CODE NO. AERB/NF/SC/RP

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GOVERNMENT OF INDIA

AERB SAFETY CODE

RADIATION PROTECTION FOR NUCLEAR FUEL CYCLE FACILITIES

ATOMIC ENERGY REGULATORY BOARD

AERB SAFETY CODE NO. AERB/NF/SC/RP

RADIATION PROTECTION FOR NUCLEAR FUEL CYCLE FACILITIES

Approved by the Board in February 2012

Atomic Energy Regulatory Board
Mumbai-400 094
India

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Price:

Order for this code should be addressed to:

The Chief Administrative Officer
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Niyamak Bhavan
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India

FOREWORD

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

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

The radiation risks to workers, members of the public and the environment arising from the operation of nuclear fuel cycle facilities including nuclear power plants must be assessed, controlled and documented. This safety code specifies the basic requirements for radiation protection of the occupational workers, the members of the public and the environment from the undue hazards of ionising radiation in the operation of nuclear fuel cycle facilities. In drafting this code, information contained in relevant documents published by the International Atomic Energy Agency (IAEA) under the Basic Safety Standards, Recommendations of the International Commission on Radiological Protection (ICRP 103, 2007) and other international publications have been extensively used. The code has also made extensive use of the provisions for radiation protection specified in Atomic Energy (Radiation Protection) Rules, 2004.

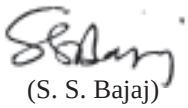
References are included to provide information that might be helpful to the user.

For aspects not covered in this code, applicable national and international standards, codes and guides acceptable to AERB should be followed. Non-radiological aspects such as environmental protection and industrial safety are not explicitly considered. Industrial safety is to be ensured through compliance with the applicable provisions of

the Factories Act, 1948 and the Atomic Energy (Factories) Rules, 1996 and the environmental safety through provisions of the Environmental Protection Act, 1986.

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

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



(S. S. Bajaj)
Chairman, AERB

DEFINITIONS

Absorbed Dose

The fundamental dosimetric quantity D is defined as:

$$D = dE/dm$$

where, 'dE' is the mean energy imparted by ionising radiation to the matter in a volume element and 'dm' is the mass of matter in the volume element. The energy can be averaged over any defined volume, the average dose being equal to the total energy imparted in the volume divided by the mass in the volume. The SI unit of absorbed dose is joule/kg (J.kg-1), termed the gray (Gy).

Activity

The quantity 'A' for an amount of radionuclide in a given energy state at a given time is defined as:

$$A = dN/dt$$

where 'dN' is the expectation value of the number of spontaneous nuclear transformations from the given energy state in a time interval 'dt'. The SI unit of activity is the reciprocal of second (s^{-1}), termed the Becquerel (Bq).

ALARA

An acronym for 'As Low As Reasonably Achievable'. A concept meaning that the design and use of sources**,** and the practices associated therewith, should be such as to ensure that exposures are kept as low as reasonably practicable, with economic and social factors taken into account.

Anticipated Operational Occurrences

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

Applicant

Any person who applies to the competent authority for consent to undertake any of the actions for which the consent is required.

Approval

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

Assessment

Systematic evaluation of the arrangements, processes, activities and related results for their adequacy and effectiveness in comparison with set criteria.

Atomic Energy Regulatory Board (AERB)

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

Authorisation

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

Clearance Levels

A set of values established by the regulatory body and expressed in terms of activity concentrations and/or total activity, at or below which sources of radiation may be released from regulatory control.

Commissioning

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

Committed Effective Dose, E (ô)

The time integral of the whole body effective dose rate following an intake of a radionuclide. The quantity 'E (ô)' is defined as

$$E(\hat{o}) = \sum w_T H_T(\hat{o})$$

where '$H_T(\hat{o})$' is the committed equivalent dose to tissue 'T' over the integration time 'ô'. When 'ô' is not specified, it will be taken to be 50 years for adults and age 70 years for intake by children.

Committed Equivalent Dose, H_T (ô)

The time integral of the equivalent dose rate in an organ or tissue following an intake of a radionuclide. The quantity 'H (ô)' is defined as

$$H_T(\hat{o}) = \int_{t_0}^{t_0+\hat{o}} \dot{H}_T(t)\, dt$$

where 't_0' is the time of intake, '$\dot{H}_T$ (ô)' is the equivalent dose rate at time 't' in an organ or tissue 'T' and 'ô' is the time elapsed after an intake of radioactive substances. When 'ô' is not specified it will be taken to be 50 years for adults and age 70 years for intake by children.

Competent Authority

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

Consent

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

Consentee

A person to whom consent is granted by the competent authority under the relevant Rules.

