GUIDE NO. AERB/SG/O-9

GOVERNMENT OF INDIA

AERB SAFETY GUIDE

MANAGEMENT OF NUCLEAR POWER PLANTS FOR SAFE OPERATION

ATOMIC ENERGY REGULATORY BOARD

AERB SAFETY GUIDE NO. AERB/SG/O-9

MANAGEMENT OF NUCLEAR POWER PLANTS FOR SAFE OPERATION

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Atomic Energy Regulatory Board
Mumbai 400 094

FOREWORD

Safety of 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 in the Atomic Energy Act 1962 (33 of 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 Gazette of India dated 31.12.1983. The Board has been entrusted with the responsibility of laying down safety standards and to frame 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 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 general public and plant personnel.

The 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 annexure, foot-notes, and bibliography are not to be considered integral part of the document. They are included to provide information that might be helpful to the user.

The emphasis in the codes and guides is on the protection of site personnel and public from undue radiological hazard. However, for aspects not covered in the codes and guides, applicable and acceptable national and international codes and standards shall be followed. Industrial safety shall be assured through good engineering practices and through compliance with the Factories Act 1948 as amended in 1987 and the Atomic Energy (Factories) Rules, 1996.

This safety guide provides guidance on all aspects of management of the nuclear power plants for safety in NPPs.

This safety guide has been prepared by the staff of AERB and other professionals. In drafting the guide, they have used extensively the relevant documents of the International Atomic Energy Agency (IAEA) developed under the Nuclear Safety Standards (NUSS) programme; specially the IAEA Safety Guide on " Management of Nuclear Power Plants for Safe Operation" (No. 50-SG-O9).

This safety guide has been reviewed by experts and vetted by the AERB Advisory Committees before issue. AERB wishes to thank all individuals and organisations who reviewed the draft and finalised this guide. The list of persons who have participated in the committee meetings, alongwith their affiliations, is included for information.

P. Rama Rao

(P. Rama Rao)
Chairman, AERB

DEFINITIONS

Acceptable Limits

Limits acceptable to Regulatory Body.

Accident Conditions

Substantial deviations from Operational States[1] which could lead to release of unacceptable quantities of radioactive materials. 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 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)

An authority designated by the Government of India to enforce the rules promulgated under the relevant Sections of the Atomic Energy Act 1962, for the control of radioactive substances (section 16), special provisions to safety (section 17) and administration of the Factories Act 1948 (section 23).

Audit[3]

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

Authorisation

See ' Regulatory Consent'.

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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 control equipment loss of power to main coolant pump.

[3] The definitions refer to Quality Assurance activity as discussed in Quality Assurance Code and Guides.

Commencement of Operation[4]

The specific activity/activities in the commissioning phase of a Nuclear Power Plant towards first approach to criticality.

Commissioning[5]

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

An officer or authority appointed or approved by the Government by notification for the purposes of the Rules promulgated under the Atomic Energy Act 1962.

Construction[5]

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

Decommissioning[5]

The process by which a 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 of the environment.

Documentation[3]

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

Emergency Situation

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

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.

Inspection[3]

Quality Control actions which by means of examination, observation or

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[4] e.g. Fuel loading in case of Light Water Reactors and in case of Pressurised 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 authorisation process. Several of the stages may coexist; e.g. Construction and commissioning, or Commissioning and Operation as approved specification.

measurement determine the conformance of materials, parts, components, systems, structures as well as processes and procedures with pre-determined quality requirements.

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 or outside the Plant;[6]

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

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

Licensed Person

A person who has been licensed to hold 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).

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

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

Nuclear Safety

Protection of all personnel from undue radiological hazards.

Objective Evidence

The term used in context of Quality Assurance, qualitative or quantitative information, record or statement of fact, pertaining to quality of an item or service, which is based on observation, measurement or test and which can be verified.

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[6] This includes successive barriers set up against the release of radioactivity from nuclear facilities.

Operating Organisation[7]

The organisation so designated by responsible organisation and authorised by Regulatory Body to operate the facility.

Operating Personnel

Those members of Site Personnel who are involved in the operation of the NPP.

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 (OLC)

(See also technical specificatrion)

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 the safe operation of the facility.

Operational Records

Documents such as instrument charts, certificates, log books, computer print outs and magnetic tapes, made to keep objective history of the NPP operation.

Operational States

The states defined under Normal Operation and Anticipated Operational Occurrences.

Plant Management

The members of Site Personnel who have been officially delegated responsibility and authority by the Operating Organisation for directing the operation of the plant.

Prescribed Limits

Limits established or accepted by Regulatory Body for specific activities or circumstances that must not be exceeded.

Qualified Person

A person who having complied with specific requirement and met certain conditions, has been officially designated to discharge specific duties and responsibilities. [For example, Reactor Physicist, Station Chemist, and Maintenance Person of a Nuclear Power Plant are qualified persons]

Quality Assurance

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

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[7] Organisation structure and not individual names.

Records

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

Regulatory Consent

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

Reliability

It is 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[8]

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

Safety

See 'Nuclear Safety'

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 minimise the risk to the public and to the site personnel.

Safety Critical Systems (Safety Systems)

Systems important to safety, provided to assure, 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 released reactivity (Containment Isolation System).

Severe Accidents

Nuclear Power Plant conditions beyond those of the Design Basis Accidents causing significant core degradation.

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[8] In the present context the Nuclear Power Corporation of India Limited (NPCIL) is the Responsible Organisation for Nuclear Power Plants in India.

Site

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

Site Personnel

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

Siting

The process of selecting a suitable site for a facility including appropriate assessment and definition of the related design bases.

Specification

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

Surveillance[9]

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 the safe operation of the facility and approved by Regulatory Body.

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

CONTENTS

1. INTRODUCTION

1.1 General

1.1.1 This Safety Guide supplements the provisions of the Code of Practice for Operation of Nuclear Power Plants (AERB/SC/O). It identifies the main objectives and responsibilities of management with respect to safe operation of nuclear power plants.

1.2 Objectives

1.2.1 The main objectives of this Guide are to highlight the important elements of effective management for safe operation of an NPP, comprising the various aspects of safety. In particular to focus on the following aspects:

(a) primary responsibility of plant management for safe operation of NPP;

(b) composition of plant management;

(c) training and qualification of various staff;

(d) inculcation of safety culture;

(e) proper procedures to be followed while involving outside experts for special tests etc.;

(f) exchange of operating experiences;

(g) liaison between plant management and the Regulatory Body;

(h) involvement of operating staff during commissioning.

1.3 Scope

1.3.1 The Guide is primarily addressed to safety matters directly related to the operating phase. However, it also covers the inter-relationships between operations and design, construction and commissioning including the involvement of the operating organisation in appropriate reviews of safety issues with reference to the future operating phase. The Guide covers matters of principle in relation to management level decision-making aimed at compliance with safety requirements.

2. MANAGEMENT OBJECTIVES AND RESPONSIBILITIES

2.1 Objectives:

2.1.1 The responsible organisation shall have the overall responsibility for safe operation of its nuclear power plants. Its management objectives shall therefore be to ensure that:

(1) The design enables the plant to be operated safely;

(2) The plant is constructed in accordance with the approved design;

(3) The plant is tested and commissioned as per prescribed specifications and procedures to demonstrate that the design, construction and operation requirements have been met and that the plant can be operated in accordance with design basis and intent;

(4) The plant is operated and maintained in accordance with design assumptions and specified operational limits and conditions by competent persons who are adequately trained for normal operation and anticipated operational occurrences and to cope with emergency situations;

(5) Adequate facilities and services (see section 6) are available in a timely manner during normal operation and anticipated operational occurrences;

(6) Adequate arrangements for emergency response during accident conditions (see section 6.5) have been made to take appropriate actions to protect the health and safety of the site personnel, the public and the environment. For this purpose, arrangements with participating organisations are adequate and effective.

2.2 Responsibilities:

2.2.1 To meet the objectives of section 2.1 defined for operating stages, the Operating Organisation or Plant Management as authorised by Responsible Organisation shall have the following main responsibilities:

(1) To structure the organisation for operation, providing resources, allocating responsibilities and delegating authority within the organisation with a view to achieving proper management and safe operation of nuclear power plants;

(2) To establish and verify satisfactory implementation of management programmes (see section 4) for safe operation;

(3) To establish liaison with public authorities and the regulatory body for the purposes of obtaining necessary clearances/approvals in compliance of safety requirements;

(4) To establish liaison with design, construction, manufacturing and other organisations to ensure proper transfer of information and experience;

(5) To provide services and facilities to plant management;

(6) To provide adequate public relations liaison;

(7) To establish necessary arrangement for carrying out the activities in accordance with the safety codes, guides and regulations; and other safety directives laid down by the regulatory body.

2.2.2 The Station Operation Review Committee (SORC) shall review on a regular basis the station operation and incidents happening in the plant operation with special reference to unusual occurrences and recommend effective remedial actions. Reports shall be sent to the Unit Safety Committee (USC) and Safety Review Committee for Operating Plants (SARCOP).

3. ORGANISATION STRUCTURE FOR OPERATION

3.1 General

The following organisational structure is suggestive. The Responsible Organisation (RO) may have different organisational structure with divisions of responsibilities without compromising with the functional duties and responsibilities as brought out in this Guide and other relevant documents of AERB. For example, if Operating Organisation (Op.O) is not instituted as envisaged in this Guide, the functional responsibilities of Operating Organisation shall be met by Responsible Organisation or Plant Management (PM) when so delegated by RO. However in all cases, the organisational structure and division of responsibilities shall clearly be defined by RO and AERB shall be kept informed.

3.1.1 A documented organisational structure shall be established. When the Op.O is not in position, the responsibility of the Op.O shall lie with RO or with PM to the extent delegated by RO. The organisation shall be staffed with competent managers and personnel having both the proper awareness of the technical and administrative requirements for safety. The plant management and the plant personnel should be motivated to implement safety policies. Functional responsibilities, (see section 2) levels of delegated authority and lines of internal and external communication shall be clearly defined for safe operation of the nuclear power plant in all operational states, for mitigating the consequences of accident conditions and for ensuring correct response to emergency situations.

