technical Specifications for Operation

A document approved by the regulatory body, covering the operational limits and conditions, surveillance and administrative control requirements for safe operation of the nuclear or radiation facility. It is also called ‘operational limits and conditions’.

Testing (QA)

The determination or verification of the capability of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental or operational conditions.

CONTENTS

1. INTRODUCTION

1.1 General

1.1.1 Safety in nuclear power plant (NPP) operation is ensured by due care and quality assurance exercised in various stages of siting, design, construction, commissioning, and operation. Safety systems provided in the design of the NPP cater to regulation and protection of the power reactor during all the phases of normal operation. The design also provides for a 'defence in depth' concept in the successive physical barriers, redundancy and diversity in safety system. Engineered safety features are provided to address the potential failure of any design safety provision so as to prevent or limit radiological fallout in the public domain within permissible limits. This has led to a high safety level achieved in the operation of NPPs the world over during the past several decades. Operational safety experience comprises, largely of safe power operation of NPP and to some extent, unexpected occurrences.

1.1.2 Operational experience is a valuable source of information for learning and improving the safety and reliability of NPPs. In operating NPPs some deviations from normal operating conditions and/or practices may occur. These deviations need to be judged for safety significance, requiring investigation and remedial measures. Recording, reporting, analysis and implementation of appropriate measures are done to prevent occurrence of safety significant events, reduce consequences of events if they occur, provide data for probabilistic safety analysis (PSA) and identify trends.

1.2 Objectives

The objective of this guide is to provide guidance for

(i) identifying deviations or conditions that may be precursors to events,

(ii) detection and categorisation of events,

(iii) creating a high level of awareness of operational safety experience feedback (OSEF) system and its applicability for improvements in operation of NPPs, and

(iv) training and organisational arrangement for effective OSEF program.

1.3 Scope

This safety guide deals with main components of OSEF system, including utilization of this information to prevent recurrence of similar events and events with similar causes in all NPPs in the country. It provides guidance for organisations professionally involved in nuclear industry. This safety guide provides procedure for establishing an OSEF system based on national/ international experience on management of safety related operational experience in NPPs.

2. SYSTEM FOR OPERATIONAL SAFETY EXPERIENCE FEEDBACK (OSEF) AND ITS ELEMENTS

2.1 Importance of OSEF for Nuclear Power Plants

2.1.1 Plants are designed to be safe with application of defence in depth concept, which addresses the possibility of a potential failure of designed safety features. Events are indicators of a weakness of one or more barriers in the defence in depth concept. An event provides an opportunity for learning. While events are stepping stone for learning, it is still better to gear up the safety management system to prevent events i.e have an event free operation. This can be brought about by comprehensive procedures, systems, practices etc. and OSEF can be effective input to achieve this. Management of NPPs with an effective OSEF system have very low probability of any latent weakness remaining undetected and ensure that corrective actions are undertaken to prevent the occurrence of safety related events. Dissemination of safety significant information should be promptly done amongst the plant staff and other relevant organisations. The sharing of operational safety experience should be co-ordinated nationally and internationally. Thus OSEF from events as well as from other sources are useful.

2.1.2 Accidents are normally marked by precursor events. Hence all departures from normal operating conditions, procedures and practices (called deviations) should be covered by OSEF for review and action. Feedback of safety experience also increases knowledge of the operating characteristics of the equipment, human factors and performance trends. OSEF also provides data for PSA.

2.2 Main Requirements of OSEF System

2.2.1 Main requirements of an effective OSEF include the following :

(i) Reporting of deviations/events within the plant.

(ii) Reporting and exchange of information among plants and organisations in the country. Designers, vendors, manufacturers, constructors, technical support organisations and operating organisation should also send the feedback.

(iii) Storage, retrieval and documentation system for events.

(iv) Screening of events.

(v) Investigation of events.

(vi) In-depth analysis of safety significant events, including causal factor analysis.

(vii) Recommended actions resulting from the assessment, including their

approval, implementation, tracking and evaluation.

(viii) Dissemination and exchange of information with national and international organisations like

(a) IAEA incident reporting system

(b) Users group, world organisations etc.

(c) Workshops, seminars on specific issues e.g. strengthening of safety culture, safe outage management, safe maintenance practices etc.

(d) International practices available through various peer reviews etc.

(e) National experience (items 5.2.1 to 5.2.7, 5.3 and 5.4)

(ix) Monitoring of programs for OSEF system.

(x) Training specific to OSEF.

The above elements generally describe the important aspects that need to be considered in the development and implementation of OSEF programme.

2.3 Role of Plant Management (PM), Operating Organisation (Op.O), Responsible Organisation (RO) and Regulatory Body (RB)

There should be a commitment from the respective management of the various participating organisations involved in the OSEF programme to ensure that it is effective.

2.3.1 Plant Management

PM should ensure that a general awareness is created amongst all the staff on the importance and usefulness of OSEF, through wide dissemination of OSEF information. Plant personnel are involved in detection, reporting, classification of deviations and events and updating databases. PM should conduct investigation and in-depth analysis of events, draw lessons learnt from them and implement applicable corrective actions for both internal and external events. All events reportable to RB shall be promptly reported and these reports are issued within the stipulated time. PM shall issue a plant specific management plan/procedure for OSEF.

2.3.2 Operating Organisation

(i) Op.O should develop a detailed procedure for OSEF based on the requirements of the RB. This procedure should define the process for dealing with all internal and external information on events in NPPs. The procedure should precisely define the structure of the OSEF system, the types of information, channels of communication, responsibilities of the groups involved and the requirements of the documentation to be produced.

(ii) Op.O should provide technical support for investigation and analysis of event. It should also monitor implementation of actions and effectiveness of OSEF. It should direct the PM on implementing actions based on external events.

2.3.3 Responsible Organisation

(i) It should disseminate relevant information and co-ordinate with other organisations like vendors, suppliers, designers and research organisation for corrective actions.

(ii) R.O may have a system for reporting the events to international organisations.

(iii) R.O should issue a detailed management plan/procedure for OSEF.

2.3.4 Regulatory Body

(i) RB should monitor that no safety significant aspect of an event has been overlooked and reports are issued in a timely manner by the PM with full technical information including human factors aspects.

(ii) RB also monitors the implementation of follow up actions.

(iii) RB directs the PM or Op.O on its requirements based on its own assessment of the event.

(iv) RB monitors the overall effectiveness of the OSEF system through structured procedural reports.

2.4 Links Between National and International Reporting Systems

2.4.1 In order to benefit from the operational safety experience gained in other countries with a nuclear power programme, India participates in the international incident reporting system (IRS) established by IAEA. The IRS is based on the voluntary commitment of the participating countries and relies upon national reporting systems. RB receives information from IAEA-IRS and disseminates it within the country to PM, Op.O, research establishments and to other technical bodies.

2.4.2 R.O may maintain links with international oganisations for exchange of operational safety experience. Exchange visits, participations in seminars, training workshops and policy meetings also strengthen the effectiveness of the national OSEF system. These may include users groups, nuclear operators groups and bilateral agreements.

2.4.3 OSEF system should have procedures to deal with international information.

2.4.4 The reports received from other countries are forwarded to the PM/Op.O. These reports should be screened by PM/Op.O. This screening should consist of evaluating the specific applicability and the possible effects on the plant,

and of estimating the potential for the event to occur at the plant. Reports identified as applicable to the plant should be subsequently treated in order to derive plant specific actions. Reports should be considered together with other similar national and international operational safety experience. This is to ensure that all aspects of events and event trends are considered.

2.4.5 Applicable international OSEF information on events with a high safety or regulatory significance should be prioritised with regard to the review and implementation process at the plant.

2.4.6 The event should be codified and the event coding system in the country should be as directed by AERB. RB sends detailed IRS report on events in Indian NPPs where event is important for safety or where important lessons are learnt and those will prevent occurrence/ reoccurrence of the event. R.O may send information regarding lessons learnt from operating experience and good practices to international organisations.

3. ORGANISATIONAL ARRANGEMENTS FOR OSEF FUNCTIONS

3.1 Plant Management

The organisational structure for effective OSEF at Plant is given in Annexure-1

3.1.1 The organisational structure for effective OSEF, at PM level, should ensure that both internal and external events are systematically analysed and appropriate actions are taken to prevent the occurrence of similar events.

3.1.2 An OSEF committee comprising of members from technical services, operation, maintenance, health physics and other relevant sections should be constituted at the plant. Member Secretary of this committee should be responsible for overall co-ordination and administration of OSEF programme at plant.

3.1.3 Technical Services Superintendent or designated OSEF in charge should ensure the effective functioning of the Station's OSEF programme. OSEF engineer should be responsible for screening of on-site deviations from normal operating conditions and /or practices to identify those events requiring further investigation. He should put up these for further discussion and analysis to the OSEF committee. The report of the OSEF Committee should be referred to the Station Operation Review Committee (SORC) for further review, categorisation and formulation of recommendations.

3.1.4 Deviations, near misses and low-level events should also be followed up by the OSEF engineer to identify trends and to draw lessons if any.

3.2 Operating Organisation

3.2.1 The typical OSEF structure at the Op.O is shown in Annexure-2. Operating organisation should have appropriate organisational structure to perform the following functions:

(a) To follow up each station's OSEF for providing technical support for investigation and analysis.

(b) Gathering information from different plants and international reports for entering into database.

(c) Multi-disciplinary review group reviews significant event report to enable drawing out the action plan for implementation of corrective action/recommendations.

(d) Multi-disciplinary review group provides feedback to responsible organisation.

(e) To follow up implementation of the recommendations based on review of both national and international events.

(f) To ensure that the safety of the design is acceptable (OSEF is to be ensured to be incorporated in design).

3.3 Responsible Organisation

The responsible organisation ensures that there is awareness and dissemination of relevant OSEF information to all the operating NPPs and projects under construction. It also ensures that there is a regular feedback to senior management on the status/follow-up of OSEF. It should set up a system by which OSEF is a mandatory input to design of new plants as well as updating of existing plants.

4. PROCEDURES FOR OSEF

4.1 Plant Management

Each plant should have written procedures for the functioning of the entire OSEF programme. The procedures should include:

(i) OSEF organisation and administration of the programme.

(ii) Interfaces with other plant management/operating organisations and regulatory body.

(iii) Reporting of OSEF experience like minutes of meeting.

(iv) Screening, assessment for safety significance, prioritisation and analysis of operational experience.

(v) Information storage and retrieval.

(vi) Monitoring and review of OSEF programme effectiveness.

(vii) Responsibility and authority of personnel participating in OSEF programme.

(viii) Flow path of OSEF process.

(ix) Review and approval requirements, implementation and tracking of actions for completion.

(x) Plant staff awareness of safety significant events through dissemination and training.

4.2 Operating Organisation/Responsible Organisation

Operating organisation/responsible organisation should have procedures for the OSEF programme including description of the following:

(i) Receiving, screening, compilation of lessons learnt and actions taken (based on applicability), dissemination of external operating experience to the plants, monitoring and tracking of completion of approved actions.

(ii) Information storage and retrieval.

(iii) Interfacing/interacting with RB and international organisations in respect of OSEF.

(iv) Monitoring and review of the effectiveness of OSEF set up at the operating organisation/responsible organisation.

5. REPORTING OF OPERATIONAL SAFETY EXPERIENCE OF NUCLEAR POWER PLANTS

5.1 Objectives of Event reporting

(i) To identify and quantify events and conditions that are precursors to potential severe core damage.

(ii) To discover emerging trends or patterns of potential safety significance.

(iii) To identify events that are important to safety, their associated safety concerns and root causes and to determine the adequacy of corrective actions taken to address the safety concerns.

(iv) To assess the generic applicability of events.

(v) To identify human factors relevant for the continued safe operation.

(vi) Analyse operation safety experience from routine reports (see section 5.2), collect feedback, incorporate and document operational experience feedback.

5.2 Routine Reports

A licensee who operates a nuclear power plant shall submit routine reports such as performance reports, inspection and testing reports, health physics reports, environmental surveillance reports, waste management reports, reliability reports, minutes of station operation review committee (SORC) and miscellaneous reports to regulatory body. The licensee shall also submit structured periodical reports on OSEF to RB and these should summarise lessons learnt and corrections incorporated.

5.2.1 Performance Reports

Routine reports of operating statistics and annual shutdown experience should be submitted on monthly and annual basis respectively. Performance report should include:

(i) Reasons for restriction on power level due to either self-imposed or regulatory requirements.

(ii) Brief description of all safety significant events including technical specification violations of the NPP.

(iii) Implementation of safety related engineering change notice (ECN), corrective actions in progress and completed during the month based on internal and external events and observations of deteriorating trends in safety system performance.

(iv) Summary of emergency exercises.

(v) Number of fire incidents that occurred, evaluation of their safety significance and summary of fire drills.

(vi) Unavailability of safety system components indicating duration and causes.

(vii) Occurrence of an earthquake that triggered alarm setting of seismic instrument.

(viii) Change of personnel in station organisation, change in station organisation setup and qualification status with respect to technical specification.

(ix) System parameters as necessary.

5.2.2 Surveillance, Inspection, Testing, ISI and Maintenance Reports

Quality Assurance Section at each station should produce the reports on inspections carried out as per ISI manual on the following subjects:

(i) Testing and Qualification Reports of the equipment used for ISI.