Contamination

The presence of radioactive substances in or on a material/the human body or other places in excess of quantities specified by the competent authority.

Controlled Area

A delineated area to which access is controlled and in which specific protection measures and safety provisions are, or could be, required for

(a) controlling normal exposures or preventing the spread of contamination during normal working conditions; and

(b) preventing potential exposures or limiting their extent should they occur.

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.

Decontamination

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

Derived Intervention Level (DIL)

The quantities that can be directly measured such as exposure rate from ground

deposited activity and activity concentration in foodstuff and water, at which intervention in the form of countermeasures should be initiated.

Derived Limits

Values of quantities related to the primary or secondary limits by a defined model such that if the derived limits are not exceeded, it is most unlikely that the primary limits will be exceeded.

Design

The process and results of developing the concept, detailed plans, supporting calculations and specifications for a nuclear or radiation facility.

Design Basis Accidents (DBAs)

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

Deterministic Effects

A radiation effect for which generally a threshold level of dose exists, above which the severity of the effect is greater for a higher dose.

Discharge (Radioactive)

Planned and controlled release of (gaseous or liquid) radioactive material into the environment.

Discharge Limits

The limits prescribed by the regulatory body for effluent discharges into atmosphere / aquatic environment from nuclear/radiation facilities.

Disposal (Radioactive Waste)

The emplacement of waste in a repository without the intention of retrieval or the approved direct discharge of waste into the environment with subsequent dispersion.

Documentation

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

Dose

A measure of the radiation received or absorbed by a target. The quantities termed absorbed dose, organ dose, equivalent dose, effective dose, committed equivalent dose, or committed effective dose are used, depending on the context. The modifying terms are used when they are necessary for defining the quantity of interest.

Dose Constraint

A prospective and source-related restriction on the individual dose delivered by the source, which serves as a bound in the optimisation of protection and safety of the source. For occupational exposures, dose constraint is a source-related value of individual dose used to limit the range of options considered in the process of optimisation. For public exposure, the dose constraint is an upper bound on the annual dose that a member of the public should receive from the planned operation of any controlled source. The exposure to which the dose constraint applies is the annual dose to any critical group summed over all exposure pathways, arising from the predicted operation of the controlled source. The dose constraint for each source is intended to ensure that the sum of doses to the critical group from all controlled sources remains within the dose limit. For medical exposure the dose constraint level should be interpreted as a guidance level, except when used in optimising the protection of persons, other than workers, who assist in the care, support or comfort of exposed patients.

Dose Limit

The value of the effective dose or the equivalent dose to individuals from controlled practices that shall not be exceeded.

Effective Dose

The quantity 'E' defined as a summation of the tissue equivalent doses, each multiplied by the appropriate tissue weighting factor:

$$E = \sum W_T . H_T$$

where 'H_T' is the equivalent dose in tissue 'T' and 'W_T' is the tissue weighting factor for tissue 'T'.

Effluent

Any waste discharged into the environment from a facility, either in the form of liquid or gas.

Emergency

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

Emergency Exercise

A test of an emergency plan with particular emphasis on coordination of the many inter-phasing components of the emergency response, procedures and emergency personnel/agencies. An exercise starts with a simulated/postulated event or series of events in the plant in which an unplanned release of radioactive material is postulated.

Emergency Plan

A set of procedures to be implemented in the event of an accident.

Employer

Any person with recognised responsibility, commitment and duties towards a worker in his or her employment by virtue of a mutually agreed relationship. (A self-employed person is regarded as being both a worker and employer).

Environment

Everything outside the premises of a facility, including the air, terrain, surface and underground water, flora and fauna.

Equivalent Dose ($H_{T, R}$)

The quantity '$H_{T, R}$' is defined as

$$H_{T, R} = D_{TR}\, W_R$$

where 'D_{TR}' is the absorbed dose delivered by radiation type 'R' averaged over a tissue or organ 'T' and 'W_R' is the radiation weighing factor for radiation type 'R'. When the radiation field is composed of different radiation types with different values of 'W_R' the equivalent dose is

$$H_T = \sum_R W_R\, D_{T, R}$$

Exclusion Zone

An area extending upto a specified distance around the plant, where no public habitation is permitted. This zone is physically isolated from outside areas by plant fencing and is under the control of the plant management.

Exemption

The deliberate omission of a practice, or specified sources within a practice, from regulatory control or from some aspects of regulatory control, by the regulatory body on the grounds that the exposures which the practice or sources cause or have the potential to cause are sufficiently low as to be of no regulatory concern.