3.1.2 In establishing the structure, the following main categories of operating organisation management functions at all levels shall be considered:

1. **Policy making functions:** These set forth the management objectives which decide the financial, material and manpower resources, approve the contents of management programmes and make the necessary changes in any of these three items on the basis of feedback of information on the overall performance in achieving the objectives as defined in section 2.1;

2. **Operating functions**: These involve executive decision making and actions in relation to the operation of a nuclear power plant, both during all operational states and during and after accident conditions;

3. **Supporting functions**: These relate to the provisions of services and facilities required to perform safe operation;

4. **Reviewing functions**: These include critical monitoring of the performance of the operating and supporting functions. The purpose

of monitoring is to check compliance with the stipulated objectives for the safe operation of the plant, to reveal deviations, deficiencies and equipment failures and to provide information for timely corrective action;

5. To ensure that the operating function is carried out by qualified personnel.

3.1.3 An organisation chart (see Fig.1) representing diagrammatically the overall operating organisation structure and the plant management structure shall be available.

1. The assignment of responsibilities to various units in the organisation should be specific and should be free from ambiguity;
2. Lines of authority and communication shall be defined.

3.1.4 The three main organisational units associated with the operation of NPPs are as follows:

(i) Responsible Organisation (R.O);

(ii) Operating Organisation (Op.O);

(iii) Plant Management (PM).

3.2 Factors Affecting Organisational Structure for Operation

3.2.1 The factors to be considered in determining the organisational structure for Operation and its staffing requirements for a nuclear power programme include the following:

3.2.1.1 Responsible Organisation:

(i) The need to ensure that structures, systems and components important to safety are maintained in accordance with the design assumptions and intent;

(ii) The necessity for the design, construction, operation and modifications to be thoroughly analysed and reviewed with the aim of ensuring safety through reliability and effectiveness of structures, systems and components;

(iii) In order to provide valuable experience and continuity of knowledge for the operational phase and to ensure that operation and maintenance requirements are appropriately considered during the design stage, experienced personnel from the operating organisation should be associated with design reviews and safety

analyses from the early stages. This will also help to ensure that design intents are clearly understood by the operating organisation. Similarly, suitable personnel should be employed in environmental monitoring and quality assurance from the early stages of the project. The operating organisation should be so structured that its personnel who were involved in the safety analysis, QA and environmental monitoring in the earlier stages can carry out similar activities in the operational phase.

3.2.1.2 Operating Organisation:

(i) The need for radiation protection and related medical provisions;

(ii) The need for assuring activities affecting items important to safety to be in accordance with quality requirements, including the need to verify whether activities have been performed as specified;

(iii) The need to know and understand the requirements of the regulatory body, to make provisions to meet these requirements and to provide a system of formal corporate communication with the regulatory body;

(iv) The need for additional services and facilities for activities such as fuel management, chemistry control, in-service inspection and performance engineering, and for modifying and procuring special items;

(v) The need for operational experience to be systematically reviewed and feed back to the designer and other concerned agencies so that appropriate actions can be taken;

(vi) The personnel involved in reviewing shall have effective independence from cost and scheduling considerations. This applies to reviews of all safety related activities and in particular to:

(a) safety analysis (design),
(b) safety analysis (operation, maintenance and surveillance),
(c) quality assurance,
(d) radiation exposure,
(e) medical supervision and investigation,
(f) access control (physical protection);

(vii) when in house expertise is not available or when it is considered otherwise necessary the Op.O may employ outside consultants to deal with the specific problems. The response time to obtain such services shall be taken into account when determining the structure of the organisation particularly with respect to power plant sited in remote location;

(viii) There is a wide range of contractual arrangements between the operating organisation and suppliers, from individual procurement to a turnkey contract. In the former case, the operating organisation has an extensive task and will need corresponding resources. It shall assign knowledgeable and skilled personnel in the pre-operational stages to meet these responsibilities. In the latter case the supplier has a more extensive role in the construction and testing of the plant. However, since the operating organisation retains the responsibility for safe operation of the plant it shall still assign a sufficient number of knowledgeable and skilled personnel during the pre-operational phase. Examples of areas where close co-operation with the supplier is necessary are:

(1) Training of operating staff,

(2) Commissioning of the plant,

(3) Pre-Service and In-Service inspection,

(4) Technical assistance during operation;

(ix) It may be organisationally advantageous to provide many of the required services from the organisation's own resources if its own capabilities are adequate;

(x) The operating organisation may procure suitable services from other bodies such as: consultants, architect/engineers, plant suppliers, equipment manufacturers and contractors; specialists such as metallurgists, health physicists, and seismic engineers and also from facilities such as for data processing, training, chemical and radiological work. However, the operating organisation shall not thereby be relieved of its overall responsibility for safety, including these services and facilities. It shall also be responsible for co-ordinating all interfaces between the contracting bodies;

(xi) When the operating organisation is authorised to operate more than one NPP, a centralised structure may be made responsible for certain activities such as safety analysis, quality assurance and for establishing special arrangements for effective exchange of experiences, services and facilities.

3.2.1.3 Plant Management:

(i) The need to ensure that systems and components provided to cool the fuel and to contain the radioactivity are operable at all times when heat generation is significant. This includes the need to remove heat generated after shutdown, since failure to do so may lead to uncontrolled release of radioactive material;

(ii) The need to ensure control of reactivity and to prevent inadvertent criticality;

(iii) The need to be prepared for emergency situations, and to co-ordinate emergency plans with those of the regulatory body, public authorities and other organisations which may be required to take action;

(iv) The need to control radioactive releases and provide for environmental surveillance;

(v) The need to control access to the plant and to certain areas within the site in order to ensure radiological safety and to protect the plant against malevolent actions that would jeopardise safety;

(vi) The need for emphasis on training and retraining of personnel to achieve and maintain an adequate level of competence, and to inculcate the necessary attitude towards safety;

(vii) The need for periodic safety review as specified by the Regulatory Body for assessment for renewal of authorisation;

(viii) Technical services and expertise, including those required for emergency situations are provided. The extent to which these are provided from inside or outside the organisation is a matter of management policy.

3.3 Division of Responsibilities in Operation of NPPs

3.3.1 Responsible Organisation:

The management responsibilities of RO are as follows:

(i) Corporate planning;

(ii) Siting;

(iii) Design;

(iv) Construction;

(v) Commissioning;

(vi) Operation;

(vii) Quality assurance;

(viii) Health & Safety;

(ix) Emergency response planning;

(x) Personnel, Finance & Accounts;

(xi) Contracts and Material Management;

(xii) Environmental Protection;

(xiii) Public Awareness;

(xiv) Decommissioning.

3.3.1.1 R.O. shall also be responsible to constitute an Operating Organisation to direct the operational aspects of the NPPs at various sites.

3.3.1.2 The R.O. shall be responsible for ensuring safe and efficient operation of the NPPs.

3.3.1.3 The R.O. shall ensure that the design, construction and operation of the NPPs are in accordance with the relevant codes established by or acceptable to the Regulatory Body.

3.3.1.4 The R.O. shall ensure that all the activities pertaining to the design, construction and operation of the NPP are carried out in accordance with the QA programme.

3.3.1.5 The R.O. shall ensure that continued protection is provided to the public and environment from residual radio-activity or other potential hazards during the operating life of the plant till a certificate for the termination of the responsibilities for that site is obtained from the Regulatory Body.

3.3.2 Operating Organisation

The responsibilities of Op.O include the following:

(i) Establishing Plant Management and delegating it with required authority for ensuring safe operation and for carrying out day-to-day operations of the NPPs;

(ii) Establishing centralised support Services System for providing support services;

(iii) Monitoring and reviewing performance of NPPs from the point of safe operation and providing necessary directives as needed;

(iv) Establishing liaison with design, construction and other related organisation to ensure information transfer etc.;

(v) Establishing co-ordination with Regulatory Body for licensing/ authorisation etc. and public authorities, for emergency preparedness and public relation liaison.

3.3.3 Plant Management:

3.3.3.1 The Plant Management (PM) shall have the primary responsibility for the safe operation of the NPP.

3.3.3.2 The PM structure shall provide for appropriate performance of all functions having an immediate bearing on the safe operation of the NPP.

3.3.3.3 The duties and responsibilities of the various groups/sections of the NPP should be clearly laid down by PM keeping in view the requirements of the Regulatory Body.

3.3.3.4 Certain functions with bearing on safety may also be performed within the Op.O by qualified persons outside the PM structure. These functions shall be clearly defined in writing. The actual implementation of these functions on site shall be subject to the approval of the PM.

3.3.3.5 P.M. shall ensure that at any time during the operation of the NPP the required number of qualified personnel as approved by the Regulatory Body shall be present in the control room and other area as specified.

3.3.3.6 An appropriate system of liaison shall be established by the PM with Regulatory Body and Public Authorities.

3.3.3.7 The PM shall keep informed Op.O on all day-to-day operational matters and also any unusual occurrences in the plant should be promptly reported in writing to Op.O.

3.3.3.8 The PM shall keep the Regulatory Body informed of all safety related unusual occurrences in the NPP and also bring out the various remedial measures provided to avoid the same.

3.3.3.9 The PM shall assure availability of Technical Specifications, QA Manuals, Flow sheets, Operating Manuals, Design Manuals, Emergency Response and Preparedness Manuals at the Station.

3.3.3.10 The PM while reporting the safety related unusual occurrences, should use the following International Nuclear Event Scale (INES) as the basis:

	Description	Scale No.
ACCIDENT	Major accident	7
	Serious accident	6
	Accident with off-site Risk	5
	Accident without significant off-site risk	4
INCIDENT	Serious incident	3
	Incident	2
	Anomaly	1
Deviation	Below scale No safety significance	0

3.3.3.11 For movement of irradiated fuel, the Plant Management should interact with relevant organisations to ensure that requirements of national/ international transport regulations are complied with, including arrangements for transport (see AERB/SC/TR-1).

