AERB SAFETY GUIDE NO. AERB/SG/G-8

CRITERIA FOR REGULATION OF HEALTH AND SAFETY OF NUCLEAR POWER PLANT PERSONNEL, THE PUBLIC AND THE ENVIRONMENT

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Atomic Energy Regulatory Board
Mumbai 400 094

Price:

Orders for this Guide should be addressed to:

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

FOREWORD

The establishment and operation of nuclear and radiation facilities, and the use of radioactive sources, contribute to the economic and social progress of the country. However, while undertaking such activities, safety of the workers concerned, the general public and the environment at large, is to be ensured, and this is possible through compliance with the relevant provisions of the Atomic Energy Act, 1962.

Since the inception of the atomic energy programme in the country, importance has been given to the adoption and maintenance of high safety standards. In order to enforce safety standards, the Government of India constituted the Atomic Energy Regulatory Board (AERB) in November 1983.

The Board is entrusted with the responsibility for laying down safety standards and framing rules and regulations covering regulatory and safety functions envisaged under the above Act. AERB has therefore undertaken a programme of developing safety standards, codes, guides and manuals for both nuclear and radiation facilities, covering all aspects such as siting, design, construction, operation, quality assurance, decommissioning and regulation.

Safety Standards contain internationally accepted safety criteria for design, construction and operation of specific equipment, systems, structures and components of nuclear and radiation facilities. Safety Codes are intended to establish objectives and to set minimum requirements that shall be fulfilled to provide adequate assurance for safety in nuclear and radiation facilities. Safety Guides provide guidelines and make available the methods for implementing the specific requirements as prescribed in line with the relevant Safety Code(s). Safety Manuals are intended to elaborate specific aspects and may contain detailed technical information and/or procedures.

Consistent with accepted practice, "shall" and "should" used in these documents distinguish between firm requirements and a desirable option respectively, for the benefit of the user.

Emphasis in these documents is on protection of site personnel, the public and the environment from unacceptable radiological hazards. For aspects not covered, applicable and acceptable national and international codes and standards shall be followed.

Industrial safety in nuclear and radiation facilities is to be ensured through compliance with the applicable provisions of the Factories Act, 1948 and the Atomic Energy (Factories) Rules, 1996.

The Codes, Guides and Manuals will be revised as and when necessary in the light of the experience and feedback from users as well as new developments in the field.

Based on its experience, AERB decided to issue a Safety Code on "Regulation of Nuclear and Radiation Facilities", to spell out the minimum safety related requirements/obligations to be met by a nuclear or radiation facility to qualify for the issue of regulatory consent at every stage leading to eventual operation. It is hoped that this will be of use to the Regulatory Body as well as to the applicant of any nuclear or radiation facility.

This Safety Guide on "Criteria for Regulation of Health and Safety of Nuclear Power Plant Personnel, the Public and the Environment" provides guidance on the safety related requirements for setting up of Nuclear Power Plants (NPPs). This Guide deals with the health and safety requirements to be met by the applicant in selecting a suitable site for NPP and outlines the design safety aspects and safety during construction and operation. It spells out the basic or minimum health, safety and environmental safety criteria to be considered at the stages of commissioning, operation and waste management. Emergency preparedness, environmental surveillance and decommissioning aspects of the NPP are also covered.

The Guide has been prepared by a Working Group consisting of AERB staff and other professionals. In drafting it, extensive use has been made of the information contained in the relevant documents of the International Atomic Energy Agency (IAEA).

Experts have reviewed the Guide and the AERB Advisory Committees have vetted it before issue. The list of persons who have participated in the Committee meetings, along with their affiliations, is appended in the document.

AERB wishes to thank all individuals and organisations who reviewed the draft and helped in the finalisation of the Guide.

(Suhas P. Sukhatme)
Chairman, AERB

DEFINITIONS

Accident Conditions

Substantial deviations from operational states which could lead to release of unacceptable quantities of radioactive materials. They are more severe than anticipated operational occurrences and include Design Basis Accidents and severe accidents.

Acceptable Limits

Limits acceptable to the Regulatory Body.

Applicant

The organisation that applies for formal authorisation to perform specified activities related to siting, construction, commissioning, operation and decommissioning of Nuclear Power Plant (NPP).

Atomic Energy Regulatory Board (AERB)

The regulatory Body that is currently functioning in India (See also 'Regulatory Body')

Commissioning

Process during which structures, systems and components of a nuclear or radiation facility, having been constructed are made functional and verified to be in accordance with design specifications and to have met the performance criteria.

Construction

Process of manufacturing, testing and assembling the components of a nuclear and radiation facility, the erection of civil works and structures and installation of components and equipment.

Decommissioning

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

Design Basis Flood (DBF)

The flood selected for deriving a design basis for nuclear facility.

Design Basis Accident (DBA)

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

Emergency Situation

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

Normal Operation

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

Nuclear Facility

All nuclear fuel cycle and associated installations encompassing activities covering from the front end to the back end of nuclear fuel cycle processes and the associated industrial facilities (viz. heavy water plants, beryllium extraction plants, zirconium plants etc.)

Nuclear Power Plant (NPP)

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

Prescribed Limits

Limits prescribed by the Regulatory Body for specific activities or circumstances that must not be exceeded.

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.

Radiation Facility

Any installation/equipment or a practice involving the use of radiation generating units, or the use of radioisotopes in research, industry, medicine and agriculture.

Regulatory Body

An authority constituted and empowered by the Central Governement to carry out the regulatory and safety functions as envisaged in the Atomic Energy Act, 1962 and the Rules issued thereunder.

The term is synonymous with the term 'Competent Authority', mentioned in the above said Rules.

Safety

Protection of all persons from undue radiological hazard.

Screening Distance Value (SDV)

The distance value used for preliminary screening purposes, beyond which potential sources of particular type of external man-induced events can be ignored.

Site

The area sorrounding the plant which is under direct control of the plant and to which members of public have no free access.

Siting

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

Surveillance

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 (also called Operational Limits and Conditions)

A document approved by the Regulatory Body covering operational limits and conditions, surveillance and administrative control requiremnets for safe operation of nuclear or radiation facilities.

Note : Some of the above definitions are modified versions of those appearing in the first two documents of this series, viz. Code No. AERB/SC/G and Guide No. AERB/SG/G-5.

CONTENTS

1. INTRODUCTION

1.1 General

1.1.1 Radiation safety of the public and the occupational workers during development, control and use of atomic energy for peaceful purposes is being ensured through enforcement of the safety provisions in the Atomic Energy Act 1962, and the rules framed thereunder [1].

For carrying out the regulatory and safety functions envisaged in the Atomic Energy Act, 1962 and the rules framed thereunder, the Regulatory Body (Atomic Energy Regulatory Board) was constituted in 1983. The Chairman of the Regulatory Body has been notified as the "Competent Authority" to enforce the above rules.

