AERB SAFETY GUIDE NO.AERB/SG/O-6

PREPAREDNESS OF THE OPERATING ORGANISATION FOR HANDLING EMERGENCIES AT NUCLEAR POWER PLANTS

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Atomic Energy Regulatory Board
Mumbai 400 094

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Orders for this Guide should be addressed to:

Administrative Officer
Atomic Energy Regulatory Board
Niyamak Bhavan
Anushaktinagar
Mumbai - 400 094.

FOREWORD

Safety of the public, occupational workers and the protection of environment should be assured while activities for economic and social progress are pursued. These activities include the establishment and utilisation of nuclear facilities and use of radioactive sources. They have to be carried out in accordance with relevant provisions of the Atomic Energy Act 1962.

Assuring high safety standards has been of prime importance since the inception of the nuclear power programme in the country. Recognising this aspect, the Government of India constituted the Atomic Energy Regulatory Board (AERB) in November 1983, vide Statutory Order No. 4772 notified in the Gazette of India dated December 31, 1983. The Board has been entrusted with the responsibility of laying down safety standards and framing rules and regulations in respect of regulatory and safety functions envisaged under the Atomic Energy Act of 1962. Under its programme of developing safety codes and guides, AERB has issued four codes of practice in the area of nuclear safety covering the following topics:

Safety in Nuclear Power Plant Siting

Safety in Nuclear Power Plant Design

Safety in Nuclear Power Plant Operation

Quality Assurance for Safety in Nuclear Power Plants

Safety guides are issued to describe and make available methods of implementing specific parts of the relevant codes of practice as acceptable to AERB. Methods and solutions other than those set out in the guides may be acceptable if they provide at least comparable assurance that nuclear power plants can be operated without undue risk to the health and safety of the plant personnel, general public and the environment.

Codes and safety guides may be revised as and when necessary in the light of experience as well as relevant developments in the field. The annexures, footnotes, and bibliography are not to be considered an integral part of the document. These are included to provide information that might be helpful to the user.

The emphasis in the codes and guides is on protection of site personnel and the public from undue radiological hazards. However, for aspects not covered in the

codes and guides, applicable and acceptable national and international codes and standards shall be followed. In particular, industrial safety shall be assured through good engineering practices and compliance with the Factories Act 1948 as amended in 1987 and the Atomic Energy (Factories) Rules, 1996.

This Safety Guide is one of a series of guides which have been prepared or are under preparation as a follow-up to the Code on Safety in Nuclear Power Plant Operation (AERB/SC/O). It prescribes guidelines for the development of a state of preparedness for response to emergencies at nuclear power plants in India and is intended for the Operating Organisation of nuclear power plants.

The Safety Guide has been prepared by the staff of AERB and other professionals. In drafting the guide, the relevant International Atomic Energy Agency (IAEA) documents under the Nuclear Safety Standards (NUSS) programme, especially the Safety Guide on Preparedness of the Operating Organisation (Licensee) for Emergencies at Nuclear Power Plants (50-SG-O6, 1982) have been used extensively. The guide has been reviewed by experts and vetted by the Advisory Committees before issue. AERB wishes to thank all individuals and organisations who have contributed in the preparation, review and finalisation of the Safety Guide. The list of persons, who have participated in the committee meetings, along with their affiliation, is included for information.

(Suhas P. Sukhatme)
Chairman, AERB

DEFINITIONS

Acceptable Limits

Limits acceptable to the Regulatory Body for Accident Conditions or potential exposure.

Accident

An unplanned event resulting in (or having the potential to result in) injury or damage to equipment, which could cause release of unacceptable quantities of radioactive material.

Accident Conditions

Substantial deviations[1] from Operational States which could lead to release of abnormal quantities of radioactive materials if the relevant engineered safety features did not function as per design intent. They are more severe than Anticipated Operational Occurrences and include Design Basis Accidents and Severe Accidents.

Anticipated Operational Occurrences[2]

All operational processes deviating from normal operation which may occur during the operating life of the plant and which in view of the appropriate design provisions, neither cause any significant damage to items important to safety nor lead to Accident Conditions.

Approval

A formal consent issued by the Regulatory Body to a proposal.

Atomic Energy Regulatory Board (AERB)

The national authority designated by the Government of India having the legal authority for issuing the regulatory consents for various activities related to the nuclear facility and to perform safety and regulatory functions including enforcement for the protection of the public and operating personnel against radiation.

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1 Substantial deviation may be a major fuel failure, a loss of coolant accident (LOCA) etc. Examples of engineered safety features are an emergency core cooling system (ECCS), and containment.

2 Examples of anticipated operational occurrences are loss of normal electric power and faults such as turbine trip, malfunction of individual items of normally running plant, failure of individual items of control equipment to function, loss of power to main coolant pump.

Audit[3]

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.

Authorization

See Regulatory Consent.

Commencement of Operation

The specific activity/activities in the commissioning phase of a nuclear power plant resulting in favourable configuration for initial criticality[4].

Commissioning

The process during which structures, systems and components of a facility, having been constructed, are made operational and verified to be in accordance with design specifications and to have met the performance criteria.

Competent Authority

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

Construction[5]

The process of manufacturing, testing and assembling the components of the facility, the erection of civil works and structures, the installation of components and equipment.

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3 the definitions refer to quality assurance activity as discussed in Quality Assurance Code and Guides.

4 e.g. fuel loading in the case of light water reactors and in the case of pressurized heavy water reactors, heavy water addition with fuel already loaded.

5 The terms siting, construction, commissioning, operation and decommissioning are used to delineate the five major stages of the authorization process. Several of the stages may coexist; for example, construction and commissioning, or commissioning and operation.

Contamination

The presence of a radioactive material in or on a material or in the human body or in any other place in excess of quantities specified by the Competent Authority.

Countermeasures

An action aimed at alleviating and mitigating the consequences of an accident.

Design Basis Accident (DBA)

Design Basis Accidents are a set of postulated accidents which are analysed to arrive at conservative limits on pressure, temperature and other parameters which are then used to set specifications that must be met by plant structures, systems and components and fission product barriers.

Decontamination

The removal or reduction of contamination by physical or chemical process.

Documentation[3]

Recorded or pictorial information describing, defining, specifying, reporting or certifying activities, requirements, procedures and results.

Dose

A measure of the radiation received or absorbed by a target. The quantities termed absorbed dose, organ dose, equivalent dose, effective dose, committed equivalent dose, or committed effective dose are used, depending on the context. The modified terms are used when they are not necessary for defining the quantity of interest.

Dosimeter

A device, instrument or system, which can be used to measure or evaluate any quantity that can be related to the determination of either absorbed dose or equivalent dose.

Emergency Plan

A set of administrative procedures to be implemented in the event of an accident to mitigate its consequences.

Emergency Situation

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

Emergency Planning Zone (EPZ)

The zone defined around the plant up to 16 km radius, providing a basic geographic framework for decision making on implementing measures as part of a graded response in the event of an emergency.

Engineered Safety Features

The system or features specifically engineered, installed and commissioned in a nuclear power plant (NPP) to mitigate the consequences of accident condition and to help restore normalcy, e.g.; emergency core cooling system, containment systems etc.

Evacuation

The temporary removal of persons from the location where dose rates or projected doses arising in an emergency situation are unacceptably high, or when the avertable dose exceeds the relevant intervention level.

Examination[3]

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.

Exclusion Zone

The Exclusion Zone extends up to a specified distance around the plant, (atleast 1.5 km radius from each reactor centre) where no public habitation is permitted. This zone is physically isolated from outside areas by fencing and is under the control of NPP.

Exposure

The act or condition of being subject to radiation. Exposure can be either external (irradiation by sources outside the body) or internal (irradiation by sources inside the body). Exposure can be classified as either normal exposure or potential exposure; either occupational, medical or public exposure; and in intervention

situations, either emergency exposure or chronic exposure. The term exposure is also used in radio dosimetry to express the amount of ion produced in air by ionization radiation.

Inspection[3]

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.

Intake

The process of taking radionuclide into the body by inhalation or ingestion, or through the skin, and the amount of given radionuclide taken in during a given period.

Intervention

Any action intended to reduce or avert exposure or the likelihood of exposure to sources which are not a part of controlled practice or which are out of control as a consequence of an accident.

Intervention Level (IL)

A level of avertable dose at which a specific protective action or remedial action is taken in an emergency exposure situation or chronic exposure situation.

Items Important to Safety

The items which comprise:

(1) those structures, systems, equipment and components whose malfunction or failure could lead to undue radiological consequences at plant site or off-site[6];

(2) those structures, systems and components which prevent Anticipated Operational Occurrences from leading to Accident Conditions;

(3) those features[6] which are provided to mitigate the consequences of malfunction or failure of structures, systems or components.

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6 These include successive barriers set up against the release of radioactivity from nuclear facilities.

License

It is 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 certain categories of radiation facilities.

Licensee

The holder of a license issued by the regulatory body to perform specific activities related to the siting, construction, commissioning, operation or decommissioning of a nuclear facility.

Licensed Person

A person who has been licensed to hold a certain Licensed Position of a NPP after due authorised procedure of certification by the AERB.

Licensed position

A position, which can be held only by persons Certified by AERB or a body, designated by it; e.g. Shift Charge Engineer, Assistant Shift Charge Engineer, Control Engineer, Assistant Shift Charge Engineer (Fuel Handling Unit) and Control Engineer (Fuel Handling Unit).

Loss Of Coolant Accident (LOCA)

It is an accident resulting from the loss of coolant to the fuel in a reactor due to a break in pressure retaining boundary of primary coolant system.

Normal Operation

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

Nuclear Power Plant (NPP)

A thermal neutron reactor or reactors together with all structures, systems and components necessary for safety and for the production of power, i.e., heat or electricity.

Nuclear Safety

Protection of all persons and the environment from undue radiological hazards.

Objective Evidence

Qualitative or quantitative information, record or statement of fact, pertaining to the quality of an item or service, which is based on observation, measurement or test and which can be verified.

Off-Site

Off-Site refers to the area outside the boundary fence of a nuclear facility.

Off-Site Emergency

Accident Condition/Emergency Situation involving excessive release of radioactive materials/ hazardous chemicals from the plant to the public domain calling for intervention.

Operating Organisation (Op. O)[7]

The Organisation so designated by the Responsible Organisation and authorised by the Regulatory Body to operate the facility.

Operation[5]

All activities following commissioning and before decommissioning performed to achieve, in a safe manner, the purpose for which an installation was constructed, including maintenance.

Operational Limits and Conditions (OLCs)

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 facility.

Operational Records

Documents, such as instrument charts, certificates, logbooks, computer printouts and magnetic tapes, made to keep an objective history of the NPP operation.

Operational States

The states defined under Normal Operation and Anticipated Operational Occurrences

7 Organisation structure and not individual.

Plant Management

The members of site personnel who have been delegated the responsibility and authority by the Responsible Organisation/Operating Organisation for directing the operation of the plant.

Postulated Initiating Events[8]

Identified events that lead to Anticipated Operational Occurrences or Accident Conditions and their consequential failure effects.

Prescribed Limits

Limits established or accepted by the Regulatory Body for operational states.

Prophylaxis

Administering of specific stable chemical compounds which have a reducing or blocking effect on the intake of certain radio nuclides; e.g., the use of stable potassium iodide (KI) or potassium iodate (KIO_3)to reduce the intake of radioiodine (particularly I-131) in thyroid gland.

Protective Action

A generic term covering various measures that can be taken to minimize the impact on people of a hazardous release of radioactive material or gases from a nuclear facility. For examples; sheltering, evacuation etc.

Qualified Person

A person who, having complied with specific requirements and met certain conditions, has been officially designated to discharge specified duties and responsibilities.[Examples: Reactor Physicist, Station Chemist etc.]

Quality Assurance

Planned and systematic actions necessary to provide an adequate confidence that an item or facility will perform satisfactorily in service as per design specifications.

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8 The primary causes of postulated initiating events may be credible equipment failures and operator errors (both within and external to the nuclear power plant), design basis natural events and design basis external man-induced events. Specification of the postulated initiating events is to be acceptable to the Regulatory Body for the nuclear power plant.

Radiation

Ionizing radiation produced by a radioactive source or an X-ray machine.

Records

Documents which furnish objective evidence of quality of items or activities affecting quality. It also includes logging of events and other measurements.

Regulatory Body

See Atomic Energy Regulatory Board (AERB).