3.4 Assignment of Responsibilities

3.4.1 Within the operating organisation there shall be an executive person to coordinate the activities of operating organisation. For a clear understanding of responsibilities, the relationships between organisational units and personnel within the operating organisation shall be defined by detailed job specifications. In particular, these relationships shall be clearly defined for all activities having a direct or indirect bearing on safety.

3.4.2 If services are provided outside the direct control of the Plant Management of the station; then functional relationships shall be defined to clarify the responsibilities of plant management and outside personnel. The PM is accountable for meeting the operating organisation's objectives and statutory requirements, including those established by the Regulatory Body.

3.4.3 Personnel outside the line of command of the PM who provide a service or advice, although they may be personally or professionally responsible for the quality of the service or advice given, shall have no direct authority over the personnel in the line of command. Line of command personnel are responsible for making decisions after taking all aspects into account and after giving careful consideration to any specialist advice provided. Specialist advisers may however report to the next higher level if their advice is not receiving due consideration.

3.4.4 Within the operating organisation, delegated powers of authority shall be specified at appropriate levels of management. Individual initiative and judgment may then be used in the exercise of those delegated powers.

3.4.5 When it is decided that services are to be provided by sources outside the PM, responsibilities shall be allocated within the organisation for specifying, controlling and monitoring those services.

3.4.6 The operating organisation shall make arrangements to verify the implementation and the adequacy of the management programmes with regard to ensuring safe operation of the nuclear power plant. This may involve establishing suitable technical audit within the operating organisation.

4. MANAGEMENT PROGRAMMES

4.1 General

4.1.1 The Operating Organisation shall establish appropriate documented management programmes to achieve its objective effectively. A management programme consists of a systematic application of planning schedules, procedures, verification of activities, reviews and audits supported by appropriate resources to administer specific management policies.

4.1.2 The various programmes to be established would include:

- Recruitment;
- Training, Authorisation and Retraining;
- Technical Services including, plant ageing management, plant life assessment, retrofitting and upgrading;
- Physical Protection;
- Maintenance;
- In-service Inspection;
- Quality Assurance;
- Environmental monitoring;
- Radiation protection;
- Commissioning;
- Operations;
- Emergency preparedness;
- Fuel Management;
- Surveillance;
- Protection against fire and flood;
- Waste Management;
- Stores and Materials Management;
- Industrial safety.

These programmes shall be addressed to administrative as well as technical aspects of plant operation and shall cover all related activities. (see item 1 of Bibliography)

Efficient integration of the separate management programmes should be provided by the operating organisation by co-ordinating activities having a bearing on safety.

4.1.3 The relevant parts of these programmes shall be available sufficiently in advance to allow the corresponding activities to be undertaken.

4.1.4 In order to ensure that adequate and appropriate practices are followed in implementing the management programmes, the operating organisation shall make arrangements for the requisite information from designers, manufactures and other organisations to be available.

4.1.5 These programmes shall consider the needs of decommissioning and therefore include requirements that may facilitate the planning of this activity.

4.1.6 In establishing the programme, due consideration shall be given to:

- Objectives to be achieved;
- Applicable regulatory requirements;
- Policies to be implemented;
- Delineation of responsibilities;
- Qualification of personnel involved;
- Scheduling of activities to be performed;
- Services and facilities required;
- Documentation and basic information required;
- Feed back of experience;
- Minimisation of man-rem;
- Reviews to be conducted on both programmes and associated procedures;
- Timely resolution of safety problems;
- Reports to be produced and records to be kept;
- Flow of information.

4.1.7 A prerequisite for implementing the programme is the establishment of a comprehensive system of manuals containing instructions and procedures to cover all relevant technical and administrative activities for guidance. These documents shall be prepared by the site staff with the cooperation of experts from manufacturing, design, construction and other organisations (refer Annexure A & B).

4.1.8 The operating organisation shall establish a documentation control system to make sure that all documents affecting activities important to safety are issued, updated, filed and circulated in such a manner as to prevent the use of superseded documents (see Safety Guide AERB/SG/QA-5).

4.2 Recruitment Programme

4.2.1 On the basis of organisational structure discussed in Section 3, appropriate staffing and qualification requirements at the different levels in the organisation shall be determined and the selection, training and retraining requirements shall be specified. In doing so, the management should recognise that a nuclear programme requires a complex technology, which is continually evolving, and such a programme would consequently require highly qualified personnel capable of ensuring efficient and safe operation under normal conditions and proper response during emergency conditions.

4.2.2 Staffing requirements shall take into account:

(1) The need to involve the operating organisation in the review of activities, including those during the design, construction and commissioning stages;

(2) The need to establish timely liaison with the regulatory body, public authority and other organisations;

(3) The minimum number of persons necessary for performing all functions with respect to plant operation and emergency situation, with a view to avoiding excessive loads being placed on individuals;

(4) The need, particularly in the case of remotely located plants, for adequate expertise, special equipment;

(5) The statutory requirements on working conditions;

(6) The man power turn over in the operating organisation;

(7) Long term manpower requirements for future projects;

(8) The policy of the operating organisation with respect to maintenance and other functions (eg. extent of maintenance carried out on shift, extent of employment of contractors, repairs versus replacement of components, centralised workshops, etc.);

(9) The need for training and retraining of plant personnel.

4.2.3 Recruitment shall start early enough to permit the establishment and proper implementation of selection methods and the timely availability of personnel for preparatory training. The management shall provide for

systematic recruitment of personnel with adequate expertise and shall ensure consistency in the standard of this expertise.

4.3 Training, Authorisation and Retraining Programmes

4.3.1 A training programme shall be established to ensure that personnel involved in all levels of operation of nuclear power plants have the requisite competence. Instructors shall be technically competent and possess teaching ability. The operating personnel shall be adequately trained to cope with both normal and emergency situations. The necessary aids, such as simulators, mock-ups and feedback of information on operating experience should be arranged by the operating organisation to ensure that the desired level of competence is maintained.

4.3.2 The programme shall provide training plans and schedules for the various categories of personnel, taking into account the background of the personnel to be trained and the facilities available.

4.3.3 The programme shall be established early enough to provide trained personnel for implementing the commissioning programmes. In addition suitable arrangements shall be made with vendors, designers and other participating organisations for training. This is to ensure that a cadre of competent personnel, including managers who are familiar with the plant and who are capable of taking decisions appropriate to their assignments, is established during the pre-operational phase.

4.3.4 The programme may be evaluated by training officers who should follow up the results of the training activities. Such a follow-up should be organised in the form of assessments undertaken at a frequency that ensures that corrections are timely. The effectiveness of the programme should be evaluated by assessment of the general results.

4.3.5 Retraining shall be on a continuing basis in order to limit the risk of human error. The extent and frequency of training and retraining should be based mainly on experience gained from analysing performance of systems and plant items, the incidents encountered, the major modifications carried out and the personnel behaviour and performance.

Operating personnel should be used where appropriate as instructors in order to provide first hand experience and information on operating characteristics and problems.

4.3.6 It shall be the responsibility of operating organisation to assess the qualification of people before their final assignment to activities having a bearing on safety (see Safety Guide AERB/SG/0-1).

4.4 Commissioning Programme

4.4.1 The operating organisation shall ensure that a comprehensive commissioning programme is established and implemented to demonstrate that the plant has been constructed as specified and will be operated in a safe and efficient manner.

4.4.2 In view of the subsequent operating phase of the plant, the operating organisation shall verify that the commissioning programme:

(1) Is consistent with the provisions of the safety analysis report;

(2) Is in accordance with the requirements of the regulatory body;

(3) Demonstrates the validity of operating instructions and procedures and provides an opportunity for the operating personnel to improve their competence;

(4) Supplies information and data necessary to verify the adequacy of provisions made for implementing the management programmes.

4.4.3 When commissioning activities are conducted, the operating organisation shall make the necessary arrangements to review and approve these activities at all stages.

4.4.4 Commissioning experience should be evaluated as an aid to formulating more effective commissioning programmes. To this end and to assist retention of commissioning expertise for use at later plants, the operating staff of the nuclear power plant should be augmented during the commissioning period.

4.5 Operations Programme

4.5.1 For the safe operation of the plant, administrative controls shall be established that include operational limits and conditions, modification procedures and operating instructions and procedures. Requirements for review and approval, particularly at the corporate level, shall be specified. These controls constitute the operations programme and shall be established before commencement of operation:

4.5.2 The Plant Management shall provide for the development of operating instructions and procedures and reviewed by Op.O so as to:

(a) ensure that all activities affecting safe operation have approved procedures and appropriate instructions;

(b) ensure compliance with operational limits and conditions and regulatory requirements;

(3) ensure that these are written and verified by properly qualified persons in accordance with quality assurance requirements (see Safety Guide AERB/SG/QA-5);

(4) ensure that these are in accordance with design assumptions and intent and updated based on safety review;

(5) ensure that these provide sufficient details for the person assigned to perform the activity to do so without direct supervision.

More details are given in Annexure B on the development of operating and maintenance procedures.

4.5.3 The steps to be taken to ensure compliance with operating instructions and procedure should include:

(a) format and layout of manuals and establishment of a documentation control procedure to ensure that the latest approved issue of any document is used;

(b) clear assignment of the tasks to be performed and recording of their completion;

(c) assurance that adequate staff are available to accomplish the tasks for both normal and emergency situations;

(d) assurance that adequate communication between plant personnel exists, particularly with regard to transfer of responsibility, plant status, abnormal conditions, unfinished work and temporary modifications. Special administrative control should exist to ensure that plant control room operators know the status of all plant items;

(e) assurance that the persons assigned to perform each activity know the precautions to be taken for their own safety and the safety of the plant.

For development of plant manuals containing instructions and procedures see Annexure A.

4.5.4 Programme for generation and interface with regional electricity boards is the responsibility of plant management.

4.6 Quality Assurance Programme

4.6.1 A quality assurance programme shall be established for the operating phase. Recommendation and guidance are provided in the Safety Guide on Quality Assurance during Commissioning and Operation of NPPs.

