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GOVERNMENT OF INDIA

AERB SAFETY GUIDE

REGULATORY CONTROL OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT AND DISPOSAL OF SOLID WASTE

ATOMIC ENERGY REGULATORY BOARD

AERB SAFETY GUIDE NO. AERB/NRF/SG/RW-10

REGULATORY CONTROL OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT AND DISPSOAL OF SOLID WASTE

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FOREWORD

Activities concerning establishment and utilisation of nuclear facilities and use of radioactive sources are to be carried out in India in accordance with the 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 (AERB) 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.

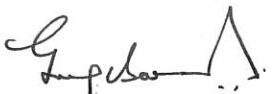
Safety codes and safety standards are formulated on the basis of nationally and internationally accepted safety criteria for design, construction and operation of specific systems, structures, equipment, and components of nuclear and radiation facilities. Safety codes establish the objectives and set 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.

This safety guide provides guidance for regulatory control of radioactive discharges to the environment and disposal of solid waste resulting from planned operations of Facilities and Activities. Guidance provided in this guide is intended to assist the applicant and regulatory body in establishing dose constraints and issuing relevant authorization related to radioactive discharges and disposal of solid waste. The guide also elaborates graded approach in authorization process considering safety and hazard potential of Facilities and Activities. For the aspects not covered in this guide, applicable national and international standards, codes and guides acceptable to AERB should be followed.

In drafting this guide, 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) and other international publications have been extensively used. Appendices / Annexure and references are included to provide information that might be helpful to the user.

This safety guide has been prepared by specialists in the field drawn from the AERB, Bhabha Atomic Research Centre (BARC), Nuclear Power Corporation of India Ltd. (NPCIL) and other consultants. It has been reviewed by the AERB Advisory Committees on Nuclear and Radiation Safety (ACNRS).

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



(G. Nageswara Rao)
Chairman, AERB

DEFINITIONS

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 and the probability and magnitude of potential exposures for radiation protection are kept as low as reasonably achievable, with economic and social factors taken into account.

Anticipated Operational Occurrence
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

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.

Authorized Limits
A limit on a measurable quantity, established or formally accepted by a regulatory body.

Authorized Person
A person authorized by the competent authority for disposal of radioactive waste in accordance with the provisions of Atomic Energy (Safe Disposal Of Radioactive Wastes) Rules, 1987

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.

Clearance
Removal of regulatory control by the regulatory body from radioactive material or radioactive objects within notified or authorized facilities and activities.

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.

Criteria
Principles or standards on which a decision or judgment can be based. They may be quantitative or qualitative.

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.

Discharge (Radioactive)
Planned and controlled release of (gaseous or liquid) radioactive material into the environment from nuclear/ radiation facilities.

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

Disposal
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.

Disposal Limits
The limits for disposal of radioactive waste, prescribed from time to time by the competent authority under Atomic Energy (Safe Disposal of Radioactive Wastes) Rules, 1987.

Document
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.

Dose Constraint
A prospective and source-related restriction on the individual dose from a source, which provides a basic level of protection for the most highly exposed individuals and serves as an upper bound on the dose in optimisation of protection for that source. For occupational exposures, the dose constraint is a 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 doses that members of the public should receive from the planned operation of any controlled source. For medical exposure, the dose constraint level should be interpreted as a guidance level, except when used in optimizing 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:

$$E = \sum_{T} W_T . H_T$$

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.

Enforcement
The action taken by regulatory body intended to correct non-compliance by a consentee with the relevant regulations and conditions stipulated in the consent.

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

$$H_T = \Sigma \; w_R \, D_{T,R}$$

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 can be either external (irradiation by sources outside the body) or internal (irradiation by sources inside the body). Exposure can be classified as either normal exposure or potential exposure; occupational, medical or public exposure; and in emergency exposure 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.