1.1.2 With a view to providing compact and cogent regulatory documents spelling out the obligations of the consentee and the responsibilities of the Regulatory Body, a comprehensive Safety Code on "Regulation of Nuclear and Radiation Facilities" AERB/SC/G has been prepared. The Code details a number of regulatory requirements to be complied with by the applicant/ consentee as well as by the Regulatory Body itself.

Industrial safety aspects are taken care of through enforcement of the safety provisions of the Factories Act, 1948 and the Atomic Energy (Factories) Rules, 1996 [2].

1.1.3 The Regulatory Body issues Safety Codes, Standards and Guides for nuclear and radiation facilities and other related activities as envisaged under the comprehensive Safety Code "Regulation of Nuclear and Radiation facilities" (AERB/SC/G). As such, this Guide on "Criteria for Regulation of Health and Safety of Nuclear Power Plant Personnel, the Public and the Environment" (AERB/SG/G-8) lays down guidelines on the safety-related requirements for setting up of NPPs.

1.2 Objectives

1.2.1 The Regulatory Body has to ensure that appropriate regulations and criteria are specified and implemented in respect of safety of plant personnel, members of the public and the environment. This involves specifying:

(i) requirements governing the safety aspects of occupational workers, the public and of the environment during various activities associated with operation of NPPs;

(ii) guidelines for environmental surveillance; and

(iii) guidelines for formulation of response procedures on any emergency which arises during operation of NPPs.

1.3 Scope

This Guide deals with the health and safety requirements to be met by the applicant in selecting a suitable site for NPP and outlines the design safety aspects and safety during construction. It spells out the basic or minimum criteria for commissioning, operation and waste management. Emergency preparedness, environmental surveillance and decommissioning aspects of NPP are also covered.

2. SITE SELECTION CRITERIA

2.1 General

The safety of NPP includes radiological safety of the personnel, members of the public and the environment both during normal operation of the plant as well as during accident conditions. Hence, basic considerations in NPP siting evolve around the study of reactor-site combination. The major aspects considered for assessing the suitability of a site for locating the NPP are:

(a) effect of site environment on NPP (e.g. natural events like seismic events, tropical cyclones, flooding, man-induced events like explosion, aircraft crashes etc.);

(b) impact of operations of any other installation in the vicinity;

(c) effect of NPP on the environment (e.g. radiological impact and associated site-related parameters); and

(d) implementation of emergency countermeasures in the public domain.

The basic criteria for selection of site for NPP shall be to ensure that site-plant interactions will not introduce any radiological or other risk of unacceptable magnitude [3].

2.2 Natural Events

(a) Seismic events

The applicable seismic zone for site selection will be determined vide IS 1893: 1984 [4]. The seismic intensity criterion while designing safety systems shall be based on an occurrence probability of less than 1 E (-4) per year. Further, a site closer than 5 km to a capable fault shall be deemed unacceptable. While arriving at seismicity criteria, reservoir-induced seismicity should also be considered. The stability of any upstream dam with respect to likely seismic intensity at the NPP site should be examined.

(b) Flooding

For inland sites, the region shall be examined to determine the extent of flooding that could take place at the site due to heavy precipitation. All historical, hydrometeorological and hydrological data shall be collected and critically examined. It is recommended to use appropriate unit hydrographic or any other appropriate model to determine the Design Basis Flood (DBF) having a return period of 1000 years. This DBF with a return period of 1000 years shall include height of water level, duration of flood and flow conditions including the effect due to efflux.

It is necessary to ensure that probable failures of upstream dams and other water-retaining structures do not endanger NPP and cause unacceptable radiological risk. Hence, the safety of the NPP needs to be ensured through postulation of dam breach for arriving at Design Basis Flood Level. The site elevation is fixed above the Design Basis Flood Level.

For inland sites, adequate quantity of water storage to the extent of 30 days' shutdown cooling requirements shall be ensured at the site to serve as Ultimate Heat Sink. If this is not available, the site shall be deemed to be unsuitable. The possibility of downstream dam failure, which may result in such conditions, shall be scrutinised.

At coastal sites, the potential for flooding by combination of high tides, wind effects and wave run-up on bodies of water shall be examined to arrive at DBF for the site.

NPP site location should be at an elevation higher than flood level that can probably be realized at site with a mean recurrence interval of 1000 years. For NPP proposed near marine coast, site elevation should be at a height above the flood level expected at site location.

Sites having a grade elevation (above astronomical tide level) less than 4 meters should be rejected for the east coast of India. Similar rejection criterion for the west coast of India should be less than 3 meters of flood water level.

The possible occurrence of tsunami and consequent flooding at site should also be considered while determining coastal flooding aspects.

(c) Extreme Winds

For design of all safety-related structures, the dynamic wind stress under extreme meteorological events like tropical cyclones, tornadoes etc., should be considered over static wind stress (uniform over all radial directions). The dynamic wind speed to be considered for this purpose should satisfy the return period criterion of 1000 years.

(d) Terrain

The valleys and hills on either side at distances more than 20 times the ridge height are acceptable. Bowl-like structures need analysis at design stage on a case-by-case basis. This criterion will allow atmospheric dilution of air-borne releases due to dispersion and transport such that build-up of radioactivity concentrations does not take place near the site.

(e) Groundwater Depth

As low-level solid radioactive wastes and solidified wastes arising out of treatment and processing of low-level liquid radioactive wastes have to be stored within the Exclusion Zone of NPP site (< 1.6 km) in near-surface disposal facilities, the ground water should preferably have a water table depth more than 2 meters below the grade level even during seasonal monsoon flooding conditions. Incorporation of adequate engineering solution is needed when this criterion is not satisfied.

(f) Other Rejection Criteria/Factors

Sites having potential for slope instability for land, landslides and soil liquefaction should be deemed to be unsuitable.

2.3 Man-Induced Events

(a) Aircraft Crashes

The probability of occurrence of an aircraft crashing on the nuclear power plant shall be studied, taking into account the flight frequencies at the nearest air-field and its distance from site.

If the study indicates that probability is more than 1.0 E (-7) per year, then the site shall be deemed unsuitable. Appropriate Screening Distance Value (SDV) may be used to obtain the above probability value. In order to safeguard NPP from aircraft crashes, the sites should be located at a minimum SDV as given below [3]:

SDV for small airports (up to 20,000 flights/y)	= 5 km
SDV for major airfields	= 8 km
SDV for military airfield	= 15 km

(b) Storage/Release of Toxic Gases/Blasting

Activities in the region involving handling, processing, transporting and storing of chemicals and explosives having potential for significant explosions and toxic gas release shall be identified. All activities involving storage of chemicals more than 1t chlorine equivalent closer to the site less than 5 km shall be prohibited unless it can be demonstrated that there is no safety implication.