Exposure

The act or condition of being subject to irradiation. Exposure may be either external (irradiation by sources outside the body) or internal (irradiation by sources inside the body). Exposure can be classified as either normal exposure or potential exposure; occupational, medical or public exposure; and in intervention situations, either emergency exposure or chronic exposure. The term 'exposure' is also used in radiation dosimetry to express the amount of ions produced in air by ionising radiation.

Health Surveillance

Medical supervision intended to ensure the initial and continuous fitness of workers for their intended task.

Intake

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

Investigation Level

The value of a quantity such as effective dose, intake, or contamination per unit area or volume, at or above which an investigation should be conducted.

Member of the Public

Any individual in the population except for one who is subject to occupational or medical exposure. For the purpose of verifying compliance with the annual dose limit for public exposure, the member of the public is the representative individual in the relevant critical group.

Monitoring

The continuous or periodic measurement of parameters for reasons related to the determination, assessment in respect of structure, system or component in a facility or control of radiation.

Nuclear Fuel Cycle

All operations associated with the production of nuclear energy, including mining, milling, processing and enrichment of uranium or processing of thorium, manufacture of nuclear fuel, operation of nuclear reactors, reprocessing of irradiated nuclear fuel, decommissioning, and any activity for radioactive waste management and research or development activity related to any of the foregoing.

Occupational Exposure

All exposures of personnel incurred in the course of their work.

Occupational Worker

Any person, working full time or part time in a nuclear or radiation facility, who may be employed directly by the “consentee” or through a contractor.

Off-site

Area in public domain beyond the site boundary.

Off-site Emergency

Accident condition/emergency situation involving excessive release of radioactive materials/hazardous chemicals from the plant to the public domain calling for intervention.

Operation

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

Plant Emergency

Declared emergency conditions in which the radiological/other consequences, confined to the plant or a section of the plant, requiring immediate operator action.

Prescribed Limits

Limits established or accepted by the regulatory body.

Quality Assurance (QA)

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

Radiation Surveillance

Measures that may be specified by the competent authority to provide adequate protection either generally or in any individual case.

Radiation Worker

Any person who is occupationally exposed to radiation, and who in the opinion of the regulatory body, should be subjected to radiation surveillance.

Radioactive Waste

Material, whatever its physical form, left over from practices or interventions for which no further use is foreseen: (a) that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level for clearance from regulatory requirements, and (b) exposure to which is not excluded from regulatory control.

Radiological Safety Officer (RSO)

Any person who is so designated by the employer and who, in the opinion of the competent authority is qualified to discharge the functions outlined in the Radiation Protection Rules, 2004.

Records

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

Reference Level

Action level, intervention level, investigation level or recording level established for any of the quantities determined in the practice of radiation protection.

Regulatory Constraints

Restrictions on radiation protection parameters as specified by the regulatory body.

Safety Analysis Report (SAR)

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

Safety Assessment

A review of the aspects of design and operation of a source which are relevant to the protection of persons or the safety of the source, including the analysis of the provisions for safety and protection established in the design and operation of the source and the analysis of risks associated both with normal conditions and accident situations.

Safety Code

A document stating the basic requirements, which must be fulfilled for particular practices or applications. This is issued under the authority of the regulatory body and mandatory to be followed by the respective utilities.

Safety Guide

A document containing detailed guidelines and various procedures/methodologies to implement the specific parts of a safety code that are acceptable to the regulatory body, for regulatory review. This is issued under the authority of regulatory body and is of non-mandatory nature.

Safety Manual

A document detailing the various safety aspects/instructions and requirements relating to a particular practice or application, that are to be followed by a utility.

Site

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

Siting

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

Source

Anything that causes radiation exposure, either by emitting ionising radiation or releasing radioactive substances or materials.

Sterilized Zone

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

Stochastic Effects (Radiation)

Radiation effects generally occurring without a threshold level of dose whose probability is proportional to the dose and whose severity is independent of the dose.

Supervised Area

Any area not designated as a controlled area but for which occupational exposure conditions are kept under review even though specific protective measures and safety provisions are not normally needed.

Surveillance

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

Technical Specifications for Operation

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

Unrestricted Use

Any release or use of materials, equipment, buildings or site without any restriction imposed by the regulatory body.

Worker

Any person who works, whether full-time, part-time or temporarily, for an employer and who has recognised rights and duties in relation to occupational radiation protection. (A self-employed person is regarded as having the duties of both an employer and worker).

SPECIAL DEFINITIONS
(Specific for the Present Code)

Classified worker

The radiation worker, who is likely to receive an effective dose in excess of three-tenths of the average annual dose limits notified by the competent authority.

Existing Exposure Situation

A situation that already exists when a decision on control has to be taken, including natural background radiation and residues from past practices.