4.6.2 The quality assurance programme (see AERB/SG/QA-5) shall ensure that all activities important to safety are adequately monitored, controlled and assured to be within design assumption and intent and plant status is within operational limits and conditions. For this purpose, review and audit processes including the establishment of safety review committees (see also section 3.2.1.2.vi) shall be provided at the appropriate management levels. During the design, construction, and pre-operational phases, the operating organisation shall conduct such reviews and audits as may be required to ensure that the design provisions are adequate for implementing the management programmes for safe operation of nuclear power plants. During the commissioning and operating phases, the operating organisation shall conduct such verifications, reviews and audits as may be required to ensure that:

(1) Management programmes are implemented adequately;

(2) All "as built" documentation is transferred to the operating organisation before commencement of operation and is thereafter kept updated;

(3) Changes external to the plant and to the site do not invalidate the safety analysis report;

(4) Any changes to operational limits and conditions and significant modifications to the plant and plant procedures are undertaken in accordance with approved procedures;

(5) Feed back of experience, inside or outside the organisation, is effective;

(6) Detrimental trends and other safety problems are identified, and the appropriate actions are taken;

(7) Safe operability of the plant is not jeopardized as a result of non-availability of spare parts or obsolescence of equipment.

(8) Non-conformance with Technical Specifications, Manual for Radiation Protection Procedures, Atomic Energy Factories Rules are recorded, reviewed and reported along with corrective actions taken.

4.7 Technical Services Programme

The Technical Service programme is established from the early stages of the formation of the P.M. at the NPP. It consists of engineers, reactor physicists and chemists with experience of participation in the commissioning activities and carries out routine and non-routine actions as indicated below:

(i) Engineering assistance as may be required to operate efficiently the station/systems at optimum performance;

(ii) Carry out technical auditing of plant systems;

(iii) Performance evaluation of systems, engineering/technical studies as necessary of systems, their reviews and reports on routine monthly/ annual basis;

(iv) Compiling all outstanding system deficiencies jobs and classifying them on priority and co-ordination in their implementation as applicable during plant operations/ short shutdowns and long shutdowns;

(v) Reactor physics, core management and fuel records;

(vi) Chemistry control of the systems;

(vii) Upkeep of computational facilities for management information service;

(viii) Upkeep of station documentation and archives;

(ix) Technical analysis of incidents and their reporting;

(x) Processing of design change proposals and arranging for their implementation;

(xi) Preparation of work plans for non-routine jobs as may be required during plant operation and shutdown.

4.8 Radiation Protection Programme

4.8.1 This programme shall cover radiation dose monitoring and control; it shall ensure that doses to individuals remain within prescribed limits and its objective shall be that collective doses be kept as low as reasonably achievable (ALARA) and within approved man-rem budget (see Safety Guide AERB/SG/0-5).

4.8.2 For protecting plant personnel, the programme shall recognise the need for effective training, particularly of people working in high radiation or contamination areas and the value of practical rehearsals performed on models or mock-ups.

4.8.3 The programme shall also consider area and process monitoring as means of detecting trends towards unacceptable conditions.

4.8.4 Plant personnel collective exposure should be systematically investigated to identify if there are any specific causes in relation to site activities. These should be taken into account in developing/modifying work procedures or facilitating plant modification so as to keep the doses within ALARA.

4.8.5 The programme shall include arrangements made by the operating organisation to secure services of medical institutions and hospitals to take care of persons exposed to excessive radiation and/or contamination.

4.8.6 Proper zoning and provision of decontamination facilities for plant personnel and equipment, measures to prevent contamination and air activities should be made.

4.9 Environmental Monitoring Programme

4.9.1 The programme shall require a preliminary study of the environment to be undertaken two or three years before start of operation and the records of this study shall be kept as a base-line data for comparison with subsequent monitoring results to give the operating organisation the assurance that operation of the plant does not result in unacceptable hazards to the public. For this purpose, an Environmental Survey Laboratory (ESL) shall be set up at NPP with the approval of AERB to collect environmental data which shall be regularly submitted to NPP/AERB.

4.10 Fuel Management Programme

4.10.1 The fuel management programme shall give special consideration to the safety aspects of fuel procurement, site storage, irradiation, handling and transportation of fuel for which the operating organisation is responsible. See SG-0-10 for further details.

4.10.2 The fuel management programme should cover:

(a) establishment of detailed technical specifications and quality assurance requirements for procurement;

(b) special studies to be undertaken to demonstrate the ability of new fuel to meet the provisions of the safety analysis report;

(c) arrangements to ensure safety during transportation, storage and handling of new and irradiated fuel (See AERB/SC/TR-1);

(d) establishment of core calculation programmes to define fuel and absorber loading patterns, to maintain compliance with reactivity, adequate shutdown margins, temperature and irradiation or burn-up limits, to verify start-up testing methods and to establish associated surveillance requirements;

(e) implementation of applicable requirements for the examination of irradiated fuel and use of results to monitor fuel performance (mainly applicable to LWRs).

4.11 Emergency Response Preparedness Programme

4.11.1 The emergency response preparedness programme shall ensure that the operating organisation and the concerned public authorities are prepared to respond adequately to on-site and off-site radiological emergency situations as applicable before the commencement of operation. To achieve this objective, an emergency plan shall be established before the commencement of operation. This plan shall be suitably integrated with public authorities. This requires interaction with national, state level, local government and other organisations to specify clearly the delineation of responsibilities. Emergency Response Preparedness Manuals are of two types:

(i) Plant and On-Site Emergency Response Manual. This is prepared by the Plant Management;

(ii) Off-Site Emergency Response Manual. This is prepared by a State Level Committee and authorised by the respective State Government after approval by National Level Committee headed by Secretary, DAE.

4.11.2 The emergency preparedness programme shall provide for:

(a) establishment of an emergency response organisation with clearly delineated responsibilities and authorities which is capable of coping with various types and magnitude of emergency situations;

(b) co-ordination and liaison with participating organisations;

(c) adherence to statutory requirements;

(d) prompt assistance to the plant management in the areas of technical effort and emergency equipment;

(e) assurance of continued emergency preparedness by means of appropriate training and rehearsals.

4.11.3 The on and off-site emergency plans shall particularly define:

(a) conditions for declaring start of emergency;

(b) activation and notification procedures;

(c) monitoring to be performed and counter measures to be taken;

(d) protective action capabilities;

(e) services and facilities to be provided;

(f) responsibilities of various units/organisations and plant personnel;

(g) conditions for declaring termination of emergency.

4.11.4 Emergencies due to initiating events such as fires, toxic clouds, etc. may jeopardize the operations of systems and components important to safety. These kinds of emergencies require special consideration in the emergency preparedness programme.

4.12 Waste Management Programme

4.12.1 The waste management programme shall ensure that gaseous, liquid and solid radioactive wastes arising from the operation of nuclear power plant are satisfactorily controlled so that authorised discharge limits are complied with, and satisfy the ALARA principle.

4.12.2 The programme shall specify the monitoring, accounting, storage and handling arrangements applicable to all types of radioactive waste arising on site, and specify any on-site processing of such wastes. Provisions for final disposal shall be made in accordance with national practices and programmes on the subject.

4.12.3 The waste management programme policies shall be established early enough to be reflected in design features such as:

(a) minimizing waste production by emphasizing reliability and leak tightness of components through suitable choice of materials and chemical processes;

(b) adequacy of the collection and storage systems;

(c) adequacy and reliability of waste treatment facilities;

(d) provision of proper monitoring instrumentation.

4.12.4 The P.M. shall make an application for discharge of radioactive wastes and obtain Authorisation for the same from Regulatory Body.

4.12.5 The P.M. shall also apply and get consent from State Pollution Control Board as applicable to discharge effluents into water and air routes.

4.13 Surveillance Programme

4.13.1 The surveillance programme shall ensure that items important to safety continue to perform in accordance with design assumptions and intent. The programme shall include evaluation and review requirements to detect in a timely manner degradation of structures, systems and components that could lead to unsafe conditions. The Safety Guide on "Surveillance of Items Important to Safety in NPPs (AERB/SG/0-8) provides recommendation and guidance.

4.13.2 The programme shall be developed sufficiently in advance of plant commissioning to permit it to be properly implemented as plant items become operational during the commissioning phase, and to ensure that the safety of the plant is not dependent upon untested or unmonitored structures, systems and components (see Safety Guide AERB/SG/0-4).

4.14 Maintenance Programme

4.14.1 The maintenance programme shall ensure that the level of reliability and effectiveness of all plant structures, systems and components important to safety remains in accordance with design assumptions and intent, and that the safety status of the plant is not adversely affected after the commencement of operation (see Safety Guide AERB/SG/0-7).

4.14.2 Because the design and design objectives of nuclear power plants have a strong influence on the maintenance programme, its development should be initiated sufficiently early in the design phase in close liaison with the design organisation (refer Annexure B).

4.14.3 The programme shall be established at such a time that it can be implemented to the extent necessary to cope with the plant systems as they are put into operation or transferred to the responsibility of the Plant Management, whichever comes first.

4.14.4 To keep radiation exposure to individuals ALARA and to prevent the spread of contamination, the maintenance programme shall include provisions for decontaminating plant items.

4.14.5 Adequate inventory of stores and consumables shall be maintained, in particular of items important to safety.

4.14.6 Spare parts to be available at site for dealing with emergency situations until such time as they are augmented from off-site sources.

4.15 Physical Protection Programme

4.15.1 Appropriate physical protection arrangements shall be planned, implemented and verified as soon as any plant items important to safety are received on site, before commencement of commissioning, and in any case before the arrival of fuel on the site.

4.15.2 Protection against external or internal malevolent actions jeopardizing safety shall be provided by trained personnel. Consideration shall be given to:

(a) access controls around the site and within the plant area;

(b) access rules to be observed for different zones of the site and provisions to detect and prevent or delay unauthorized entry;

(c) establishment of procedure for access authorisation;

(d) selection and training of security personnel;

(e) communication systems to be used;

(f) security arrangements for items important to safety at site.