(ii) In-service inspection reports.

PM should generate surveillance and maintenance reports.

5.2.3 Health Physics Reports

(i) Health physics reports should be prepared by the Health Physics Division of BARC on radiological safety aspects of the plant on quarterly and annual basis.

(ii) The report should include data on personnel radiation exposures, incidents involving health physics procedural deviations, contamination spread in accessible areas, categorisation and quantification of radioactive effluent releases and general radiation conditions in the plant.

(iii) It should also include brief summary of unusual /special observations of radiological significance.

5.2.4 Environment Surveillance Reports

Environment surveillance reports issued by Health Physics Division, BARC, should consist of the radiological measurements carried out in various matrices and areas within and beyond the plant inhabited areas to demonstrate compliance or otherwise with radiation exposure limits set for the members of the public.

5.2.5 Waste Management Reports

PM is required to submit annual reports for discharge of solid, liquid and gaseous waste disposed by either the NPP itself or the waste transferred to a Waste Management Agency (BARC).

5.2.6 Minutes of SORC Meetings

Minutes of SORC should be sent to regulatory body.

5.2.7 Miscellaneous Reports

Any occurrence not covered by the above mentioned reports but warranting documentation should be brought out as a miscellaneous report. Few important feedbacks are obtained during commissioning which are important inputs for safe operation. On many occasions vendors, manufacturers and some regulatory bodies issue useful reports on equipment performance which would need attention.

5.3 Event and Significant Event Reporting System

The event reports and significant event reports are prepared for events required to be reported to the regulatory body, by the licensee. The detailed reporting criteria for these two categories are given in Annexure 3 & 4. Correspondingly the PM has to issue either an event report or significant event report depending on the criteria for reporting. In case the event falls in both the reporting criteria i.e. for event report and significant event report, plant shall prepare significant event report only.

5.3.1 Event Report (ER)

For the events, which have relatively lower safety significance (limited consequences from safety point of view) but are nevertheless important for OSEF, event reports are required to be prepared. The reporting criteria for such events are given in Annexure-3. The format for ER is given in Annexure-5. These events are to be reported to regulatory body in accordance with the procedure given in section 5.3.3.1

5.3.2 Significant Event Report (SER)

Events with relatively higher significance for safety are required to be reported as 'Significant Event Reports' as per the reporting criteria given in Annexure-4. These shall be reported in three stages to the regulatory body.

(i) Prompt Notification:

Prompt Notification in the prescribed format (Annexure-6) shall be sent within 24 hours of the occurrence of the event. If the event is rated at INES level 2 or higher, the INES rating form for the event as

per INES event reporting format should also be filled up and sent along with prompt notification.

(ii) Significant Event Report

Having informed the RB about the 'significant event' through a prompt notification, the plant is also required to submit a detailed significant event report (SER) in the prescribed format for SER (Annexure-7) within a period of 20 days from the date of occurrence of the event. RB reviews SER at the earliest but within 3 months and indicates any further investigations required.

(iii) Event Closing Notification Report (ECNR)

The PM shall issue an 'Event Closing Notification Report' (ECNR) for those significant events, for which all required investigations including the root cause analysis was not completed before issue of SER. ECNR shall be submitted in the prescribed format (Annexure-9) indicating that all the investigations have been completed.

5.3.3 Reporting Procedures (Type of Reports, Timing, Format and Content)

5.3.3.1 Procedure for Reporting Events

(i) Event reports should be prepared for the events falling in reporting criteria as given in Annexure 3. The prescribed format for event report is given in Annexure-5. These events can be reported to the regulatory body through SORC, within 20 days of the occurrence of the event. SORC should meet as soon as possible and discuss/review the event. The SORC minutes containing the ER in prescribed format must reach AERB within 20 days of occurrence of the event. Events related to radiation dose as covered in reporting criteria ER-5 (radiation dose crossing investigation limits) may be reported through Overexposure Investigating Committee.

(ii) ER may not be attached with the minutes of SORC/Overexposure Investigation Committee, provided that these minutes contain all the required information as given below:

(a) Event title.

(b) ER No.

(c) Date and time of event

(d) Category of ER (Annexure-3).

(e) Brief description of event (including relevant annunciations and relevant fluctuations in system parameters).

(f) Cause of the event.

(g) Recommendations.

(h) Action taken/proposed to be taken to avoid recurrence.

(i) Technical specifications/station policy deviations, if any.

(j) Quantity of heavy water spilled if any.

(k) Radiological impact, if any.

5.3.3.2 Procedure for Prompt Notification

(i) The PM should ensure that significant events are communicated to RB in the prescribed format for prompt notification, within 24 hours of the event.

(ii) PM should send the prompt notification electronically or through fax followed by confirmatory copy.

(iii) Before a detailed written SER is submitted, additional information may be submitted to RB for reasons such as:

(a) Further degradation in the level of safety of the plant.

(b) Major changes in the perception of the significance of the event as a result of additional evaluation.

(c) Discovery of new information.

(d) The need to correct factual errors.

5.3.3.3 Procedure for Reporting Significant Events

(i) PM should submit SER to the RB within 20 days.

(ii) The main report should contain sufficient technical details and wherever applicable human factor data for an understanding of the event, without the need for additional information. The main report should include basic information, narrative description, safety assessment (consequences and implications), causes, corrective actions (taken or/and planned), lessons learnt, graphic information for better understanding of the event and guide words with their codes. For these guide words guidance should be sought from the code list as given in Annexure 8. The contents of the SER are described below:

(a) Basic information

This is given in item 1 to 10 of the SER format.

(b) Narrative description

The narrative description should explain what happened and what was discovered in the event. Emphasis should be on

how the plant responded and how structures, systems, components and operating personnel performed. A description of what the operator observed and performed, understood or misunderstood is important and should be given. Unique characteristics of the plant, which influenced the event (favorably or unfavorably), should be described. Specific information like plant status prior to the event, event sequence in chronological order, system and component faults and operator actions/procedural controls should be included. These should include beneficial or adverse actions, the use of procedures and any procedural deficiencies and any aspect of the man-machine interface that contributed to the event. This information should help to detect and diagnose safety problems triggered by the event.

(c) Safety assessment

The safety assessment should focus on the actual and potential safety consequences and implications of the event. The primary aim of this review is to ascertain why the event occurred and whether the event would have been more severe, under reasonable and credible alternative conditions, such as different power levels or operating modes. The safety significance of the event should be pointed out. It should indicate the degraded barriers for the observed deficiencies and the effective barriers, which terminated the event. Wherever possible the relevant safety aspects of human performance should be included.

(d) Root cause analysis

The direct, root causes and causal factors of the event should be clearly described. Causes should include reasons for equipment malfunctions, human performance problems, organisational weaknesses, design and manufacturing deficiencies and other facts. The root cause analysis methodology used should be referred in the report. For events where human factors play significant role, the factors as given in the code list (Annexure-8, item 5.1.10 to 5.6) should be highlighted.

(e) Corrective actions

All corrective actions should be listed and described in sufficient detail including the following aspects:

- Nature of the corrective action (recovery, short term or

long term) and target dates set for implementation.

- Agency responsible for implementing the action (operation, maintenance, technical etc.).
- For every action, a cross-reference to the identified causes to allow an assessment of the adequacy of the corrective action.

(f) Lessons learnt

The report should identify learning points. Lessons learnt should result in enhanced safety, positive changes in working practices; increased reliability of equipment and improvements in the procedures.

(g) Additional information

Additional information like sketches of equipment, schematics, recorder charts, event sequence recorder charts, drawings etc. may be included for better understanding.

(h) Consequences of occurrence

These are given in item 19 to 20 of SER. These should include personnel injuries, radiation doses received and radioactivity released to environment.

(i) Classification of event

The main objective of classification of an event using code list is to facilitate retrieval and searches in the database. The classification of the event is to be given in item 21 of the SER format. The classification is done using the code list given in Annexure-8. As the codes are provided for retrieval purposes, they must reflect the event conditions, the observed phenomena and the problems encountered. More than one code may be selected under each category.

(iii) Follow up report

The plant management should submit follow-up reports whenever the initial report is known to be incomplete or if significant additional information becomes available. The operating organisation should also submit specific additional information and assessments as it considers necessary, or if the regulatory body finds it necessary for a complete understanding of an event. When such a request is made, the information and assessments should be provided within an agreed time period. If after the main report is submitted, substantial additional

corrective actions are taken or more information from further investigation is available, this should be reported as follow-up information, giving reference of SER.

5.3.3.4 Procedure for ECNR

After issue of SER and subsequent investigations, if in the opinion of the plant, all investigations required are completed, the plant should issue an ECNR in the prescribed format (Annexure-9). The reasons for closing the SER should be clearly brought out in ECNR.

5.4 Low Level and Near Miss Events

OSEF system can be further strengthened through reporting and analysis of low level events (LLEs) and near miss events (NMs) in order to ensure that all events, which have the potential to be instructive, are reported and investigated to discover the root causes. Cumulative effect of these apparently less significant problems can result in slow decline in safety performance. Individually these events may appear to be insignificant and unconnected, however when viewed together they can reveal certain features, common patterns and trends that can lead to more significant events. Detection and correction of such events will therefore greatly contribute to enhancing safety. It is also necessary that timely feedback is given on the findings and remedial actions, both within the plant and to other NPPs which might experience the same problem. Some of the important elements for establishing such a system are given in Annexure-10.

6. INFORMATION STORAGE AND RETRIEVAL

6.1 General

6.1.1 The information storage is essential for effective operational safety experience feedback system at plant site, operating organisation, and responsible organisation levels. The information storage should be well categorised for quick retrieval of all the deviations and incidents. For this purpose documentation and computerised database should be established at all plant sites and operating organisation.

6.1.2 Reports in the OSEF system should be stored in such a manner that information they contain can be easily stored and retrieved. The information should be arranged to enable frequently needed searches for

(i) Recovery and corrective actions.

(ii) Events at similar plants.

(iii) System or components which failed or affected safety performance.

(iv) Causes of the events.

(v) Deficiencies in design, construction and operation.

(vi) Analysis and trending of events.

(vii) Events with similar consequences to the environment or personnel.

(viii) Failure types.

(ix) Human factors for the events.

(x) Effects of external events, either man made or natural origin.

(xi) Degradation in barriers and safety related items.

(xii) Numeric Search.

(xiii) Free form search.

6.1.3 The retrieval and evaluation of information can be facilitated by using a coding scheme and arranging the storage system to contain records of each single component, system fault or human action involved in the reported event. The system should provide search capability on multiple search criteria.

6.1.4 The OSEF database together with application programmes should achieve following objectives:

(i) The collection of information is comprehensive and no data is lost.

(ii) The information collected is screened efficiently so as to ensure that all safety related issues, which ought to be analysed with priority, would actually get selected.

(iii) The relevant corrective actions are implemented promptly to prevent recurrence of similar events that could be affected by same underlying root causes.

(iv) The lessons learnt are disseminated promptly to enable other plants to take corrective actions before similar event occurs.

6.2 Documentation System and Computerised Database at Plant

6.2.1 The objective of system at plant is to ensure availability of the complete data generated, for all deviations and events occurring at the plant. At the plant level, OSEF engineer should be responsible for event data collection, analysis, preparation of reports, storage, dissemination of information related to the events. Source documentation include extracts from different logs, records of parameters, results of in-service inspection and any further testing required. According to the established practice, the reports starting with the construction of the plant are usually stored. The complete history of the components and systems is helpful in analysis throughout the life of the plant. The computerised database also provides the basis for assessing the reliability of the components and systems.

6.2.2 The database at plant should contain information on following:

(i) Information on Deviations/Events/Significant Events

- (a) Deviation reports (noticed during operation/maintenance/ testing).
- (b) Event reports.
- (c) Minutes of the meeting of SORC.
- (d) Maintenance analysis reports.
- (e) Technical analysis reports.
- (f) Prompt notifications.
- (g) Significant event reports.
- (h) Root cause analysis reports.
- (i) Special reports.
- (j) Technical specification violations.
- (k) Station policy deviations.
- (l) Event closing notification reports.

(ii) Information on Performance Monitoring and Trending

- (a) Plant performance indicator values.
- (b) Operational check reports on safety parameters.

(c) ISI (implémentation, data, analysis reports).

(d) Chemical parameter monitoring.

(e) Radiological effluent release monitoring.

(f) Collective dose budgeting and expenditure.

(g) QA programme audit reports.

(iii) Industrial and Radiological Safety

(a) Reports on accidents, causes, lessons learnt, recommendations and follow-up.

(b) Reports on radiological exposures, causes, lessons learnt, recommendations and follow-up.

(iv) Maintenance Reports

(a) Monthly reports.

(b) Annual shutdown reports.

(c) Special maintenance reports.

(v) Follow-up and implementation of Recommendations of Safety Bodies

(a) Station operation review committee.

(b) Over exposure investigation committee.

(c) Unit safety committee.

(d) Safety review committee for operating plants.

(e) Regulatory body.

(f) Headquarters design group/NPCIL safety review committee.

(vi) Drawings/Documentation and Status on Updation

(a) System flow sheets.

(b) Electrical & control system drawings

(c) Engineering change notices (ECNs)/field change notices (FCNs) issued and implemented.

(d) Design manuals.

(e) Technical bulletins issued after implementing design modifications.

(f) Operating manuals.