Sites closer to 10 km or less from military installations storing ammunition shall be deemed unsuitable.

Facilities which are storing or conducting operations with toxic substances or having a potential for release of toxic gases like Cl_2, H_2S, NH_3 etc., that can affect reactor operations and maintenance staff should be at distances farther than screening distances listed below:

SDV for manufacture, storage and transportation of toxic, inflammable or explosive chemicals > 5 km,
SDV for mining and blasting > 5 km.

2.4 Environment related Factors

(a) Atmospheric Dispersion

Basic data on wind direction, wind speed, insolation and cloud cover are required for candidate sites from nearby meteorological stations for the previous ten years to make a preliminary assessment of possible air-borne radioactivity dispersion in various wind direction sectors.

(b) Population Distribution

The basic goal of NPP siting is to locate the reactor in a relatively low population zone. For this purpose, the population around the plant shall be controlled as follows:

The area up to 1.6 km distance around the plant shall be physically isolated from external areas by plant fencing, and no public habitation shall be permitted in this area. This area, known as 'Exclusion Zone', shall be under the control of the plant.

Around this exclusion zone, up to a distance of 5 km, only natural growth shall be permitted and developmental activities which may result in the growth of population, shall be restricted by administrative control. This annular area is called 'Sterilised Zone'.

With these zones in position, the desirable population distribution characteristics in plain terrain shall be as follows:

(i) population density within 10 km of the site shall be less than 2/3 of the average population density in the state;

(ii) there should be no population centre of greater than 10000 persons within 10 km of the plant;

(iii) there should be no population centre of more than 1 lakh persons within 30 km from the plant; and

(iv) the total population in the sterilised area should be small, preferably less than 20,000.

(c) Dose Limit in Public Domain [5]

The limit of public exposure as laid down by the Regulatory Body is an effective dose of 1 mSv in a year. If exposures are both external and internal, the limit of 1 mSv in a year shall apply to the sum of effective dose from external exposure and 70 year committed effective dose from intake incurred during the year.

Under Design Basis Accident Conditions, a member of the public shall not receive an effective dose of more than 0.1 Sv for the whole body and an equivalent dose of 0.5 Sv for thyroid of children.

(d) Other Desirable Guidelines [6]

The Ministry of Environment and Forests (MOEF) have formulated some guidelines for location of NPP. They are:

(i) Sites should be preferably 25 km or farther away from ecologically sensitive areas. Sites falling within 5 km from ecologically sensitive areas should be rejected;

(ii) Sites should not be within 0.5 km of flood plains of the riverine systems or flood control systems;

(iii) Transport and communication systems like highways and railways should not be within 0.5 km of the proposed site; and

(v) A green belt should be built around the plant.

3. QUALITY ASSURANCE

3.1 General

The Safety Code on Regulation of Nuclear and Radiation Facilities (AERB/SC/G) prescribes that the applicant/consentee shall have established a Quality Assurance programme at and for various stages of consenting process and such programme description documents are submitted to the Regulatory Body for review and necessary action. This submission should be made at the earliest, preferably before commencement of work of that stage. This is meant to ensure quality in all safety-related activities undertaken by the applicant/consentee and to comply with requirements prescribed by the Regulatory Body in the code AERB/SC/QA.

3.2 Contents of QA Manuals

The applicant/consentee is required to prepare separate Quality Assurance Manuals for design, construction, commissioning, operation and decommissioning. The contents of the manuals have been detailed in AERB/SC/QA and other safety guides on Quality Assurance, issued by the Regulatory Body. Manuals pertaining to each stage are to be submitted to the Regulatory Body for review and for incorporation of any check points/hold points of regulatory interventions, if so desired by the Regulatory Body.

The Quality Assurance Manual is classified as one of the main documents to be submitted along with application for issue of consent.

4. DESIGN SAFETY ASPECTS

4.1 General

In accordance with the objectives mentioned in section 1.2, the equipment and components within NPPs including waste management systems, should be located, arranged and shielded to minimise radiation exposure to occupational workers during commissioning, operation and maintenance. The system and equipment design arrangement shall limit the need for personnel to enter high radiation areas to perform maintenance, inspection and testing and to keep radiation exposures as low as reasonably achievable (ALARA). In addition, the design layout and construction should cover protection against conventional hazards both for plant personnel and equipment.

4.2 Building and General Layout

Building structures and the general system layout should be arranged such that gross leakage of effluents from any piping system or equipment is confined to the local area. The layout should consider segregating equipment/material with high radioactivity. Some of the other aspects that need to be considered in general layout include the following:

- access,
- location of pumps, valves, instruments, etc.,
- shielding and shield penetrations,
- pipe runs,
- contamination control,
- location of eye washes, change rooms, showers, etc.,
- layout and safety provisions in electrical equipment cable penetrations,
- maintainability of equipment,
- routing of cables and cable trays,
- escape routes,
- fire load and fire barriers,
- layout and location of fire fighting system.

4.3 Containment

The reactor should have a containment system to ensure that radioactive releases to the environment during normal operation and any accident conditions, are limited to acceptable levels. A containment system includes:

- containment structures and appurtenances;
- equipment required to isolate containment envelope and assure its integrity following an accident;
- equipment required for depressurisation of containment; and
- equipment required to limit the release of radioactive materials from containment following an accident.

4.4 Conventional Safety [7]

At design stage of buildings, the following aspects should be considered:

- illumination,
- structural safety,
- space requirements,
- guarding of machines, openings/elevated places and proper means of access,
- fire protection,
- flooring,
- material storage,
- lightning protection,
- electrical wiring,
- ventilation requirements,
- material handling equipment,
- roads, parking lots and side-walks,
- drainage and effluent control,
- physical protection and fencing, and
- landscaping.

4.5 Electrical Safety

All electrical installations should be in accordance with the Indian Electricity Act 1910 [8], the Indian Electricity Rules 1956 [9] and other applicable Code(s). Adequate safeguards by way of suitable barriers, sufficient space in front of installations, circuit protection and suitable ground-fault circuit interrupters shall be provided for personnel protection. Proper grounding and bonding shall be provided.

All electrical equipment installations shall be provided with signs prohibiting unauthorised access, disconnecting means such as switches, circuit breakers and over-current protection and means of waterproofing at damp or wet locations.

Battery rooms shall be provided with appropriate ventilation, acid-proof flooring, proper retention enclosures to prevent escape of electrolytes and adequate number of personal protective equipment.[10]

All locations handling inflammable materials shall be provided with approved electrical fittings matching with the work atmosphere as per relevant ISI Codes.