Remediation

Any measures that may be carried out to reduce the radiation exposure from existing contamination of land areas through actions applied to the contamination itself (the source) or to the exposure pathways to humans. (See also decontamination)

Representative Person

An individual receiving a dose that is representative of the more highly exposed individuals in the population.

CONTENTS

1. INTRODUCTION

1.1 General

Radiation exposure can occur to occupational workers, members of the public and the environment during the operation of various nuclear fuel cycle facilities. Therefore it is important to have a radiation protection programme to manage, control and minimise exposures to ionising radiation so that deterministic effects are prevented and stochastic effects are reduced to the extent reasonably achievable.

A well-established radiation protection programme helps in minimising radiation exposure. For this, radiation exposure to occupational workers, members of the public and the environment shall be assessed and the records shall be maintained.

1.2 Objective

This safety code specifies the basic requirements for radiation protection of the occupational workers, members of the public and the environment against the undue exposure to ionising radiation.

1.3 Scope

This safety code shall apply to all nuclear fuel cycle facilities such as :

(a) mining and milling of uranium and thorium ores;

(b) fuel enrichment/fabrication;

(c) nuclear power plants;

(d) research/experimental reactors;

(e) fuel reprocessing;

(f) radioactive waste management plants; and

(g) any other facility as determined by AERB.

The code specifies radiation protection requirements in siting, design, construction, commissioning, operation and decommissioning of nuclear fuel cycle facilities. The code also specifies the requirements with respect to roles and responsibilities of the consentee, the radiological safety officer (RSO) and occupational workers with respect to radiation safety. The requirements on control, monitoring, surveillance and quality assurance aspects of radiation protection programme are also brought out in the code.

2. BASIC REQUIREMENTS

2.1 General

In view of the potential health effects of radiation exposures, it is necessary that all activities involving radiation exposures and the facilities handling radioactive materials are regulated. An appropriate and approved radiation protection programme shall be implemented to ensure radiation safety of the occupational workers, members of the public and the environment.

2.2 Statutory Provisions

All nuclear fuel cycle facilities for the purpose of radiation protection requirements shall be subject to, but not limited to the relevant statutory provisions of the following Act and Rules:

(a) Atomic Energy Act, 1962 (33 of 1962),

(b) Atomic Energy (Radiation Protection) Rules, 2004,

(c) Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987, and

(d) Atomic Energy (Working of the Mines, Minerals and Handling of Prescribed Substances) Rules 1984.

2.3 Radiation Protection Programme

All nuclear fuel cycle facilities shall establish and implement the radiation protection programme commensurate with the scope of their activities. For establishing these requirements, the radiation exposure situations in a nuclear fuel cycle facility shall be distinguished as planned and emergency exposures [2, 3]. The guiding radiation protection principles in all these situations shall be:

(a) Justification of practice

(b) Optimisation of protection

(c) Dose limitation

The Consentee shall submit the radiation protection programme of the facility to AERB for approval. The radiation protection programme shall be reviewed periodically and modified if required, with the approval of AERB or any other agency decided by competent authority.

The radiation protection programme of the facility shall be inspected/audited by AERB or its authorised agency at prescribed intervals.

The consentee shall report AERB any non-compliance with radiation protection requirements.

3. RADIATION PROTECTION PROGRAMME AND CONSENTING PROCESS

3.1 General

Nuclear fuel cycle facilities shall ensure radiological safety of occupational workers and the public and shall also consider the radiological impact on the environment and natural resources. Therefore, the radiation protection requirements for a facility shall be considered at different stages like siting, design, construction, commissioning, operation and decommissioning based on the consents issued.

3.2 Siting

Siting requirements with respect to radiation protection for nuclear power plants shall be as per AERB 'Code of Practice on Safety in Nuclear Power Plants Siting' (AERB/SC/S) [4]. For other nuclear fuel cycle facilities requirements shall be decided on a case-by-case basis by AERB.

3.3 Design and Construction

The design and construction of the facility shall meet the radiation shielding requirements. Wherever the possibility of induced radioactivity exists, special attention shall be given for selection of materials used for structures, systems, equipment and components. Information on selection of material and the basis shall be included in the design basis reports.

The facility shall have appropriate engineered safety features such as containment/ confinement systems for handling radioactive materials.

The design of the facility shall take into account the appropriate radiation zoning requirements to control radiation exposure. The radiation zoning and the basis shall be included in the design basis report.

The radiological impact of the facility shall be evaluated both for normal operation as well as postulated design basis accident conditions and shall be included in the safety analysis report. Details of radiation monitoring instruments and systems provided in the facility shall be included in the design basis report. The estimated radiation levels at various locations of the plants, estimated radiation dose to the occupational workers and the public shall be included in design basis reports. The predicted radiological impact to the members of the public and the environment shall be within the limits prescribed by AERB.