Regulatory Consent

It is a written permission issued by the Regulatory Body to perform specified activities related to the facility. The types of Consent are 'License', 'Authorisation', 'Registration' and 'Approval', and will apply depending upon the category of the facility, the particular activity and the radiation sources involved.

Reliability

It is the probability that a structure, component, system or facility will perform its intended (specified) function satisfactorily for a specified period under specified operating and environmental conditions.

Relocation

The removal of the members of public from their homes for an extended period of time, as a protective action in a chronic exposure situation.

Repair

The process of restoring a non-conforming item to a condition such that the capability of this item to function reliably and safely is unimpaired, even though that item may not still conform to the original specifications.

Responsible Organisation (RO)[9]

The Organisation having an overall responsibility for siting, design, construction, commissioning, operation and decommissioning of a facility.

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9 In the present context the Nuclear Power Corporation of India limited (NPCIL) is the Responsible Organisation for nuclear power plants in India.

Safety Limits

Limits upon process variables, within which the operation of the facility has been shown to be safe.

Safety Report

A document provided by the applicant or licensee to the Regulatory Body containing information concerning the facility, its design, accident analysis and provisions to minimize the risk to the public and to the site personnel.

Safety Systems

Systems important to safety, provided to ensure under anticipated operational occurrences and accident conditions, the safe shutdown of the reactor (Shutdown System) and the heat removal from the core (Emergency Core Cooling System) and containment of any radioactivity (Containment Isolation System).

Severe Accident

Nuclear power plant conditions beyond those of the Design Basis Accidents causing significant core degradation.

Sheltering[10]

Sheltering means to stay in-doors and refrain from going outside until further advice in the event of an emergency.

Site

The area containing the facility defined by a boundary and under effective control of the Plant Management.

Site Personnel

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

Specifications

A written statement of requirements to be satisfied by a product, a service, a material or a process, indicating the procedure by means of which it may be determined whether the specified requirements are satisfied.

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10 Sheltering is normally for a period of 12-24 hours.

Sterilised Zone

Sterilised zone is the annulus of between specified radii around the plant, beyond the exclusion zone, where only natural growth is permitted and developmental activities which lead to growth of population are restricted by administrative control.

Surveillance[11]

All planned activities namely monitoring, verifying, checking including in-service inspection, functional testing, calibration and performance testing performed to ensure compliance with specifications established in a facility.

Technical Specifications for Operation

A document submitted on behalf of or by the Responsible Organisation covering operational limits and conditions, surveillance and administrative control requirements for safe operation of the facility and approved by the Regulatory Body.

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11 This includes activities performed to assure that provisions made in the design for safe operation of NPP continue to exist during the life of the plant.

CONTENTS

1. INTRODUCTION

1.1 General

1.1.1 This Safety Guide has been prepared as part of the Atomic Energy Regulatory Board's (AERB) programme for establishing Codes of Practice and Safety Guides relating to Nuclear Power Plants (NPPs). It supplements the Code of Practice on Safety in NPP Operation (AERB/SC/O). A provisional list of Safety Guides on Operation is given at the end of this publication.

1.1.2 Nuclear power plants (NPPs) are designed, constructed, commissioned and operated in conformity with existing stringent nuclear safety standards. These standards ensure an adequate margin of safety so that NPPs can be operated without undue radiological risks to the plant personnel or members of the public. Notwithstanding these safety standards, it is necessary to develop, as a measure of abundant caution and in conformity with international practice, emergency response plans so that any eventuality, with a potential to result in undue radiological risk to plant personnel and public, may be handled effectively. Preparedness for response to emergencies is an important responsibility of the Operating Organisation. The guidelines given in this document can be used by other facilities handling radioactive materials.

1.1.3 The Operating Organisation's emergency response plan shall include the action plans which will be invoked by the Organisation in the event of an emergency. Before the commencement of operation of an NPP the Operating Organisation shall ensure that the following requirements are met:

(i) The emergency response preparedness plans for NPP shall be drawn up and approval from appropriate competent authority obtained.

(ii) Necessary training shall be imparted to the personnel to be deployed in implementing the action plans.

(iii) The implementability of the plans shall be confirmed by conducting exercises.

1.1.4 The handling of emergency situations calls for co-ordination among various response Organisations including the different service groups of the NPP and, in the event of an emergency with potential radiological consequences in the public domain, the public functionaries such as district and other State Officials and Central Government Authorities. The responsibility for the overall co-ordination in the case of personnel, plant, and site emergencies shall rest with the Operating Organisation (licensee) whereas in the case of off-site emergencies it shall rest with the public functionaries. Allocation of responsibilities to various response agencies, their sub-units and also the officials concerned shall be unambiguously indicated in the emergency response plans.

1.2 Objectives

1.2.1 The purpose of this document is to prescribe guidelines for the development of a state of preparedness for response to emergencies at nuclear power plants. This Guide is intended for the Operating Organisation of nuclear power plants.

1.2.2 The main objectives of this safety guide are:

(a) to highlight to plant management the various categories of emergencies that could arise at NPP;

(b) to focus on the contents of the emergency manuals in respect of resources and procedures to help respond adequately to emergency situations;

(c) to emphasize the responsibilities of plant management regarding personnel, plant and site emergency and responsibilities of the State Government in respect of off-site emergency and need for close liaison between Plant Management and Public Authorities;

(d) to bring out the importance of maintaining efficient and effective communication links among Plant Management, Operating Organisation, Responsible Organisation, Regulatory Body, State Authorities and the Department of Atomic Energy Crisis Management Group (DAE-CMG); and

(e) to develop the infrastructure including manpower and their training.

1.3 Scope

1.3.1 This guide provides the important considerations relevant to the preparation and implementation of emergency response plans by the Operating Organisation. The considerations are as follows.

(i) the technical basis for assessing the need for and extent of emergency plans and content of such plans;

(ii) the types of emergencies warranting response preparedness plans;

(iii) responsibilities of the response agencies with respect to measures to protect persons on-site and co-ordination with public functionaries for protection of the public living Off-Site; and

(iv) development of infrastructure for manpower and training.

1.3.2 Since the Plant Management has the responsibility for providing technical assistance to Public Authorities of the State Government who are in-charge of dealing with Off-Site Emergencies, sufficient details are included to guide the Plant Management in this regard.

1.3.3 Regarding the responsibilities of the Regulatory Body in respect of emergencies at NPPs, reference shall be made to AERB/SG/G-5 on “Role of Regulatory Body Concerning Emergencies at Nuclear and Radiation Facilities”.

2. BASES AND CONTENTS OF EMERGENCY RESPONSE PLAN OF OPERATING ORGANISATION

2.1 General

Preparedness for emergencies is basically an action plan to respond to emergencies. The nature and magnitude of the response measures would depend on the specific category or extent of emergency. Though safety evaluation of an NPP relates to design basis, the operating Organisation emergency response plan shall be based not only on the design basis events but also on accident conditions due to more severe events, even if they have a very low probability of occurrence. An analysis of such events and the projected radiological consequences specific to NPP shall form the basis of response plans, so that the nature and magnitude of response actions could be established.[Ref. Safety Manuals for The Preparation of Site Emergency Preparedness for Nuclear Facilities(AERB/SM/EP-1) and The Preparation of Off-Site Emergency Preparedness for Nuclear Facilities (AERB/SM/EP-2)].

2.2 Preparation of Emergency Response Manual

2.2.1 Emergency response procedures to be described in the manual shall be prepared in a comprehensive manner for different classifications of emergencies. Some of the important considerations are given below:

(i) intervention levels and countermeasures shall be determined [Ref. Intervention Levels and Derived Intervention Levels for Off-site Radiation emergency (AERB/SG/HS-1)];

(ii) response persons shall be identified. Specific action plans for each response person shall be drawn up;

(iii) communication channels to be activated in an emergency shall be demarcated; and

(iv) the updated complete addresses of each of the response personnel together with their office and residential telephone numbers shall be compiled and documented.

2.2.2 All the above information shall be included in a single manual for ease of reference.

The action plans shall be formulated on the basis of

(a) an analysis of emergency situations which are likely to arise in the plant or are postulated for emergency response planning purposes;

(b) the types and quantities of materials likely to be released in the environment;

(c) the exposure pathways;

(d) time-dependent characteristics of potential releases and exposures;

(e) escape routes for site personnel and assembly areas where countermeasures would need to be initiated;

(f) extent of co-ordination with public authorities that would be required;

(g) magnitude of deviations of actual actions from planned actions that could be allowed;

(h) instrumentation needed and types, quantities and location of instruments;

(i) manpower requirement;

(j) communication facilities needed in an emergency;

(k) medical and transport facilities needed in an emergency; and

(l) habitability of the affected area within the site.

2.2.3 During various emergencies, the possibility of contamination of personnel exists. Frequently the contaminated personnel may have also suffered injuries. These persons would need to be taken to a hospital after personal decontamination and emergency treatment at the first-aid centre at plant site. The manual shall also specify clear action plans for such situations.

2.2.4 Emergency response preparedness status shall be maintained by imparting suitable training to the response personnel and by the conduct of exercises. Preparation and maintenance of records and reports is a vital factor in emergency preparedness. The emergency response plan for site emergency situation shall be issued by the Operating Organisation/ Responsible Organisation and approved by the Regulatory Body. The emergency response action plans for off-site emergency situations has to be issued by the state level Emergency Response Committee of the state where the NPP is situated.

3. CLASSIFICATION OF EMERGENCIES

3.1 General

3.1.1 The Emergency Response Manual shall describe classifications of emergencies based on severity and magnitude of the condition in the affected zones [Ref. Fig. 1]. Each category shall be associated with an intervention level for which appropriate countermeasures shall be specified. In accordance with different degrees of severity of the potential consequences, emergency situations[12] are graded.

Emergency situations are categorized as follows:

(i) emergency standby;

(ii) personnel emergency;

(iii) plant emergency;

(iv) site emergency; and

(v) off-site emergency.

3.1.2 The agencies responsible for carrying out remedial measures during the different categories of emergencies [Ref. Role of Regulatory Body Concerning Emergency Response at Nuclear & Radiation Facilities (AERB/SG/G-5)] mentioned above are as follows:

Type of Emergency	**Responsible Agency**
Emergency standby	Plant management
Personnel emergency	Plant management
Plant emergency	Plant management
Site emergency	Plant management
Off-site emergency	District Authorities of the State Government having jurisdiction over the public domain affected by the accident, normally the District Collector.

12 International Atomic Energy Agency has evolved an international nuclear event scale (INES) for classifying nuclear events according to their severity. [Ref. Figs. 2A,2B&2C].

3.2 Emergency Standby

3.2.1 Emergency standby is defined as abnormal plant conditions with potential to develop into accident situations, if timely preventive actions are not taken. During this situation pre-identified plant personnel are placed in a state of alert for implementing the emergency response procedure. Examples of situations that would justify initiating an emergency standby are as follows:

(i) failure of safety-related plant features, that may potentially lead to unacceptable releases of radioactivity;

(ii) a forecast or notification of severe natural phenomena in the vicinity of plant site, such as floods, earthquakes, cyclones, hurricanes or tornadoes;

(iii) a major fire at plant or at an adjacent facility;

(iv) a toxic or noxious gas release on-site or off-site;

(v) a threat to plant security;

(vi) an incident at an adjacent nuclear installation; and

(vii) station blackout.

3.2.2 The manual shall identify specific conditions under which emergency standby alert can be declared. The response action plans shall aim at minimizing non-essential activities in the plant but focus on preventing the threatened situation from materializing.

3.3 Personnel Emergency

3.3.1 When the radiological consequences of an abnormal situation are confined to some personnel working in a plant, without affecting the plant, it is described as a personnel emergency. For example, some of the plant personnel may happen to be working at a location within the reactor building where the radiation field is significantly above prescribed limits for extended period resulting in their excessive radiation exposure. Some other examples of personnel emergency are given below:

(i) splashing of radioactive material on personnel (moderator or primary heat transport liquid) while carrying out operation/ maintenance in such a manner that excessive contamination, internal and/or external, has occurred or is suspected;

(ii) high uptake of radioactive material has inadvertently occurred or is suspected (as per assessments or indications);

(iii) personnel contamination at levels exceeding prescribed limits;

(iv) high external exposure has occurred or is indicated;

(v) the person is physically injured or incapacitated (internally or externally); and

(vi) exposed to a heavy chlorine dose in the chlorination plant.