4.6 Fire Protection [11]

4.6.1 Fire Protection Design Approach

Protection from fire and fire-related explosions assumes importance in the design of a nuclear power plant. Fire protection should also ensure safe shutdown of the reactor and removal of decay heat. Fire protection programme to the overall plant design of a NPP shall take into account plant layout, formation of fire cell, fire zone boundary and fire fighting devices close to passages such as doors, hatches, pipes and cable entry ways.

A minimum fire resistance rating of one hour shall be provided for any boundary of a fire zone.

4.6.2 Fire Hazard Analysis

Fire hazard analysis should be carried out to meet the following purposes:

- identification of items important to safety;
- identification of fire hazards and consequences;
- determination of the type of protection to be provided and its adequacy; and
- determination of fire resistance rating required of zone boundaries.

4.6.3 Fire Prevention

Fire prevention aspects should be taken care of in the design stage itself. Location of temporary structures housing explosives or inflammable materials shall have proper safe distance from other buildings and structures. Necessary firestops/barriers and fire dampers etc., should be provided as applicable in cable trays and ventilation ducts.

Storage of combustible materials should be limited to minimum requirements consistent with operational requirements. There should be provision to purge the hydrogen filled systems with inert gas before filling or draining of these systems (viz., generator cooling system). There should also be a provision for detection of leakages from this system.

4.6.4 Lightning Protection

Potential fires due to lightning shall be considered. Buildings or areas containing safety systems shall be provided with lightning protection systems as per National Code [7].

4.6.5 Fire Detection and Alarm System

Each fire zone shall be provided with a fire-detection and alarm system suitable for that zone. It should be energised periodically and annunciated by audible and visual alarms. The system should be tested periodically.

4.6.6 Fire Fighting Water Supply System [12]

Adequate dedicated water supply system should be provided for fire fighting. This should be powered by reliable electrical source or diesel-operated pumps.

4.6.7 Fire Hydrant System

Adequate numbers of hydrants at suitable intervals with hose and stand-pipe riser with compatible connections should be provided.

4.6.8 Sprinkler System

The sprinkler system (water or gas) selected should be based on the nature of the area. When water sprinkler system is employed, the design shall provide protection of sensitive equipment.

4.6.9 Mitigation of Fire Effects

The following are some of the aspects to be taken into account during design stage for mitigation of fire effects:

- ventilation of main control room and supplementary control room points;
- fire venting;
- electrical equipment and cabling;
- explosion protection;
- special location (main control room and supplementary control points); and
- personnel access/egress.

Further, adequate personnel escape routes, independent ventilation to each fire zone, clearance of combustible products, protection of electrical systems etc. should be accomplished through the above. Measures should be taken to prevent recirculation of smoke in case of fire through air conditioning duct/local air conditioners.

4.6.10 Fires of External Origin

Precautionary measures should be taken to reduce the amount of combustibles in the vicinity of the plant and access routes to minimise fire hazard from external origin. Area around the plant should be free of grass/vegetation. All open areas in close vicinity of the plant having fire potential should be asphalted or metalled. The plant design shall prevent smoke or heat from fires of external origin from impairing the accomplishment of necessary safety functions.

4.7 Radiological Safety Provisions

4.7.1 All design provisions required to limit radiation exposure of occupational workers and members of public within prescribed limit shall be incorporated. These include the following:

- The reactor core and other radioactive equipment, piping, etc. should be provided with adequate shielding to bring down the radiation levels within stipulated levels.

- Adequate provisions shall be incorporated to ensure that under no conditions of storage/handling of the fuel outside the reactor core a critical assembly can be formed. All precautions should be taken to positively preclude the formation of any critical assembly.

- Areas that are contaminated or showing high radiation field during reactor operation shall be put under access control system. This system, consisting of interlocked doors and gates, should ensure that no person can normally enter unless the reactor power is brought down to an extremely low level (< 0.1% of full power).

- The active and potentially active areas, process piping and ducting should be provided with adequate radiation monitoring instrumentation. These monitors should have both local and remote alarms. Alarms should have audio-visual warning systems.

- The active/potentially active areas should be provided with ventilation, exhaust and air purification systems as applicable to ensure that air contamination levels are kept at acceptably low levels.

4.7.2 For effective control of radioactive contamination, the design layout of the plant should conform to the following zoning system:

Zone 1 - Clean zone.

Zone 2 - Buffer zone between contaminated and clean zones which may infrequently become contaminated due to inadvertent tracking during personnel movement.

Zone 3 - Zone containing enclosed sources which could occasionally get surface contamination subsequent to escape of active fluid or whenever the enclosed sources are opened up (e.g. during servicing and maintenance).

Zone 4 - Zone containing open sources of contamination.

4.7.3 Ventilation system should be so designed that air should not flow from higher radioactive area to lower radioactive area.

4.7.4 All drainage from floor drains, washings, sinks, etc., in the active areas of the plant should be led to the Liquid Effluent Segregation System (LESS). The liquid waste collected in LESS through covered drain lines should be segregated and subsequently transferred to waste management facility for further processing and safe disposal.

4.7.5 All releases of radioactive effluents from the nuclear power plant should be continuously monitored. In general, radioactive materials shall be released only through known authorised routes. All active gaseous discharges from the plant should be made through stack discharge after necessary air cleaning or in case of liquid discharges through main outfall.

4.7.6 Appropriate monitoring provisions should be made to detect and quantify the discharges of individual radionuclides. The types and ranges of effluent monitors chosen should be adequate to retain their monitoring capability under all conceivable conditions of normal operation, operational transients and accident conditions.

4.7.7 Adequate release limiting and accident mitigation features should be provided to ensure that environmental releases both during normal operation and accident conditions are minimised.

These features may include:

(i) suitable high efficiency filters, absorbers;

(ii) tall stack for releasing active air-borne effluents;

(iii) containment buildings with double containment features;

(iv) clean-up systems such as primary containment filtration and pump-back systems in some PHWRs;

(v) active liquid effluent treatment system; and

(vi) adequate dilution before discharge to environment.

5. SAFETY DURING CONSTRUCTION

5.1 General

Construction of NPP at various sites is executed by consentee and or his contractor's personnel. Consentee and his contractors shall take all safety precautions during execution of works and shall comply with all applicable provisions of safety regulations. The construction, design and layout of the plant should provide adequate protection against conventional hazards. Consentee's safety organisation shall monitor the compliance of safety requirements.

5.2 Use of Explosives [13,14]

After obtaining the required licence, all blasting operations should be carried out only by licensed persons and in conformity with the procedures stipulated and approved. Minimum possible quantity of explosives required for immediate use should only be stored at site. After the blasting operation, the explosives brought in should be properly accounted. Blasting explosives and detonators should be stored separately.