Facilities and Activities
A general term encompassing nuclear facilities, uses of all sources of ionizing radiation, all radioactive waste management activities, transport of radioactive material and other practices or situations in which people may be subject to exposure to radiation from naturally occurring or artificial sources.

***Facilities*:** These include: nuclear facilities; irradiation installations; some mining and raw material processing facilities such as uranium mines and mills; radioactive waste management facilities; and any other places where radioactive material is produced, processed, used, handled, stored or disposed of — or where radiation generators are installed — on such a scale that consideration of protection and safety is required.

***Activities*:** These include: the production, use, import and export of radiation sources for industrial, research and medical purposes; the transport of radioactive material; the decommissioning of facilities; radioactive waste management activities such as the discharge of effluents; and some aspects of the remediation of sites affected by residues from past activities.

The term facilities and activities provides an alternative to the terminology of sources and practices (or intervention) to refer to general categories of situations.

Graded Approach
For a system of control, such as a regulatory system or a safety system, a process or method in which the stringency of the control measures and conditions to be applied is commensurate, to the extent practicable, with the likelihood and possible consequences of, and the level of risk associated with a loss of control

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

Institutional Control
Control of a radioactive waste site by an authority or institution designated under the laws of the country. This control may be active (monitoring, surveillance, remedial work) or passive (land use control) and may be a factor in the design of a facility (e.g. a near surface disposal facility).

Justification
The process of determining for a planned exposure situation whether a practice is, overall, beneficial; i.e., whether the expected benefits to individuals and to society from introducing or continuing the practice outweigh the harm (including radiation detriment) resulting from the practice.

Licence
A type of regulatory consent, granted by the regulatory body for all sources, practices and uses for nuclear facilities involving the nuclear fuel cycle and also certain categories of radiation facilities. It also means authority given by the regulatory body to a person or to an organisation having overall responsibility to perform specified functions related to a facility or an activity.

Long- lived Waste
Radioactive waste that contains significant levels of radionuclides with a half-life greater than 30 years.

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 group.

Migration
The movement of radionuclides in the environment as a result of natural processes. Most commonly, movement of radionuclides in association with groundwater flow.

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.

Natural Source

A naturally occurring source of radiation, such as the sun and stars (sources of cosmic radiation) and rocks and soil (terrestrial sources of radiation), or any other material whose radioactivity is for all intents and purposes due only to radionuclides of natural origin, such as products or residues from the processing of minerals; but excluding radioactive material for use in a nuclear installation and radioactive waste generated in a nuclear installation.

Near Surface Disposal
Disposal of waste with/without engineered barriers, on or below the ground surface with adequate final protection covering to bring the surface dose rate within prescribed limits.

Nuclear Facility
All nuclear fuel cycle and associated installations encompassing the activities from the front end to the back end of nuclear fuel cycle processes and also the associated industrial facilities such as heavy water plants, beryllium extraction plants, zirconium plants, etc.

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.

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

Planned Exposure Situation
This situation of exposure arises from the planned operation of a source or from a planned activity that results in an exposure due to a source.

Public Exposure
Exposure incurred by members of the public from radiation sources, excluding any occupational or medical exposure and the normal local natural background radiation, but, including exposure from authorised sources and practices and from intervention situations.

Quality Assurance (QA)

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

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.

Records

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

Regional Source

Radiation sources responsible for exposure to the public due to the discharges / disposals other than local sources. These sources of radiation exposure generally encompasses radial zone of 100 to 1500 km around the facilities.

Registration

A type of regulatory consent issued by the regulatory body for sources and practices of low hazard (see also 'Consent').

Regulatory Clearance

A type of regulatory consent, which is issued for a nuclear facility during the intermediate stages of consenting process.

Regulatory Constraints

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

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 *doses* to the more highly exposed individuals in the population. The representative person will generally be a hypothetical construct and not an actual member of the population.

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.

Short- lived Waste

Radioactive waste that does not contain significant levels of radionuclides with a half-life greater than 30 years.