3.3.2 The manual shall specify the action to be taken for providing necessary medical aid to the affected personnel and the measures for preventing further exposure of more personnel. The Site Emergency Director(SED) is the person competent to declare and terminate a personnel emergency [Ref. section 4.2.2].

3.4 Plant Emergency

3.4.1 When the radiological consequences of an abnormal situation are expected to remain confined to the plant, it is described as a plant emergency. This situation may arise during operation or shutdown maintenance of the reactor. The manual shall specify action plans for plant emergencies.

3.4.2 SED is the person competent to declare and terminate a plant emergency. Some examples of plant emergency are given below:

(i) closure of Reactor Building dampers on high activity or high pressure in reactor building;

(ii) failure of irradiated fuel transfer system resulting in the fuel bundle getting stuck in transit to spent fuel inspection bay;

(iii) very large steam leak in boiler room;

(iv) water loss from spent fuel bay;

(v) excessive heavy water spillage leading to high contamination in a section of the plant;

(vi) actual or incipient occurrence of loss of core cooling either during operation or shutdown;

(vii) failure of shielding resulting in high radiation fields;

(viii) failure of process water pipe line in reactor building, beyond the handling capability of the active liquid/water drainage/management system;

(ix) failure of all lighting (normal and emergency) in reactor building;

(x) major fire in reactor building;

(xi) failure of mask air system in reactor building and at the same time loss of cooling to spent fuel in fuelling machine or fuel transfer room;

(xii) station blackout; and

(xiii) contamination/radiation field in excess of the prescribed limits in respect of the following:

- tritium in air-contamination in accessible areas;
- particulate-in-air contamination;
- radio iodine in air;
- general surface contamination in reactor building accessible areas; and
- primary heat transport (PHT) system piping in accessible area.

3.5 Site Emergency

3.5.1 An accidental release of radioactivity extending beyond the plant but confined to the site boundary (exclusion zone) constitutes a site emergency. An assessment of such a situation would imply that protective measures are limited to the exclusion zone.

3.5.2 The manual shall specify action plans for activating the emergency personnel, declaring the emergency and alerting the Off-Site Emergency Director (OED) and protecting the potentially affected personnel and visitors to the site. The limits (radioactivity release/radiation field) for the declaration of site emergency shall be specified in the manual. The protective measures may include evacuation from the affected parts of the site and also radiological monitoring of the environment in the emergency-planning zone (EPZ). OED after being alerted, will take necessary steps to cater to potential off-site emergencies.

3.5.3 Site emergency is declared and terminated by SED. Some examples of site emergencies are given below:

(i) significant loss of coolant;

(ii) fire affecting safety systems;

(iii) severe natural phenomenon being experienced or projected, with plant not in cold shutdown state;

(iv) other hazards such as aircraft/ missile crash, explosion, entry of toxic/inflammable gases in vital areas;

(v) station blackout;

(vi) main steam line break outside containment; and

(vii) radiation or contamination level in excess of prescribed limits in respect of the following:

- radioactive inert gas release;
- radioiodine release through reactor building exhaust;
- gross gamma in reactor building exhaust;
- tritium stack release;
- particulate activity;
- iodine activity in primary heat transport system (PHT) coolant;
- iodine activity in air in spent fuel storage bay;
- air borne activity in reactor building (short-lived particulates);
- liquid waste stored in liquid effluent management plant (LEMP) tanks; and
- radiation field on PHT piping in accessible area.

3.6 Off-Site Emergency

3.6.1 An off-site emergency occurs when the radiological consequences of an emergency situation originating from NPP are likely to extend beyond the site boundary (exclusion zone) and into the public domain. For the purpose of planning off-site emergency, an emergency-planning zone (EPZ) up to 16-km radius is specified. The manual shall specify the criteria to determine an off-site emergency in terms of the release of radioactivity as indicated by the radiation monitoring system.

3.6.2 The protective measures in public domain shall be specified in the Emergency Response Manual. These measures would have to be implemented by the District Officials under the direction of the District Collector or Divisional Commissioner, who shall be designated as the Off-Site Emergency Director (OED).

3.6.3 The manual on Off-Site Emergency Response Plans would need to be issued by the State Level Emergency Response Committee of the relevant State. The manual should specify the need for radiation impact assessment based on immediate, intermediate and long-term consequences according to space-time domain concept and the necessary intervention measures such as evacuation in domain-1, sheltering in domain-2 and food control in domain-3 (Ref. AERB/SG/HS-1).

3.6.4 Off-site emergency shall be declared and terminated by OED on the basis of technical assessment made by SED. Some examples of off-site emergencies are given below:

(i) Loss of Coolant Accident (LOCA) plus failure of both the reactor shutdown systems and containment impairment characterised by:

- failure of one set of containment isolation dampers, or
- failure of containment isolation logic, or
- one door of main airlock stuck open and seals on second door deflated;

(ii) LOCA plus failure of emergency core cooling system followed by loss of moderator heat sink and containment impairment characterised by failure of containment isolation logic; and

(iii) Failure of coolant channel seal plug or end fitting leading to ejection of fuel bundle from coolant channel coupled with containment impairment characterised by failure of one set of containment isolation dampers.

4. ORGANISATION FOR EMERGENCY RESPONSE

4.1 General

4.1.1 The Emergency Response Manual shall identify the following particulars:

(i) description of the facility and site including geographical, meteorological and demographic characteristics. Essential details shall include (a) description of the facility; (b) site location; (c) site area maps; (d) site area (Ref chapter 4 of AERB/SG/EP-1& AERB/SG/EP-2) and (e) land and water body used.

(ii) individuals, groups and authorities who have been assigned roles in an emergency and also their responsibilities.

(iii) communication channels and the extent of redundancy required; also the procedure to be followed for notifying and alerting plant personnel, Operating Organisation, Responsible Organisation, Regulatory Body, the Crisis Management Group (DAE-CMG) and Public Authorities.

(iv) the procedure and resources for mobilizing essential personnel.

(v) the chain of command, devised in a manner that would preclude anomalies, duplication and exclusion due to break of links.

4.2 Site Emergency Organisation [typical structures are given in Figs. 3A&3B]

4.2.1 Declaration of Site Emergency.

4.2.1.1 The declaration and termination of a site emergency are important statements and must be made only by an authorized person. Only the SED shall declare/terminate personnel, plant and site emergencies.

4.2.1.2 The format of message of the declaration of a site emergency shall be specified in the emergency response manual and shall be adhered to by SED while declaring the emergency.

4.2.2 Site Emergency Director(SED)

4.2.2.1 Site Emergency Director (SED) shall be the Chairman of the Site Emergency Committee (SEC) and is responsible for convening the SEC

(see section 4.3) when the first report of the initiation of an emergency is received by SED. SED shall obtain technical inputs, such as particulars of the accident, radiological monitoring data, wind direction, wind speed, etc. from members of SEC. The decisions for declaration/ termination of an emergency shall be based on inputs so obtained.

4.2.2.2 The Station Director (SD) of the nuclear power station or equivalent designated by the Responsible Organisation is usually identified as SED. The chain of command drawn up in the manual shall indicate who would take over as SED in the absence of SD.

4.2.2.3 The responsibilities of SED shall be prescribed in the manual and shall include:

(a) declaration of emergency;

(b) notification of emergency to site personnel and OED in the event of site and off-site emergency;

(c) taking remedial measures in NPP for controlling the emergency;

(d) accounting for all site personnel, visitors and contract personnel within the premises of nuclear power station;

(e) arranging for medical aid for the injured;

(f) personal decontamination of the affected individuals;

(g) maintenance of plant security;

(h) keeping the authorities, prescribed in the manual, informed about the status of the emergency;

(i) radiological monitoring of the site premises and off-site, as appropriate;

(j) collection of data relating to emergency and the assessment of data during all phases of the emergency;

(k) advising OED about the implementation of countermeasures, such as sheltering, prophylaxis and evacuation in the event of an off-site emergency;

(l) evacuation of site, if required;

(m) termination of emergency; and

(n) maintenance of a log of events.

4.2.3 Shift Charge Engineer (SCE)

4.2.3.1 The Shift Charge Engineer (SCE) on duty is among the first to learn about the occurrence of an off-normal situation. He shall evaluate the conditions and the data on the basis of which an emergency may be declared/terminated. He shall notify SED about any condition which may warrant the declaration of a standby or an emergency.

4.2.4 Personnel/Plant Emergency Assignments

4.2.4.1 For providing initial personnel/plant emergency response in key functional areas, such as reactor physics, health physics, chemistry, medical care, security and transport the staffing shall be adequate. In order to liaise with Off-site Authorities, a person or, preferably, a team of persons shall be identified**.** Recommended plant emergency response actions flow diagram is given in Fig. 4.

4.2.4.2 The manual shall take into account not only the personnel available on each shift but also the off-site personnel mobilized for the purpose. Emergency response duties assigned to the shift personnel primarily relate to attending to plant and personnel safety and shall include:

(a) reactor shutdown and plant system operations;

(b) rescue operation;

(c) fire-fighting;

(d) plant security;

(e) announcements through public address system;

(f) communication;

(g) radiological monitoring;

(h) first-aid;

(i) access control;

(j) decontamination;

(k) assessment of consequence of accident and its mitigation;

(l) personnel accounting; and

(m) logging of events.

4.3 Support to Site Emergency Organisation

4.3.1 Emergency preparedness and emergency response require administrative and technical support. In order to organize the support, the SED shall appoint a Site Emergency Committee (SEC). The responsibilities of the committee shall include:

(a) maintenance of degree of emergency preparedness stipulated in the manual;

(b) provision of technical input to the SED such as the result of radiological monitoring of the environment at the site and off-site, in the event of emergency;

(c) provision of technical support for the emergency response personnel, e.g. transportation, temporary accommodation, water and power supply, fire-fighting, medical aid, decontamination, etc.;

(d) notification and communication;

(e) co-ordination with off-site authorities, e.g. District Collector, Police, Transport, Health and Civil Supplies Authorities;

(f) establishment and operation of an emergency control centre at the site; and

(g) support for post-emergency activities.

4.4 Off-Site Emergency Organisation [Ref. Figs. 5 & 6 for typical action flow during emergencies]

4.4.1 Declaration of Off-Site Emergency

4.4.1.1 Though an off-site emergency is first identified as such by SED the declaration/termination of an off-site emergency is recognised as the responsibility of the Off-Site Emergency Director (OED) on the advice of SED. SED assesses the effect of any abnormal release of radioactive material extending beyond the site boundary and will instruct actuation of warning systems (sirens etc.). This will be simultaneously intimated to OED who will then declare off-site emergency and move to the off-site emergency control centre.

4.4.1.2 The format of message of the declaration of an emergency shall be specified in the Emergency Response Manual and adhered to by OED while declaring the emergency.

4.4.2 Off-Site Emergency Director (OED)

4.4.2.1 The OED shall be the chairman of the Off-Site Emergency Committee (OEC) and is responsible for convening OEC when the report of the initiation of an emergency is received by OED. OEC is the most important and elaborately planned unit in an emergency management organisation. It is directly responsible for all off-site emergency actions. It is headed by the District Collector/District Magistrate or Divisional Commissioner, who is also designated as the Off-Site Emergency Director (OED). Its membership includes the Chiefs of all Public Services relevant to emergency management in the district.

4.4.2.2 The general responsibilities of OED shall be prescribed in the manual and shall include:

(a) declaration of the emergency;

(b) organizing public announcements;

(c) implementation of countermeasures, such as sheltering, prophylaxis, evacuation and food for evacuated public;

(d) arranging for medical aid to the injured;

(e) keeping the media informed;

(f) organizing medical care to the affected public;

(g) ensuring that nobody enters the affected area and the traffic is diverted suitably. (All key personnel should be allowed to move through blockades for directing and rendering help during emergency. Certain predetermined and identified vehicles only will be allowed into any disaster area without further identification. For this purpose special placards should be provided to vehicles.);

(h) ensuring communication among emergency control centre, police headquarters, SED, media and other public department headquarters;

(i) ensuring the safe return of public once the emergency is completely controlled, and the “all clear signal” is given;

(j) taking care of the property of those who have been evacuated from their houses during emergency;

(k) termination of emergency;

(l) food control in contaminated areas;

(m) assistance in environmental monitoring; and

(n) assistance in radioactive decontamination.