(g) Radiation protection procedure.

(h) Standard test plans.

(i) Station instructions.

(j) Technical specifications.

(k) Station policies.

(l) Safety reports.

(vii) OSEF Information from Other Organisations

The data communication links between units and also between units and headquarters should be established. If these links are not established, such information should be copied from database of other units and stored in the local database of the units.

(viii) Collated useful experience from commissioning.

(ix) Useful information from manufacturers, vendors and constructors.

6.3 Documentation System and Computerised Database at Operating Organisation

The objective of system at operating organisation is to ensure the availability of the entire data generated in the organisation for an effective OSEF programme and also for follow up of recommendations applicable for similar plants. The database at operating organisation should selectively include reports (preferably summaries) on significant events of all plants within the country as well as the applicable reports from the plants outside the country. The system at operating organisation should be able to access the entire data at all plants through suitable user security structure. The database maintained at operating organisation should be accessible to all plants. Typically, the database at operating organisation should contain information on following:

(i) Recommendations from various safety committees, which are applicable to more than one plant and which need to be followed up from operating organisation.

(ii) Condensed significant event reports from within the country and outside, including information on mitigation of events, modifications, recommendations, lessons learnt etc.

(iii) Design manuals, safety reports, technical specifications and design basis reports of all plants.

(iv) Wide area network links to the plants for events/safety significant event reports, performance monitoring, trending of plant parameters, technical specifications and station policies.

(v) Engineering change notices (ECNs) issued from headquarters and follow up.

(vi) Event reports (as available) from outside the country.

(vii) Good practices (as available) from outside the country.

(viii) IAEA-IRS Reports.

(ix) Feedback from international seminars, meetings, workshops (IAEA, nuclear operators groups, user groups etc.).

7. SCREENING OF EVENTS

7.1 Objectives of Screening

7.1.1 Screening is undertaken to ensure that no safety relevant experience is overlooked and that no applicable lessons learnt are disregarded. The main goal of the screening process is to identify events that are selected for further detailed investigation and analysis. This would also include prioritisation according to safety significance and recognition of adverse trends. Criteria for screening are:

(i) Safety implication.

(ii) Potential consequences.

(iii) Probability of occurrence.

(iv) Organisational or human deficiencies.

7.1.2 All organisations involved in the OSEF process should screen information on events depending upon the objective of the organisation. The operating organisation should provide the relevant feedback information to the responsible organisation in order to improve the design and manufacture of structures, systems and components. Research establishments should receive additional guidance for establishing research goals and programmes.

7.2 Screening at the Plant Site

7.2.1 At the plant level, two sources of information are available: internal and external operating experience. Internal events are those which occur at the plant. External information is the experience coming from outside, either from within the country or foreign NPPs featuring similar or different technologies.

7.2.2 Dedicated operational safety experience feedback engineer should screen internal deviations and classify them for further processing

7.2.3 The screening of internal events should be carried out promptly so as to rank the priorities in the event feedback process for follow-up actions. The events that are screened out and found initially to be of less safety significance should be entered into database for trend analysis and reported as deviations. Events, which require additional information to arrive at thorough understanding, should also be considered after details are collected.

7.2.4 OSEF committee responsible for screening of internal events may, at times, include professionals in relevant disciplines (like human aspects, probabilistic analysis, physics, chemistry, inspection etc.). Technical Services Superintendent's approval to proposed reporting classification is required. The results of this screening should be considered by the station operation review committee (SORC).

7.2.5 External information should be reviewed to determine whether it is applicable for the plant. The determination of applicability involves aspects such as:

(i) Generic implications.

(ii) Similar equipment, system design.

(iii) Similar practices.

(iv) The occurrence of a similar event earlier.

(v) Reported actions which are applicable.

(vi) Lessons learnt.

7.2.6 Screening of external information at plant level should be undertaken periodically. Those inputs considered applicable should be distributed to the specific groups (operations, maintenance, technical and training etc.) for information and necessary follow up action.

7.3 Screening at the Operating Organisation

7.3.1 The operating organisation should have safety significant event review group (safety review committee), which ensures that no safety significant aspect of any internal event is overlooked and no applicable generic lessons is disregarded. It should also consider unfavorable trends or events whose repetition may show a pattern that has to be corrected. The group should also review all the events received from international bodies for their applicability and categorise them as mandatory assessment requirements and desirable assessment requirements for various plants within the country.

8. EVENT INVESTIGATION

8.1 Purpose and General Concepts

8.1.1 On the spot investigation shall be timely, objective and systematic with INES classification, to fulfill following requirements:

(i) For in-depth analysis of root causes and preparation of corrective recommendations.

(ii) To report promptly all events of safety significance to regulatory body.

(iii) To restore public confidence for events of public interest.

8.1.2 In-depth investigation can be carried out in the following manner:

(i) A brief investigation by an assigned engineer from the plant is sufficient in cases of events where causes and effects are well understood and complex human factors are not involved.

(ii) Regulatory body or operating organisation may form an investigation team consisting of experts from other groups or organisations to carry out an evaluation of the events such as:

(a) Sufficiently complex or unique or not well understood events.

(b) An event involving damage to property and/or equipment, unscheduled shutdown, radiation exposure to plant personnel or public in excess of permissible limits, unusual release of radioactive material from the plant and events of high public interest.

(c) Large number of events.

(d) Recurring events.

8.2 Team Composition and Responsibilities

8.2.1 The number of investigators and their areas of expertise should be based on the type of plant and characteristics of the event. Appropriate experts in reactor systems, human factors, operations, maintenance and technical services may be needed. Additional members could include specialists in safety, physics, plant behavior, radiological assessment, health physics, chemistry, materials, emergency preparedness, or other specialised areas. For more difficult and complex investigations, there may be the need for at least one expert facilitator in methods of investigation.

8.2.2 The investigators should possess adequate investigation skills as well as technical, administrative and managerial competencies. They should be familiar

with investigation techniques, documentation requirements, interviews and conflict resolution.

8.2.3 During event investigation attention should be paid to following points:

(i) The root cause of the event.

(ii) Chronology of the event.

(iii) Safety significance of the event.

(iv) Design deficiencies.

(v) Deficiencies in operation and maintenance of the plant (human error, organisation's weaknesses).

(vi) Correspondence to earlier events and actions taken there upon.

8.2.4 During investigation ensure that information is not modified, lost or diminished or that evidence is not removed. Ensure that the on-site investigation does not interfere with the functioning of the plant operational staff to achieve and maintain a stable reactor state.

8.2.5 Interviews should start with the individual who has direct personal knowledge of the event. Interviews should be recorded. The compilation of sequence of events should be started immediately and continuously updated as new data is obtained.

8.2.6 The investigation team should prepare a written report and present it to the management which constituted the team. A filled in data form should be attached with the report in which special emphasis should be laid on human factor issues and on performance of licensee organisation.

8.2.7 The investigation should include:

(i) Preparation of status reports and other interim reports documenting significant activities, findings and concerns.

(ii) Keeping the plant management advised of status, progress and future plans.

(iii) Initiating requests for information, interviews with witnesses, laboratory tests and technical or administrative support.

(iv) Maintenance of control of proprietary and other sensitive information.

8.2.8 It is not the objective of the investigation to assign blame or fault, or to recommend disciplinary actions, either for the plant or the operating staff of the plant.

9. SAFETY ASSESSMENT AND ROOT CAUSE ANALYSES OF EVENTS

9.1 Root Cause Analyses, Criteria and Techniques

9.1.1 It is necessary to distinguish between symptoms and causes and to categorise causes into direct cause, causal factors and root causes. Unless detailed investigation is done, underlying root cause(s) remain unrevealed and situation can not be corrected. Most events have multiple causes that combine synergistically to produce the event. The root cause should provide the explanation as to why the immediate cause leading to the event took place.

9.1.2 General Criteria for Performing Root Cause Analysis:

Events considered significant enough to warrant a plant root cause investigation should include, but not necessarily be limited to, events of the following types:

(i) Importance to Nuclear Safety and Public Safety

- (a) Events that affect core reactivity management.
- (b) Degraded ability to provide coolant to the reactor core.
- (c) Loss of ultimate heat sink.
- (d) Breach of any fission product barrier.
- (e) Uncontrolled release of radioactive material.
- (f) Loss of shutdown cooling resulting in coolant system temperature increase.

(ii) Major Equipment Failures that affect Generation Capability, Nuclear Safety and Public Safety

- (a) Transients, including reactor scrams/trips, main turbine trips, feed water control problems, and other conditions that reduce generating capability.
- (b) Safety system malfunctions or unplanned actuation.
- (c) Equipment failure that resulted in hazardous chemical or radioactivity release.

(iii) Human Errors that Caused or Could Cause a Safety Significant Event

- (a) Errors in handling spent fuel or highly radioactive materials.
- (b) Human performance problems that cause or aggravate a plant transient.

(c) Improperly operated plant equipment.

(iv) Important for NPP Operating Performance

(a) Deficiencies in areas such as design, analysis, testing, or procedures with potentially generic implications.

(b) Component failures with generic implications.

(v) Loss of Configuration Control that could affect Plant Safety or Reliability

(a) Inadequate implementation of the design basis.

(b) Improper equipment installation.

(c) Components installed in systems that were manufactured from inappropriate material.

(vi) Potential for Significant Unplanned Radiation Dose, Contamination, or Personnel Injury

(a) Unplanned radiation dose significantly greater than expected or prescribed limits.

(b) Industrial safety incidents or personnel fatalities.

(c) Near miss events that would have been more severe if different and reasonably expected conditions had been present.

(d) Adverse or declining performance identified in a particular area through trending.

(e) Spread of airborne activity and surface contamination.

(f) Abnormal behavior of radiation monitors or error in dose reporting.

9.1.3 Procedures for Root Cause Analysis

Event analysis should be conducted in a time-scale consistent with the event significance. The main phases of event analysis can be summarised as follows:

(i) Selection of analysis methodology.

(ii) Establishment of the complete event sequence if any.

(iii) Determination of abnormalities if any in event sequence.

(iv) Cause analysis.

(v) Assessment of safety significance.

(vi) Identification of corrective actions.

9.1.4 Root Cause Analysis (RCA) Techniques and Methodologies

For identifying root cause(s) of the event different RCA techniques like task analysis, change analysis, barrier analysis and event & causal factor charting are available. For consistent approach to root cause analysis, standard methods like Human Performance Enhancement System (HPES), Human Performance Investigation Process(HPIP), Assessment of Safety Significant Event Team Method (ASSET), Accident Evolution & Barrier Function Analysis (AEB) may be used depending on the nature of the event. For example:

(i) ASSET may be used for investigating events such as:

(a) Events of high safety significance.

(b) Generic events which are applicable to large number of NPPs.

(c) Events which involve managerial and organisational aspects.

(ii) HPES methodology may be used for analysis of events which involve any deficiency on the part of operation and maintenance personnel.

9.2 Safety Assessment Methodologies and Techniques

9.2.1 Safety assessment should be started at the screening stage and continued throughout the investigation and analysis process to determine the consequences of the event. This is necessary to understand the event and its implications on safety of the plant. Depending on the nature of the event, the following types of specific assessment may be performed:

(i) Determination of the consequences of the event including, secondary faults associated with the event (e.g. faults caused by associated environmental conditions).

(ii) Evaluation of whether the event would be significantly more serious under different permitted operating conditions (e.g. higher or lower power levels) or if equipment faults were involved.

(iii) Determine whether event serves as a precursor to a significantly more serious fault if other conditions were different.

(iv) Detailed investigation of the consequences, using applicable structural analyses (e.g. stress analysis of pressure retaining components).

9.2.2 Analytical Approaches in Safety Assessment

(i) Deterministic Event Analysis: The event is analysed to show that the response of the plant and its safety systems satisfy predetermined specifications for both performance of the plant itself and for meeting the safety targets. In case the results of this analysis indicate that

safety targets are violated, remedial measures for preventing/ reducing the consequences of the event should be recommended.

(ii) Probabilistic Event Analysis: Probabilistic analysis can be used to evaluate the core damage frequency associated with the particular event that has occurred. In case the relative contribution of the accident sequences associated with the event increases above accepted value, corrective measures for reducing the frequency of occurrence of the event should be suggested.

10. HUMAN FACTORS IN EVENT ANALYSES

10.1 General

Human factors play an important role in day-to-day activities associated with nuclear power plant operation. Hence the potential for error in events related to human characteristics or activity continues to be of concern in nuclear industry. An effective and adequate reporting and analysis of errors associated with human activity is important in reducing the chances of human errors and there by improving the level of safety of the plant.

10.2 Elements of Human Characteristics

The reporting of events related to errors involving human activities in NPPs and associated facilities should contain the information on:

(i) Categories of Human Errors

(a) Slips: These are errors of execution. In spite of a good understanding of the system, process, procedure, specific context and the intention to perform the task correctly, an unconscious, unintended action or failure to act occurs, or a wrong reflex or inappropriate instinctive action takes place.

(b) Mistakes: These are intended wrong actions resulting in undesired outcome during an activity. The wrong actions are consequence of improper understanding of the system, procedure, the specific context, the prescribed task etc.

(c) Violation: In spite of the good understanding of the system, process, procedure, and specific context, the person breaks known rules, prescriptions, without any malevolent intention.

(d) Sabotage: This is breaking of rules, prescriptions with malevolent intention.