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

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

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.

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1. INTRODUCTION

1.1 General

Facilities and Activities that give rise to radiation risks are required to be designed, constructed and operated with adequate level of protection to the people and the environment. During normal operation, some Facilities and Activities generate radioactive effluents containing small amounts of radionuclides that may result in exposure to the public and the environment to low levels of radiation. In many cases, the complete prevention of the release of such effluents is either technically impractical or extremely costly to achieve. The radiation doses to the member of the public from such radioactive releases must be kept below the prescribed limits. Considering the very low radiological significance of the releases and the possibilities of high costs that may be associated with reducing them further, such releases would be acceptable with regard to protection and safety in accordance with the optimisation requirements and ALARA principle.

Facilities and Activities generating radioactive releases in normal operation that result in very low doses to the public and where there is no risk of an unexpected accidental release can be managed through the concept of exemption. However, releases from some facilities may result in doses with a higher level of radiological significance or the Facility or Activity may possess potentially higher radiation risks, the releases from such Facilities and Activities need to be managed by means of authorisation, which establishes stringent technical and regulatory conditions, including adequate administrative and engineering measures.

The authorisation for radioactive waste discharge and disposal to the environment is governed by the provisions of the Atomic Energy Act, 1962 [1], Atomic Energy (Radiation Protection) Rules 2004 [2], Atomic Energy (Safe Disposal of Radioactive Wastes) Rules 1987[3] and the requirements specified by regulatory bodies [4]. Accordingly, any Facility or Activity that discharges / disposes radioactive wastes need to establish dose constraint[1] and obtain authorisation from the regulatory body [4, 5].

[1] *Dose constraint is prospective and source related restriction on individual dose to serve as an upper bound in optimisation of protection for that source. The dose constraint can be used for occupational as well as public exposure. The dose*

This safety guide elaborates guidance on aspects related to dose constraint and authorisation for radioactive waste discharges / disposal to the environment.

1.2 Objective

The objective of this safety guide is to provide guidance for regulatory control of radioactive discharges to the environment and disposal of solid waste from Facilities and Activities for planned exposure situation. The guide provides harmonised, structured and graded approach for authorisation of waste discharge / disposal considering optimisation of protection and safety guidance for implementation of waste discharge / disposal authorisation to ensure compliance with the safety requirements. This safety guide also provides guidance regarding disposal of waste from radioactive consumer products.

1.3 Scope

This safety guide applies to radioactive discharge to the environment and disposal of solid waste for different types of nuclear fuel cycle and radiation facilities during normal operation. It is applicable for nuclear installations including mining and processing of ores for the extraction of uranium or thorium as part of the nuclear fuel cycle programme and the applications of radioisotopes in industry, medicine, agriculture and research. This safety guide is applicable for new, existing and modified facilities/ activities or for the review of an established waste discharge / disposal authorization.

For disposal of solid waste, this safety guide covers only the aspects related to the dose constraint and the authorisation process for disposal in near surface disposal facilities. It does not address the disposal criteria or the methodologies for assessment of radiological consequences arising from the disposal facilities. These aspects are covered in AERB Safety Guide "Near Surface Disposal of Radioactive Solid Waste" (AERB/NRF/SG/RW-4) [6].

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constraint for each source is intended to ensure that the sum of doses to the representative person from all controlled sources remains within the dose limit.

In the concept of dose apportionment, the dose limit for a member of the public is apportioned among the various facilities operating and planned at the site, among atmospheric, aquatic and terrestrial pathways and also among specific radionuclides depending on the specific characteristics of the installation.

When the dose apportionment is approved by the regulatory body, it becomes dose constraint and forms part of the regulatory instrument. Dose constraint is a regulatory term and dose apportionment is notional term evolved from practice. The regulatory body usually sets dose constraints (apportionment of dose limit) for monitoring compliance with dose limit for the public.