4.4.2.3 The manual shall prescribe the channels of communication and also the chain of command both for the site emergency Organisation and for off-site authorities. The efforts on the part of site Organisation shall be aimed at providing technical advice and support to the off-site authorities for ensuring that the correct measure of response is effected.

4.5 Co-ordination with Regulatory Body

4.5.1 The Regulatory Body prescribes the intervention levels to be incorporated in the Emergency Manuals for determining when a specified countermeasure such as administration of prophylactics or evacuation has to be initiated or the duration in which such action has to be completed. As stipulated by the Regulatory Body, the nuclear power station shall have an approved Off-Site Emergency Response Manual issued by the State Government. Also exercises shall be conducted by the Operating Organisation as prescribed in the manual in association with Public Authorities. For monitoring the exercises, the Regulatory Body may nominate its representatives [Ref. AERB/SG/G-5].

4.5.2 The Emergency Response Plan should be updated and reviewed and where relevant, approval of Competent Authority duly obtained by the Operating Organisation as required by the Regulatory Body at an appropriate time period acceptable to the Regulatory Body.

5. INFRASTRUCTURE FOR EMERGENCY RESPONSE

5.1 General

5.1.1 The existence of infrastructure for conducting entire emergency handling operations in a systematic, co-ordinated, organized, effective and efficient manner is a very essential requirement.

5.2 Plant Control Room

5.2.1 Plant control room is used by the Site Emergency Committee (Advisory Group) to get first hand information about the emergency situation and to direct the actions in the initial stages of emergency.

5.2.2 In the event when the main control room is not available under any situation, the status of plant can be monitored from the supplementary control room.

5.3 Emergency Control Centre

5.3.1 An Emergency Control Centre (ECC) for site emergency shall be suitably located at the site for use of SEC for directing emergency handling operations and co-ordination with off-site emergency response, so that control room staff is not distracted from performing control room operations. It shall be established with due consideration of shielding requirements, so that it is habitable throughout the emergency period. This building shall house emergency equipment centre, treatment area, personnel decontamination area and shall have sufficient space to accommodate SED, SEC members, rescue teams, health physics staff, emergency maintenance unit staff and stores and industrial safety group. In addition, it shall accommodate section heads and senior engineers. It shall be equipped with communication system, public address (PA) system, emergency equipment/instruments, stationery, standard operating and emergency procedures, design basis reports. P&I diagrams, maps of emergency power supplies, potassium iodate (KIO_3) tablets, isodose curve maps etc.

5.3.2 An emergency control centre for off-site emergency shall be located outside the exclusion zone. This control centre shall be used by OED for directing off-site emergency response operation. It shall be equipped with the required facility for handling off-site emergency response operation.

5.3.3 Each NPP shall establish an emergency shelter where site personnel awaiting evacuation in a site emergency shall assemble.

5.4 Communication System

5.4.1 NPPs shall have efficient communication systems such as subscriber's trunk dialing (STD), hot line, satellite, telex, radio, voice-mail, e-mail and fax communication facilities besides power line carrier communications. These shall be utilized to communicate with Headquarters, DAE Emergency Control Room and others concerned. These systems shall be available for use at all time. Appropriate channels should be established to ensure communication to the Regulatory Body.

5.5 Assessment Facilities

5.5.1 The Operating Organisation should provide suitable facilities to assess the nature and severity of a radiation incident and its impact on environment. These include environment survey vehicle, plant control room instruments, field survey meters, contamination monitors, meteorological data, isodose curves, air samplers, counters, maps etc.

5.6 Protective Facilities

5.6.1 The Operating Organisation should provide suitable facilities to protect plant personnel, site personnel and members of public at large. These include assembly areas, temporary shelters, treatment areas, decontamination centres, first-aid centres, respirators, prophylactics, thermoluminiscence dosimeters (TLDs), direct reading dosimeters (DRDs) and protective clothing.

6. EMERGENCY MEASURES

6.1 General

6.1.1 The emergency measures consist of emergency actions in respect of notification, alerting, and assessment of situation, corrective actions, mitigation, protection and control of contamination. These should be detailed in the emergency response manual.

6.2 Notification

6.2.1 Any emergency situation shall be promptly notified to key personnel as per the notification plan. The message conveyed in the notification shall be clear and concise. No codes shall be used in the message as a coded message requires proper understanding and falling back on memory may result in confusion, at times.

6.3 Assessment Action During Emergency

6.3.1 Indicating, recording and annunciating instruments provided in the main control room, radiation surveys, environmental surveys, meteorological data and status of plant shall be utilized to assess the situation and for predicting projected doses. These assessment actions are necessary as these go a long way in planning the timely corrective and protective actions.

6.4 Corrective Actions

6.4.1 These actions are taken to correct plant abnormal situations and to bring the plant under control. These are imperative for the return to normalcy. Types of corrective actions are decided by the prevailing situations at that point of time.

6.5 Protective Measures (also known as countermeasures)

6.5.1 These are important actions taken to mitigate the consequences of a radiological event and to protect, plant, site personnel, off-site personnel and livestock from radiation. These include sheltering, administration of prophylactics and finally evacuation. It is essential to ensure that the response measures would reduce the overall detriment to public to a

level significantly lower than what they would be subject to in the absence of such measures. The manual should give details of protective measures and the AERB approved intervention levels for initiating protective measures to limit radiation exposures.

6.5.2 Evacuation is a very effective countermeasure but needs careful consideration before a decision to implement is taken. The benefits and risks of this countermeasure have to be carefully assessed in terms of dose averted if this countermeasure is enforced and the effect of disruption in social life. Evacuation, however, is an urgent temporary measure of moving out persons outside the affected area. If radiation levels in the affected zone continue to exist beyond acceptable levels, then relocating the evacuees should be resorted to.

6.6 Contamination Control Measures

6.6.1 Contamination control measures are meant to check the spread of radioactive contamination. These actions include segregation of highly contaminated persons and decontaminating them, decontamination of vehicles, regulating the traffic, access control to prevent unauthorized entry to keep traffic routes open solely from the emergency response point of view, confiscation of contaminated lots of meat, fish, poultry products, milk, vegetables, fruits and substituting fresh uncontaminated food in its place, banning fishing in contaminated sea/river water, banning the consumption of contaminated water and its replacement with contamination-free water, identification of contaminated earth areas and excavation and disposal of contaminated soil, decontamination of contaminated dwellings or their disposal, and destroying the contaminated crops and grass.

6.7 Termination of Emergency

6.7.1 The termination of emergency shall be declared by SED in the case of plant or site emergencies or by OED in the case of off-site emergency as soon as the respective emergency conditions are assessed to have returned to normal.

7. ASSISTANCE TO AFFECTED PERSONNEL

7.1 General

7.1.1 During occurrence of a radiation event, the personnel affected at plant and site shall be provided with all necessary assistance in respect of their rehabilitation and treatment, sheltering and evacuation as necessary. This shall be the responsibility of the Plant Management. The responsibility for providing such assistance to persons off-site rests with the District Administration, State Government and Central Government.

7.2 First-aid

7.2.1 Each NPP site shall have at least one fully equipped first aid centre manned by a trained nurse round the clock for providing first aid to injured/affected persons at the site. This should preferably be located as close to personnel decontamination centre as possible.

7.3 Decontamination

7.3.1 Monitoring the contamination and carrying out the decontamination of personnel, equipment, facilities and areas within plant and site shall be the responsibility of plant management. The Plant Management shall also be responsible for setting up fixed and mobile facilities for carrying out decontamination with adequate sources of water. Such operations in public domain under the guidance of plant management and setting up and maintaining such facilities shall be the responsibility of the Public Authorities and the State Government.

7.4 Transportation

7.4.1 All necessary resources for transport including drivers shall be mobilized within the plant in the shortest possible time in case of plant emergency and within the site in case of site emergency to undertake evacuation of non-essential staff under the supervision and control of a common authority. Adequate stock of diesel oil and petrol shall be maintained all times to face such an eventuality. Arranging transport of evacuees in the affected sectors in the public domain is the responsibility of OED. District Authorities may also mobilize private sector vehicles as necessary.

7.5 Medical Treatment

7.5.1 Injured and affected site personnel shall be treated as necessary in radiation emergency treatment wards in the hospitals of the Responsible Organisation. These wards shall be fully equipped with necessary instruments, medicines, operating theatres, beds, decontamination centres etc. These should be operational at all times.

7.5.2 The responsibility for treatment of affected persons in the public domain rests with the District Health Authority/State Government. However, any guidance needed in the treatment, it shall be provided by the experts of the Medical Division of the Responsible Organisation or/and the Department of Atomic Energy.

8. MAINTAINING EMERGENCY PREPAREDNESS

8.1 General

8.1.1 A viable mechanism shall be evolved to assess the overall emergency preparedness of an NPP. The required emergency preparedness shall be maintained by organizing various training courses for site and off-site personnel at regular intervals, conducting periodical rehearsals/mock exercises involving all concerned personnel, updating plant emergency procedures and site and off-site emergency action plans at a specified frequency, making suitable changes in the plan in the light of periodic reviews based on emergency exercises and keeping all emergency equipment and accessories in operational condition.

8.2 Training

8.2.1 Appropriate training shall be imparted to employees of the plant and site at all levels at regular intervals, say every two years, to familiarize them with respective actions during emergency. Similar training courses shall be organized round the year to various Public Authorities and State Government Officials. Periodic training for Public Authorities is all the more important in view of the possibility of their frequent transfers.

8.3 Exercises

8.3.1 Exercises shall be conducted at regular intervals and all concerned shall take part. Exercise shall be used for the twin purposes of emergency preparedness and gauging the success of emergency preparedness programme. The plant emergency exercise should be conducted at the periodicity specified in the Emergency Response Manual. It is recommended that each Shift Charge Engineer takes part in these exercises at least once a year. Site emergency exercise and off-site exercise shall be conducted as prescribed by AERB. The results of each exercise shall be discussed immediately in Station Operation Review Committee (SORC) meeting and deficiencies promptly corrected.

8.4 Review and Updating of Plans and Procedures

8.4.1 All plans and procedures shall be reviewed in totality at specified intervals of time and corrections/changes carried out to keep these up to date.

8.5 Emergency Equipment and Supplies

8.5.1 Emergency equipment centre, personnel decontamination centre, emergency survey vehicle, radio equipment, contaminated casualty kits, respirators, emergency treatment area, first aid centre, stretchers, ambulance, emergency shelters, strategically located emergency equipment kits, assembly areas, plant emergency control centre, radiation survey and contamination monitors, protective clothing, DRDs, TLDs, communication equipment, standard operating procedures, design basis reports, process & instrumentation(P&I) diagrams, emergency power supplies, radiation emergency ward etc. shall be kept up to date and ready. At regular specified intervals an inventory of various items shall be taken and verified by the health physics section/other identified agencies. Deficiency, if any, found shall be promptly corrected by replacement and replenishment as the case may be. Items for personnel use shall necessarily be withdrawn after use and replaced with fresh stocks. Instruments shall be checked for calibration and batteries replaced periodically.

8.6 Internal and External Auditing

8.6.1 A system of internal auditing by the Quality Assurance Group of the Responsible Organisation and external auditing by the appropriate agency at Responsible Organisation's Headquarters shall be evolved for purpose of checks and counterchecks and used in gauging the effectiveness of emergency preparedness and ensuring compliance with requirements. Auditing should ensure checking of all equipment/ instruments kept in emergency survey vehicle for their availability and operability.

9. RECORDS

9.1 General

9.1.1 The station shall maintain all relevant records to assess the level of emergency preparedness and shall prepare an action plan to rectify deficiencies noted during the emergency exercises conducted periodically and strengthen the training procedure for plant personnel.

9.2 Emergencies

9.2.1 A chronological log of events during the entire period of emergency shall be maintained. Aids such as prepared forms, tape recorders and telecopy machines etc. would be helpful in increasing the effectiveness of data collection and record keeping. The following important data need to be recorded:

(i) description of the event, radiological conditions (radiation fields, surface and air contamination levels), personnel injuries, equipment damage etc;

(ii) readings of plant instruments;

(iii) meteorological conditions;

(iv) time of informing the emergency units and the time when unit personnel responded/reported;

(vi) number of vehicles available and the time when additional vehicles (with numbers) reported;

(vii) time of informing and response from the Responsible Organisation's Headquarters.