The ventilation system of the facility shall be designed to ensure that the radionuclide concentrations in air at various locations of the facility including

the working environment are well within the prescribed limits. Stack design shall consider the radiological impact to the surrounding environment and radiation dose to the public due to the releases of radioactive effluent during normal, anticipated operational occurrences and design basis accidents in the facility.

The facility shall have appropriate design provisions for management of radioactive waste generated during operation and decommissioning of the facility.

3.4 Commissioning and Operation

Testing the adequacy and integrity of the radiation shielding, the proper functioning of the ventilation system in radioactive areas and other systems important to safety, safety inter-locks and the performance of radiation protection instruments shall be carried out during commissioning of the facility.

Occupational workers shall be adequately trained in radiation protection aspects as stipulated by AERB before engaging them in any radioactive work.

Radiation protection manual for the facility shall be approved by AERB.

Consentee shall submit status reports to AERB on radiological safety of the facility including monitoring data as per the format and frequency specified by AERB.

3.5 Emergency Preparedness

An emergency preparedness programme shall be established, tested and maintained prior to commencement of operation to provide reasonable assurance that, in the event of an emergency situation, appropriate measures can be undertaken to mitigate the consequences. An emergency preparedness plan considering the possible emergency scenarios for the facility shall be submitted to AERB for approval while seeking the consent for operation**.**

Site-specific intervention and derived intervention levels shall be established and got approved by AERB for undertaking various protective measures and shall be included in the emergency preparedness plan.

3.6 Plant Life Management, Augmentation and Decommissioning

In designing the equipment/structures in a facility, the requirements for radiation protection including safe management of radioactive waste during the life of the facility and the decommissioning of the facility shall be taken into account. The radiological characterisation data for these stages of the facility shall be estimated at the design stage and updated periodically based on operating experience.

4. CONTROL OF RADIATION EXPOSURE

4.1 General

Radiation exposure shall be controlled within the limits prescribed by AERB for various exposure situations, both for occupational workers as well as members of the public. All facilities shall establish appropriate ALARA programme to minimize the radiation exposure and the number of persons exposed.

4.2 Radiation Protection Criteria

Individual dose constraints/limits, cumulative life time dose limits and reference levels applicable for various exposure situations prescribed by AERB shall be followed by all facilities.

No person under the age of 18 years shall be employed as a radiation worker. No person under the age of 16 years shall be employed as an apprentice or recruit as a trainee for radiation work.

Radiation dose to the occupational workers, apprentice and trainees shall not exceed the limit prescribed by AERB. Any exposure exceeding the prescribed dose limits shall be investigated as per the procedures approved by AERB.

The facility shall follow the dose limits and the procedure approved by AERB for employing temporary workers in respect of radiation work.

There is no special occupational dose limit for women in general. However, once a woman employee declares pregnancy, the radiation dose to the pregnant woman during the remainder of the pregnancy period shall be controlled as per the limit prescribed by AERB.

4.3 Dose Assessment

The consentee shall monitor and control the radiation exposures (both external and internal) to all occupational workers to demonstrate compliance with the prescribed limits. A periodic report containing the exposure details shall be submitted to AERB. The dose assessment scheme and accreditation of the dosimetry facility shall be approved by AERB. The consentee shall preserve the exposure records of each worker for the time period specified by AERB.

4.4 Control of Occupational Exposure

Facility shall develop a plan to continually review and reduce the individual and collective exposures by engineering and administrative measures including training.

4.5 Control of Exposure to Members of the Public

Radiation dose to members of the public from a facility shall not exceed the limit prescribed by AERB. For estimation of the public dose, site-specific environmental parameters and the concept of a representative person shall be used.

Each facility shall use approved dose apportionment (terrestrial, aquatic and atmospheric pathways) for deriving the waste disposal/discharge limits which shall form the basis for the authorised limits for safe disposal of radioactive waste under statutory provisions. Design features, source term, site-specific environmental parameters, standard predictive models and operating experience shall be used for deriving the waste disposal/discharge limits. The authorised discharge limits shall be included in technical specifications for operation of the facility.

4.6 Transport of Radioactive Material

Onsite transport of radioactive materials shall be carried out as per the approved procedure. Offsite transport of radioactive material shall meet the requirements of AERB/SC/TR-1 [5].

4.7 Exemption and Clearance

Exemption and clearance of radioactive material shall be based on the limits prescribed by AERB [6].

5. RESPONSIBILITIES

5.1 General

The Consentee shall have the overall responsibility for the radiological safety of the facility during all its operational states. The roles and responsibilities of these agencies shall be clearly defined and delineated in the radiation protection manual/procedure of the facility.