Guidance provided in this guide may also be used for the discharges or disposal of radioactive wastes generated from decommissioning or remediation activities. However, the extent of applicability of the guide in such situations would be decided by the regulatory body on case by case basis.

This safety guide does not address the methodologies for assessment of radiation dose to the members of public which are addressed in AERB Safety Guide "Methodologies for Environmental Radiation Dose Assessment" (AERB/NF/SG/S-5) [7].

This safety guide does not address the radioactive discharges and disposal of solid waste arising from a nuclear or radiological accident or an emergency exposure situation.

Similarly, this safety guide does not also address the radioactive discharges and disposal of solid wastes containing naturally occurring radioactive material generated from non-nuclear industries such as thermal power plants, oil and gas industries, industries dealing with Naturally Occurring Radioactive Material (NORM) etc. These aspects are covered in AERB Safety Guide "Radiological Safety in Handling Beach Sand Minerals and other Naturally Occurring Radioactive Materials" (AERB/FE-FCF/SG-5) [8].

2. PRINCIPLES OF RADIATION PROTECTION FOR CONTROL OF EXPOSURE

2.1 General

The mission of AERB is to ensure that the use of ionizing radiation and nuclear energy does not cause undue risk to the health of the people and the environment. The AERB safety codes on Radiation Protection (AERB/NF/SC/RP) [5] and Radioactive Waste Management (AERB/NRF/SC/RW) [4] specify the radiation protection requirements which must be fulfilled during the radioactive effluent discharge and disposal of solid wastes. These requirements are based on the justification, optimisation and dose limitation principles of the IAEA Safety Standard [9] and recommendations of ICRP [10].

2.2 Justification of Facilities and Activities

Justification applies to the overall practices and not to any individual aspects of practices such as discharges or disposals. The regulatory body ensures that the radioactive waste discharge / disposal authorizations are issued only to justified Facilities and Activities and the radiation exposures to the individuals (workers / public) resulting from authorized Facilities and Activities should remain within the prescribed dose limit.

2.3 Optimisation of Protection

The magnitude and potential of radiation exposure to the public should be kept As Low As Reasonably Achievable (ALARA), social and economic factors being taken into account. To facilitate this, the generation of radioactive waste should be kept to the minimum practicable in terms of both volume and activity through appropriate design and process planning. The best available techniques with due consideration of waste characteristics should be used for waste management activities including treatment / conditioning and disposal of radioactive waste.

The volume and activity of waste discharged / disposed and the estimated / predicted dose to the public can be used as performance indicators for optimisation of protection [9, 11]. Comparison with reasonably well operated similar facilities in

terms of volume and activity in waste will facilitate benchmarking and optimisation of waste management activities.

2.4 Application of Dose Limit

Dose limits prescribed by AERB [12] and the dose constraints should be used for control of radiation exposure to the workers and the public. The exposure to the workers and the public should be reviewed and protection should be optimized so as to maintain individual doses as per ALARA principle. Radioactive waste handling and discharge / disposal practices should be carried out in a manner so as not to cause any unacceptable radiation dose to the workers and the members of the public.

For assessment of radiation dose to the members of the public, the concept of *representative person* should be used. The representative person is "a hypothetical concept of an individual receiving radiation dose that is representative of the doses to the more highly exposed individuals in the population" [10, 13]. The radiation dose to the representative person should be estimated for all important exposure pathways considering major radionuclides associated with the radioactive waste discharges / disposal practices. Standard validated models should be used to estimate the doses to the representative person considering all the relevant pathways and site-specific parameters. Exclusion of any exposure pathway should be justified. The radiation dose to members of the public should be estimated for the discharges and demonstrated through environmental radiation monitoring for ensuring compliance with the prescribed dose limits/constraint.

During normal operation of facilities, source specific dose constraints should be used for radiation protection of the public. The sum of radiation dose constraint from planned operation of all Facilities and Activities at the site that may contribute radiation exposure to the public (excluding natural background) should be within the prescribed dose limit.