(viii) time of informing and response from off-site agencies;

(ix) time of declaration and termination of emergency; and

(x) report on detailed analysis, causes leading to emergency and recommendations to prevent its reoccurrence.

9.3 Exercises

9.3.1 Records of all exercises along with deficiencies observed and critiques shall be maintained for periodic review and rectification as well as updating emergency plans and procedures.

9.4 Training

9.4.1 The records of training of all personnel on emergency plans shall be maintained.

9.5 Emergency Equipment and Supplies

9.5.1 The records of calibration, maintenance and inventories on emergency equipment and supplies shall be maintained. Operating instructions for equipment and other instrumentation shall be prepared and stored with equipment. Procedures shall include inventory lists and provisions for calibration and maintenance. All the records shall be reviewed as necessary and as specified in the emergency response manual.

FIGURES
&
ANNEXURES

FIGURES

CLASSIFICATION OF EMERGENCIES AND ZONES BASED ON EXISTING NUCLEAR POWER PLANTS

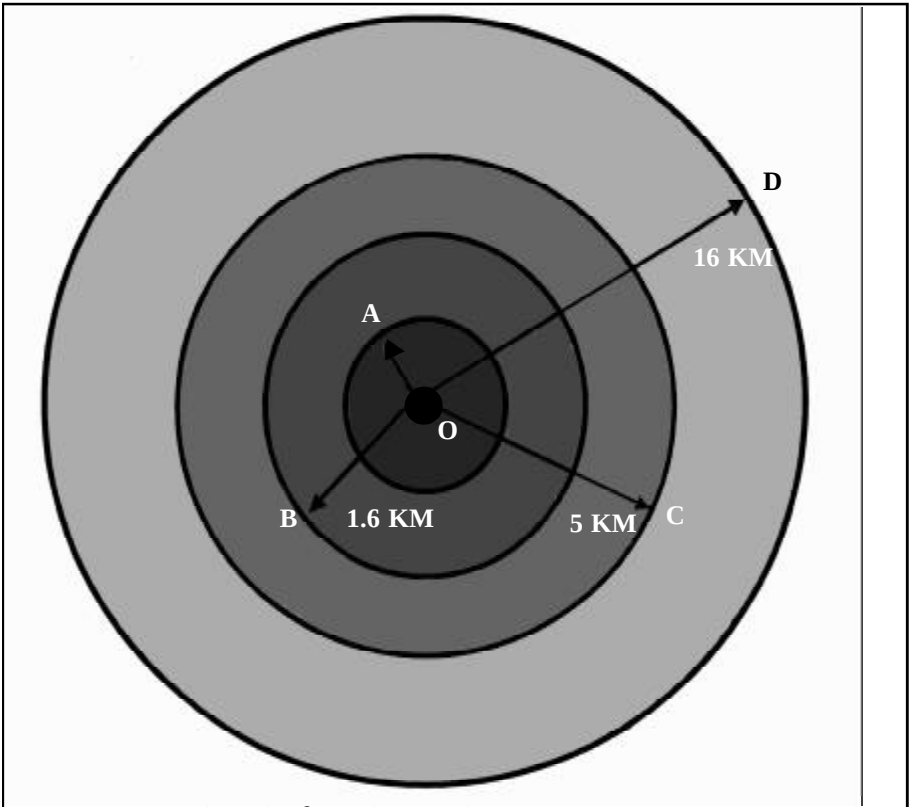

Fig. 1 (Ref. Section 3.1.1) [Drawing not to sale)

O	STACK LOCATION
OA	PLANT/STATION AREA
OB	1.6 KM (SITE AREA)
OC	5 KM
OD	16 KM

S.N.	EMERGENCY CLASSIFICATION	AFFECTED ZONES
1.	EMERGENCY STANDBY	OA
2.	PERSONNEL EMERGENCY	OA
3.	PLANT EMERGENCY	OA
4.	SITE EMERGENCY	OB
5.	OFF-SITE EMERGENCY	BD (+OB AS APPLICABLE)

S.N	ZONES	
1	EXCLUSION ZONE	OB
2	STERILISED ZONE	BC
3	PUBLIC DOMAIN	BD & BEYOND
4	EMERGENCY PLANNING ZONE	OD

THE INTERNATIONAL NUCLEAR EVENT SCALE

for prompt communication of safety significant

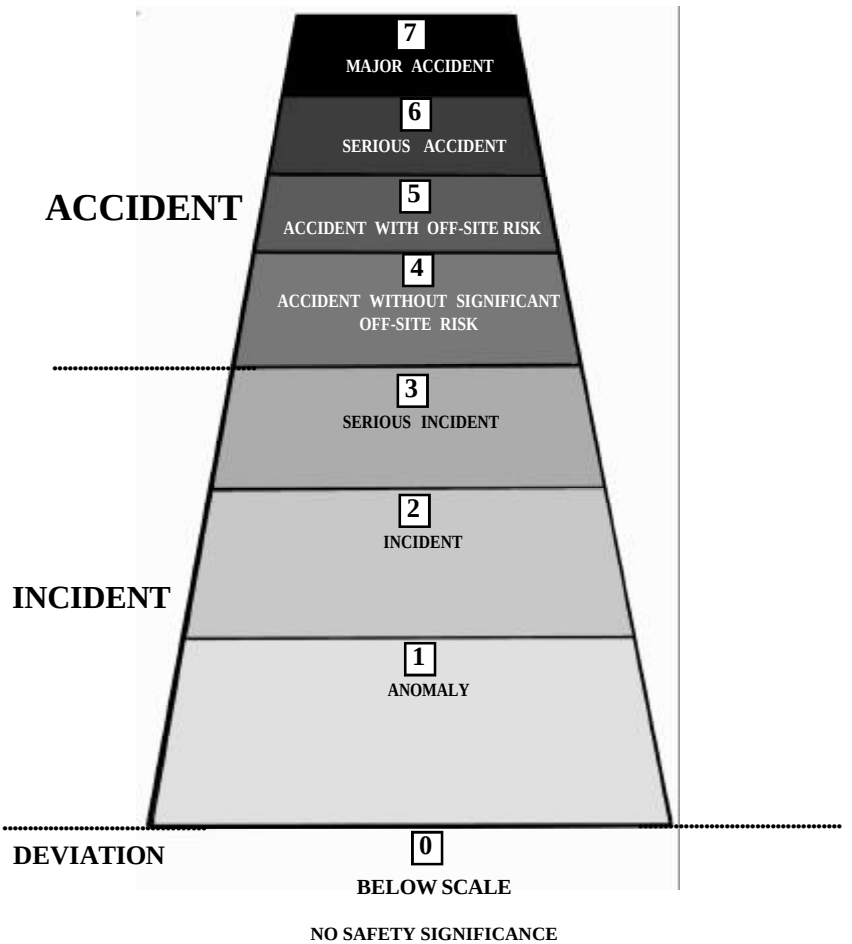

Fig. 2A (Ref. Section 3.1.1)

BASIC STRUCTURE OF THE SCALE

(Criteria given in matrix are broad indicators only)
Detailed definitions are provided in the INES users' manual

	CRITERIA OR SAFETY ATTRIBUTES		
	OFF-SITE IMPACT	**ON SITE IMPACT**	**DEFENCE IN DEPTH DEGRADATION**
7 MAJOR ACCIDENT	MAJOR RELEASE WIDESPREAD HEALTH AND ENVIRONMENTAL EFFECTS		
6 SERIOUS ACCIDENT	SIGNIFICANT RELEASE: LIKELY TO REQUIRE FULL IMPLEMENTATION OF PLANNED COUNTERMEASURES		
5 ACCIDENT WITH OFF-SITE RISK	LIMITED RELEASE: LIKELY TO REQUIRE PARTIAL IMPLEMENTATION OF PLANNED COUNTERMEASURES	SEVERE DAMAGE TO REACTOR CORE/ RADIOLOGICAL BARRIERS	
4 ACCIDENT WITHOUT SIGINIFICANT OFF-SITE RISK	MINOR RELEASE: PUBLIC EXPOSURE OF THE ORDER OF PRESCRIBED LIMITS	SIGNIFICANT DAMAGE TO REACTOR CORE/RADIOLOGICAL BARRIERS/FATAL EXPOSURE OF A WORKER	
3 SERIOUS INCIDENT	VERY SMALL RELEASE: PUBLIC EXPOSURE AT A FRACTION OF PRESCRIBED LIMITS	SEVERE SPREAD OF CONTAMINATION/ ACUTE HEALTH EFFECTS TO A WORKER	NEAR ACCIDENT- NO SAFETY LAYERS REMAINING
2 INCIDENT		SIGNIFICANT SPREAD OF CONTAMINATION/ OVEREXPO SURE OF A WORKER	INCIDENTS WITH SIGNIFICANT FAILURES IN SAFETY PROVISIONS
1 ANOMALY			ANOMALY BEYOND THE AUTHORISED OPERATING REGIME
0 BELOW SCALE EVENT DEVIATION	NO SAFETY SIGNIFICANCE		
OUT OF SCALE EVENT	NO SAFETY RELEVANCE		

Fig. 2B (Ref. Section 3.1.1)

THE INTERNATIONAL NUCLEAR EVENT SCALE

for prompt communication of safety significance

LEVEL	DESCRIPTION	CRITERIA	EXAMPLES
ACCIDENTS 7	MAJOR ACCIDENT	• External release of a large fraction of the radioactive material in a large facility (e.g. the core of a power reactor). This would typically involve a mixture of short and long-lived radioactive fission products (in quantities radiologically equivalent to more than tens of thousands terabecquerels of iodine-131). Such a release would result in the possibility of acute health effects; delayed health effects over a wide area, possibly involving more than one country; long-term environmental consequences.	Chernobyl NPP, USSR (now Ukraine), 1986
6	SERIOUS ACCIDENT	• External release of radioactive material (in quantities radiologically equivalent to the order of thousands to tens of thousands of terabecquerels of iodine-131). Such a release would be likely to result in full implementation of countermeasures covered by local emergency plans to limit serious health effects.	Kyshtym Reprocessing Plant, USSR (now in Russia), 1957

LEVEL	DESCRIP-TION	CRITERIA	EXAMPLES
5	ACCIDENT WITH OFF-SITE RISK	• External release of radioactive material (in quantities radiologically equivalent to the order of hundreds to thousands of terabecquerels of iodine-131). Such a release would be likely to result in partial implementation of countermeasures covered by emergency plans to lessen the likelihood of health effects. • Severe damage to the nuclear facility. This may involve severe damage to a large fraction of the core of a power reactor, a major criticality accident or a major fire or explosion releasing large quantities of radioactivity within the installation.	Windscale Pile, UK, 1957 Three Mile Island, USA, 1979
4	ACCI-DENT WITHOUT SIGNIFI-CANT OFF-SITE RISK	• External release of radioactivity resulting in a dose to the most exposed individual off-site of the order of a few milisieverts. With such a release the need for off-site protective actions would be generally unlikely except possibly for local food control. • Significant damage to the nuclear facility. Such an accident might include damage to nuclear plant leading to major on-site recovery problems such as partial core melt in a power reactor and comparable events at non-reactor installations. • Irradiation of one or more workers which results in an overexposure where a high probability of early death occurs.	Windscale Reprocessing Plant, UK, 1973 Saint-Laurent NPP, France, 1980 Buenos Aires Critical Assembly, Argentina, 1983

LEVEL	DESCRIP-TION	CRITERIA	EXAMPLES
INCI-DENTS 3	SERIOUS INCIDENT	• External release of radioactivity above authorised limits, resulting in a dose to the most exposed individual off site of the order of tenths of millisievert.* With such a release, off-site protective measures may not be needed. • On-site events resulting in doses to workers sufficient to cause acute health effects and/or an event resulting in a severe spread of contamination for example a few thousand terabecquerels of activity released in a secondary containment where the material can be returned to a satisfactory storage area. • Incidents in which a further failure of safety systems could lead to accident conditions, or a situation in which safety systems would be unable to prevent an accident if certain initiators were to occur.	Vandellos NPP, Spain, 1989
2	INCIDENT	• Incidents with significant failure in safety provisions but with sufficient defence in depth remaining to cope with additional failures. • An event resulting in a dose to a worker exceeding a statutory annual dose limit and/or an event which leads to the presence of significant quantities of radioactivity in the installation in areas not expected by design and which require corrective action.	