(ii) Types and Modes:

These include:

(a) External Error Mode: This involves errors in action response such as error of omission, error of commission, extraneous act.

(b) Internal Error Mode: This is associated with errors in cognitive response such as misdetection, misinterpretation, misdiagnosis error, decision error.

(iii) Mechanisms: These include processes/mechanisms specific to the human that lead to internal and external error modes.

(a) Attentional failure-inattention/attention level low.

(b) Memory failure.

(c) Misperception.

(d) Stereotype takeover.

(e) Spatial misorientation.

(f) Uncertainty.

(g) Invoking a short cut.

(h) Rule violation.

(iv) Root Causes and Causal factors:

Root cause is the fundamental cause that, if corrected, will prevent the recurrence of the event or adverse condition arising out of the human action performed. Causal factors are the causes, if corrected, would not by themselves prevent the event but are important enough to be recognised as needing corrective action to improve the quality of human performance. These can be due to any of the following causes/ causal factors:

(a) Verbal communications.

(b) Personal work practices, work scheduling and personal factors.

(c) Environmental conditions.

(d) Man-machine interface.

(e) Training/qualification.

(f) Written procedure and documents.

(g) Supervisory methods.

(h) Work organisation.

The various activities that are encompassed by the above factors are shown in Annexure-11.

10.3 Reduction of Human Errors

10.3.1 The above information not only permits an understanding of the errors committed but also the causes that have contributed to the inappropriate behavior of the persons involved. In addition to the technical description of the event, human characteristic information should also be reported whenever necessary. This can help in developing procedures/modifying the existing procedures so that the chances of human error of the kind observed are minimised/eliminated.

10.3.2 It has to be borne in mind that all information concerning persons should be

depersonalised as this leads to a better quality of the report while maintaining the privacy of the individuals involved. The report should discuss the root causes of human performance problems so that effective measures to prevent the recurrence of the event can be taken.

10.3.3 Elucidation of the mechanisms and root causes help in assessing performance-shaping factors. These are used to alter nominal human error rates to suit the given situation in any human reliability analysis.

10.4 Human Errors in Event Analyses

10.4.1 The purpose of human factor analysis is to take into account and to use established knowledge about basic human behavior in order to understand the contributing and influencing factors that have led the individual to make an error.

10.4.2 In order to understand operational events involving human actions, it is necessary to understand the modes, mechanisms and causes of human errors. Human errors can seldom be attributed to one cause. Many factors in the environment have a direct influence on the individual.

10.4.3 Human factors specialist should participate in the event investigation and in the evaluation of the contributing personnel, group and organisational deficiencies.

10.4.4 Individual's perception has an important influence on his behavior during the activities he performs. Collection of such information is vital in the analysis of events involving human errors.

11. ACTION TAKEN ON OPERATIONAL SAFETY EXPERIENCE

11.1 General

Actions are taken on important lessons learnt from operational safety experience to help prevent occurrence or reoccurrence of safety significant events. It improves plant operability, reliability and safety.

11.2 Formulation of Recommendations

11.2.1 Corrective actions are proposed after in-depth analysis of both internal and external feedbacks. Formulation of recommendation should not be impulsive but should be derived from brainstorming for the solutions. Factors to be considered during formulation of recommendations are:

(i) Should be accurate, precise, implementable and should lead to significant improvement.

(ii) Should be compatible with other actions.

(iii) Should address root cause of the problem.

(iv) Should evaluate cost, change implementation and training with respect to perceived benefits.

(v) Should include provision for verification of effectiveness of action.

11.2.2 Corrective actions should focus on following aspects:

(i) Improvement of procedure for operation, maintenance, testing and inspection.

(ii) Training of personnel to impart up-to-date knowledge.

(iii) Correcting organisational weakness.

(iv) Improvement in human performance.

(v) Modification of design to achieve safety requirement.

(vi) Modification of equipment to serve the design intent and reliability.

11.2.3 Corrective actions can be immediate or interim, which address direct causes and are measures to recover from transients. Procedure should exist as contingency plans where actions are not finalised and approved. Specific procedure should exist to cover cases where implementation of corrective actions is needed urgently. Long term actions are planned after detailed evaluation and approval. Corrective action identified may have different impact on an operating plant; plant under construction and plant still in the design stage and it is implemented only where it is practical.

11.3 Approval, Implementation and Tracking of Recommendations

11.3.1 SORC reviews all recommendations. It also approves implementation of all plant level recommendations. All recommendations which call for modification of design or have effect on safety are further reviewed by operating organisation and regulatory body as necessary. The documents that should be submitted for seeking regulatory body approval, should contain information on

(i) A detailed description of proposed corrective actions including drawings, sketches, etc.

(ii) A safety review which assures that the proposed corrective action improves safety and has no adverse effects.

(iii) Quality plans assuring compliance with design standards.

(iv) Plans and schedules for implementing the corrective actions.

(v) Safe working procedure.

(vi) Organisational and human performance considerations.

11.3.2 Implementation

Implementation of corrective action is the responsibility of individual plants. Quality assurance and documentation should be carried out as approved. Priority of implementation is assigned, agency for implementation is identified and expected implementation date is committed. Sufficient resources are deployed so that approved corrective actions are completed in a timely manner. An evaluation should be done to check the effectiveness of actions implemented.

11.3.3 Tracking of Recommendations

(i) All approved recommendations are entered into plant database for tracking the status. Pending recommendations beyond committed date are reviewed, reasons ascertained and report submitted to plant management for rescheduling/allocation of additional resources.

(ii) For recommendations needing inputs from engineering and other agencies, report is submitted to responsible organisation for obtaining proper priority.

(iii) Periodic progress reports on implementation of recommendations made by safety committees/regulatory body is submitted by plant to regulatory body.

(iv) Non-compliance report is issued if implementation is not completed by committed date.

(v) In addition to the documentation and follow-up actions associated

with each event, a systematic compilation of action taken over the years may provide an information base of lessons learnt.

(vi) When these actions are compiled and sorted out on the basis of the systems affected or the safety issues raised, they can serve as a solution for similar problems which may arise in future.

12. DISEMMINATION, EXCHANGE AND UTILISATION OF OPERATIONAL SAFETY EXPERIENCE

12.1 General

(i) Operating safety experience feedback related information provides opportunities to learn weakness in plant systems, personnel and organisation. Dissemination of information regarding problems, their solutions and lessons learnt, goes a long way in improving nuclear power plant operation and safety.

(ii) Distribution of formal reports and access to databases provide necessary information to all concerned organisations. However reports and information generated within plant, country and internationally are voluminous and for effective benefit and action within reasonable time, it is necessary to have dissemination process targeted at different levels.

12.2 Station Personnel

It is necessary to create high level of awareness amongst station personnel regarding importance and usefulness of OSEF system.

(i) Displaying events appropriately on notice boards, discussion within work group and among shift personnel are some of the methods useful for this purpose.

(ii) Operating personnel are front-line staff and therefore special training sessions are necessary to update operating staff periodically regarding OSEF.

(iii) Station engineering staff is involved in reporting, investigating, analysing, forming and implementing the recommendations. Case studies on events should be discussed amongst multidisciplinary group and corrective actions need to be brought out.

(iv) OSEF engineer should scan documents from other operating stations within country as well as those received from international bodies. The issues arising out of this and the good practices followed in other NPPs should be given wide circulation.

(v) It is necessary to have regular periodic meeting of OSEF engineers of all stations to exchange information, review implementation of recommendations and deliberate on the effectiveness of OSEF.

12.3 Operating Organisation Personnel

Operating organisation should have access to all plant database and head

quarter database that have to be reviewed for preparing follow-up action plans. It should disseminate information to engineering, manufacturing, R & D divisions and safety review personnel to enable feedback and improvements. Operating organisation has to ensure dissemination of external information to all stations. They have also to monitor implementation of recommendation in timely manner. They should also generate information that can be shared with other nuclear operators, users group etc.

13. MONITORING AND REVIEW OF SYSTEM FOR OPERATIONAL SAFETY EXPERIENCE FEEDBACK (OSEF)

13.1 General

13.1.1 Monitoring of OSEF system is required to ensure that all elements of the feedback process and corrective actions are performed efficiently and effectively. OSEF System should significantly minimise the likelihood of recurrence of events and occurrence of new events due to similar causes or even new causes. There are two approaches to monitor the OSEF System:

(i) A systematic review or audit covering all the elements of the OSEF system.

(ii) Trend and pattern analysis for measurable indicators e.g. number of repeat events, frequency of recurrence, severity rate, and common root causes for different events.

It is desirable to practice both the above approaches.

13.1.2 The purpose of the review is to provide feedback on the management of overall effectiveness of the system to the operating organisation and responsible organisation and to recommend remedial measures to resolve any weakness identified.

13.1.3 The review also verifies that the corrective actions arising from the OSEF system are implemented in a timely manner, and are effective in solving original problems and preventing event recurrence.

13.1.4 Identified weaknesses should be assessed to determine their effect on the overall effectiveness of the system. The required corrective actions based on the recommendations should be identified. The implementation of the recommended actions to address identified weaknesses should be prioritised and tracked to ensure timely completion.

13.1.5 The OSEF system review should encompass a representative sample of operating information both from internal and external sources. Selected samples should be representative of the source material and time period. For example the sample should include human performance reports and equipment failures in the same proportion as the total number of events reported. In addition the sample reports reviewed should be spread covering the time period of interest. The review samples should cover all sources of OSE e.g., in-house operating experience, IAEA-IRS, users groups event analysis reports, significant operating experience report recommendations, inspection & enforcement notices, bulletins, service information letters, power reactor events, information from vendors, suppliers etc.

13.1.6 The complete documented history of each step of the OSEF system should be available to be audited/ monitored in the process.

13.1.7 A periodic report on OSEF should be prepared, at an interval not exceeding three years. It should summarise the activities performed over the interval considered in the framework, of OSEF i.e listing the in-house events and outside experience that have been analysed, corrective actions approved and the status of their implementation. For the corrective actions not yet completed, target date should be indicated.

13.1.8 OSEF input is important for renewal of authorisations by RB.

13.2 By Plant Management

13.2.1 The OSEF system at the plant should be audited and reviewed at regular intervals usually annually, by the experienced group not directly involved in the OSEF programme of the station. The audit team should be made up of personnel familiar with assessment of OSEF information and quality assurance staff belonging to the same plant and at least one member of a different plant, operating organisation and the responsible organisation. The independent audit team should act on behalf of the senior management of the plant to whom the audit findings are reported. The review should cover complete OSEF system including all its elements.

13.2.2 The monitoring and review by the plant management should include the existence and effectiveness of the following aspects of the OSEF programmes.

13.2.2.1 Organisation and Administration

(i) Organisational structure/functional arrangements are clearly defined.

(ii) Staffing and resources available are sufficient to accomplish the assigned targets. OSEF personnel have adequate technical experience and training especially in root cause analysis.

(iii) The responsibilities and authority of each management, supervisory and professional position in the programme are clearly defined and understood by all concerned.

(iv) Involvement and support of management down the line in OSEF programme to ensure that the programme receives appropriate attention and is carried out correctly.

(v) Periodic reports, usually annually summarising the activities under the OSEF programme, are issued.

(vi) Action items resulting from operational safety experience review should receive appropriate approval and are tracked to completion.

(vii) Availability and adequacy of the procedures (as mentioned in item

4.0) defining the functioning of the OSEF programme.

(viii) Completeness of documentation, storage, easy handling and retrieval of information pertaining to OSEF.

(ix) Dissemination of the OSEF to station personnel, their knowledge and understanding of the material provided and their effectiveness in translating the operating experience into corrective actions.

(x) Feedback to all involved agencies e.g. designers, quality assurance engineers, vendors, suppliers etc. are provided.

(xi) Interfaces with in-house and external supporting groups are clearly defined and understood by all concerned.

(xii) Appropriateness of the corrective measures.

(xiii) Corrective actions are formally analysed for safety implications, approved and implemented in a timely manner. All expertise available in house is effectively utilised.

13.2.2.2 In-house Experience

(i) All internal events including deviations, near misses and low level events, are covered in the OSEF process.

(ii) Various in-house events, equipment failures and other types of deviations are screened for significance and prioritised for evaluation.

(iii) In-depth investigations are performed on safety significant events to determine root causes, generic implications and necessary corrective actions to prevent recurrence.

(iv) Relevant in-house operational experience is reviewed as part of the investigation.

(v) Types of events and root causes are trended to identify adverse trends for determining appropriate actions.

(vi) In case of internal events, recurrences are minimised.

(vii) No single root cause dominates the statistics.

(viii) Timely notification is provided to other operating organisations and responsible organisations.

(ix) The performance of the plant with respect to safety significant events, deviations and unavailability of safety functions show no adverse trend over the period assessed.

(x) Data on equipment failures are collected in a systematic manner and the reliability database is updated.

(xi) Events, which may require immediate action, are given proper attention.

(xii) Approved corrective or preventive actions are fully implemented in a timely manner.

(xiii) In-house experience should also include all items other than events and significant events.

13.2.2.3 External Operational Safety Experience

All applicable external operational safety experience is received, screened for applicability; significance prioritised, actions based on lessons learnt are reviewed and implemented in a timely manner after approval. Monitoring and tracking of actions are done.