5.3 Earth Work

Consentee should ensure proper access to trenches, provision of sloping to avoid collapse, safe deposition of excavated material, provision of lighting if necessary and fencing around open excavation locations during construction operations.

5.4 Concreting

Consentee should follow proper and approved procedures during concreting. Shuttering and supporting structures shall be of adequate strength to withstand load and prevent collapse.

5.5 Demolition

Before commencing any demolition work, consentee should adequately cordon off the area. Power and other service facilities should be isolated and protected against damage. Demolition work should not give rise to any hazard to the public living nearby.

5.6 Working at Heights [15]

Adequate and safe means of access stay and exit shall be provided for all work-places. Scaffolding and ladder shall conform to relevant specifications. Floor openings at elevated places should be properly guarded. Guidelines for working at heights given in the National Building Code by Bureau of Indian Standards [7] should be followed.

5.7 Welding and Cutting

Welding and cutting operations should be done only by qualified and authorised persons. Proper precautions should be taken to prevent occurrence of any fire by removing all combustible material from nearby area. Precaution should be taken against personnel getting electric shock in case of electrical arc welding and any eye injuries. Fire extinguishers should be provided where required.

5.8 Personal Protective Equipment [16,17]

The required protective equipment such as helmets, goggles, faceshields, and safety shoes shall be easily available at site for use of persons employed on the site. These should be maintained in good condition. Use of appropriate personal protective equipment shall be ensured by responsibile supervision and enforced by appropriate regulations.

5.9 Medical Facilities

Facilities for first aid and emergency medical treatment for workers should be available at site.

5.10 Fire Safety

Necessary precautions should be taken to prevent outbreak of fires at construction sites. Fire fighting arrangements should be available at site.

5.11 Work Practices

5.11.1 Work permit system should be adopted for identified hazardous process [2].

5.11.2 All construction machinery and equipment should be properly maintained and operated only by authorised persons. Where applicable, they should be subjected to periodic inspection and testing. Effective supervision and good housekeeping practices should always be maintained.

5.12 Noise Protection

Proper precautions should be taken to protect workers and nearby public from high level noise exposures. There should be proper engineering safeguards in addition to the use of personal protective equipment.

5.13 Industrial Radiography at Site

All open field industrial radiography shall be carried out as per AERB "Safety Guide on Radiological Safety in Open Field Industrial Radiography" (Safety Guide No. AERB/SG/IN-2) and only by authorised radiographers under the direct supervision of a Safety Site-in-Charge/ Radiological Safety Officer.

5.14 Electrical Safety [8,9]

Adequate safety measures should be taken while providing electrical power at work sites. The requirements laid down in Indian Electricity Rules, (1956) shall be followed.

5.15 Accident Reporting [2]

All reportable accidents and dangerous occurrences as defined in the Atomic Energy (Factories) Rules, 1996 shall be reported to the concerned authorities.

6. COMMISSIONING AND OPERATION

6.1 General

During all phases of commissioning and operation of nuclear power plant, it should be ensured that adequate level of protection is provided to plant personnel and others including contract workers and members of public against industrial and radiation hazards that may result/occur on account of commissioning, operation and maintenance at the plant. Relevant codes and regulations concerning industrial hygiene and safety, radiological safety and environmental safety shall be followed. In addition, training/qualification/retraining and work supervision of all personnel (whether permanent or temporary) working at plant should be enforced to ensure strict adherence to safety procedures laid down.

6.2 Industrial Hygiene and Safety

6.2.1 Atomic Energy (Factories) Rules, 1996

All activities at plant should be carried out with due regard to personnel safety as per relevant stipulations of Atomic Energy (Factories) Rules 1996.

6.2.2 Station Industrial Safety Manual

The plant should prepare the Station Industrial Safety Manual, which should contain safety procedures for working in different areas/locations.

6.3 Radiological Safety

6.3.1 Radiation Protection Programme

Radiation protection programme at the plant shall include adherence to various safety directives and technical specifications, preparation of radiological protection procedures and instituting an ALARA programme.

6.3.2 Limits of Exposure

Limits for radiation exposures of radiation workers and members of public shall be as per the standard prescibed by the Regulatory Body.

6.3.3 Station Radiation Protection Programme and Procedures [16]

Prior to commissioning, the Station should prepare a Radiation Protection Programme. This programme should include the following:

(i) organisational structure and channels of communications;

(ii) radiation protection training and qualification requirements for health physics and other station personnel, as well as workers temporarily employed in the plant;

(iii) radiation dose limits prescribed by the Regulatory Body (viz. in-house limits, recording/reference levels and investigation levels of both internal and external exposures for occupational radiation workers and temporary workers);

(iv) requirements of protective clothing and safety equipment;

(v) station zoning and access control procedures;

(vi) radiation dose control and maintenance of dose records;

(vii) documentation of all radiation-related data such as radiation fields, contamination levels, doses, activity discharges, waste management data, etc.;

(viii) on-site and off-site radiological monitoring and surveillance procedures;

(ix) decontamination procedures;

(x) methods and devices for measuring external and internal exposures;

(xi) instructions for use of different radiation/contamination measuring instruments;

(xii) control, handling, storage and transport of radioactive materials including radioactive wastes;

(xiii) radioactive waste management procedures;

(xiv) emergency procedures - site and off-site as per guidelines of the Regulatory Body; and

(xv) ALARA approach for radiation exposures both for occupational workers and the public.

6.3.4 ALARA Programme [17]

The station should initiate and implement an ALARA programme for radiation exposures both for occupational workers and the public. This programme should consist of the following important elements:

(i) Inculcation of an overall safety culture among all levels of plant personnel. This should include efforts at limiting radiation exposures and active/contaminated locations/areas.

(ii) Prior review of each active job and introduction of features which would lead to minimization of dose/contamination. The techniques introduced should consist of one or more of the following:

- Provision of shielding to reduce radiation levels,
- Remote operation using special tools or other equipment, robotics, etc.,
- Provision of air cleaning or exhaust arrangement for reduction of air contamination,
- Effective use of personal protection equipment such as gloves, protective suits, respirators, ventilation harnesses, etc.,
- Improved procedure control and reduction of unnecessary personnel in active areas,
- Close supervision of radiation works,
- Use of mock-ups, pre-training of workers, video records or CCTV for information and training of concerned personnel to reduce their exposures, and
- Use of experienced/skilled personnel for minimization of time expenditure and avoiding need for repetitive maintenance.

6.3.5 Technical Specifications and Station Policies

Plant operations should be governed strictly by technical specifications and station policies for plant operation approved by the Regulatory Body.

6.3.6 Medical Surveillance

Pre-employment medical examinations and periodic medical examinations during the employment should be undertaken through appropriate medical surveillance. Relevant records should be maintained at site hospital.