***** The doses are expressed in terms of effective dose equivalent (whole body dose). Those criteria where appropriate can also be expressed in terms of corresponding annual effluent discharge limits authorised by national authorities.

LEVEL	DESCRIP-TION	CRITERIA	EXAMPLES
1	ANOMALY	• Anomaly beyond the authorised operating regime. This may be due to equipment failure, human error or procedural inadequacies. (Such anomalies should be distinguished from situations where operational limits and conditions are not exceeded and which are properly managed in accordance with adequate procedures. These are typically "below scale").	
BELOW SCALE/ ZERO	DEVIATION	NO SAFETY SIGNIFICANCE	

Fig. 2C (Ref. Section 3.1.1)

PLANT AND SITE EMERGENCY RESPONSE ORGANISATION

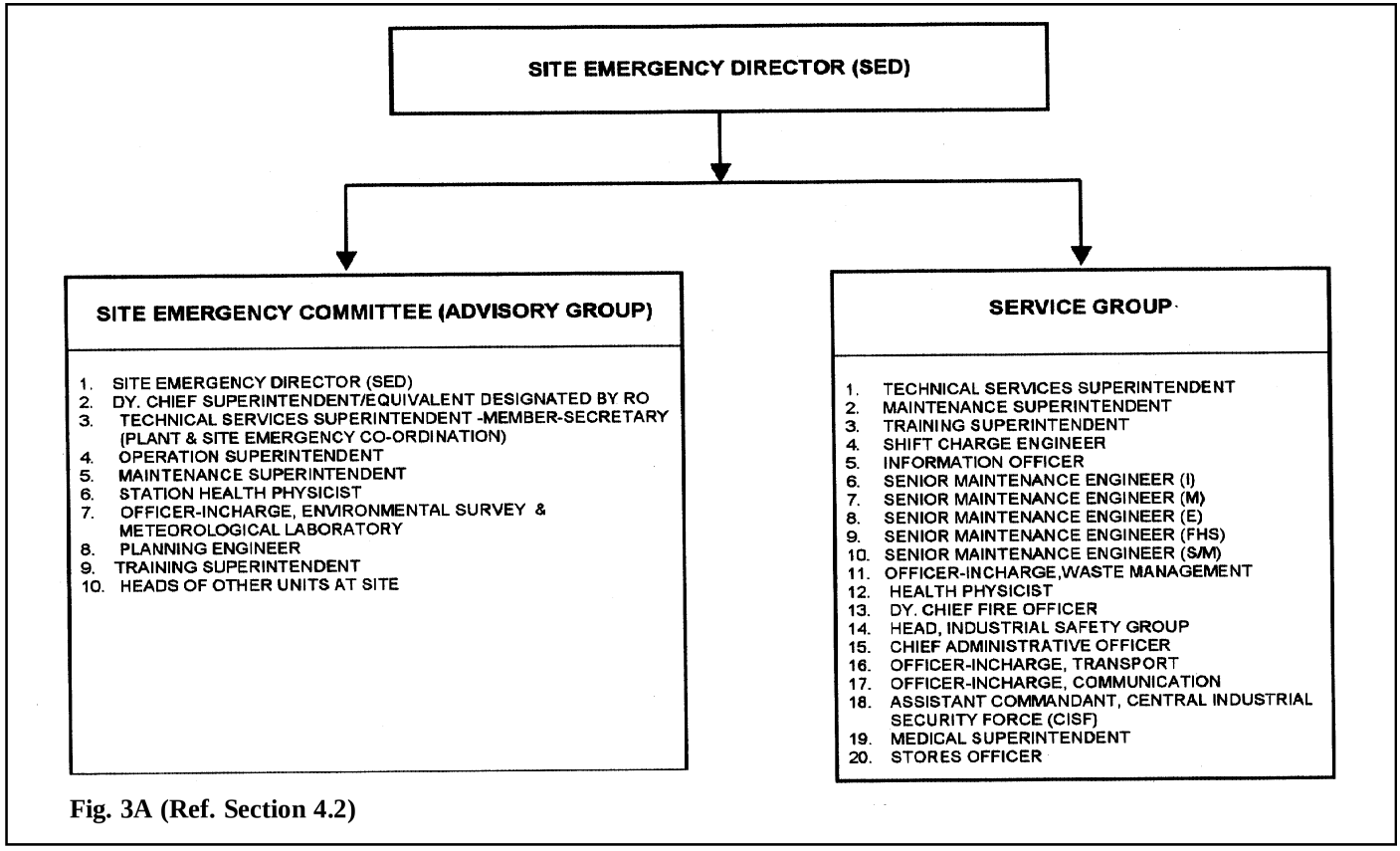

Fig. 3A (Ref. Section 4.2)

PLANT AND SITE EMERGENCY RESPONSE COMMITTEE ORGANISATION

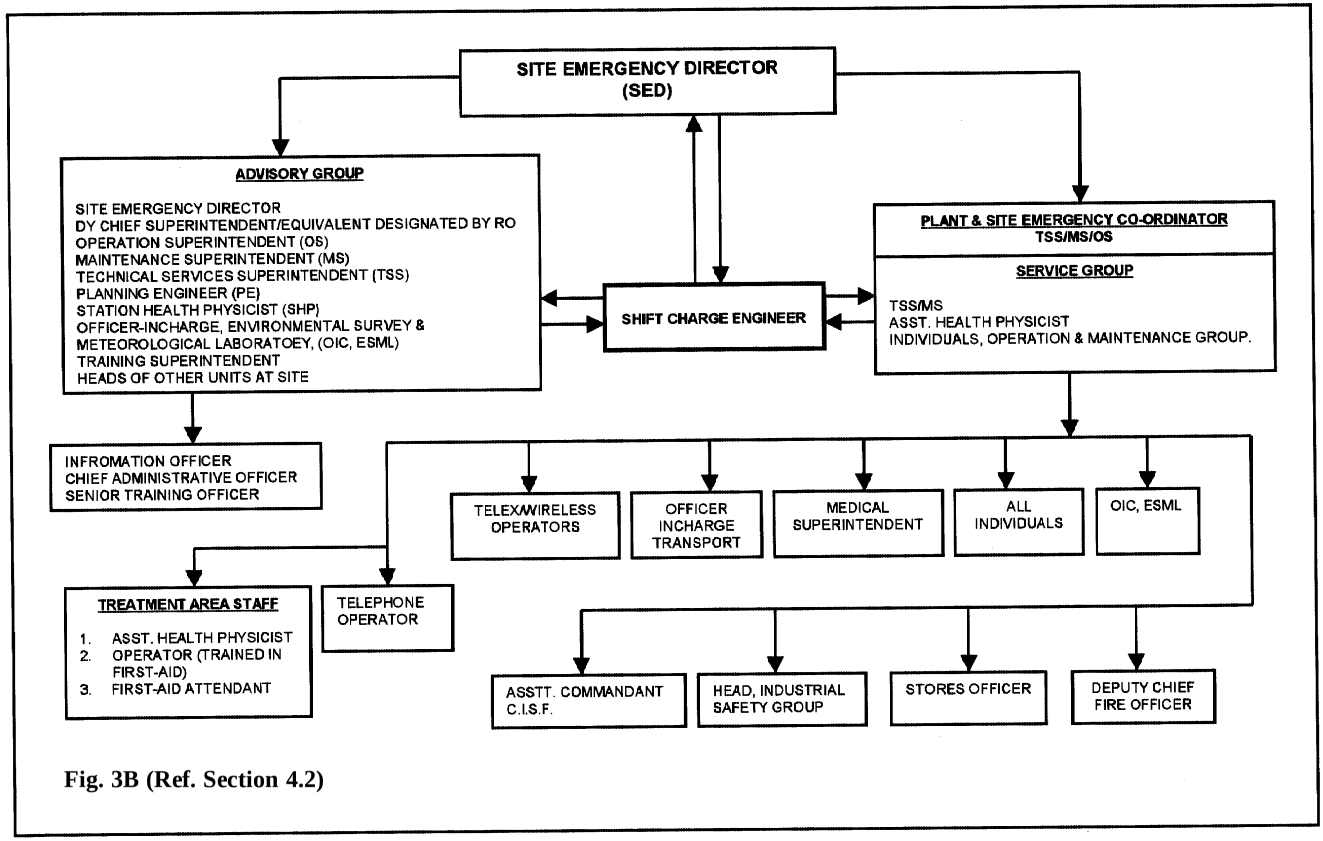

Fig. 3B (Ref. Section 4.2)

PLANT EMERGENCY RESPONSE ACTION FLOW DIAGRAM

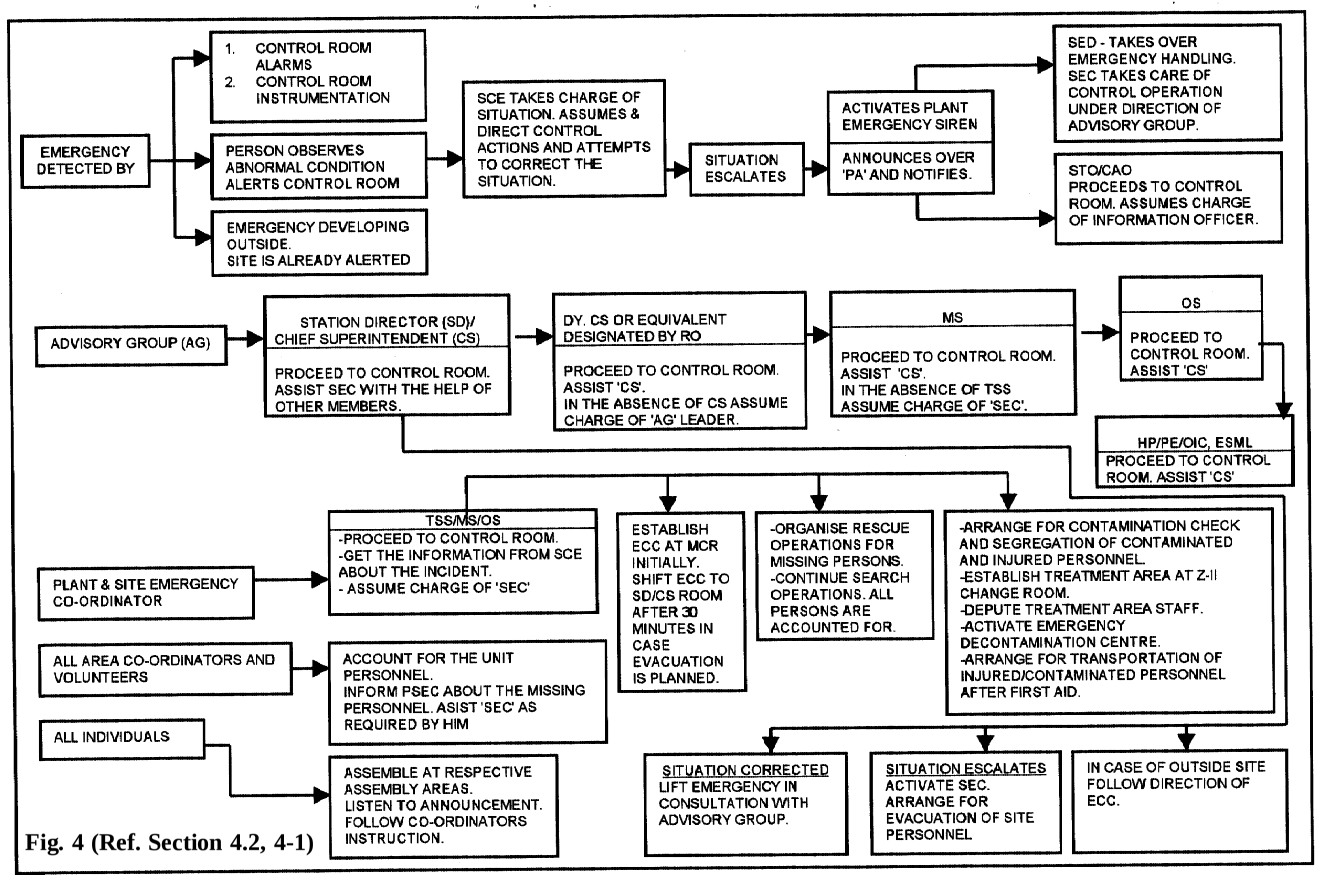

Fig. 4 (Ref. Section 4.2, 4-1)