13.2.2.4 Plant Awareness through Dissemination and Training

(i) Information regarding significant in-house and external operational safety experience is disseminated to appropriate personnel in order to improve their knowledge and experience.

(ii) Information on in-house and external OSEF events is used in training of personnel.

(iii) These form important elements of qualification and licensing of personnel.

13.2.3 Problems or deficiencies noted in the audit/review report covering the overall administration or function of the OSEF programme should be discussed with the senior management and remedial measures should be proposed to address the identified weakness.

13.3 By Operating Organisation

13.3.1 The OSEF programme of the plant should be monitored by the operating organisation by means of routine reports, interactions and communications.

13.3.2 The OSEF programme at the operating organisation should be monitored by the head of the organisation. The programme implementation and effectiveness should be audited and reviewed at regular intervals not exceeding three years by a team of experienced personnel who are not directly involved in the OSEF programme. The audit team is usually made up of personnel familiar with assessment of OSEF information from within the same or other Directorate and Quality Assurance Directorate. Members from the plants should also be included in the review/audit team. The audit team acts on behalf of the senior management of the operating organisation to whom the audit findings are reported. The deficiencies or shortcomings noted in the OSEF programme are reviewed by the senior management of the responsible organisation.

13.3.3 The review by the Op.O will be similar to that at the plant level. The frequency of review may also be same. The main difference is that at the operating

organisation the international operating experience reports are received, screened, safety significance determined, prioritised for review and reviewed for applicability. Lessons learnt are drawn and the information is disseminated to the plant in a time scale appropriate to their significance. Availability and adequacy of resources, procedures, documents storage and retrieval, implementation of the programme and its effectiveness should be checked. Feedback in this regard, from the plants should also be considered.

13.4 By Responsible Organisation

13.4.1 The overall effectiveness of the OSEF programme should be monitored by senior management of the responsible organisation by means of reports of the review done by the plant and the operating organisation level teams and the regulatory body.

13.4.2 Failure to fully satisfy some of the review criteria may not be indicative of an unsatisfactory programme. In an effective and efficient OSEF programme, the identified weaknesses are assessed to determine their impact on the overall effectiveness of the programme. After discussion at the senior management level remedial measures are proposed and recommendations are made for necessary follow up actions.

13.4.3 Responsible organisation should also monitor that the feedbacks are sent not only by plant management but also by designers, vendors, manufacturers, constructors, technical support organisations and operating organisation. It may be useful to issue information bulletins on some important issues including expected actions.

13.4.4 The implementation should be undertaken on the approved recommended measures and should be monitored to ensure timely completion.

13.5 By Regulatory Body

13.5.1 Regulatory Body should have a system to monitor effectiveness, efficiency and impact of OSEF system.

13.5.2 OSEF should form an important element in various reviews for renewal of authorisations including periodic safety reviews.

14. TRAINING

14.1 Target Groups

14.1.1 The operational safety experience feedback training is required for the two distinctly identified groups of the plant.

(i) Operational safety experience feedback group members.

(ii) Operations and maintenance personnel.

14.1.2 The OSEF group members are responsible for identifying and recommending OSEF items for training.

14.2 Updating of OSEF Group Personnel on Events

14.2.1 Initial and refresher training should be provided for the OSEF group personnel on external events. This should include:

(i) Case studies of the deviations.

(ii) Event reports and root cause analysis reports.

14.2.2 For the internal events OSEF group should take part in the investigation. For this purpose OSEF group should be trained in investigation techniques (e.g. Human Performance Enhancement System (HPES), Event and Causal Factor Charting (ECFC) etc.), documentation requirements, interviewing techniques, conflict resolution and dealing with confidentiality issues.

14.2.3 The systematic approach to training (i.e. SAT) should be adopted for the training of OSEF group personnel for both internal and external events.

14.3 Development of Skills

14.3.1 For the purpose of the development of skills for O&M personnel on OSEF one or more of the following methods can be adopted:

(i) Lectures supported by audiovisuals and multi-media.

(ii) Participants interaction with an expert on the subject matter.

(iii) Site specific operational practices compared with operational experience feed back.

14.3.2 Before imparting OSEF training, specific skills and competencies should be identified and analysed, documented and written down in a standard format. The design of framework for the training modules, self-learning packages is to be done by OSEF group.

14.3.3 The development of the OSEF training program and modules will require the need of a joint effort of subject matter expert and OSEF group. The written

down OSEF training program should have:

(a) Training plan for OSEF

(b) Trainers module

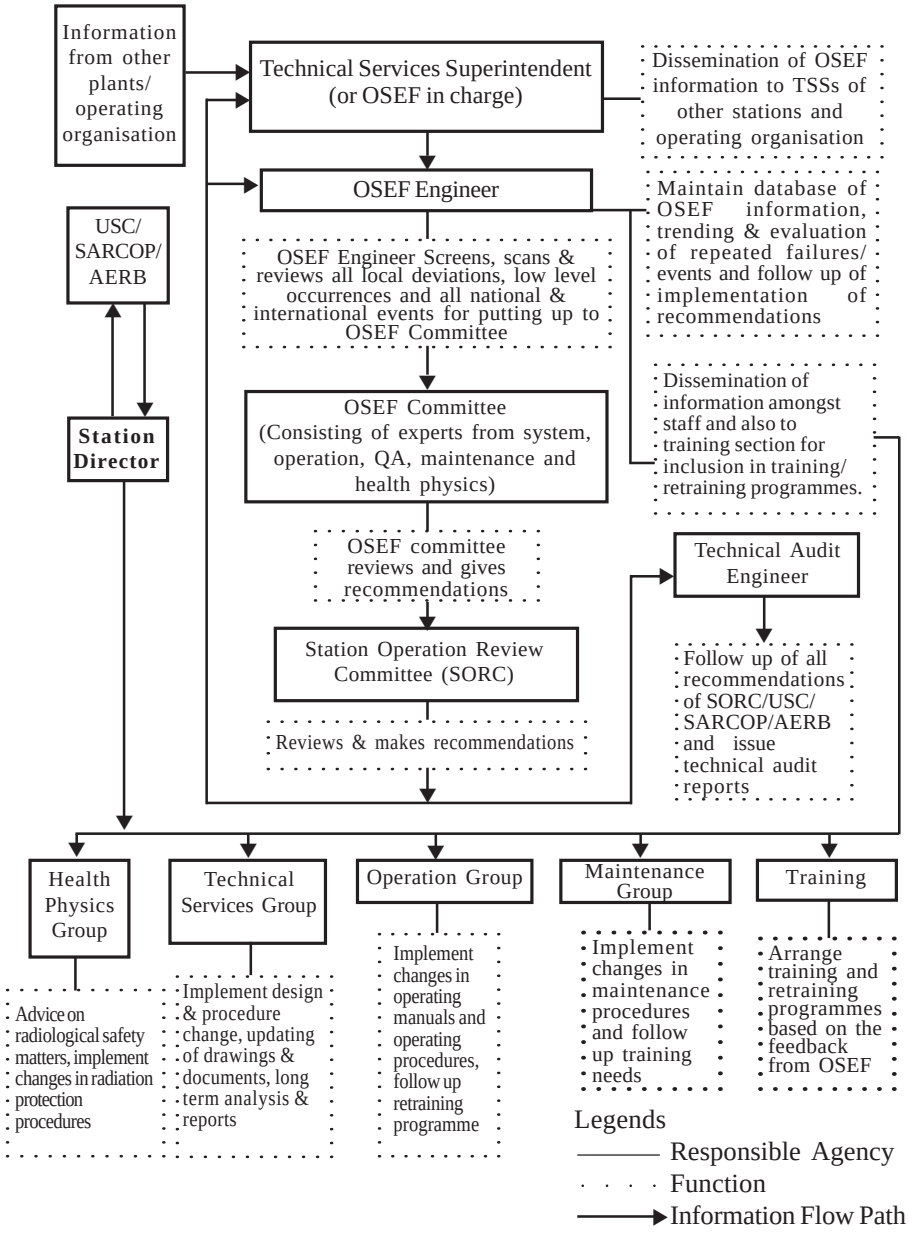
(c) Set of related transparencies

(d) Trainee's/participant's hand outs.

14.3.4 After establishing the OSEF training program, its evaluation is required to determine the effectiveness of OSEF training.

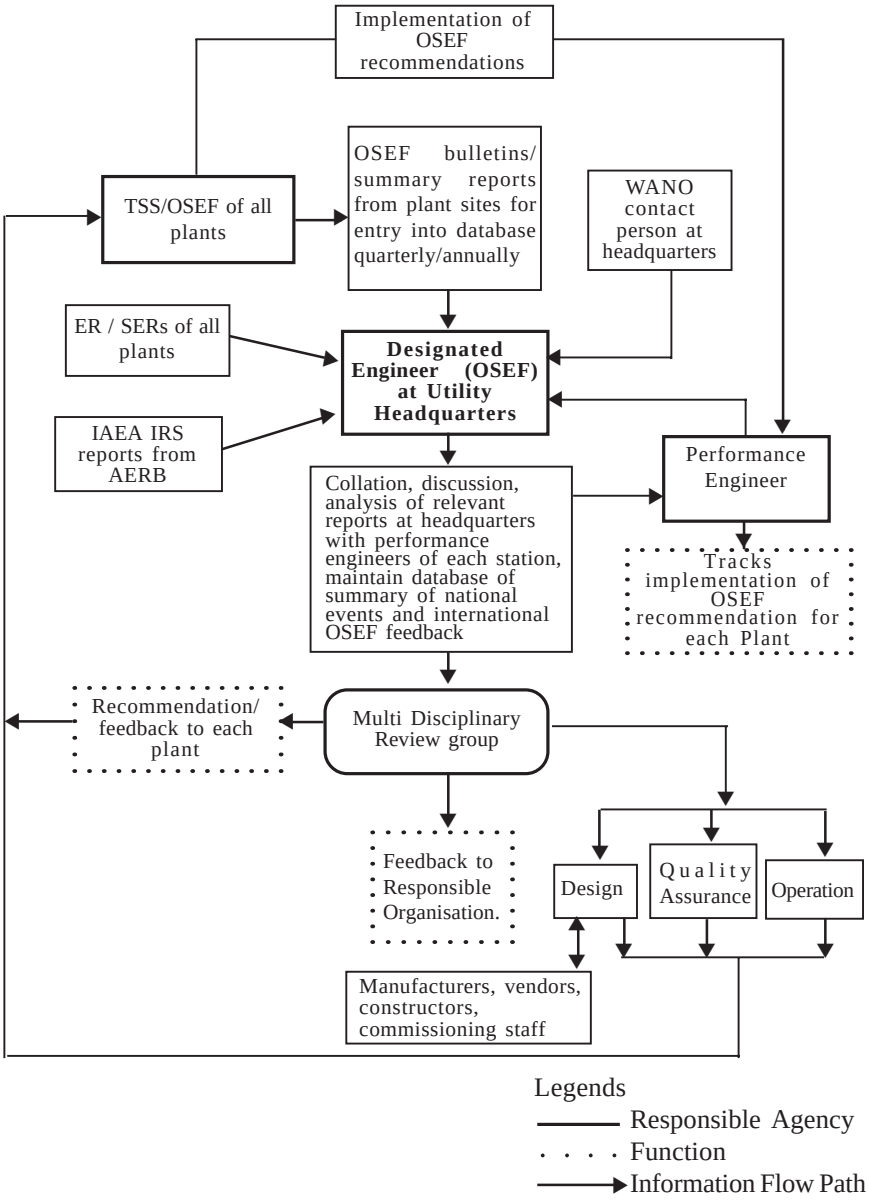
ANNEXURE-1
(Section 3.1)

OSEF FUNCTIONAL ARRANGEMENT AT PLANT



ANNEXURE-2
(Section 3.2)

TYPICAL OSEF FUNCTIONAL ARRANGEMENT AT OPERATING ORGANISATION



ANNEXURE-3
(Section 5.3.1)

REPORTING CRITERIA FOR EVENT REPORTS

The reporting criteria for events, which need to be reported as 'Event Report' is as follows:

ER-1 A plant shutdown required by the limiting conditions for operation (LCO) as given in technical specifications. (An example of this kind of event could be that the reactor had to be shutdown in case deuterium concentration in moderator cover gas could not be brought down to less than 4% V/V within 8 hours as required by technical specification).

ER-2 Any reactor trip initiated because of grid disturbances and class IV power supply failure that results in safe shutdown of the plant as intended. (An example of this kind of event could be reactor trip initiated because of grid failure and all diesel generators coming on line as intended, one of the primary circulating pumps trip due to grid voltage disturbance on switching faults or transient faults causing reactor trip).

ER-3 Failure or degradation of safety system detected during surveillance. (An example of this kind could be diesel generator not starting during testing, opening or closing time of valves/ dampers more than specified values, drift in instrument settings etc.).

ER-4 Non availability of safety system within technical specification requirement (reactor protection system or safety system instrument channel or component only has failed in such a manner as not to prevent the fulfillment of functional requirements of the system).

ER-5 Radiation dose (whole body) received by any person crossing investigation limits set by AERB. (as given in section 11.1 of AERB safety manual for Radiation Protection for Nuclear Facilities, see table below for ready reference)

Table for Exposure Investigation Levels (ref: ER-5)

S. No	Monitoring Period	Investigation Level
1	External Exposure	
	1 Month	10 mSv
	3 Months	15 mSv
	1 Year	20 mSv
2	Internal Exposure other than Tritium	
	1 Month	500 micro Sv
	3 Months	1.5 mSv
	1 Year	6 mSv

ANNEXURE-3 (CONTD.)