5.2 Responsibilities of the Consentee

The consentee shall:

(a) comply with statutory provisions listed in section 2.2.

(b) adhere to the terms and conditions of the regulatory consent,

(c) comply with the provisions of surveillance procedures, safety codes and safety standards specified by the competent authority,

(d) establish written procedures and plans for controlling, monitoring and assessment of exposure for ensuring adequate protection of workers, members of the public and the environment, wherever applicable,

(e) ensure that all radioactive discharges to the environment are within the authorised limits,

(f) maintain occupational history and dose records of workers,

(g) arrange for preventive and remedial maintenance of radiation protection equipment, and monitoring instruments,

(h) investigate case(s) of exposure, if any, in excess of regulatory constraints received by individual workers in consultation with the radiological safety officer and maintain records of such investigations,

(i) inform competent authority promptly of the occurrence, investigation and follow-up actions in cases of exposures in excess of regulatory constraints, including steps to prevent recurrence of such incidents,

(j) estimate the inventory of radioactive material and maintain the records,

(k) secure radiation sources , inform the competent authority and local law enforcing agency of any loss of radiation source,

(l) investigate and inform the competent authority of any accident involving source and maintain record of investigations,

(m) verify the performance of radiation monitoring systems, associated safety interlocks and protective devices in the radiation installation,

(n) prepare emergency preparedness plans in consultation with radiological safety officer,

(o) conduct or arrange for quality assurance tests of radiological safety related equipment,

(p) ensure that all the workers including the temporary workers are familiarised through appropriate training programmes with contents of the relevant surveillance procedures, safety standards, safety codes, safety guides, safety manuals and emergency response plans,

(q) provide facilities and equipment to the radiological safety officer and other worker(s) to carry out their functions effectively in conformity with the regulatory constraints,

(r) prior to employment of a worker, procure from his/her former employer applicable dose records and health surveillance reports; upon termination of service of worker provide to his new employer, on request, his dose records and health surveillance reports,

(s) arrange periodic health surveillance of radiation workers,

(t) extend all assistance to enable the regulatory inspection to be carried out effectively and unhindered, and

(u) provide all the information/documents/records to the regulatory inspectors as required.

5.3 Responsibilities of the Radiological Safety Officer (RSO)

The radiological safety officer shall be responsible for advising and assisting the consentee and workers with respect to radiological safety. The radiological safety officer shall:

(a) carry out/facilitate routine measurements and analysis of radiation and radioactivity levels in the controlled area, supervised area and premises of the facility and maintain records of the results thereof;

(b) investigate any situation that could lead to potential exposures;

(c) advise the consentee regarding:

  (i) the necessary steps aimed at ensuring that the regulatory constraints and adherence to terms and conditions of the license,

  (ii) the safe storage and movement of radioactive material within the radiation installation,

  (iii) initiation of suitable remedial measures in respect of any situation that could lead to potential exposures,

(iv) routine measurements and analysis of radiation and radioactivity levels in the site/off-site environment of the radiation installation and maintenance of the results thereof,

(v) the modifications in working conditions of a pregnant worker,

(vi) the safety and security of radioactive sources, and

(vii) regular decontamination of controlled areas.

(d) ensure that :

(i) reports on all (radiation) hazardous situations along with details of any immediate remedial actions taken are made available to the consentee for reporting to the competent authority, and

(ii) radiation monitoring including portable instruments are calibrated periodically;

(e) assist the consentee in:

(i) instructing the workers on hazards of radiation and on suitable safety measures and work practices aimed at minimizing exposures to radiation sources, the safe disposal / transfer of radioactive waste, and

(ii) developing suitable emergency response plans to deal with accidents and maintaining emergency preparedness;

(f) furnish periodic reports on radiological status of facility to the consentee and also to AERB.

5.4 Responsibilities of the Occupational Worker

Every worker shall observe the safety requirements and follow safe working procedures and shall refrain from any willful act that could be detrimental to self, co-workers, the facility and the public.

The worker shall:

(a) provide to the employer information about his/her previous occupations including radiation work, if any,

(b) make proper use of such protective equipment, radiation monitors and personnel monitoring devices as provided, and

(c) inform the consentee and the radiological safety officer, of any accident or potentially hazardous situation that may come to his/her notice.

A female worker on becoming pregnant shall inform the consentee and the radiological safety officer about her pregnancy and to change her working conditions if necessary.

6. CLASSIFIED WORKER AND CLASSIFICATION OF RADIOACTIVE AREAS

6.1 General

For effective monitoring and surveillance, the radioactive areas of the facility shall be classified as (i) supervised areas and (ii) controlled areas. Radiological evaluation and past experience of similar facilities help in classification of radioactive areas of a particular facility.