ACTION FLOW DIAGRAM FOR SITE/OFF-SITE EMERGENCIES

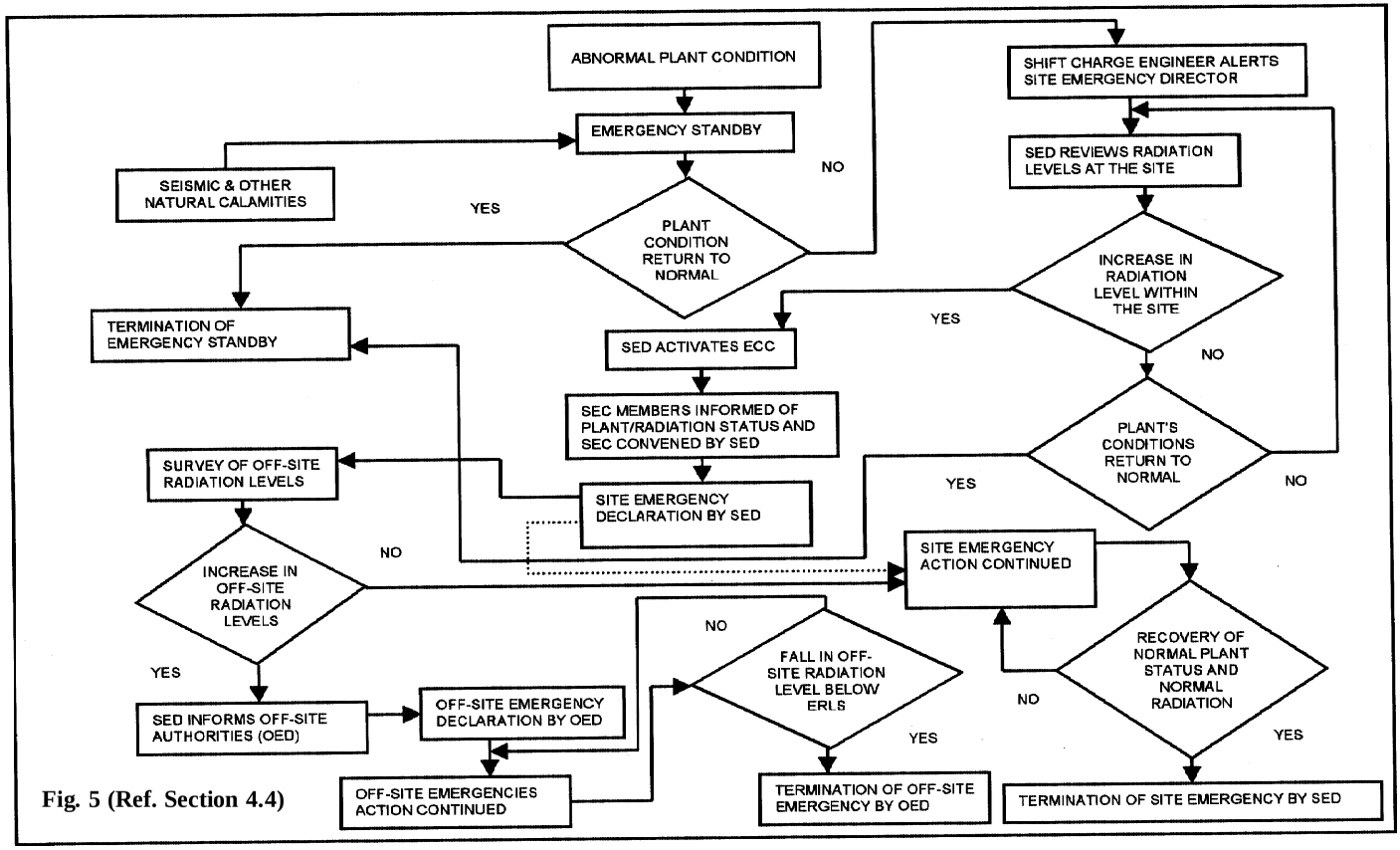

Fig. 5 (Ref. Section 4.4)

INFORMATION FLOW DIAGRAM FOR SITE/OFF-SITE EMERGENCIES

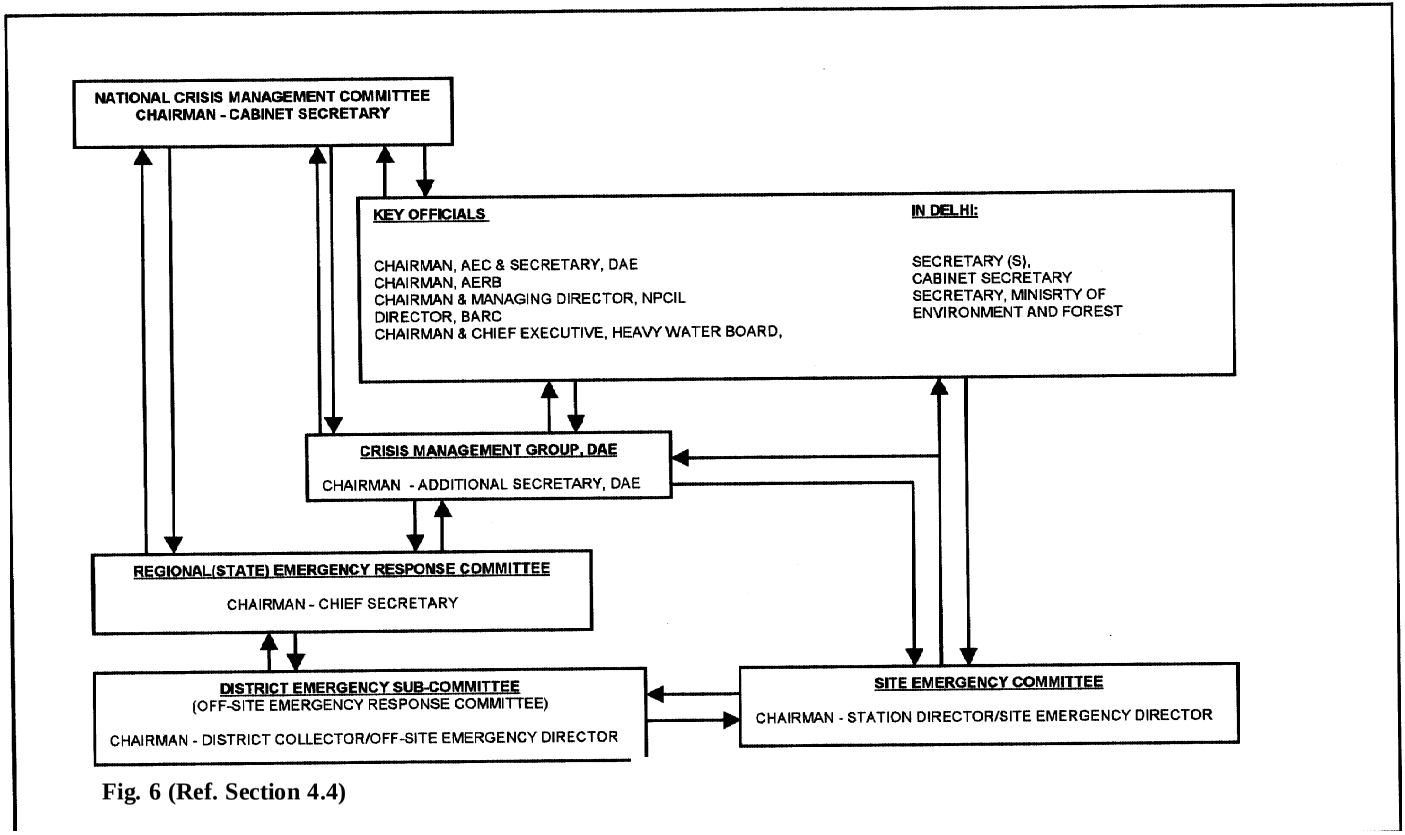

Fig. 6 (Ref. Section 4.4)

ANNEXURES

ANNEXURE - I

TYPICAL EMERGENCY PLAN IMPLEMENTING PROCEDURES

Emergency plan procedures shall include the following:

(1) Duties of an individual who discovers an emergency situation

(2) Duties of the Shift Charge Engineer

(3) Duties of the Site Emergency Director (SED)

(4) Provision of chemistry and health physics support

(5) Provision of maintenance support

(6) Provision of technical support

(7) Access control during emergency situations

(8) Notification procedures

(9) Guides for radiation exposure estimation, classification of emergencies and protective action

(10) Evacuation of personnel, and accountability for them

(11) Handling injured and contaminated personnel

(12) Actions to be taken in case of natural emergencies

(13) Actions to be taken in case of fire emergencies

(14) Re-entry procedures

(15) Emergency exercises

ANNEXURE - IIA

TYPICAL EQUIPMENT NEEDED FOR HANDLING EMERGENCIES

List of emergency equipment stored in main control room and site emergency control centre is given below:

(1) Site layout drawings

(2) Plant and equipment layout drawings

(3) Latest maps of area surrounding the plant showing access roads, sampling points, etc.

(4) Plant personnel roster

(5) Two-way wireless (walkie-talkie) set

(6) Flash lights and head lanterns (with batteries)

(7) Action plan for handling emergency (plant, personnel, site)

(8) Logic diagrams and checklists

(9) Photographs of plant and surroundings

(10) Pre-calculated isodose curves for a predetermined spectrum of mete-orological conditions

(11) Plant safety report and system description manuals

(12) Station operating procedures for emergency conditions duly approved and an emergency log book

(13) Current telephone directory

ANNEXURE - IIB

TYPICAL EQUIPMENT STORED IN OFF-SITE EMERGENCY CONTROL CENTRE AND IN EMERGENCY DECONTAMINATION CENTRE

1. Emergency Control Centre Accessories:

Desk	1 no.	Emergency procedures/plans	
Chairs	6 nos.	District maps	
Stationery		Site plans	
Plant personnel roster		System flow sheets and floor plans	
Photographs of plants and surroundings.		Pre-calculated isodose curves for a pre-determined spectra of meteorological conditions.	
Plant safety report and system descriptions.			

2. Instruments:

Two way radio communication sets	4 nos.
Gamma detector/monitor	5 nos.
High gamma meter (teletector)	2 nos.
Frisker (manually operated contamination monitor)	5 nos.
Portable radiation survey meter [range 0 - 0.2 mSv (0-20 mR/hr)]	2 nos.
Multipurpose survey meter [range 0 - 0.05 Sv (0-5 R/hr)]	2 nos.
Air sampler	1 no
Portable dosimeter charger	2 nos.
Radioiodine monitor	1 no
Tritium monitor	1 no
Gamma dosimeter [5 milli Grey (500 millirad) range]	10 nos.
Battery air sampler	2 nos.

3. Protective Equipment:

Scott air pack (SCBA)	8 nos.	Undergarments	100 nos.
Spare air cylinder	16 nos.	Vests	100 nos.
Respirators	100 nos.	Pairs of socks	100 nos.
Air supplied respirators	100 nos.	Pairs of orange rubber shoes	100 nos.
Air hose lengths (7.62 m)	100 nos.	Pairs of red rubber shoes	25 nos.
fitted with quick fit connectors		Pairs of rubber boots	25 nos.
for ventilation harnesses	25 nos.	Pairs of gum boots	10 nos.
Plastic suits	200 nos.	Pairs of cotton gloves	200 nos.
Plastic hoods	200 nos.	Boxes of latex gloves	5 nos.
Coveralls	100 nos.	Pairs of arm-length gauntlets	6 nos.
Caps	100 nos.	Towels	100 nos.
Pairs of lineman gloves	6 nos.		

4. Contamination Control Equipment:

Detergent	10 kg.	Hand soap (lux)	50 cakes
Mop-head	100 nos.	Hand brush	12 nos.
Mop handle	25 nos.	30 m barrier rope (radiation)	50 nos.
Pails and squeezer	10 nos.	Masking tape (2 inch)	20 rolls
Disposal bag	300 nos.	Steel paper	25 nos.
Radiation sign	25 nos.	Smear paper	12 pkts.
Polythene sheet	1 roll	Radioactive material tape	5 rolls
Waterproof paper sheet	1 roll	Filter discs	100 nos.
		Charcoal filter discs	100 nos.

5. Medical Equipment:

Stretcher	2 nos.	Blankets	4 nos.
Basket stretcher	1 no.	First-aid-kit	1 no.