Table for Exposure Investigation Levels (ref: ER-5) (Contd.)

S. No	Monitoring Period	Investigation Level
3	Internal Exposure-Tritium Weekly	 4 GBq/ m^3
4	External and Internal Exposure 1 Month 3 Months 1 Year	 10 mSv 15 mSv 20 mSv

ER-6 All cases of shutdown refuelling (only for PHWR type of reactors)

ER-7 Heavy water (D_2O) spillage/escape of more than 100 kg because of a single event.

ANNEXURE - 4
(Section 5.3.2)

REPORTING CRITERIA FOR SIGNIFICANT EVENT REPORT

The reporting criteria for events, which need to be reported as 'Significant Event Report' is as follows

SER 1. Non Compliance

SER 1.1 Non-adherence to any of the stipulations made in the technical specifications including surveillance requirements of safety and safety related systems.

SER 2. Safety Barriers

SER 2.1 Any event or condition that resulted in the condition of the NPP, including its principal safety barriers being seriously degraded. The fuel or fuel cladding, primary pressure boundary or containment would be included as principal safety barriers.

SER 2.2 Degradation discovered in reactor coolant pressure boundaries or containment because of change to the size, material property or reduction in wall thickness beyond that allowed in design. (e.g. thinning of PHT feeders, primary coolant piping affected because of IGSCC, discovery of cracks in containment wall).

SER 3. Reactivity Control

SER 3.1 Reactivity anomalies involving:

(a) Disagreement, with the predicted value or reactivity balance under steady state conditions during power operation, greater than or equal to 1-% dk/k (10 mk).

(b) A calculated reactivity balance indicating the shutdown margin less conservative than that specified in safety report.

(c) Short-term reactivity increases that correspond to a reactor period of less than 10 seconds.

(d) Sub-critical unplanned reactivity increases of more than 5 mk.

(e) The occurrence of any unplanned criticality.

SER 3.2 Unintended power change of reactor.

SER 4. Safety Systems

SER 4.1 A safety system setting less conservative than limits established in technical specification.

SER 4.2 Any event or condition that resulted in a manual or automatic operation of the

reactor protection system or engineered safety features with some exceptions dependent on the actual circumstances, such as events

(a) covered under ER -2,

(b) actuation from and part of a pre-planned testing sequence, and

(c) when the system was properly removed from service.

Typical systems would include emergency power, ECCS, auxiliary feed water, service water, containment cooling and other systems related to accident prevention and mitigation.

SER 4.3 Failure of the reactor protection system or of systems with limiting safety settings or of other systems to initiate and complete the required protective function upon the relevant monitored parameter(s) exceeding the set point(s) specified as instrument setting(s) in the technical specifications. (PHT pressure exceeds the limiting safety system setting value without reactor trip, log rate of neutron flux rise exceeds limiting safety system setting value without reactor trip).

SER 4.4 Failure or malfunction of one or more components of engineered safety features which prevents or could prevent by itself the fulfillment of the functional requirements of system(s) for coping with accidents analysed in the safety report. (Clogging of fuel oil lines resulting in failure to supply fuel to emergency diesel generators, multiple instrument drifts resulting in loss of protective function).

SER 4.5 Inadequacies in the implementation of and deficiencies revealed in the administrative or procedural controls, which threaten to cause reduction in the functional performance and/or of the degree of redundancy provided in the reactor protection system or engineered safety systems. (No water for fire fighting available due to some of the header isolation valves being kept inadvertently closed, failure to perform surveillance test at the required/ specified frequency).

SER 5. Refuelling

SER 5.1 Significant events during shutdown and refuelling, such as dropping of a fuel element, dropping objects into a reactor vessel, loss of reactivity control during refuelling, or loss of shutdown heat removal systems or loss of coolant inventory in the reactor vessel (only for BWR, PWR and FBR type of reactor).

SER 5.2 Significant events during refueling or fuel transfer operation resulting in movement of bundles to a path different from normal path, dropping of bundles,

incapacitation of fuelling machine preventing box up of coolant channel, loss of cooling to spent fuel bundles in fuelling machine and fuel transfer system (only for PHWR type of reactor).

SER 6. Over exposure

SER 6.1 Exposure of site personnel to radioactivity in excess of authorised limits.

SER 7. Confinement

SER 7.1 Degradation of systems designed to contain radioactive materials resulting from fission or activation processes other than those given in SER 2.1 above. (Through wall leak resulting in seepage of a radioactive liquid from a container or storage tank, damage to the shielding of any equipment resulting in high radiation field).

SER 7.2 Loss, misplacement, misuse or accident during transportation of any radioactive material while under the jurisdiction of station authorities.

SER 8. Radiological Releases

SER 8.1 Liquid or airborne release of radioactivity to environment in excess of technical specification limits or discharge through unauthorised route.

SER 9. Common Cause Failures

SER 9.1 Any event where a single cause or condition caused at least one independent train or channel to become inoperable in multiple systems, or two independent trains or channels to become inoperable in a single system that is related to reactor shutdown, decay heat removal, control of the release of radioactive material, or the mitigation of the consequences of an accident. Events reported under this criterion can include previously unrecognised common-cause (or dependent) failures and systems interactions. For example, if a number of snubbers were found to be inoperable such that they would not have been working properly then this could be an instance of generic common-mode problem in multiple independent trains in one or more safety systems.

SER 10. Human Performance Related

SER 10.1 Human performance problems including problems related to procedural use or adequacy, training, communications, man-machine interface, and management and supervision aspects which prevent or could prevent by themselves the fulfillment of the functional requirements of systems required to cope with accidents analysed in safety report.

ANNEXURE - 4 (CONTD.)

SER 11. Emergency Conditions

SER 11.1 Occurrence (radiological, chemical, fire or any other) involving damage to or having hazardous potential of damage to plant, personnel or environment.

SER 11.2 Declaration of an emergency condition (plant, site or offsite) as specified in the emergency plan.

SER 12. External Events

SER 12.1 Any natural phenomenon or other external condition that posed an actual threat to the safety of the NPP or significantly hampered site personnel in the performance of necessary duties for safe operation or require reactor shutdown. (Some examples include earthquake, fires of an external nature, high winds, lighting, and external threats that might arise from near by industrial facilities.)

SER 13. Unanalysed Situations

SER 13.1 Problem or defect in the design, fabrication or operation that results in, or could result in, an operating condition not previously analysed or that could exceed design basis conditions.

ANNEXURE- 5

(Section 5.3.1)

FORMAT FOR EVENT REPORT

1. Date of occurrence of event _____ time _____
2. Event title:
3. Is there any outage? : Yes/No

   Duration of outage
4. Status of unit before event:
5. Description of event:
6. Spot assessment:
7. Relevant fluctuations in system parameters during event:
8. Relevant annunciations during event:
9. Electrical relay flagged during event:
10. Action taken:
11. Probable cause of occurrence:
12. List of deficiencies noted:
13. Suggestions to avoid recurrence:
14. (a) Is it a significant event ? : Yes/No.

    (b) If yes, reporting criteria clause: _____
15. (a) Is there any technical specification deviation ? : Yes/No.

    (b) If yes, technical Specifications clause no: _____
16. (a) Is there any deviation from station policy ? : Yes/No.

    (b) If yes, station policy clause no: _____
17. Is prompt notification required? : Yes/No
18. Is there any spillage of heavy water? : Yes/No
19. How much heavy water escaped during the event?
20. (a) Is there any radiological impact ? : Yes/No

ANNEXURE - 5 (CONTD.)

(b) If yes, provide initial assessment _____

Signature	Signature
Prepared by	Checked by
Designation	Designation
Date:	Date:
Shift/Crew	Shift/Crew

Prompt notification issued: Yes/Not required

Signature: …….....……

Name: …….....……

(Operation Superintendent)

ANNEXURE- 6
(Section 5.3.2 (i))

FORMAT FOR SIGNIFICANT EVENT PROMPT NOTIFICATION REPORT

PN No.	**PN/Station Name/ Unit No./ Year/ No.**
Installation	
Date of issue	
Title	
Date of event	
Time of event	
Affected systems	
Brief description of the event	
Spot assessment	
Relevant technical specisification clause	

Prepared by:

Reviewed by:

Approved by (CS/SD) :

To

Chairman, AERB
Vice-Chairman, AERB
Chairman, SARCOP
Member Secretary, SARCOP
Chairman, Unit Safety Committee

ANNEXURE-7

(Section 5.3.2 (ii))

FORMAT FOR SIGNIFICANT EVENT REPORT (SER)

(Nuclear Power Plants)

1. Event Title:
2. Installation:
3. Reactor Type:
4. SER Report No.:
5. Ref PN No.:
6. Date and time of occurrence:
7. (i) Rated power of the unit: MWe

   (ii) Power level prior to incident : MWe MWt
8. Event reporting criteria:
9. (i) Nature of report Provisional ☐

   Final ☐

   (ii) If provisional, indicate expected date for final report
10. Is ECNR required to be issued Y/N ☐
11. (i) Whether similar occurrence has taken place earlier Y/N ☐

    (ii) If yes, give reference number
12. Narrative description (Event description, including system/component affected, observed cause, actions taken to bring the situation under control and termination of the event):
13. Safety assessment:
14. (i) whether incident covered in safety analysis report Y/N ☐

    (ii) If yes, mention the clause no.and the title of the enveloping event

    (iii) (a) Whether an emergency operating procedure (EOP) was existing for such events Y/N ☐

ANNEXURE - 7 (CONTD.)

(b) Give EOP no. and title

(iv) Technical specification violation (if yes, mention clause no. & quote clause) Y/N ☐

(a) Safety limit exceeded Y/N ☐

(b) Limiting safety system setting exceeded Y/N ☐

(c) Limiting condition for operations crossed Y/N ☐

(d) Surveillance requirement not met Y/N ☐

(e) Administrative/procedural control not complied with Y/N ☐

15. Root Cause Analysis (RCA):

(i) Criteria for root cause analysis

(ii) Attach RCA report as annexure

16. Corrective Actions:

(i) Immediate action(s) taken

(ii) Long range actions planned

(iii) Comments of SORC including comments of RCA committee:
(attach a copy of the extract of the minutes)

(iv) Details of similar occurrence taken place earlier if any.
(Also mention the recommendations made after the earlier incident and indicate the status of their implementation)

17. Lessons learned:

18. Additional information useful in assessing the occurrence:

19. Consequences of the occurrence:

ANNEXURE - 7 (CONTD.)

19.1 Effect on installation:

(i) Effect on operation

(ii) Damage to the plant/equipment

19.2 Effect on site personnel:

(i) Injury (permanently disabled)

(ii) Fatalities

(iii) Radiation Exposure

Maximum individual effective dose msv
Maximum individual external dose msv
Maximum individual internal dose msv
Maximum individual internal uptake (kBq)
Tritium intake :
I-131 :
Sr-90 :
Pu-239 :
Any other intake :

(iv) Any other exposure: (including chemical exposure) (Specify)

19.3 Radioactivity released to the environment:

(i) Location

(ii) Nature and quantity

Description	**Liquid**	**Gaseous**
Nature of nuclide		
Quantity (TBq)		
Percentage of technical specification		
Concentration (Bq/ml), also mention Percentage of technical specification (for liquids only)		

20. Conditions (Radiation and /or any other) in the installation after the occurrence:

ANNEXURE - 7 (CONTD.)

21. Classification of event (indicate from code list, refer Annexure 8):

21.1 Reporting categories
21.2 Status of installation prior to occurrence (Mention as applicable)
21.3 Failed/affected systems
21.4 Failed/affected equipment/components
21.5 Cause of the occurrence
21.6 Effect on operation
21.7 Characteristics of the incident
21.8 Nature of failure or error
21.9 Nature of recovery action

Date: Issued by
Station Director (Licensee)

To,

Chairman, AERB
Vice Chairman, AERB
Chairman, SARCOP
Member Secretary, SARCOP
Chairman, Unit Safety Committee

Annexures:
Drawings, Sketches, tables, report, E.S.R. chart etc.
Copy of the extracts of the minutes of SORC meeting

ANNEXURE-8
(Section 5.3.3.3)

CODE LIST AS PER IAEA INCIDENT REPORTING SYSTEM (IAEA-IRS)[1]

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**
1.2.1	Fuel cladding failure
1.2.2	Degradation of primary coolant pressure boundary, main steam or feedwater line
1.2.3	Degradation of containment function or integrity
1.2.4	Degradation of systems required to control reactivity
1.2.5	Degradation of systems required to assure primary coolant inventory and core cooling
1.2.6	Degradation of essential support systems
1.3	**Deficiencies in design, construction, operation (including maintenance and surveillance), quality assurance or safety evaluation**
1.3.1	Deficiencies in design
1.3.2	Deficiencies in construction
1.3.3	Deficiencies in operation (including maintenance and surveillance)
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] Numbering system followed in this list is same as that given in IAEA-IRS coded watch list.

ANNEXURE - 8 (CONTD.)