6.2 Classified Worker

The consentee shall designate classified workers as those workers, who are likely to receive an effective dose in excess of three-tenths of the average annual dose limits prescribed by AERB and shall inform those workers that they have been so designated [7].

6.3 Supervised Areas

The consentee in consultation with radiological safety officer shall designate any area as a supervised area where occupational exposure conditions need to be kept under review even though specific protective measures and safety provisions are not normally needed.

The arrangements of supervised area shall be appropriate to the nature of the installation, sources and also to the exposure magnitude. Control measures and monitoring of the area shall be appropriate to take care of the exposure situation.

The consentee shall periodically monitor and review the radiological conditions of the supervised areas to assess the need for protective measures and safety provisions or change in the boundaries of supervised areas. The consentee shall:

(a) delineate the supervised areas by appropriate means, and

(b) display standard symbols/signs at appropriate access points to the supervised areas.

6.4 Controlled Areas

The consentee in consultation with radiological safety officer shall designate any area as controlled area in which specific protective measures or safety provisions are required for:

(a) controlling normal exposures or preventing the spread of contamination during normal working conditions, and

(b) preventing or limiting the extent of potential exposures.

In determining the boundaries of any controlled area, the consentee shall take into account the magnitudes of the expected normal exposures, the likelihood and magnitude of potential exposures, the nature and extent of the required protection and safety procedures. Appropriately, high dose rates may be adopted in controlled area where compliance with the relevant limits can be achieved only by limiting the time spent or by using special protective equipment. The consentee shall :

(a) delineate controlled areas by physical means or, where this is not reasonably practicable, by some other suitable means;

(b) where a source is brought into operation or energised only intermittently or is moved from place to place, delineate an appropriate controlled area by means that are appropriate under the prevailing circumstances and specify exposure times.

(c) display the standard radiation symbol and appropriate instructions at the access points and other appropriate locations within the controlled areas and arrange regular decontamination of area as per the advice of the radiological safety officer;

(d) establish occupational radiation protection and safety measures including, as appropriate, physical measures to control the spread of contamination and procedures for controlled areas;

(e) restrict access to the controlled areas by means of administrative procedures such as the use of work permits, and by physical barriers, which could include locks or interlocks. The degree of restriction shall be commensurate with the magnitude and likelihood of the expected exposures;

(f) provide as appropriate at entrances to the controlled areas:

  (i) personal protective clothing and equipment,

  (ii) monitoring equipment,

  (iii) suitable storage for personal clothing;

(g) provide as appropriate at exits from controlled areas:

  (i) equipment for monitoring for contamination of skin and clothing,

  (ii) equipment for monitoring for contamination of any object or substance being removed from the area,

  (iii) washing or showering facilities for decontamination,

  (iv) suitable storage for contaminated protective clothing and equipment;

(h) periodically review radiological conditions to determine the possible needs to revise the protective measures or safety provisions or the boundaries of the controlled areas.

6.5 Zone Classification

To restrict the radiation exposure/spread of contamination, the controlled area of the facility shall be divided into various zones with respect to the probability and magnitude of radiation field/potential for contamination. Each zone shall have appropriate ventilation design, access control, radiation monitoring programme and personal protective equipment including clothing. Consideration shall be given to possibility that it may be necessary during operation or planned maintenance to reclassify certain areas temporary or permanent. In this regard, particular attention shall be paid to the planning of access routes. Under such conditions the zones and the controlled areas shall be reevaluated.

7. MONITORING AND SURVEILLANCE

7.1 General

Radiation monitoring and surveillance programme shall be established for all nuclear fuel cycle facilities. The radiation monitoring and surveillance programme of the facility shall include radiation monitoring of the facility, working personnel, radioactive waste, effluents and the environment.

7.2 Workplace Monitoring and Surveillance

Radiation monitoring and surveillance programme of the facility shall be established before commissioning of the facility.

The monitoring and surveillance programme of the facility shall be reviewed periodically and updated with operating experience with the approval of AERB.

Areas of the facility having potential for radiation exposure and spread of contamination shall be equipped with appropriate radiation monitoring instruments and standard radiation warning symbols/signboards including instructions.

The facility shall be provided with centralized radiation monitoring system, as appropriate.

Facility shall maintain records pertaining to the periodic monitoring and surveillance of the facility. The nature and frequency of monitoring of the facility shall be adequate to enable:

(i) evaluation of the radiological conditions in all workplaces,

(ii) exposure assessment in controlled areas and supervised areas,

(iii) review of the classification of controlled and supervised areas, and

(iv) identification of classified radiation workers.