2.5 Protection of the Environment

Usually, explicit consideration of the exposure of flora and fauna will not influence the setting of discharge / disposal limits because control of human exposure due to radioactive substances in the environment is sufficiently restrictive for adequate

protection of other species [10]. Thus a separate dose limit or dose constraint is not required for protection of the environment. A prospective radiological impact assessment for the public and compliance with radiological protection criteria established for the public ensure adequate safety to the environmental species also.

The radiological environmental impact assessment for the public in normal operation uses estimates of the dose to the public due to the discharges resulting from the operation of the facility. The radiological environmental impact assessment quantified in terms of effective dose to members of the public should be conducted as part of the authorization process. The results of the radiological environmental impact assessment should be compared with predefined radiological criteria. The methods used to perform a radiological environmental impact assessment (e.g. the assumptions, the conceptual models, the mathematical models, the input data) may differ according to the complexity of the Facility or Activity and exposure pathways. The radiological environmental impact assessment should take into account graded approach considering the scope of Facilities and Activities and the potential for public exposure.

To ensure adequate protection of the environment from all radiological and non-radiological effects, the facility should ensure that approved operating procedures, radiation monitoring and surveillance programme, appropriate waste discharge / disposal criteria and quality assurance programme are in place especially for those Facilities and Activities having higher radiological significance.

3. DOSE CONSTRAINT FOR FACILITIES AND ACTIVITIES

3.1 General

Dose constraint is used for planning radioactive waste discharges / disposals to the environment and control of radiation exposure to the public. AERB Safety Code (AERB/NRF/SC/RW) [4] specifies safety requirements including establishing dose constraint for management of radioactive wastes. The concept of dose constraint is prospective in nature and is specific to the Facilities and Activities for which protection is being optimised.

3.2 Dose Constraint

Dose constraint should be set in terms of annual effective dose to the members of the public excluding natural background. While setting the dose constraint for radioactive discharges / disposals, the following aspects should be taken into account:

(a) Radiation hazard potential of the Facilities and Activities;
(b) ALARA principle on radioactive waste generation and management;
(c) Techniques used for waste treatment / conditioning;
(d) Consideration of public exposures from other sources including dose contributions from other authorized or foreseeable future facilities of the site;
(e) Operating experience of similar Facilities and Activities; and
(f) Dose contribution from regional sources.

Dose constraints should be applied to each controllable source of public exposure to ensure that the dose limit for an individual from all controllable sources of a particular site should remain within the prescribed limit. Considering the negligible hazard potential, radiation dose upto 10 μSv / y [9] should be considered as the exemption level for implementation of regulatory control. Typical dose constraint for various Facilities and Activities are given in Appendix I.

3.3 Control of Exposure from Multiple Sources

The member of public may receive radiation exposure from different sources. For example if there are multiple nuclear sites[2] located along water bodies such as river / lake, discharges into the water bodies from these sites could possibly give rise to radiation exposure to the person residing in downstream of the water body. Typical

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

situation may arise when two sites releasing radionuclides into the environment are close enough that the representative person may receive exposure from both sites. To optimize the radiation dose to the representative person, the nuclear or radiation facility sites should have adequate distance from each other so that the radiation dose to the public is within the prescribed limit. This distance varies for different Facilities and Activities depending on the hazard potential. Also, it is possible to conceive of situation where individual may receive exposure from regional sources[3] [14] in addition to the local sources. These situations should be analysed and considered on a case by case basis while setting the dose constraint for Facilities and Activities. The regional dose contribution to the public should be estimated in a site specific manner and the same should be kept as unallocated reserve at every site. Typical example of establishing dose constraint for Facilities and Activities is shown in Figure 1:

[3]Radiation sources responsible for exposure to the public due to the discharges / disposals other than local sources. These sources of radiation exposure generally encompass the radial zone of 100-1500 Km around the facilities.