6. Miscellaneous:

Head light lantern	6 nos.	Axes	2 nos.
Loud hailers	2 nos.	Multi-purpose knives	6 nos.
Nylon rope	100 m	Pairs of scissors	2 nos.

7. Personnel Decontamination:

Bathing soap	50	cakes
Detergent	1	kg.
Decontamination agent	100	pkts.
Soft bristle brush	5	nos.
Coverall	25	nos.
Lab coat	25	nos.
Shoe cover (plastic)	50	nos.
Shoe cover(cotton)	50	nos.
Canvas shoes(pairs)	20	nos.
Glove(rubber post-mortem)	50	pairs
Tissue paper roll	5	nos.
Masking tape roll	5	nos.
Radioactive sign tape	5	rolls
Radiation caution sticker	50	nos.
Cordoning tape	30	m
Battery operated lamp(instalite)	2	nos.
Swipe paper disc	100	nos.
Loud hailer (Mega-phone)	1	no.

ANNEXURE - III

TYPICAL EMERGENCY SHELTERS & REQUIRED EQUIPMENT

(1) Rooms of adequate size to house the required number of plant personnel.

(2) Telephone facility.

(3) Doors and windows with closing/securing arrangements.

(4) Area radiation monitoring and contamination (air, surface) monitoring equipment should be provided (or available nearby).

- Iodine-in-air monitor
- Stable iodine (KI or KIO_3) pills
- Respirators.

ANNEXURE - IV

TYPICAL EQUIPMENT/INSTRUMENTS IN EMERGENCY SURVEY VEHICLE

(1)	Vehicle gamma meter (high range)	1 no.
(2)	Two-way radio sets	2 nos.
(3)	Contamination meter	2 nos.
(4)	Gamma meter (low range)	2 nos.
(5)	Battery-operated air sampler	2 nos.
(6)	Filter discs	100 nos.
(7)	Charcoal filter discs	100 nos.
(8)	Emergency light	100 nos.
(9)	White out-fit and safety shoes (set)	1 no.
(10)	Packets of personnel decontamination agents	10 nos.

ANNEXURE - V

TYPICAL LIST OF EQUIPMENT/INSTRUMENTS IN THE CONTAMINATION CASUALTY KITS (2 nos.)

(1)	Contamination meter	1 no.
(2)	Film/TLD dosimeter holder	12 nos.
(3)	High range gamma dosimeter	12 nos.
(4)	Portable charger	1 no.
(5)	0.25mm plastic sheets	30 sq.m.
(6)	Radiation black board sign	2 nos.
(7)	Contamination sign	2 nos.
(8)	Latex gloves box	1 no.
(9)	Cotton gloves (pairs)	6 nos.
(10)	Masking tape roll	2 nos.
(11)	Disposal bag	24 nos.
(12)	Contamination label	24 nos.
(13)	Respirators	6 nos.
(14)	Packet of hand cleaner	24 nos.
(15)	Portable dosimeter charger	1 no.

ANNEXURE - VI

TYPICAL LIST OF FIRST-AID PROVISIONS STORED AT FIRST AID CENTRE

(1)	Leg rest	1 no.
(2)	Boxes of applicators cotton tipped (10 nos. each)	2 nos.
(3)	Rolls of bandages of different sizes	5 nos.
(4)	Rolls of elastic rubber bandages of different sizes	5 nos.
(5)	Adhesive tape (cotton and plastic) of various sizes	50 rolls each
(6)	Box of 50 eye pads	1 no.
(7)	Boxes of gauze (strips) of various sizes	2 nos. each
(8)	Respirators(oro-nasal)	100 nos.
(9)	Tourniquets	5 nos.
(10)	Resuscitation apparatus	1 no.
(11)	Blankets	2 nos.
(12)	Pillows	2 nos.
(13)	Splints for fracture of limb	5 nos.
(14)	Decontamination powder packets	50 nos.
(15)	Soft bristle brush	5 nos.
(16)	Skin cream (Boroline)	2 tubes
(17)	Bed	1 no.
(18)	Treatment cabin	1 no.
(19)	Treatment chair	1 no.
(20)	Water tap and sink	1 system
(21)	Oxygen apparatus	1 no.
(22)	Stretcher	1 no.
(23)	Antiseptics (set)	1 no.
(24)	Analgesics (set)	1 no.

ANNEXURE - VII

TYPICAL LIST OF AMBULANCE ACCESSORIES

(1)	Contamination casualty kit	1 no.
(2)	Oxygen apparatus	1 no.
(3)	Stretchers	2 nos.
(4)	Beds, pillows	2 each
(5)	Folding wheel chair	1 no.
(6)	First aid box	1 no.
(7)	Water tank and wash basin	1 no.

ANNEXURE - VIII

TYPICAL LOCATION OF STRETCHERS

(1)	Outside reactor building Unit-1	1 no.
(2)	Outside reactor building Unit-2	1 no.
(3)	Service building zone-2 corridor	2 nos. (one basket stretcher)
(4)	Plant emergency equipment centre at administrative building	1 no.

ANNEXURE - IX

CONTAMINATION CONTROL IN TRANSPORTATION OF CASUALTIES

1. The vehicles used for the transport of contaminated persons should be provided with a suitable protective lining on its interior which is sufficiently thick to avoid tearing, in order to minimize the spread of contamination. The contaminated injured persons being transported should be wrapped in blankets or sheets. To facilitate this, the blankets or sheets should be placed on the stretcher prior to the placement of the injured in the stretcher.

2. The ambulance should be directed in accordance with a pre-arranged plan, to a specified entrance of the hospital, where there will be minimum interference by general traffic. The floors and elevators on the way to a surgical room which has been set aside for treatment of contaminated persons should be covered with sheets of plastic for ease of later decontamination.

3. The ambulance personnel should leave the blankets or sheets in the hospital and replenish the contaminated sheets with fresh ones. The hospital should return contaminated solid waste to the nuclear power plant for disposal. Liquid wastes can be discharged as stipulated by the competent authority.

4. The ambulance shall be thoroughly checked for any remnants of contamination and decontaminated if necessary.

ANNEXURE - X

EFFECT OF ADMINISTRATION OF STABLE IODINE ON DOSE REDUCTION

Time after intake of radioactive iodine	Dose reduction (%)
Before intake	100
2 Hours after intake	80
6 Hours after intake	50
12 Hours after intake	Very little reduction
24 Hours after intake	No reduction

Note-1: To minimize the intake of radioactive iodine from the environment it is necessary to take dose of stable iodine by the affected individuals. The oral administration of iodide or iodate (KI or KIO_3) is done to reduce uptake of radio-iodine (I-131) in thyroid gland. The radiation dose is 3 times greater in the case of children than in adults. After intake, iodine in thyroid builds up to a maximum in 1-2 days, half of this maximum is achieved in about 6 hours. Hence thyroid needs to be blocked preferably at least one hour before inhalation.

Note-2: The following doses of stable iodine are recommended for adults:

Administration of stable iodine means oral intake of potassium iodate (KIO_3) tablets. Administration of KIO_3 tablets should be done as follows:

(i) All individuals above the age of 12 years:

Acute Exposure :
- 170 mg (KIO_3) - as soon as possible
- 85 mg (KIO_3) - second and third day only
- 170 mg (KIO_3) - repeat after two weeks, if required.

Chronic Exposure: [Ref. AERB /M/NISD-2, 1988]
- 35 mg every 12 hrs, 5.5 g over 8 days.

(iii) Pregnant women and children of age 3 to 12 years:
- 50% of quantities given in (i).

(iii) Children under the age of 3 years:
- 25% of quantities given in (i).

EQUIPMENT AND SCHEDULE FOR CHECKING THEIR AVAILABILITY

The schedule for checking the availability status of the emergency equipment/materials is given below:

S.NO.	EQUIPMENT	FREQUENCY	AGENCY
1.	Radiation instruments	Once in a month. Batteries to be changed in every 3 months.	Health Physics Unit Control Maintenance Unit.
2.	Emergency equipment and other protective equipment	Once in a month	Operation Unit.
3.	Instruments requiring batteries.	Batteries to be changed in every 3 months	Operation Unit
4.	Emergency monitoring vehicle and its instruments	Once a week	Transport Section, Control Maintenance Unit and Environmental Survey & Meteorological Lab. (ESML)
5.	Wireless sets (walkie-talkie)	Once a week	Operation Unit & Control Maintenance Unit
6.	First-aid equipment	Once a month	Operation Unit and First Aid Attendant.
7.	Site ambulance	Once a week	Operation Unit, Transport Section and First Aid Attendant.
8.	Wireless/telex/fax/ e-mail/ voice-mail and telephones	Every day	Wireless Telex/ Fax/ e-mail/ voice-mail and Telephone Operator
9.	Emergency siren	Once a week	Operation Unit.

The routine test/check results shall be routed through SEC members/SCE for information and review.

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LIST OF PARTICIPANTS

WORKING GROUP

Dates of Meeting : February 10, 1993
February 17, 1993
May 1, 1997

Members of the Working Group:

Shri B.K.S. Nair (Chairman)	:	Directorate of Operations, NPCIL (Formerly)
Dr. A.N. Nandakumar	:	Radiological Physics and Advisory Division, BARC
Shri P.S. Bhatnagar	:	Training Superintendent, TAPS, NPCIL
Shri S.A. Khan (Member-Secretary)	:	DRI&E, AERB

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

Dates of Meeting : February 25, 1993
May 8, 1995
March 28 & 29, 1997
June 13 & 14, 1997
October 24, 1997
June 24 & 25, 1999

Members and alternates participating in the meeting:

Shri G.V. Nadkarny (Chairman)	:	Director E &PA, NPCIL (Formerly)
Shri R.S. Singh	:	AERB
Shri. K.M. Sinha	:	NPCIL
Shri Ram Sarup	:	AERB (Formerly)
Shri Y.K. Joshi	:	KAPS, NPCIL
Shri V.V. Sanath Kumar	:	Kaiga Generating Station, NPCIL
Shri Ravindranath	:	TAPS, NPCIL
Shri S.K. Warrier (Member-Secretary):		AERB
Shri S. T. Swamy (Co-opted)	:	AERB

ADVISORY COMMITTEE ON NUCLEAR SAFETY (ACNS)

Date of Meeting	:	November 28, 1998

Members and alternates participating in the meeting:

Shri S.K. Mehta (Chairman)	:	Director RG, BARC (Formerly)
Shri S.M.C. Pillai	:	President and Chief Executive, Nagarjuna Power Corporation Limited
Prof. U.N. Gaitonde	:	IIT, Mumbai
Shri S.K. Goyal	:	Addl. General Manager, BHEL, Hyderabad
Shri Ch. Surendar	:	Executive Director (Operations), NPCIL
Dr. U.C. Mishra	:	Director, H&SE Group, BARC (Formerly)
Shri S.K. Sharma	:	Director, RG, BARC
Dr. V. Venkat Raj	:	Director , H&SE Group and RDDG, BARC
Shri S.P. Singh	:	Head, NSD, AERB (Formerly)
Shri G.K. De	:	Head, NSD, AERB (Formerly)
Shri K. Srivasista (Member-Secretary)	:	NSD, AERB

PROVISIONAL LIST OF SAFETY GUIDES ON OPERATION OF NUCLEAR POWER PLANTS

Safety Series No.	Provisional Title
AERB/SG/O-1	Staffing, Recruitment, Training and Authorisation of Operat ing Personnel of NPPs
AERB/SG/O-2	In-Service Inspection of NPPs
AERB/SG/O-3	Operational Limits and Conditions for NPPs
AERB/SG/O-4	Commissioning Procedures for Pressurised Heavy Water Based NPPs
AERB/SG/O-5	Radiation Protection during Operation of NPPs
AERB/SG/O-6	Preparedness of the Operating Organisation for Handling Emergencies at NPPs
AERB/SG/O-7	Maintenance of NPPs
AERB/SG/O-8	Surveillance of Items Important to Safety in NPPs
AERB/SG/O-9	Management of Nuclear Power Plants for Safe Operation
AERB/SG/O-10A	Core Management and Fuel Handling for Pressurised Heavy Water Reactor Based NPPs
AERB/SG/O-10B	Core Management and Fuel Handling for Boiling Water Reactor Based NPPs
AERB/SG/O-11	Management of Radioactive Wastes Arising During Operation of NPPs
AERB/SG/O-12	Renewal of Authorisation for Operation of NPPs
AERB/SG/O-13	Operational Experience Feedback