6.4 Training, Qualification and Licensing

In-plant training and qualification programme should include all relevant safety aspects. The following safety related topics should be included among others:

- industrial safety procedures;
- fire fighting and fire equipment handling procedures;
- first aid;
- radiation protection procedures;
- access control procedures;
- use of radiation monitoring instruments in the plant; and
- site and off-site emergency preparedness plans.

7. WASTE MANAGEMENT

7.1 General

Release of radioactive gaseous and liquid waste and disposal of solid wastes to the environment from various nuclear facilities shall be controlled such that the dose limit to members of public as prescribed by AERB is complied with.

7.2 Dose Apportionment

The dose limit to members of public is apportioned amongst various nuclear facilities at a site to arrive at authorised discharge limits for gaseous and liquid wastes. Long-term radiological impact arising from solid waste management operation at the site should also be taken into consideration during dose apportionment. Each nuclear facility located at a site is apportioned a fraction of the above dose limit for radioactive waste disposal. This dose is further sub-divided into atmospheric and aquatic releases. Each nuclide likely to be released in atmospheric and aquatic routes is assigned a fraction of applicable apportioned dose from respective routes.

7.3 Derived Discharge Limits for Liquids and Gases

Determination of a derived limit involves the use of a model to establish a relation ship between release of a particular radionuclide to the environment and the resulting dose to man. The model has two components:

(i) environmental component of the model for computing concentration of a radionuclide in a typical aquatic system due to routine releases;

(ii) the radiological component of the model for translating the concentration of radionuclide in the medium to the resulting dose to a member of a critical group via various exposure pathways from the aquatic system. The derived discharge limit to an aquatic system can be computed based on the ratio of basic limit (primary dose limit or apportioned dose limit) to that of computed dose per unit release rate. Alternatively, a maximum permissible concentration of a radionuclide (for primary dose limit or apportioned dose limit) in the aquatic medium can be computed which is then translated into discharge limit by multiplication with volume discharge rate and dilution factor available in the medium.

Similarly, the derived discharge limits for radionuclides released through atmospheric route are also computed as ratio of primary dose limit (or apportioned dose limit for radionuclide) and computed dose per unit release rate. The dose is computed using all relevent atmospheric pathways. The concentration of radionuclides at specific locations is computed using annual average χ/Q (dispersion factor) generated for the site based on micro metereological database (where χ = ground level air concentration in Becquerel/m^3 and Q = Release rate in Becquerel/seconds.); and

(iii) Release rates for aquatic and atmospheric releases should be arrived at, based on site specific dose assessment model; wherever site specific data are not available, default values could be used.

Discharge limits thus arrived at by the above procedure should be incorporated in technical specifications for operating the facility and submitted to the Regulatory Body for approval.

7.4 Solid Waste Disposal

For solid waste disposal, appropriate models should be established taking into account characterisation of wastes and packaging adopted, the type of disposal, site characteristics and applicable leach-rates of waste packages and groundwater movement. This is to demonstrate that apportioned dose to members of public through groundwater usage will not be exceeded. NPP is authorised by the Regulatory Body to transfer solid waste to waste management facility. This authorisation takes into account the volume and activity of different categories of waste. The waste management agency is authorised to dispose such wastes in the approved disposal facilities. NPP and waste management facilities shall submit annual returns to the Regulatory Body, indicating the volume and activity of wastes of different categories disposed.

7.5 Waste Disposal and Monitoring

The following aspects should be considered while handling and disposal of radioactive waste:

(i) *Segregation and Classification of Waste:* Waste should be segregated to make optimal use of treatment and conditioning methods. They should also be classified based on radionuclide content, specific activity, chemical nature, surface dose rates etc.

(ii) *Transportation of Waste:* Solid waste should be transported to disposal facility after proper packaging and appropriate shielding. Liquid waste should be transferred from the place of generation to treatment plant or from treatment plant to dilution and discharge point through pipelines. Tankering mode can also be adopted in certain cases.

(iii) *Documentation of Waste Disposal:* Waste management facilities should maintain records of type, location, movement, quantity and activity levels of radioactive wastes stored/discharged to the environment.

(iv) *Site-burden and Licensing by the Regulatory Body for Near Surface Disposal Facility (NSDF) :* The total authorised dose limit prescribed by the Regulatory Body for any site containing all nuclear facilities should be apportioned between various facilities at the site and for different routes viz., terrestrial, aquatic and atmospheric. License for waste management facility should be obtained from the Regulatory Body after submission of safety reports of the facility.

(v) *Closure of NSDF :* Based on the institutional control period of 300 years for storage of waste, the closure of the NSDF should be undertaken at an appropriate time for release of the site to public.

7.5.1 Liquid and Gaseous Discharges

For compliance with discharge limits, NPP should establish and maintain an adequate monitoring programme. This includes monitoring of stack releases and discharge of liquid effluents by aquatic route and maintenance of relevant records.

7.5.2 Monitoring of Solid Waste Disposal Facilities

Borehole sample monitoring around solid waste management facilities should be undertaken and samples analysed periodically to ensure integrity of containment of the waste disposed. Records of borehole sample monitoring should be maintained.

8. ENVIRONMENTAL SURVEILLANCE

8.1 General

Operation of any NPP involves release of small quantities of radioactive waste into the environment. Such releases are always to be controlled as per the stipulation in technical specifications.

Initial surveillance on these releases is at the release point itself by employing source monitoring. A confirmatory evaluation of releases is done by environmental monitoring, wherein different matrices in the environment around the nuclear facility are routinely monitored for their radioactivity content and the dose in public domain is estimated.

8.2 Pre-operational Phase

8.2.1 Pre-operational survey of the site should be undertaken, atleast three years before active operation of the plant, for establishing base-line radioactivity data for site environment. This survey should include assessment of natural and man-made radioactivity content in air, water and terrestrial environment.

8.2.2 Radioactivity content due to natural sources and from fall-out in different environmental matrices, estimated prior to operation of the facility forms the base-line data which can be compared with environmental measurements during operational phase of the facility.

8.2.3 External gamma dose rate due to natural sources (cosmic rays, U, Th and K-40 deposits in the earth) should be established using appropriate monitoring techniques (e.g. thermoluminiscent dosimeter (TLD) and high sensitivity background gamma chambers). These surveys should cover all seasons of the year.

8.2.4 Seasonal shifting and movement of natural radioactivity bearing sand and soil, if any, should be studied and the effect of these on external gamma dose rate established.

8.2.5 Internal dose due to Radon, Thoron, K-40, Rb-87 and from cosmogenic radionuclides (Tritium, C-14, Br-87, Na-22) should be assessed.

8.2.6 Pre-operational environmental survey should include assessment of radioactivity levels in dietary items, air and water due to global fall-out following atmospheric nuclear weapon testing and nuclear accidents.