FPNG-Fission Products Noble Gases , NSDF- Near Surface Disposal Facility.

* The grouping of radionuclides is done on the basis of radiological characteristics and dosimetric behavior. Details can be found in Section 4.9 of the guide.

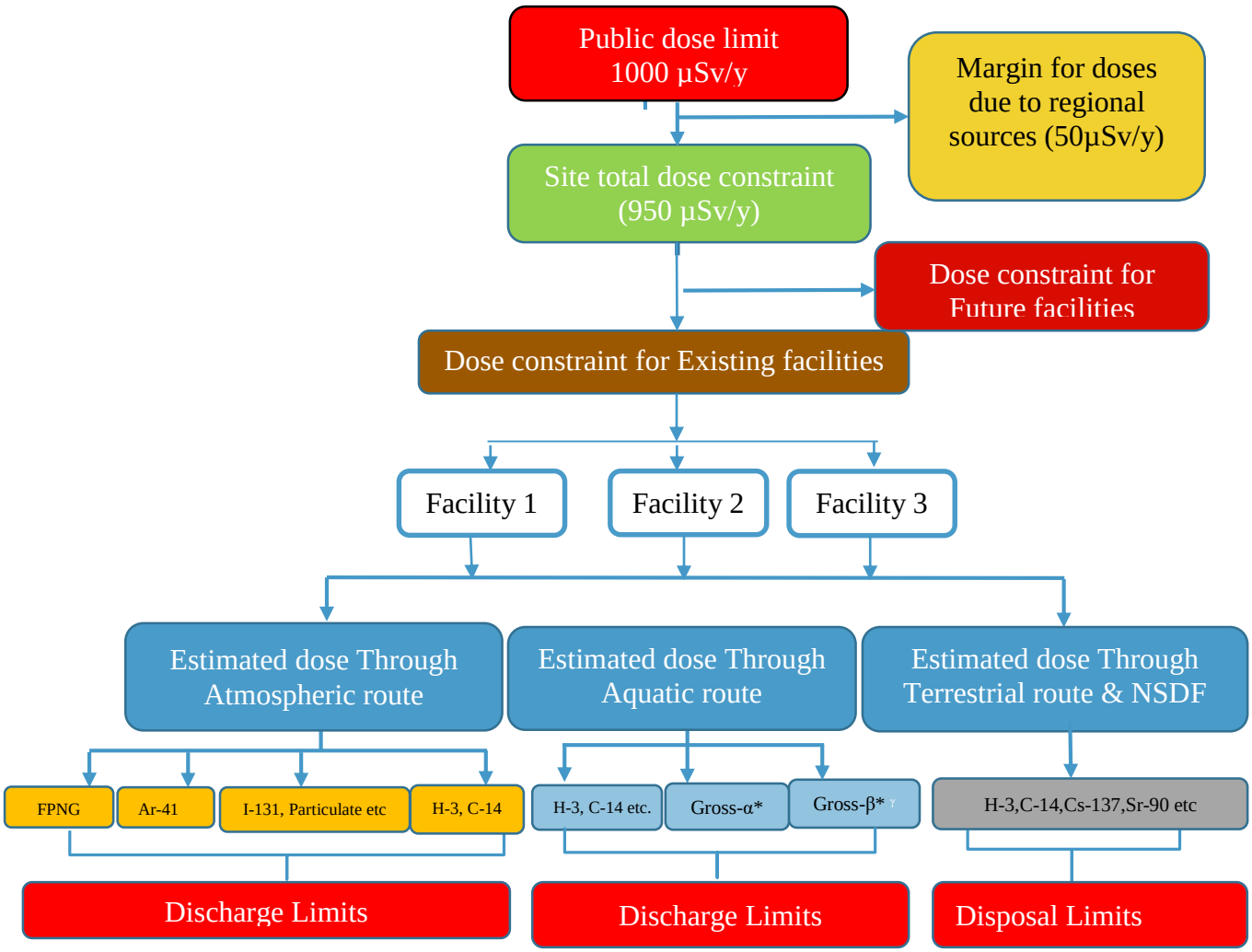

Figure 1: Typical example of setting dose constraint of Facilities and Activities