4.16 Fire Protection Programme

4.16.1 Adequate arrangements for protection against fire shall be provided and should include the following:-

(a) fire detection system;

(b) portable fire extinguishers;

(c) fixed fire extinguishing system;

(d) fire fighting staff;

(e) fire barriers/stops;

(f) fire retardant coatings;

(g) fire dampers on ventilation ducting.

4.17 In-Service Inspection (ISI) Programme

4.17.1 Regular ISI of components, systems and structures shall be carried out as specified in the plant ISI document (see AERB/SG/O-2).

4.17.2 The ISI should be coordinated with annual shutdown outages.

4.17.3 The critical equipment shall be identified and inspected more frequently.

4.17.4 The frequency of inspection shall be governed by the observed deviations.

4.17.5 Appropriate corrective actions based on the findings of ISI shall be taken.

4.18 Industrial Safety Programme

4.18.1 The Plant Management shall make adequate arrangements for industrial safety of all personnel working at the site. The P.M. should ensure that all the requirements of Atomic Energy (Factories) Rules, 1996 are complied with.

5. INFORMATION AND LIAISON

5.1 Information Flow

5.1.1 The programmes discussed in section 4 shall provide for efficient dissemination of relevant information, including operating experience to levels where it can be properly utilised. The information shall be selected and distributed to appropriate personnel in summarised form when that is desirable.

5.1.2 All technical information generated in the station or outside should be available in the library. Important information shall be displayed on notice boards.

5.1.2 To meet the management objectives discussed in Section 2, an appropriate system of liaison shall be established between participating organisations. Particular attention shall be placed on establishing channels to ensure that:

(1) General Safety principles and policies relevant to operation are taken into account in the design.

(2) There is adequate feed back of operation, maintenance and surveillance experience particularly to design and operating personnel (see Safety Guides AERB/SG/0-7 and AERB/SG/0-8).

(3) Requisite information is provided to the regulatory body and arrangements made for appropriate dissemination of its requirements within the operating organisation.

5.2 Liaison at the Design Stage

5.2.1 The operating organisation should participate in design review early in design stage so that a positive contribution could be made for improvement in plant design by way of feedback of operating experience. In addition, it also helps to acquire an in-depth knowledge of the plant design and a thorough understanding of operational limits and conditions for operation. The operating personnel should especially consider the following:

(1) Adequacy of redundancy of systems and components to meet operational limits and conditions and other operational requirements;

(2) Extent of automatic control;

(3) Specifications concerning:

(a) Components,

(b) Instrumentation for normal operation and accident conditions;

(4) Post-accident conditions;

(5) Radioactive waste handling and disposal, including provision for post accident conditions;

(6) Type and number of spare parts and their procurement time;

(7) Requirements for maintenance, surveillance and in-service inspection including access and availability of equipment and facilities;

(8) Radiation protection arrangements to meet ALARA principle and statutory requirements;

(9) Assessment of on-site and off-site consequences of postulated accident conditions;

(10) General layout as regards convenience and efficiency of operation, particularly in relation to contamination control and keeping doses ALARA;

(11) Ergonomic aspects, especially to provide for rapid assessment of plant conditions, proper operator response and prevention of inadvertent actions;

(12) Maintainability, testability and calibration of instruments;

(13) Provision for decommissioning.

5.3 Liaison During the Construction Stage

5.3.1 The operating organisation should arrange for the involvement of its maintenance personnel in construction activities so that they undergo hands-on training in complex operations requiring special skills. This would also assist in the development of operating and maintenance instructions and in the transfer of all requisite "as built" documentation.

5.4 Liaison During the Commissioning Stage

5.4.1 Direct involvement of the operating organisation in commissioning tests, performance and evaluation of test results would enable them to validate the operating procedure and obtain operating experience to facilitate the transfer of responsibilities from the commissioning to the operating groups. Detailed recommendations and guidance are given in Safety Guide on Commissioning of Nuclear Power Plants (AERB/SG/0-4).

5.5 Liaison During the Operational stage

5.5.1 Liaison during the operational stage shall be established to provide the feedback of experience to the various groups in the operating organisation, design organisation, architect/engineer organisation,

research services and the regulatory body as appropriate. This liaison should thereby lead to improvements in the operational aspects of design and in the operating procedures relevant to the operational needs of the plants. The system shall also ensure the collection and evaluation of information from other operating plants on any unresolved safety question, maintenance problems, incident and accident conditions, and component and system behaviour.

5.6 Liaison with the Regulatory Body

5.6.1 The operating organisation shall maintain a close liaison with the Regulatory Body to meet the safety requirements specified in the appropriate safety codes, guides, standards and other safety directives issued by the regulatory body. Nuclear power plants are required to submit periodic reports containing performance parameters, details of surveillance, major maintenance activities, data on disposal of radioactive wastes and radiation exposure to personnel. Safety related unusual occurrences and violations of plant Technical Specifications are required to be reported in a prompt manner. Prior approval from the regulatory body is required for modifications and design changes to safety related systems. The operating organisation shall participate/co-operate in the regulatory review process at various levels as established by the regulatory body and implement the recommendations made by the different safety committees of the regulatory body. Plant shall co-operate with the regulatory body in carrying out regulatory inspections and take prompt necessary steps to correct deficiencies noticed after such inspections.

6. SUPPORTING FUNCTIONS

6.1 General

6.1.1 Certain services and facilities complementary to the direct operating functions are called supporting functions. The services are the expertise and assistance made available to the plant management to support the operation of the nuclear power plant. The facilities are the equipment and systems required by the services. All personnel performing services shall be technically competent and adequately trained in administrative controls, quality assurance requirements, radiation protection and applicable emergency procedures.

6.1.2 The operating organisation shall make arrangements to provide the following services and facilities:

(1) Training Service (Section 6.2);

(2) Technical Services (Section 6.3);

(3) Quality Assurance Services (Section 6.4);

(4) Radiation Protection and Emergency Preparedness (Section 6.5);

(5) Maintenance and Surveillance Services (Section 6.6).

6.1.3 Other services and facilities to be provided include:

(1) Fuel management;

(2) Performance engineering;

(3) In-service inspection, including special inspection services;

(4) Assessment of design or procedural modifications taking into account abnormal occurrences, emergency situations and accident conditions;

(5) Waste management and environmental monitoring;

(6) Chemistry control;

(7) Major repairs, modifications and maintenance;

(8) Decontamination;

(9) Review of implementation of management programmes;

(10) Stores.

6.2 Training Service

6.2.1 Appropriate specialists shall be provided for training operating personnel in accordance with the training programme. Facilities for practical initial training and retraining of plant operators shall be available including training on simulator. The training of maintenance personnel may be augmented by secondment to manufacturers' establishment or construction group.

6.2.2 The training of personnel for special operational or maintenance activities, particularly where high radiation fields may be encountered, should utilize models and mock-ups under realistic conditions so as to improve the quality of the work and to keep radiation doses ALARA. Photographs taken during construction of the plant, or during special maintenance operations, will be helpful in subsequent training courses.

6.3 Technical Services

6.3.1 The responsible organisation shall arrange for the availability of personnel competent to undertake and/or sponsor independent assessments of design studies and development of work modifications on plant items important to safety. This service may be called on to provide assistance in the production of plant specifications, assessment of proposed designs and supervision of the engineering work.

6.3.2 An advisory service with appropriate expertise should be provided. The service should be established to evaluate operating experience, including the analysis of incidents and accidents, so that timely investigations of safety issues can be undertaken and any consequential changes to the operational limits and conditions, and to operating and maintenance instructions, and any plant modifications can be made without delay.

6.3.3 Special arrangements shall be made for maintaining commissioning and operational records, including their long term storage. The compilation of operational data should be such as to facilitate the determination of component reliability, and to provide information useful for design and for plant modification activities.

6.3.4 Services for core management and fuel accounting shall be provided. The Safety Guide AERB/SG/0-10 provides guidance and recommendations on this subject.

6.3.5 Support services and facilities shall be arranged in relation to performance engineering, chemistry control, decontamination and major repairs and modifications.

6.3.6 Retrofitting

6.3.6.1 The requirements for retrofitting of systems may emerge in the context of upgradation based on regulatory requirements as a consequence of subsequent increase in knowledge with respect to what was originally considered.

6.3.6.2 Retrofitting of components may be necessitated in the context of subsequent availability of improved components of better and acceptable quality.

6.3.6.3 Retrofitting of structures, may be necessitated based on the additional requirements as a result of operating experience.

6.3.7 Ageing Management

6.3.7.1 Ageing of the NPP is an expected occurrence which is dependent mainly on the factors described below and appropriate measures are necessary to ensure that the useful life of the plant is achieved. The factors to be considered are:

(i) Corrosion;

(ii) Irradiation effect;

(iii) Deterioration in components performance;

(iv) Degradation in components and structures;

(v) Timely identification of degraded equipment when the general condition of the plant is satisfactory;

(vi) Thermal cycling effects.

6.3.7.2 The measures to control ageing related effects are:

(i) Chemical control;

(ii) In-service inspection;

(iii) Spare parts management;

(iv) Surveillance, repair and replacement;

(v) Timely procurement of major components requiring replacement.

6.4 Quality Assurance

6.4.1 Consideration shall be given to the supporting services needed by the operating organisation management to meet the recommendations of the

Safety Guide on Quality Assurance during Operation of Nuclear Power Plants (AERB/SG/QA-5) and any regulatory requirements.

6.4.2 The following activities should be undertaken by centralised services in all power stations to maintain uniform safety standards.

(1) Assessing manufacturers' systems for the application of quality assurance to plant and equipment being provided for nuclear power plant modification;

(2) Ensuring that equipment delivered is of the specified quality;

(3) Arranging for training and, where appropriate, certifying the competence of personnel for specialized crafts and inspection techniques;

(4) Developing and maintaining quality standards, common purchasing specifications and classification codes for systems, components and materials;

(5) Verifying that the quality assurance programme has been implemented satisfactory. This includes verifying coordination of on and off-site activities;

(6) Providing a pre-commissioning inspection service on new systems and equipment installed on-site;

(7) Making available suitable qualified staff to undertake the review and audit activities mentioned in Section 4.6.