7.3 Exposure Monitoring and Health Surveillance

The consentee shall establish external and internal radiation monitoring and dose assessment programme including dosimetry services for radiation workers. Appropriate and adequate number of dose monitoring/assessment instruments shall be available for all exposure situations including normal and off-normal operations. Approved methods and procedures shall be used for assessment of both external and internal exposures.

Every worker, initially on employment [7] and a classified worker thereafter, at least once in three years (as long as the individual is employed) shall be subjected to the following:

(a) general medical examination as specified by the competent authority, and

(b) health surveillance to decide the fitness of each worker for the intended task.

The health surveillance shall also include:

(i) special tests or medical examinations as specified by AERB for workers who have received dose in excess of the regulatory limits, and

(ii) counseling of pregnant workers.

7.4 Solid Waste and Effluent Monitoring

Facility shall establish adequate monitoring provisions for radioactive solid, liquid and gaseous waste. The radioactive waste management of the facility shall meet the safety requirements specified in AERB safety code 'Management of Radioactive Waste' AERB/NRF/SC/RW [8].

Only monitored, treated and characterised waste shall be discharged or disposed off to the environment or transferred to other onsite or offsite facilities. Such operations shall be as per the approved procedures and in accordance with the terms and conditions of the authorisation issued for the purpose [9].

7.5 Environmental Monitoring

Before commissioning of the facility, the environmental monitoring and surveillance programme shall be in place for establishing the baseline data for the site environment. The frequency of monitoring and surveillance during the operational phase shall be established based on the nature and type of the facility and the potential for environmental contamination. The monitoring and surveillance programme shall meet the requirements of both normal operation as well as emergency situations. Approved procedures shall be used for environmental monitoring and dose assessment. The facility shall submit periodic environmental monitoring reports to AERB.

7.6 Site Remediation and Monitoring

Remediation of a contaminated site shall be carried out if the radionuclide concentration exceeds the reference levels prescribed by AERB. The final report on the remediated site shall be submitted to AERB.

8. QUALITY ASSURANCE PROGRAMME

8.1 General

For effective radiation protection programme each facility shall develop appropriate quality assurance (QA) programme.

8.2 Quality Assurance Programme (QAP)

The facility shall establish an approved quality assurance programme for radiation protection. The QA programme shall include calibration of the monitoring instruments, use of appropriate standard sources, radiation monitoring, dose assessment and environmental surveillance.

8.3 Training

Only trained and qualified personnel shall carry out radiation work. Training programme shall be devised for new as well as existing occupational workers and personnel engaged in environmental monitoring and surveillance programme. The facility shall develop appropriate training programme in radiation protection for different categories of occupational workers. Refresher training shall be provided periodically and whenever the procedures are revised.

8.4 Documentation and Records

Facility shall maintain all radiological safety related documents and records with respect to the facility, occupational workers and the environment for a period prescribed by AERB.

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LIST OF PARTICIPANTS

EXPERT COMMITTEE FOR PREPARATION OF SAFETY CODE ON RADIATION PROTECTION FOR NUCLEAR FUEL CYCLE FACILITIES

Dates of meeting	:	April 9, 2009 May 28, 2009 August 21, 2009

Members of the Expert Committee:

Shri A.R. Sundararajan (Chairman)	:	AERB (Former)
Dr. Pushparaja	:	BARC (Former)
Shri A.H. Khan	:	BARC (Former)
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ADVISORY COMMITTEE FOR CODES, GUIDES & ASSOCIATED MANUALS FOR SAFETY IN OPERATION OF NUCLEAR POWER PLANTS (ACCGASO)

Dates of meeting	:	December 3, 2009 December 4, 2009 May 25, 2010

Members of ACCGASO:

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Shri K.K. Vaze	:	BARC
Shri S.G. Ghadge	:	NPCIL
Shri S.A. Khan	:	AERB
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ADVISORY COMMITTEE ON NUCLEAR SAFETY (ACNS)

Dates of meeting	:	February 8 & 9, 2011

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PROVISIONAL LIST OF REGULATORY DOCUMENTS ON RADIATION PROTETION

S.No.	AERB Document No.	Title
1.	AERB/NF/SC/RP; 2012	Radiation Protection for Nuclear Fuel Cycle Facilities
2.	AERB/NPP-PHWR/SG/D-12; 2005	Radiation Protection Aspects in Design for Pressurised Heavy Water Reactor Based Nuclear Power Plants
3.	AERB/SG/O-5; 1998	Radiation Protection during Operation of Nuclear Power Plants
4.	AERB/SG/G-8; 2001	Criteria for Regulation of Health and Safety of Nuclear Power Plant Personnel, the Public and the Environment
5.	AERB/NF/SM/O-2 (Rev. 4); 2005	Radiation Protection for Nuclear Facilities

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