1.6	Events of potential safety significance
1.7	Effects of unusual external events of either man-made or natural origin
2.	**PLANT STATUS PRIOR TO THE EVENT**
2.0	Not applicable
2.1	On power
2.1.1	Full allowable 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	Refuelling on power
2.2	**Hot shutdown (reactor sub-critical)**
2.2.1	Hot standby (coolant at normal operating temperature)
2.2.2	Hot shutdown (coolant below normal operating emperature)
2.3	**Cold shutdown (reactor sub-critical and coolant temperature < 93^0C)**
2.3.1	Cold shutdown with closed reactor vessel
2.3.2	Refuelling or open vessel (for maintenance)
2.3.2.1	Refuelling or open vessel-all or some fuel inside the core
2.3.2.2	Refuelling or open vessel-all fuel out of the core
2.3.3	Mid-loop operation (PWR)
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.A	**Primary reactor systems**
3.AA	Reactor core (fuel assemblies, control and poison rods, guide thimbles,...)
3.AB	Control rod drive (mechanism, motor, power supply, hydraulic system, other shutdown systems)

ANNEXURE - 8 (CONTD.)

3.AC	Reactor vessel (with core internals, PHWR or LWGR pressure tubes, ...)
3.AD	Moderator and auxiliaries (PHWR)
3.AE	Primary coolant (pumps and associated materials, loop piping,...)
3.AF	Pressure control (includes primary safety relief valves)
3.AG	Recirculating water (BWR,…)
3.AH	Steam generator, boiler, steam drum
3.AK	At power fuel handling systems (PHWR, LWGR, GCR)
3.AL	Annulus gas (PHWR, LWGR**)**
3.B	**Essential reactor auxiliary systems**
3.BA	Reactor core isolation cooling (BWR)
3.BB	Auxiliary and emergency feedwater
3.BC	Emergency poisoning function (PWR mainly with the boron injection tank, chemical and volume control system participation)
3.BD	Standby liquid control (BWR)
3.BE	Residual heat removal (PWR and BWR except emergency core cooling functions)
3.BF	Chemical and volume control (PWR with main pumps seal water,...)
3.BG	Emergency core cooling (core spray or relevant parts of residual heat removal, chemical and volume control system)
3.BH	Main steam pressure relief (reactors which have secondary loops)
3.BK	Nuclear boiler overpressure protection (BWR)
3.BL	Core flooding accumulator (PWR)
3.BP	Failed fuel detection (GCR)
3.BQ	Gas cleanup system (LWGR, PHWR)
3.C	**Essential service systems**
3.CA	Component cooling water (including reactor building closed cooling water)
3.CB	Essential raw cooling or service water
3.CC	Essential compressed air
3.CD	Borated or refuelling water storage (PWR)

ANNEXURE - 8 (CONTD.)

3.CE	Condensate storage
3.CF	CO_2 injection and storage (GCR)
3.D	**Essential auxiliary systems**
3.DA	Spent fuel pool or refuelling pool cooling and cleanup
3.DB	Containment isolation (with BWR leakage control and air lock door seals)
3.DC	Main steam or feedwater isolation function (with BWR main steam isolation valve leakage control)
3.DD	Containment spray and ice condensers
3DE	Containment pressure suppression (not including spray)
3.DF	Containment combustible gas control
3.DG	Essential auxiliary steam (GCR)
3E	**Electrical systems**
3.EA	High voltage AC (greater than l5kV including off-site power)
3.EB	Medium voltage AC (600V to l5kV)
3.EC	Low voltage AC (less than 600V - mainly 480V)
3ED	Vital instrumentation AC and control AC
3.EE	DC power
3.EF	Emergency power generation and auxiliaries (includes fuel oil supply)
3.EG	Security and access control
3.EH	Communication and alarm annunciation
3.F	**Feedwater, steam and power conversion systems**
3.FA	Main steam and auxiliaries (including auxiliary steam)
3.FB	Turbogenerator and auxiliaries
3.FC	Main condenser and auxiliaries (non-condensable gases extraction and treatment)
3FE	Turbine by-pass
3.FG	Condensate and feedwater
3.FM	Condensate demineraliser
3.FN	Circulating or condenser cooling water (including raw cooling and service water)

ANNEXURE - 8 (CONTD.)

3.H	**Heating, ventilation and air conditioning systems (HVAC)**
3.HA	Primary reactor containment building HVAC
3.HB	Primary containment vacuum and pressure relief
3.HC	Secondary containment recirculation, exhaust and gas treatment
3.HD	Dry well or wet well HVAC and purge and inerting (BWR)
3.HE	Reactor or nuclear auxiliary building HVAC
3.HF	Control building HVAC (including main control room)
3.HG	Fuel building HVAC
3.HH	Turbine building HVAC
3.HK	Waste management building HVAC
3.HM	Miscellaneous structures HVAC
3.HN	Chilled water
3.HP	Plant stack
3.HQ	Emergency generator building HVAC
3.HR	Seismic/bunkered emergency control building HVAC
3.I	**Instrumentation and control systems**
3.IA	Plant/process computer (including main and auxiliary computers)
3.IB	Fire detection
3.IC	Environment monitoring
3.ID	Turbogenerator instrumentation and control
3.IE	Plant monitoring (including the main control room equipment and various remote control functions)
3.IF	In-core and ex-core neutron monitoring
3.IG	Leak monitoring
3.IH	Radiation monitoring (in the plant and of workers)
3.IK	Reactor power control
3.IL	Recirculation flow control (BWR)
3.IM	Feedwater control
3.IN	Reactor protection

ANNEXURE - 8 (CONTD.)

3.IP	Engineered safety features actuation (including emergency systems actuation)
3.IQ	Non-nuclear instrumentation
3.K	**Service auxiliary systems**
3.KB	Sampling
3.KC	Control and service air (non-essential) and compressed gas
3.KD	Dernineralised water
3.KE	Material and equipment handling
3.KG	Nuclear fuel handling and storage
3.KH	Fire protection
3.KP	Chemical additive injection
3.S	**Structural systems**
3.SA	Primary reactor containment building
3.SB	Secondary reactor containment building or vacuum building (PHWR)
3.SC	Reactor or nuclear auxiliary building
3.SD	Control building
3.SE	Emergency generator building
3.SF	Fuel building (including wet and dry storage buildings)
3.SG	Turbine building
3.SH	Waste management building
3.SK	Pumping stations
3.SL	Backup ultimate heat sink building
3.SM	Cooling towers
3.SN	Switchyard (enclosed/open)
3.SP	Seismic/bunkered emergency control building
3.W	**Waste management systems**
3.WA	Liquid radwaste
3.WB	Solid radwaste
3.WC	Gaseous radwaste

ANNEXURE - 8 (CONTD.)

3.WD	Non-radioactive waste (liquid, solid and gaseous)
3.WE	Steam generator blowdown
3.WF	Plant drainage (floor, roof)
3.WG	Equipment drainage (including vents)
3.WH	Suppression pool cleanup (BWR)
3.WK	Reactor water cleanup (BWR, PHWR, LWGR…)
3.Z	**None of the above systems**
4.	**FAILED/AFFECTED COMPONENTS**
4.0	No specific component involved
4.1	**Instrumentation (gauges, transmitters, sensors)**
4.1.0	Others
4.1.1	Pressure
4.1.2	Temperature
4.1.3	Level
4.1.4	Flow
4.1.5	Radiation/Contamination
4.1.6	Concentration
4.1.7	Position
4.1.8	Dewpoint, moisture
4.1.9	Neutron flux (detectors, ion chambers and associated components)
4.1.10	Speed measuring
4.1.11	Fire detectors
4.1.12	Hydrogen detectors
4.1.13	Electrical (current, voltage, power)
4.2	**Mechanical**
4.2.0	Others
4.2.1	Pumps, compressors, fans
4.2.2	Turbines (steam, gas, hydro), engines (diesel, gasoline, ...)

ANNEXURE - 8 (CONTD.)

4.2.3	Valves (including safety/relief/check/solenoid valves), valve operators, controllers, dampers and fire breakers, seals and packing
4.2.4	Heat exchangers (heaters, coolers, condensers, boilers, air dryers, ...), 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, thermal sleeves, snubbers
4.2.8	Strainers, screens, filters, ion exchange columns
4.2.9	Penetration (personnel access, equipment access, fuel handling,...)
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	Others
4.3.1	Switchyard equipment (switchgear, transformers, buses, line isolators,...)
4.3.2	Circuit breakers, power breakers, fuses
4.3.3	Alarms
4.3.4	Motors (for pumps, fans, compressors, valves, motor generators, ...)
4.3.5	Generators of emergency and stand-by power
4.3.6	Main generator and auxiliaries
4.3.7	Relays, connectors, hand switches, push buttons, contacts
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

ANNEXURE - 8 (CONTD.)

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 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

5.1.2 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

5.1.2.4 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

5.1.3 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

ANNEXURE - 8 (CONTD.)

5.1.4	**Hydraulic/pneumatic failure**
5.1.4.0	Other hydraulic/pneumatic failure
5.1.4.1	Water hammer, abnormal pressure, pressure fluctuations, over 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
5.1.4.6	Moisture in air systems
5.1.4.7	Vibration due to fluid flow
5.1.5	**Instrumentation and control failure**
5.1.5.1	Other instrumentation and control failure
5.1.5.2	False response, loss of signal, spurious signal
5.1.5.3	Oscillation
5.1.5.4	Set point drift, parameter drift
5.1.5.5	Computer hardware deficiency
5.1.5.6	Computer software deficiency
5.1.6	**Environmental (abnormal conditions inside plant)**
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
	Fire, burning, smoke, explosion
5.1.7	**Environmental (external to the plant)**
5.1.7.0	Other external environmental cause (fire, toxic/explosive gases,...)

ANNEXURE - 8 (CONTD.)

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

5.1.7.7 Heavy rain or snow

5.1.10 Human factors

5.1.10.1 Slip or lapse

5.1.10.2 Mistake

5.1.10.3 Violation

5.1.10.4 Sabotage

5.3 Inadequate human action- plant staff involved

5.3.1 Maintenance

5.3.2 Operations

5.3.3 Technical and engineering

5.3.4 Management and administration

5.4 Inadequate human action - type of activity

5.4.1 Not relevant

5.4.2 Normal operations

5.4.3 Shutdown operations

5.4.4 Equipment startup

5.4.5 Planned/preventive maintenance

5.4.6 Isolating/de-isolating

5.4.7 Repair (unplanned/breakdown maintenance)

5.4.8 Routine testing with existing procedures/documents

5.4.9 Special testing with one-off special procedure

5.4.10 Post-modification testing

ANNEXURE - 8 (CONTD.)

5.4.11	Post-maintenance testing
5.4.12	Fault finding
5.4.13	Commissioning (of new equipment)
5.4.14	Recommissioning (of existing equipment)
5.4.15	Decommissioning
5.4.16	Fuel handling/refuelling operations
5.4.17	Inspection
5.4.18	Abnormal operation (due to external or internal constraints)
5.4.19	Engineering review
5.4.20	Modification implementation
5.4.21	Training
5.4.22	Actions taken under emergency conditions
5.4.23	Other activity
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	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 organisation**
5.5.9.0	Others

ANNEXURE - 8 (CONTD.)

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	Organisational/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
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

ANNEXURE - 8 (CONTD.)

6.3	**Load reduction**
6.3.1	Automatic load reduction
6.3.2	Manual load reduction
6.4	Activation of engineered safety features
6.5	**Challenge to safety or relief valve**
6.5.1	Challenge to safety or relief valve in the primary circuit
6.5.2	Challenge to safety or relief valve in the steam or condensate cycle
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
6.8	Personnel or public injuries
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
7.4	Loss of safety function
7.5	Significant degradation of safety function
7.6	Failure or significant degradation of the reactivity control
7.7	Failure or significant degradation of plant 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
7.11	Transient
7.11.0	Other transient

ANNEXURE - 8 (CONTD.)

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
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

ANNEXURE - 9

(Section 5.3.2 (iii))

FORMAT FOR EVENT CLOSURE NOTIFICATION REPORT (ECNR)

ECNR No.	**ECNR/Station Name/ Unit No./ Year/ No.**
Date of Issue	
Ref. PN No.	
Ref. SER No.	
Reasons for Closing (indicate if all investigations and review are completed)	

Prepared by:

Reviewed by:

Issued by:

Station Director
Licensee

To,

Chairman, AERB
Vice-Chairman, AERB
Chairman, SARCOP
Member Secretary, SARCOP
Chairman, Unit Safety Committee

ANNEXURE- 10
(Section 5.4)

ESTABLISHING LOW LEVEL AND NEAR MISS EVENTS SYSTEM

1. Criteria for Identification, Reporting and Analysis of Precursors

1.1 LLEs and NMs are to be identified and reported by all the plant staff including plant personnel working at the shop floor level. They should be encouraged to report all the observed deviations related to safety, security, quality, production and economics.

1.2 A standard format should be used for reporting of LLEs and NMs. A broad criteria for quick identification and reporting of LLEs and NMs can be mentioned in the format.

1.3 The selection of LLEs and NMs for further analysis should be based on potential consequences and learning opportunities. LLEs and NMs reported by plant staff should be screened by designated operation safety experience feedback engineer at the plant for further analysis and classified in the following categories:

- Systems (including procedures and human performance)
- Equipment, plant component and structures
- Industrial safety
- Generic (human related, management related, procedure related, surveillance related)
- Deficiencies in housekeeping, usage of industrial and radiation protection equipment.