6.4.3 The Plant Management shall establish, at least before the commissioning stage, a comprehensive documentation control system to ensure that:

(a) documents are prepared, reviewed, approved and circulated according to established procedures;

(b) documents are categorised, filed and stored in an easily retrievable manner;

(c) documents are updated according to established procedures;

(d) only the latest version of any document is available to personnel; this is to prevent the use of superseded documents.

The above documentation system shall also continue during the operational stage of the NPP.

6.5 Radiation Protection and Emergency Preparedness

6.5.1 The requirements for application of radiation protection in a nuclear power plant are fully detailed in the Safety Guide, Radiation Protection

during Operation of Nuclear Power Plants (AERB/SG/0-5). Suitably qualified personnel shall be made available as necessary to carry out an independent review of the activities of radiological services provided at the plant.

6.5.2 Appropriate specialist services shall be provided to give advice and technical support on:

(1) Safety analysis during design and during the review of designs and processes;

(2) Specification of radiological laboratories for monitoring personnel and the environment;

(3) Radiological aspects of commissioning and operation including emergency arrangements;

(4) Evaluation of operational experience in the radiological field;

(5) Radiological aspects of modifications to plant and procedures;

(6) Development of techniques and equipment to reduce personnel doses;

(7) Compliance of statutory requirements and the methods of ensuring satisfactory evidence of compliance with these requirements in relation to authorisations to discharge radioactive effluents, to transport radioactive material, and to manage contaminated waste on site.

6.5.3 The Health, Safety and Environment Group of BARC shall maintain a central radiation exposure record system and use it for regulating individual exposures.

6.5.4 Suitable medical advice and appropriate bioassay facilities shall be made available so that appropriate medical examinations on personnel employed in the process can be performed and advice on specific radiological medical problems can be provided. Standby provision of hospital services shall be arranged to cover the possibility that medical assistance involving radiological factors may be required.

6.6 Maintenance and Surveillance Services

6.6.1 A routine maintenance service shall be provided to meet the requirements of the maintenance schedule, maintenance instructions and the surveillance programme. The personnel of maintenance team shall possess the requisite standard of skills and receive appropriate training in radiation protection and quality assurance.

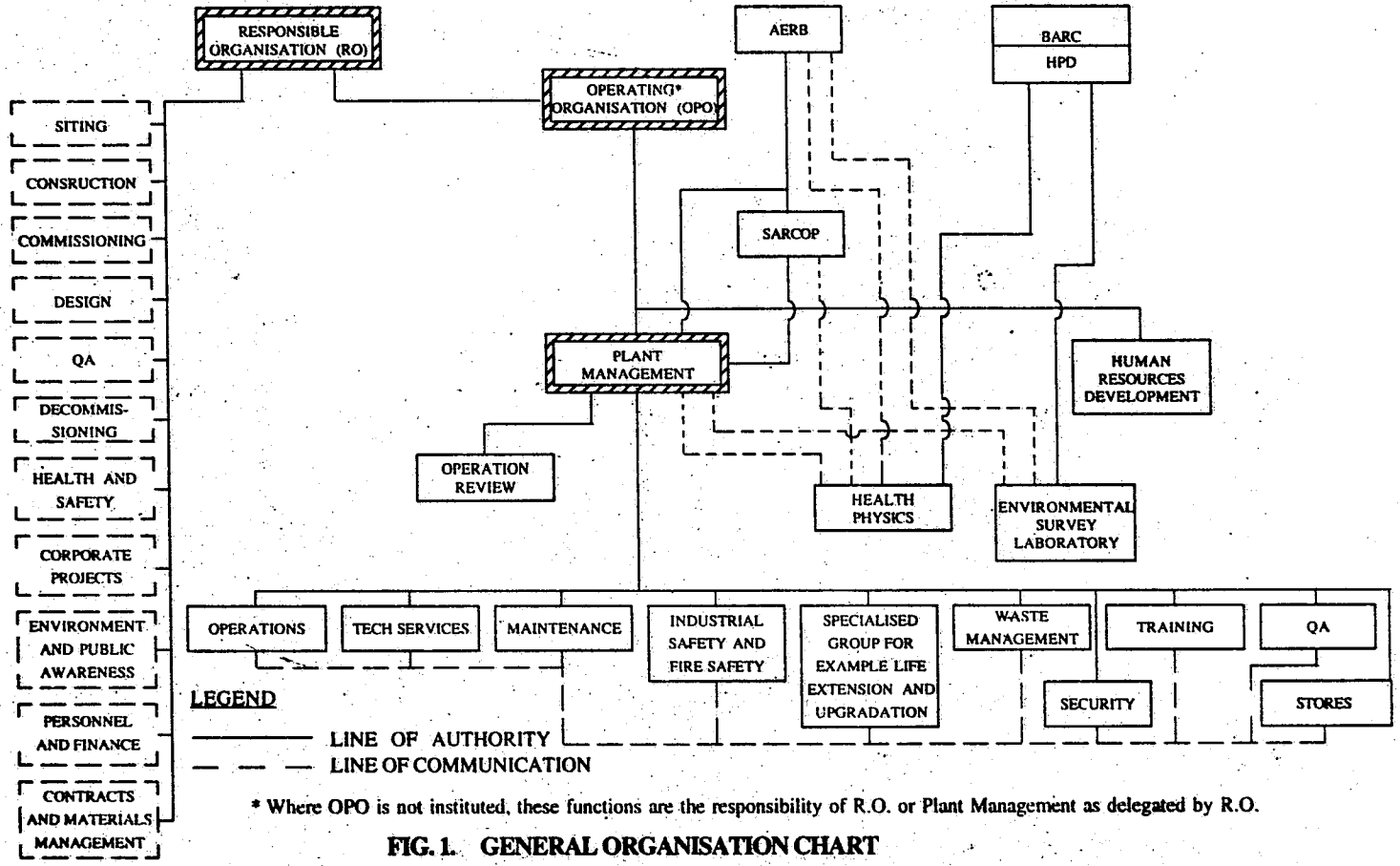
6.6.2 Provision should be made for compiling maintenance records to facilitate the review of methods and frequency of maintenance, and test and inspection procedures, and to provide reliability data for component reliability evaluation.

6.6.3 Consideration shall also be given to achieving uniformity in pre-service and in-service inspection standards.

6.6.4 Development work employing appropriate mock-ups may be carried out in order to test new inspection and repair equipment before use on the actual plant.

6.6.5 Maintenance services should provide the expertise for the independent assessment of maintenance aspects of new designs and of plant modifications during service.

6.6.6 The surveillance programme will require provision of a service for calibrating instruments in accordance with relevant details given in the Safety Guide on Surveillance of Items Important to Safety in NPPs, AERB/SG/0-8.



* Where OPO is not instituted, these functions are the responsibility of R.O. or Plant Management as delegated by R.O.

FIG. 1. GENERAL ORGANISATION CHART

ANNEXURE-A

DEVELOPMENT OF INSTRUCTIONS AND PROCEDURES

A-1 Introduction

A-1.1 Section 4, on management programmes, states that all activities affecting safety shall be described by written instructions and procedures. For this purpose a set of plant manuals that serve as authoritative reference source should be issued and made available to all plant personnel. These plant manuals should provide a fundamental understanding of the operation and maintenance of the plant, plant systems, plant items and the rules that govern the activities of all plant personnel in relation to their responsibilities and duties. The manuals shall be produced in accordance with quality assurance requirements.

A-1.2 The manuals which consist of a series of documents should include the following subjects:

(1) Design concepts;

(2) Plant description and functions;

(3) Component descriptions;

(4) Operational limits and conditions;

(5) Station operating organisation and responsibilities;

(6) Operating instructions and procedures;

(7) Maintenance instructions and procedures;

(8) Testing instructions and procedures;

(9) Statutory conditions and management policy;

(10) Radiation protection procedures.

A-1.3 Additional instructions and procedures should be elaborated on the basis of the actual local need and local administrative responsibilities.

A-1.4 The manuals will require continuous updating to include any modifications. The procedure to ensure that the appropriate modifications to the manuals are made shall be incorporated into the documentation control system (see section 6.4.3).

A-1.5 The layout of each section of the manual shall be consistent and clear, with each page identified as a distinct part of the document, and any revision that may have been made shall be shown along with its authorisation.

A-1.6 Preparation and submission of the following documents shall be ensured by the operating organisation sufficiently in advance as indicated for purpose of obtaining approval as necessary from the regulatory body. These documents shall further be made available to the plant personnel as plant manuals. (Please refer to item 13 of bibliography)

Submission of Supporting Documentation with Application for Authorisation at Different Stages

	Name of Document	Typical Schedule for Preparation
1.	Safety Report	Preliminary: prior to start of construction Final: prior to request for operation at desired power level
2.	Technical Specification and Station Policies for plant operation	Prior to fuel loading/heavy water addition
3.	Complete set of flow sheets and logic diagrams	Prior to relevant commissioning
4.	On-site and Off-site Emergency Preparedness Plans	Prior to first approach to criticality
5.	Design basis manuals	Prior to authorisation for commissioning
6.	Training Manuals	Available at site prior to fuel loading/heavy water addition whichever is earlier
7.	Operating Manuals	Available at site prior to fuel loading/heavy water addition whichever is earlier
8.	Radiation Protection Manual	Available at site prior to fuel loading/heavy water addition
9.	Maintenance Manuals	Available at site prior to PHT hot conditioning
10.	Fire Protection Manuals	Available at site prior to start of construction
11.	Commissioning/Testing and Inspection Manuals	Before relevant authorisation stage
12.	Commissioning Report	Before seeking authorisation for subsequent stage
13.	In-service Inspection and Testing Manuals	Prior to initial criticality

A-2 Brief Scope of Typical Plant Manuals

A-2.1 Safety Reports

In regulation of Nuclear Power Plants, safety reports form the principal communication between the applicant and the Regulatory Body. Safety reports should be precise, lucid and easily understandable. These should contain sufficient information to enable regulatory body to conduct a review of the safety analysis. When necessary, further details on certain information should be given by reference to specific documents. Safety reports should contain the Principal Design Criteria and Design Bases Information and include Design Evaluation and Safety Analysis of the proposed NPP.