8.2.7 In the pre-operational meteorological measurement programme, data should be collected for a sufficiently long period but not less than three years so that annual average meteorological parameters for the site could be established. These data should be used for establishing site-specific derived limits for gaseous discharges from the facility and to compute dose to members of public from routine releases of gaseous effluent from the facility.

8.2.8 Dilution capability of the aquatic environment into which liquid effluents are to be released should be established based on appropriate techniques during pre-operational stage for assessing the recepient capacity of the aquatic environment. This will help to establish realistic and site-specific derived limits for aquatic discharges from the facility and to compute dose to members of public from routine releases into aquatic environment from the facility.

8.3 Environmental Monitoring for Operational Phase

8.3.1 Compliance with the guidelines stipulated by the Regulatory Body can be assessed through monitoring of environment. In general, this should cover:

(a) establishment of base-line data for natural and fall-out radioactivity in the environment;

(b) establishment of sampling stations for monitoring on the basis of micro-meteorological and hydrological data and human utilisation of environment;

(c) obtaining data on diets and habits of population and possible identification of critical nuclides, pathways and populations;

(d) obtaining data on recepient capacity of local environment for radionuclides; and

(e) computation of radiation doses from releases with application of environmental models.

8.4 Environmental Monitoring Programme

8.4.1 Environmental monitoring programme should cover select matrices in atmospheric, aquatic and terrestrial environments. The survey should cover at least areas falling up to radial distance of 30 km from the plant. The distance may increase depending on site characteristics.

8.4.2 For implementing the environmental monitoring programme the radial distance should be divided into angular sectors which are further sub-divided into sector-segments. Distances of segments from plant should be 5 km, 10 km, 15 km, 20 km and 30 km. Beyond 30 km, the distance can be selected according to site characteristics. Sector segments, all around the site, will form the grid system for environmental sampling programme.

8.4.3 The frequency and selection of matrices for sampling should be based on existence of population centres in these sector segments and the utilisation of environment. To get a constant and realistic trend of the exposure, sampling locations and type of sample in each sector/segment should remain more or less the same during monitoring period. Table I gives the examples of various samples collected from flora and fauna for analysis.

8.5 Assessment of Radiation Dose

8.5.1 External Gamma Dose

The plume gamma dose due to release of noble gases from power plant facility should be computed at the centre of sector-segment starting from exclusion distance of the plant. Annual average release rate of noble gases and annual average diffusion climatology of the site should be used for dose computation.

As a supplementary measurement, a suitable number of dosimetry devices (eg. TLD or other dose integrating devices) can be kept at appropriate locations and read at regular intervals.

TABLE I - ENVIRONMENTAL SAMPLING PROGRAMME

Environment	Matrix	Radionuclides to be analysed
Atmospheric	Air	Gross α, gross β; radionuclides of Cs, Sr, iodine; transuranics and tritium
Atmospheric	Rain water	Gross α, gross β and tritium
Aquatic	Sea/river water	Gross α, gross β; radionuclides of Cs, Sr, iodine; transuranics, tritium and any other relevant activation or corrosion products.
Aquatic	Drinking water (pond, well, borewell)	Gross α, gross β, Cs-137 Sr-90, tritium
Aquatic	Weeds, silt, sediment, salt, fish and marine organisms	Cs-137, Sr-90 and tritium
Terrestrial	Dietary items (vegetables, cereals, fruits, meat, eggs, fish milk etc.)	Cs-137, Sr-90, radioiodines radiocobalt and transuranics
Terrestrial (indicator sample)	Goats' thyroid	I-131, Cs-137 and Sr-90
Trend indicators	Weeds, soil and grass	Cs-137 and Sr-90
Miscellaneous samples	Plantain leaves and whole meal	Cs-137 and Sr-90

8.5.2 Internal Dose Assessment

8.5.2.1 Inhalation Dose

The annual effective dose to members of public due to inhalation of a radionuclide is computed using following factors:

- the average concentration of the radionuclide in air;
- the volume of air breathed in a year; and
- the inhalation dose coefficient for radionuclide.

8.5.2.2 Ingestion Dose

The annual effective dose to members of public due to ingestion of a radionuclide is computed using the following factors:

- the average concentration of radionuclide in food item;
- the annual intake of food items by members of public; and
- the ingestion dose coefficient for the radionuclide.

Dose resulting from each radionuclide and from each food item should be added to get total dose from inhalation and ingestion routes.

From the large number of samples collected from each sector/segment, a mean value of concentration for each radionuclide and in each of the matrices should be evaluated from that sector/segment. This mean value should be used for dose assessment in that sector-segment resulting for a particular matrix and radionuclide. The dose in public domain resulting from plant operation and dose due to natural and fall-out activity applicable to the site should be separately furnished.

9. EMERGENCY PLANNING

9.1 General

Nuclear power plants are designed, constructed, commissioned and operated/ maintained with due consideration for safety. Furthermore, the defense-in-depth approach adopted gives sufficient assurance that the consequences of any abnormal situation or accident would be limited. However, the probability of accident situation leading to release of radioactive material either within the plant/site premises or off-site cannot be assured to be zero. To provide reasonable assurance that in the event of any emergency situation appropriate measures can and will be taken to mitigate the consequences and provide acceptable level of safety to both plant personnel and surrounding public, the nuclear power plants shall establish an emergency preparedness programme which will provide for necessary measures to cope with situations and ensuring readiness of persons, facilities and equipment and effective co-ordination between various groups at site and off-sites including public authorities. This programme shall be in force before commencement of operation. Emergency plans will have the following major components:

(i) site emergency plan; and

(ii) off-site emergency plan.

9.2 On-site and Off-site Emergency Plans

Two separate documents should be prepared containing full details of plans to handle emergency situations either having consequences restricted to plant and site alone (site emergency plan) or those with off-site consequences also (off-site emergency plan).

9.3 Accident Scenarios and Emergency Actions

The plans should outline different design basis accident scenarios, their probability of occurrence and consequences within the plant, site and off-site domains. The emergency action plans for mitigating accident consequences should also be outlined.

9.4 Categorisation of Emergencies

Radiation emergencies are categorised into personnel, plant, site and off-site emergencies, which depend upon the nature, extent and severity of the accident. The plan should include clear instructions to identify and categorise each of these types of emergencies.

9.5 Emergency Organisations and Key Emergency Personnel

The emergency plan should clearly indicate the emergency organisations and key emergency personnel for handling different functions required to be carried out during emergencies. These should also include the personnel/agencies at stations/site, at headquarters, off-site authorities and Regulatory Body. Updated lists of all these key personnel with telephone numbers and addresses should be maintained.