1.4 For NMs, analysis should include superimposition of various possible plant conditions and occurrences.

1.5 The analysis should result into logical corrective actions, wherever possible.

1.6 Human errors should be analysed to determine whether it is due to improper or inadequate training, wrong procedure, and/or faulty design including ergonomics/man machine interface or negligence.

2. Timely Corrective actions and monitoring of system for LLEs and NMs

2.1 For most of the LLEs, it may not take much time and effort to implement corrective actions. If a precursor has high potential to result in a safety significant event, corrective action should be implemented immediately.

ANNEXURE - 10 (CONTD.)

2.2 The analysis of groups of related LLEs and NMs can reveal deficiencies, which may require review by plant management. The corrective actions in such cases should be implemented based on recommendations of plant management.

2.3 Database should be made at the plant to record, analyse and for tracking implementation of corrective actions based on LLEs and NMs.

2.4 Mechanisms should also be established to monitor the functioning of the system for LLEs and NMs.

2.4.1 Effectiveness of the system should be reviewed periodically by plant management.

2.4.2 Management information system (MIS) needs to be worked out.

2.4.3 Indicators to assess the effectiveness of this system can also be framed.

3. Sharing of Information on LLEs and NMs

3.1 The information on LLEs and NMs need to be shared within the plant.

3.2 The information on LLEs and NMs should be shared with other plants also. This can be done by generating periodic reports and through discussions in the meetings between the plant managements at various levels.

3.3 The analysis of LLEs and NMs can also reveal improvements required in design. This feedback should be given to the relevant designers and manufacturers.

3.4 Operating organisation should ensure that the information on LLEs and NMs is shared between various NPPs.

4. Blame free culture and open communication

4.1 The person who commits the error also has knowledge about the causal factors, which can be revealed if the focus is on fact finding rather than fault finding. Mistakes should be treated as stepping stones for learning and improving.

4.2 To encourage reporting of these evernts by all plant staff and to take corrective actions, it is necessary that blame free culture be established. This will lead to open communication between the plant staff and the management and help in identifying the causal factors.

4.3 A good reward and sanction system may be developed with optimum balancing for staff to be forthcoming.

ANNEXURE - 10 (CONTD.)

5. Sustaining LLEs and NMs system

5.1 While establishing system for LLEs and NMs, it is possible that initially large number of such events is reported and the number may come down subsequently. To avoid such a situation it is essential that the interest of the plant staff be sustained. This is possible by giving feedback about the corrective actions taken, to the person reporting the suggested improvements.

5.2 A periodic summary report may be generated highlighting the improvements and the accrued benefits from the system.

ANNEXURE- 11
(Section 10.2)

ACTIVITIES ENCOMPASSED BY ROOT CAUSES/CAUSAL FACTORS

No	Root Cause/ Causal Factor	Activities
1.	Verbal communications	i. Shift hand-over inadequate ii. Pre-job briefing inadequate/ not performed iii. Message misunderstood/ misinterpreted iv. Communication equipment inadequate or not available v. Receiver not listening vi. Communications incorrect/inadequate vii. Inter-team communication inadequate viii. Supervisor not notified of problem
2.	Personnel work practices	i. Self checking not used or ineffectively applied ii. System alignment /isolation not verified iii. Required procedures, drawings or other references not used iv. Administrative controls circumvented or intentionally not performed v. Conditions not verified prior to work vi. Task not adequately researched prior to work vii. Unauthorised material substitution viii. Inadvertent bumping, stepping on or damages to equipment ix. Radiological work practices/ALARA not followed x. Inattention to detail xi. Independent checking not used or ineffectively applied xii. Personal protective equipment not used/ worn xiii. Improper tools/equipment used xiv. Failure to maintain written logs xv. Inappropriate habits developed through pressure/ culture xvi. Lack of questioning attitude
3.	Personnel work scheduling	i. Excessive overtime ii. Called during odd hours iii. Working continuously for considerable number of hours

ANNEXURE- 11 (CONTD.)
(Section 10.2)

ACTIVITIES ENCOMPASSED BY ROOT CAUSES/CAUSAL FACTORS

No	Root Cause/ Causal Factor	Activities
		iv. Working without rest day for considerable time v. Frequent changes of shift vi. Time pressure to complete the task vii. Unfamiliar work cycle
4.	Environmental conditions	i. Lighting inadequate ii. Housekeeping inadequate iii. Temperature too high/low iv. Excessive noise level v. High humidity vi. High radiation vii. Cramped work space viii. Distractions
5.	Man-machine interface	i. Label missing/ inadequate ii. Interface design inappropriate for task iii. Controls provided not adequate iv. Alarms provided not adequate v. Too many standing alarms vi. Too many incoming alarms vii. Indications provided not adequate
6.	Training/ qualification	i. Training not provided on how to perform a task ii. Training not provided on how to use special equipment or tools iii. Training not provided on relevant system(s)/ components iv. Training not based on current plant requirements v. Demonstration of task proficiency not required prior to qualification vi. Insufficient refresher training vii. Training not attended viii. Training standard not adequate ix. Training not provided to required level of competence for task x. Training not provided in personnel work practice xi. Shortfall in on-job training/experience

ANNEXURE- 11 (CONTD.)
(Section 10.2)

ACTIVITIES ENCOMPASSED BY ROOT CAUSES/CAUSAL FACTORS

No	Root Cause/ Causal Factor	Activities
		xii. Inadequate definition of required qualifications
7.	Written procedure and documents	i. No document available ii. Technically incorrect iii. Technically incomplete iv. Cautionary information not included v. Not up to date with plant design vi. Not formally stated vii. Unclear or complex wording viii. Format deficiencies ix. User aids deficient/ not provided x. Inadequate technical review process xi. Responsibility for following procedure not stated xii. Inadequate safety assessment provided
8.	Supervisory methods	i. Duties and tasks not clearly explained ii. Progress not adequately monitored iii. Supervision levels not decided prior to task iv. Supervisor too involved in tasks v. Inappropriate balance between timescale and standards vi. Standards not adequately communicated vii. Control of contractors inadequate viii. Frequent task re-allocation ix. Inappropriate selection of staff for task x. Safety aspects of task not emphasised
9.	Work organisation	i. Planning done without site visit ii. Special conditions or requirements not identified iii. Co-ordination of all relevant on-site departments not achieved iv. Work initiated prior to ensuring all skills, parts, tools, instruments, etc., are available v. Job walk- through not performed vi. Work package did not address all administrative requirements vii. Scheduling conflicts not identified

ANNEXURE- 11 (CONTD.)
(Section 10.2)

ACTIVITIES ENCOMPASSED BY ROOT CAUSES/CAUSAL FACTORS

No	Root Cause/ Causal Factor	Activities
		viii. Task or routine not assigned ix. Too few workers of the correct trade/ specialisation x. Co-ordination of relevant on-site and off-site departments not achieved xi. Planning of parallel tasks inadequate
10.	Personnel factors	i. Fatigue ii. Stress/perceived lack of time/boredom iii. Skill of the craft less than adequate/not familiar with job performance standards

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LIST OF PARTICIPANTS

WORKING GROUP

Dates of meeting	:	June 28,1999	August 4, 2000
		July 5, 1999	August 18, 2000
		August 23, 1999	August 28, 2000
		October 9, 1999	September 4, 2000
		December 24, 1999	September 9, 2000
		January 5, 2000	September 11, 2000
		February 14, 2000	September 25, 2000
		February 18, 2000	October 3, 2000
		February 28, 2000	October 20, 2000
		March 23, 2000	November 7, 2000
		April 24, 2000	December 7, 2000
		May 16, 2000	February 8, 2001
		June 6, 2000	March 8, 2001
		July 18, 2000	March 13, 2001

Chairman and Members of the Working Group:

Shri C.M. Kothari, (Chairman)	:	NPCIL (Former)
Shri S.K. Agarwal	:	AERB (Former)
Shri S.N. Ahmed	:	NPCIL
Shri O.P. Madhvi	:	NPCIL
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Shri Ram Sarup	:	AERB (Former)
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Shri Deepak De	:	AERB (Former)
Shri S. Dayal	:	NPCIL
Shri Deepak Ojha (Member Secretary)	:	AERB

ADVISORY COMMITTEE ON CODES, GUIDES AND ASSOCIATED MANUALS FOR SAFETY IN OPERATION OF NUCLEAR POWER PLANTS (ACCGASO)

Dates of meeting	:	July 26 & 27, 2001
	:	September 6,7 & 8, 2001
	:	October 24 & 25, 2002
	:	August 7 & 8, 2003

Members of ACCGASO:

Shri G.V. Nadkarny (Chairman till February 2002)	:	NPCIL (Former)
Shri Rajasabai (Chairman since March 2002)	:	NPCIL (Former)
Shri M.S. Gupta	:	NPCIL
Shri S.K. Agarwal (till August, 2003)	:	AERB
Shri R.S. Raju (till May, 2003)	:	NPCIL
Shri V.V Sanath Kumar (till May, 2003)	:	NPCIL
Shri H.C. Mehta (since May, 2003)	:	NPCIL
Shri R.M. Sharma (till May 2003)	:	BARC
Shri.M.L. Joshi (since May, 2003)	:	BARC
Shri Y.K. Joshi (till May, 2003)	:	NPCIL
Shri S.K. Agarwal (since May, 2003)	:	BARC
Shri Ravindranath (since May, 2003)	:	NPCIL
Shri P.R. Krishnamurthy	:	AERB
Shri Y.K. Shah (Member-Secretary)	:	AERB

ADVISORY COMMITTEE ON NUCLEAR SAFETY (ACNS)

Dates of meeting : June 26, 2004

Members and invities of ACNS:

Shri.Ch. Surendar (Chairman)	:	CMD NPCIL (Former)
Shri S.K.Sharma	:	AERB
Dr. V. Venkat Raj	:	BARC
Shri R.K.Sinha	:	BARC
Shri. S.P.Singh	:	AERB (Former)
Shri S.S.Bajaj	:	NPCIL
Shri Ramesh D. Marathe	:	L & T Ltd.
Shri S.K.Agarwal (till August, 2003)	:	AERB
Shri P. Hajra (Since September,2003)	:	AERB
Shri K..Srivasista (Member-Secretary)	:	AERB
Shri N. Rajasabai (Invitee)	:	Chairman, ACCGASO
Shri Y.K.Shah (Invitee)	:	Member-Secretary, ACCGASO

ADVISORY COMMITTEE ON NUCLEAR SAFETY (ACNS)
(Reconstituted since July 2005)

Dates of meeting	:	October 25, 2005
	:	February 20, 2006
	:	March 9, 2006

Members of ACNS:

Shri G.R. Srinivasan (Chairman)	:	AERB (Former)
Shri S.C. Hiremath	:	HWB
Shri S.S. Bajaj	:	NPCIL
Shri D.S.C. Purushottam	:	BARC (Former)
Shri R.K.Sinha	:	BARC
Shri H.S. Khushwaha	:	BARC
Prof J.B.Dixit	:	IIT Bombay
Shri A.K. Anand	:	BARC (Former)
Shri S. Krishnamony	:	BARC (Former)
Dr S.K. Gupta	:	AERB
Shri K. Srivasista (Member Secretary)	:	AERB

PROVISIONAL LIST OF SAFETY GUIDES ON OPERATION OF NUCLEAR POWER PLANTS

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Safety Series No.	Title
AERB/SG/O-1	Staffing, Recruitment, Training, Qualification and Certification of Operating Personnel of Nuclear Power Plants
AERB/SG/O-2	In-Service-Inspection of Nuclear Power Plants
AERB/SG/O-3	Operational Limits and Conditions for Nuclear Power Plants
AERB/SG/O-4	Commissioning Procedures for Pressurised Heavy Water Reactor Based Nuclear Power Plants
AERB/SG/O-5	Radiation Protection During Operation of Nuclear Power Plants
AERB/SG/O-6	Preparedness of Operating Organisation for Handling Emergencies at Nuclear Power Plants
AERB/SG/O-7	Maintenance of Nuclear Power Plants
AERB/SG/O-8	Surveillance of Items Important to Safety in Nuclear Power Plants
AERB/SG/O-9	Management of Nuclear Power Plants for Safe Operation
AERB/SG/O-10A	Core Management and Fuel Handling in Operation of Pressurised Heavy Water Reactors
AERB/SG/O-10B	Core Management and Fuel Handling in Operation of Boiling Water Reactors
AERB/SG/O-11	Management of Radioactive Waste Arising During Operation of Nuclear Power Plants
AERB/SG/O-12	Renewal of Authorisation for Operation of Nuclear Power Plants
AERB/SG/O-13	Operational Safety Experience Feedback on Nuclear Power Plants
AERB/NPP/SG/O-14	Life Management of Nuclear Power Plants
AERB/NPP/SG/O-15	Proof and Leakage Rate Testing of Reactor Containments
AERB/NF/SM/O-1	Probabilistic Safety Assessment Guidelines
AERB/NF/SM/O-2 (Rev. 4)	Radiation Protection for Nuclear Facilities
AERB/NPP/TD/O-1	Compendium of Standard Generic Reliability Database for Probabilistic Safety Assessment of Nuclear Power Plants

AERB SAFETY GUIDE NO. AERB/NPP/SG/O-13

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