(i) Safety reports should be issued in two successive stages as indicated below.

(a) Safety Report (Preliminary): This should contain preliminary description of the NPP and safety analysis based on the intended siting and design. Where any of the topics cannot be given full coverage at this stage, sufficiently detailed information (design bases, specifications and calculations) should be provided to enable assessment of the feasibility of the plant at the proposed site, with regard to public health and safety, before commencement of construction.

(b) Safety Report (Final): This should be updated version of the safety report (preliminary) with current specific information. It should also include detailed description of the operational aspects and safety of operating personnel.

(ii) Contents of Safety Report

In terms of content there are two parts of the Safety Report as follows:

Part-A : Design Description, bringing out the Design Bases, safety aspects of the plant and data relevant for safety analysis.

Part-B : Safety Analysis giving an assessment of the consequences of postulated initiating events (PIEs) and event consequences.

A-2.2 Technical Specification for Operation and Station Policies

This gives limiting conditions for operation, station operating organisation responsibilities, surveillance requirements, statutory conditions and management policies with the main aim of ensuring safety of station personnel, members of public, the environment and plant equipment.

A-2.3 Operating Instructions and Procedures

These are covered in the operating manuals. Operating manuals will cover all systems, which need to be operated. Some of the important systems are listed below:

(i) Primary heat transport;

(ii) Moderator;

(iii) Boiler steam and water;

(iv) Reactor auxiliaries;

(v) Emergency core cooling;

(vi) Reactor protection;

(vii) Reactor regulation;

(viii) Fuel handling;

(ix) Turbo generator;

(x) Electrical;

(xi) Common services;

(xii) Waste management;

The contents will include:

(a) normal operation (start-up, steady state and shut-down);

(b) safety limits and alarms;

(c) off-normal operations/Emergency operations;

(d) precautions and hazards.

The method of developing operating manuals is given in Annexure-B.

A-2.4 Maintenance Instructions and Procedure Manuals

This section contains the latest issues of all maintenance instructions. These are in the form of step-by-step instructions for preventive and breakdown maintenance, taking into account the need for maintaining radiation doses ALARA, as well as the identification of the spare-parts and assemblies, special equipment and tools that are needed.

A method similar to that given for the development of operating instructions (see Annexure-B) should be adopted for maintenance instructions.

ANNEXURE-B

DEVELOPMENT OF OPERATING AND MAINTENANCE PROCEDURES

B-1 Introduction

B-1.1 General

B-1.1.1 All operating and maintenance related activities shall be performed in conformity with written documents, as applicable, issued in accordance with approved procedures. This annexure highlights some of the more important aspects of a method to develop plant procedures.

B-1.1.2 Persons shall be designated to draw up and verify procedures and they shall possess an appropriate level of competence and experience to carry out this work.

B-1.2 Scope of Procedures

Each procedure shall be sufficiently detailed for a qualified individual to be able to perform the required activities without direct supervision, but need not provide a complete description of the plant process involved.

B-1.3 Contents of Procedures

The format of procedures may vary from plant to plant, depending on the policies of the operating organisation, but it shall be in accordance with quality assurance requirements.

B-2 Operating Procedures

B-2.1 General

B-2.1.1 Operating procedures cover:

(a) systematic procedures for operating within specified operational limits and conditions, including; startup, shutdown, changing modes of operation, and operation of items and systems related to safety;

(b) general plant procedures for operating within specified operational limits and conditions, including: starting the reactor and establishing power operation, planned shutdowns or reactor trips, planned load changes, process monitoring, and fuel handling;

(c) procedures for anticipated operational occurrences, including corrective actions to bring the plant to safe state;

(d) procedures for identifying an emergency, correcting the off-normal conditions and mitigating the consequences.

B-2.2 Arrangements for Development of Operating Procedures

B-2.2.1 Procedures for operation during commissioning

B-2.2.1.1 Construction, commissioning and operating groups co-exist during the commissioning phase, and a gradual transfer of responsibilities takes place, from one group to the other, until the responsibility for the complete plant is taken over by plant management. During this time, operations should be performed by the operating group, under the responsibility of the commissioning group, in accordance with test procedures prepared for implementing the commissioning programme. The test procedures should follow normal plant operating procedures to the extent practicable; this is in order to verify and, if necessary, amend such procedures, and to provide an opportunity for operating personnel to become familiar with normal plant operating procedures.

B-2.2.2 Procedures for Operating Phase

B-2.2.2.1 Plant operation and surveillance are carried out in accordance with operating procedures developed along the lines shown in Fig.B-1 following quality assurance requirements.

B-2.2.2.2 Drafting of operating procedures (box 1, Fig.B-1) is normally done by the operating group. The main documents used as references include:

(1) Design assumption and intentions;

(2) Contractual documents of the constructors giving guidance on operation of systems and components;

(3) Commissioning documents, procedures for nuclear power plants;

(4) Procedures from plants of the same or similar type.

The operating group shall ensure in any case that procedures are consistent with safety reports, operational limits and conditions and any other regulatory requirements, as well as with the operating organisation policy contained in the plant manuals. (see Annexure A).

B-2.2.2.3 Review of the first draft, and in particular of its safety aspects (box 2, Fig.B-1) is to be performed by a suitably qualified person whose qualification is at least equal to that of the drafter of the document.

B-2.2.2.4 Comments on the draft are requested from the operating staff and as appropriate, from the designer (boxes 2 and 2A, Fig.B-1).

B-2.2.2.5 After approval by the plant management (box 3, Fig. B-1), the procedure is validated by first attempting to implement the procedure during the actual initial operation of each system or if necessary during simulated operation (box 4, Fig.B-1). This validation should be performed, where possible, by personnel other than those responsible for the drafting and review.

In those cases where only a simulated operation was carried out, the procedure is finally validated by the actual operation of the system as soon as this is possible.

B-2.2.2.6 If the validation test is satisfactory, the draft is sent to the station superintendent/chief superintendent with the recommendation that it be made executive. If it is not satisfactory, the draft is sent back to the drafter with proposed modifications (box 3A, Fig.B-1).

B-2.2.2.7 The procedures are made executive after it has been confirmed that no further modifications are considered necessary (box 5, Fig.B-1). The procedures are then entered into the documentation system, included in the plant manual and treated in accordance with quality assurance requirements (box 5, Fig.B-1).

B-2.2.2.8 All procedures thus made executive are distributed in accordance with written procedures and made available for use in the control room (boxes 6 and 7, Fig.B-1).

B-2.2.2.9 Reviews are carried out at stated intervals (usually one or two years) or whenever required in the light of operating experience (box 8, Fig.B-1).

B-2.2.2.10 Any modification to the procedures as a result of the above reviews is made in accordance with the flow diagram followed by the initial document (see Fig.B-1).

B-2.3 Particular Aspects of Emergency Procedures

B-2.3.1 The actions required for the operation of the plant under emergency conditions results from a diagnosis of the situation.

B-2.3.2 Operators have two major means at their disposal for making this diagnosis: firstly, information presented by control room instrumentation on plant conditions and particularly on the action taken by automatic protective systems; and secondly, the diagnostic aids provided (a) by documents stating the action to be taken for each alarm, (b) by a diagnostic logic diagram, and (c) by any special diagnostic facilities (such as a computer with diagnostic programs) that may be available.

B-2.3.3 It is extremely difficult to distinguish between procedures prepared for the purpose of correcting off-normal conditions (which in themselves do not constitute actual emergency situations, but which could conceivably degenerate into true emergencies in the absence of positive corrective action) and procedures required for coping with true emergencies that have already occurred. Some operating organisation use the term off-normal procedures for the same purpose that others use emergency procedures. When the information initially available to operating personnel via instrument readings, physical conditions, and personal observations does not clearly indicate the difference between a simple operational problem and a serious emergency, the actions outlined in the emergency procedures shall be based on a conservative course of action by the operating personnel. Careful judgment on the part of the competent personnel is required before any departure from the emergency procedures is made.

B-2.3.4 Because of the large amount of information presented to the operator in an emergency situation, the diagnosis-aid-document and the emergency procedures shall be clear, simple and reliable so that they permit a rapid and correct diagnosis and a correct response to the situation.

B-2.3.5 In order that the diagnosis-aid-document should respond to the above objectives, it should consist of two parts:

(a) a check list to ensure that automatic actions have been initiated and, if appropriate, corrective action taken;

(b) a diagnosis diagram.

B-2.3.6 The diagnosis diagram should specify the parameters (pressure, temperature, coolant level/boiler level, radioactivities, etc.) to be checked. This diagram should lead the operator towards the correct diagnosis and the appropriate emergency procedure.

B-2.3.7 Owing to the very nature of emergency procedures, considerable care has to be taken to present their contents clearly and to make them rapidly assimilable, so that the operator knows which actions appropriate to the situation are to be taken immediately and which should be taken later.

B-2.3.8 Emergency procedures should include:

(a) guidance on operator action in the event of unplanned situations not covered by specific instructions or procedures to ensure that core cooling is maintained;

(b) possible alternative procedures when the diagnosis has been found to be in error or is difficult to establish;

(c) warnings against premature or inappropriate actions.

B-3 Maintenance Procedures

B-3.1 Maintenance is carried out in accordance with procedures developed along lines similar to those shown in Fig. B-1.

B-3.2 The extent of documentation required for maintenance will depend on the complexity of the plant item concerned. The structure of the overall maintenance manual should be related to plant systems and divided as far as possible into constituent plant items in a systematic manner. An example of the break-up of the plant system into general instructions and detailed work specifications is shown in Fig.B-2.