9.6 Notifications

The methods of notifications of emergency situations include PA announcements, sirens, messages etc. and different communication channels (to ensure adequate redundancy of communication) should be clearly indicated.

9.7 Intervention Levels of Doses and Countermeasures [18]

9.7.1 Different countermeasures employed for protection of plant personnel and public are as follows:

- sheltering and adhoc respiratory protection;
- distribution and administration of stable iodine;
- evacuation;
- relocation;
- control of access;
- control of food and water and use of spattered animal feed; and
- decontamination of affected areas and buildings.

9.7.2 The intervention level of doses applicable during emergency situations both for plant personnel, emergency workers and public domain should be included in the emergency plan. Intervention levels applicable for different countermeasures should also be indicated.

9.8 Emergency Facilities and Equipment

Emergency facilities which include emergency control room, on-site emergency control centre, personnel monitors, decontamination facilities, off-site emergency control centre etc. should be clearly identified. Emergency equipment including breathing air set, two-way radio sets, emergency survey/monitoring vehicles, ambulance, protective equipment, radiological monitoring, counting instruments, sampling equipment, external and internal decontamination chemicals, road maps, stable iodine tablets, etc. should also be provided. All locations of storage of these items shall be indicated in the plan.

9.9 Maintenance of Emergency Preparedness

9.9.1 Constant preparedness for handling emergency situations should be maintained by following actions:

- periodic updating of emergency plans along with the address/ designation, telephone/telex/fax numbers of all key emergency personnel;
- periodic checking/replacement of instruments, communication system, emergency facilities etc.;
- rehearsing emergency actions both within the plant/site as well as off-site at prescribed frequencies;
- post-exercise critique/review and corrective actions in the deficient areas; and
- training and periodic retraining/requalification of all the emergency personnel and plant workers in the emergency preparedness plans.

9.9.2 Information on emergency actions should also be disseminated to public as part of the public awareness programme.

9.9.3 Records

NPP should collect and maintain all records pertaining to emergency preparedness plans, emergency exercises, training/retraining, checks/ replenishments of emergency facilities/equipment/instruments, public awareness programmes etc.

10. DECOMMISSIONING

10.1 General [19]

When a nuclear power plant reaches the end of its useful operating life, it may have to be decommissioned. The main objective of decommissioning is to retire the nuclear power plant such that it no longer poses a hazard to the safety of occupational workers, the members of public and the environment. The ultimate goal of decommissioning may be to release the facility for unrestricted use or incorporate it in a new facility. Several methods are adopted for decommissioning of NPP. During decommissioning operations, exposure to occupational workers and others should be controlled within limits by ALARA programme and manrem budgetting. Aspects to be considered during decommissioning should include the following:

10.2 Waste Management

Waste generated during decommissioning activities should be considered in advance in terms of inventories of various waste categories to assess the adequacy of the existing waste disposal facility or plan for additional facility. Safety of the disposal site should be analysed to assure that with disposal of contaminated waste arising from decommissioning, exposure to occupational workers and members of public will not exceed prescribed limits.

10.3 Clearance Levels

During decommissioning considerable quantity of useful materials (such as concrete) with very low levels of activity would be generated. Clearance levels of these materials should be established and apprised by the Regulatory Body to ensure that once released to public domain or recycled the subsequent exposure to public is trivial.

10.4 Monitoring

At the end of decommissioning, a final radiation survey/monitoring should be conducted to ensure that the decommissioned plant has ambient radiation or residual radioactivity below prescribed/restricted levels. Restrictions, if any, on future activities (such as excavation or deep burrowing activities) due to residual radioactivity left at that decommissioned plant should be specified.

10.5 Release of the Site

The decommissioned site is released for unrestricted use or restricted use by the facility after approval is obtained from the Regulatory Body on submission of final decommissioning report.

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LIST OF PARTICIPANTS

WORKING GROUP

Dates of Meeting:	June 29, 1995 September 25, 1995 November 10, 1995 February 9, 1996 May 21, 1997

Members of the Working Group:

Shri B.M.L. Sah (Chairman)	:	NPC
Dr. T.M. Krishnamoorthy	:	BARC
Shri S. Venkatesan	:	AERB
Shri K.K. Narayan	:	BARC
Shri P.G.G. Menon	:	BARC
Shri G. Natarajan (Member-Secretary)	:	AERB

ADVISORY COMMITTEE ON PREPARATION OF CODE AND GUIDES ON GOVERNMENTAL ORGANISATION FOR REGULATION OF NUCLEAR AND RADIATION FACILITIES (ACCGORN)

Dates of Meeting:	Sept 27, 1996 Oct 3, 1996 Jan 8, 1998 May 27, 1999 June 10, 1999 June 19, 2000

Members and invities participating in the meetings:

Dr. S.S. Ramaswamy (Chairman)	:DG, FASLI, (Formerly)
Shri G.V. Nadkarny	:NPC, (Formerly)
Shri A.K. Asrani	:AERB
Shri T.N. Krishnamurthi	:AERB
Dr. I. S. Sundara Rao	:AERB
Dr. K.S. Parthasarathy	:AERB
Shri N.K. Jhamb	:AERB
Shri A.S. Bhattacharya	:NPC
Shri P.K. Ghosh	:AERB
Shri G.K. De (Member-Secretary till Sept. 1999)	:AERB
Shri R.S. Singh (Member-Secretary)	:AERB
Shri S.T. Swamy (Permanent- Invitee)	:AERB
Shri Y.K. Shah(Invitee)	:AERB

LIST OF SAFETY CODE AND GUIDES ON REGULATION OF NUCLEAR AND RADIATION FACILITIES

Safety Series No.	Title
AERB/SC/G	Regulation of Nuclear and Radiation Facilities
AERB/SG/G-1	Consenting Process for Nuclear Power Plants and Research Reactors : Document Submission, Regulatory Review and Assessment of Consent Applications
AERB/SG/G-2	Consenting Process for Nuclear Fuel Cycle Facilities and Related Industrial Facilities: Document Submission, Regulatory Review and Assessment of Consent Applications
AERB/SG/G-3	Consenting Process for Radiation Facilities: Document Submission, Regulatory Review and Assessment of Consent Applications
AERB/SG/G-4	Regulatory Inspection and Enforcement in Nuclear and Radiation Facilities
AERB/SG/G-5	Role of the Regulatory Body with respect to Emergency Response and Preparedness at Nuclear and Radiation Facilities
AERB/SG/G-6	Codes, Standards and Guides to be Prepared by the Regulatory Body for Nuclear and Radiation Facilities
AERB/SG/G-7	Regulatory Consents for Nuclear and Radiation Facilities: Contents and Formats
AERB/SG/G-8	Criteria for Regulation of Health and Safety of Nuclear Power Plant Personnel, the Public and the Environment

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