B-3.3 Detailed work specifications issued to craftsmen shall be complied in accordance with quality assurance requirements and include the following, where appropriate:

(a) means of identifying the plant item or equipment or constituent parts thereof;

(b) specification of the necessary tools, material and equipment;

(c) sufficient information in an appropriate form for the task to be performed in a safe, practical and efficient manner;

(d) break-up of the task into sequential steps with sufficient detail for the work to be done by a competent person without continuous supervision;

(e) provision of adequate drawings and illustrations;

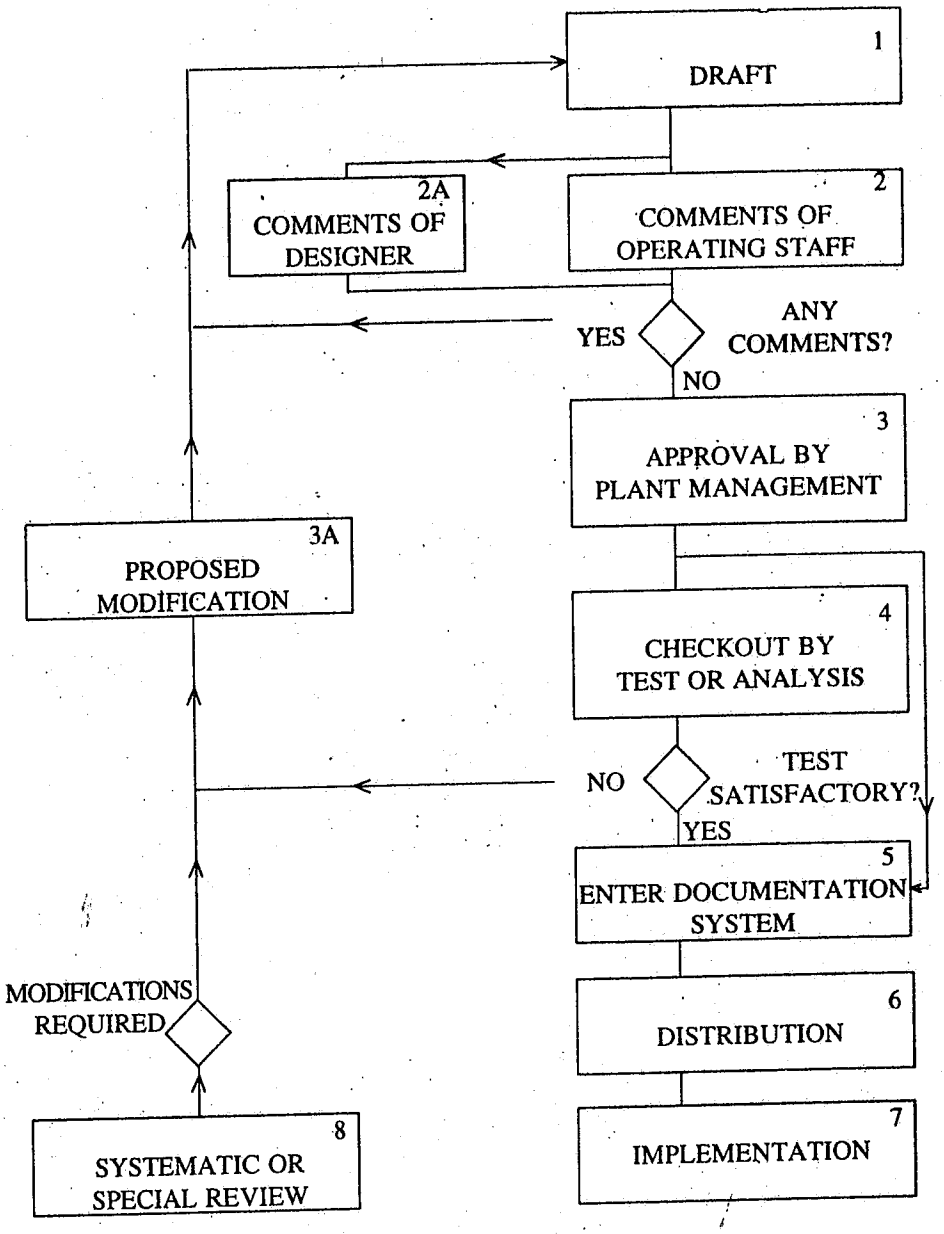
(f) identification of special tools or techniques needed at appropriate steps in the sequence;

(g) details of interfaces with complementary work carried out by other personnel;

(h) warnings of potential danger to plant or personnel and clear specification of precautions to be taken.

(i) identification of hold points where progress to the next step is dependent upon independent review. (Check sheets for signature by persons authorised to carry out this function are a useful aid to achieving compliance with the instructions).

An example of a work specification format is given in Fig.B-2.



NOTE: While preparing the operating procedures the safety requirements specified by aerb should be complied with. In specialised case when considered by PM approval of AERB may be required.

FIG. B-1 HOW DIAGRAM FOR DEVELOPING AN OPERATING PROCEDURE

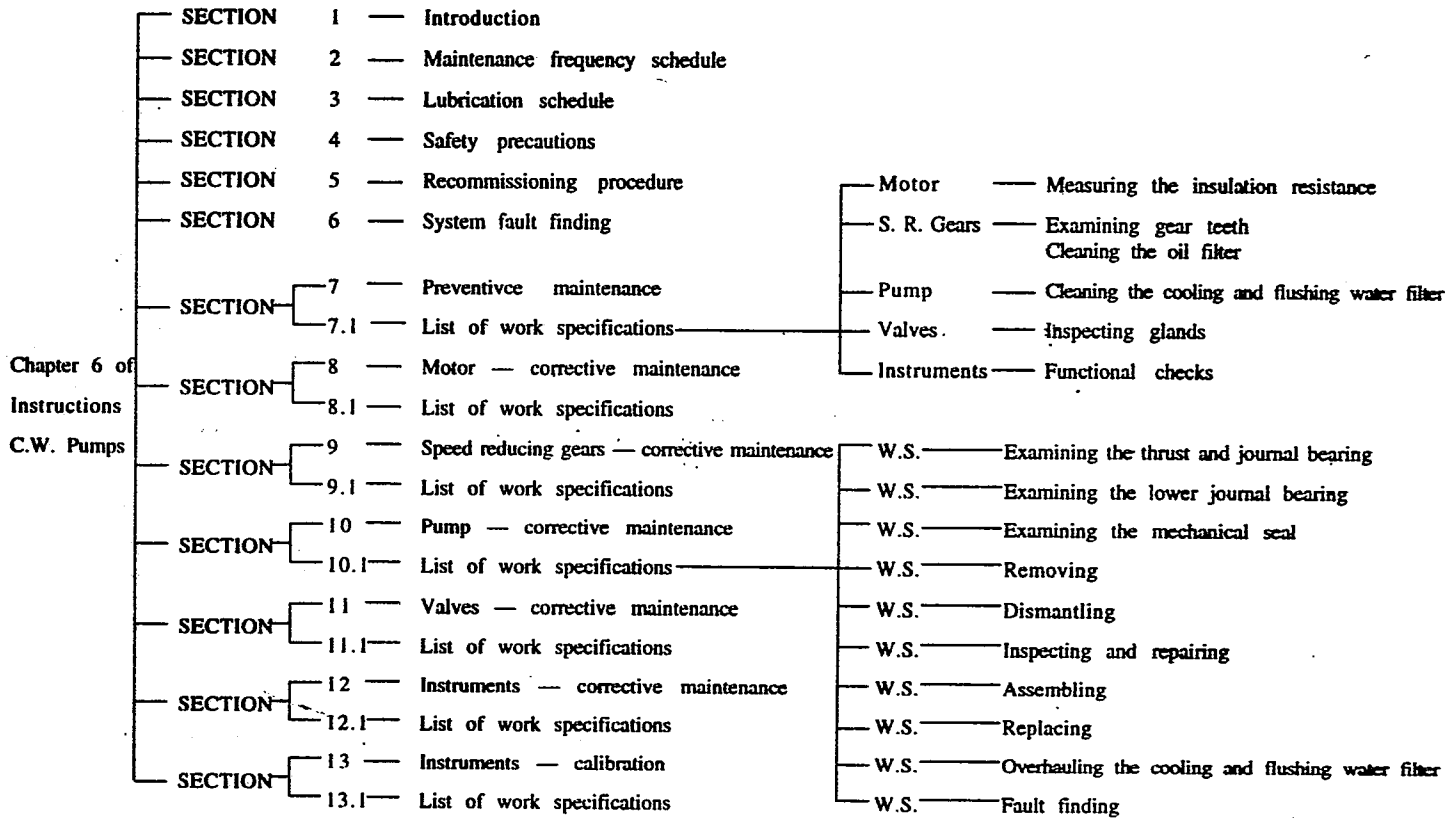


FIG. B-2. EXAMPLE OF BREAK-UP OF MAINTENANCE INSTRUCTIONS FOR A TYPICAL SYSTEM INTO GENERAL AND DETAILED WORK SPECIFICATION.

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14. AERB Safety Guide on QA during Commissioning of NPPs - AERB/SG/QA-5

15. Radiation Protection Procedures (Manual) : DAE/SRC, 1989 for Nuclear Facilities

LIST OF PARTICIPANTS

Advisory Committee on Codes, Guides and Associated Manuals for Safety in Operation of Nuclear Power Plants (ACCGASO)

Dates of Meeting	:	March 17, 18 & 19, 1993
		June 16, 1993
		January 31 & February 1, 1997

Members and alternates participating in the meeting:

Shri G.V. Nadkarny (Chairman)	:	Former Director E&PA, NPC
Shri V.S. Srinivasan	:	NPC
Shri Y.K. Joshi	:	RAPS/NPC
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ADVISORY COMMITTEE ON NUCLEAR SAFETY (ACNS)

Dates of the Meeting	:	February 27, 1996
		March 23, 1996
		September 27, 1997
		October 25, 1997.

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Shri S.M.C.Pillai	:	Nagarjuna Power Corp.
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PROVISIONAL LIST OF SAFETY GUIDES ON OPERATION OF NUCLEAR POWER PLANTS

Safety Series Nos.	Provisional Title
AERB/SG/O-1	Training and Qualification of Operating 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 Emergencies at NPPs
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AERB/SG/O-9	Management of NPPs for Safe Operation
AERB/SG/O-10	Core Management and Fuel Handling for NPPs
AERB/SG/O-11	Management of Radioactive Wastes Arising During Operation of NPPs