3.4 Criteria for Setting Site Dose Constraint

The following criteria should be used for setting dose constraint for Facilities and Activities for a particular site:

(a) All Facilities and Activities that discharge or dispose radioactive waste to the environment should carry out prospective radiological environmental impact assessment addressing radiation dose to the representative person. The methodology should consider all the relevant radionuclides and exposure pathways and the methodology used should be approved by the regulatory body. Exclusion of any pathways or radionuclides should be well justified. If the potential for radiation dose to the representative person from the Facilities and

Activities is less than 10 μSv / y [9] during normal operation and where there is no risk of unexpected accidental release, such Facilities and Activities may be exempted from the requirements of assigning dose constraint and the issuance of a formal authorisation for radioactive waste discharge or disposal.

(b) The contribution of radiation dose to the public due to regional sources for a site should be assessed in a site specific manner and quantified. It should be kept as unallocated reserve for every site. In the absence of site specific regional dose data, the regional dose contribution to the public should be considered as 50 μSv / y [15] and kept unallocated at every site.

(c) The upper level dose constraint for any site should be estimated by subtracting the regional dose contribution from the dose limit for members of the public (1000 μSv / y). For example, if the regional dose contribution of a site is 50 μSv / y, the upper level of dose constraint for any site including co-located solid waste disposal facilities should be limited to 950 μSv/y.

(d) The site dose constraint should take into account the dose contribution from other nearby site of nuclear fuel cycle or radiation facilities if the dose contribution to the representative person from the other site is more than 10 μSv/y.

(e) The maximum dose constraint (atmospheric and aquatic discharges) for individual Facility and Activity should be limited to 300 μSv / y [16]. Out of this, the contribution of dose constraint due to long lived artificial radionuclides should not exceed 100 μSv / y.

(f) The design, construction, operation and closure of Near Surface Disposal Facilities (NSDF) should consider that there is no release of radionuclides or only very minor release of radionuclides to the environment as a result of natural process such as weathering, degradation of waste matrix & isolation barriers and migration. The dose constraint for NSDF during the operational phase till closure of the facility should be limited to 50 μSv/y and for the post-closure phase it should not exceed 300 μSv/y [6]. If the NSDF is co-located with other nuclear fuel cycle or radiation facility at a site, the dose contribution to the representative person from other Facilities and Activities located at the site should be taken into

account so that the total dose to the representative person should remain within the site dose constraint.

(g) For any site, a fraction of the upper level dose constraint should be kept as reserve for future facilities or augmentation of existing facilities. The concept of optimisation and ALARA principle should be taken into account while deciding dose constraint for Facilities and Activities and site.

(h) The source term and dose constraint of the facilities should be revisited / revised considering the operational experience, regulatory requirements and changes / improvement in public dose computation, changes in public occupancy pattern or if there is any modification in Facilities or Activities that changes the established discharge pattern.

(i) The ratio of the sum of the dose constraint (DC_i) for individual facilities including the reserve dose and the dose from regional sources (DR_i) for a particular site to the effective dose limit (E) for the public should be always equal or less than 1,

i.e

$$\frac{\sum DC_i + \sum DR_i}{E} \leq 1.$$

where:

ΣDC_i is the sum of the dose constraint for individual facilities of a site (μSv/y);

ΣDR_i is the sum of the dose contribution from individual radionuclides of regional sources (μSv/y); and

E is the effective dose limit for the public specified by the regulatory body (μSv/y).

The regulatory body ensures that the dose contributions from various Facilities and Activities located at the site and the dose from regional sources at the site are adequately accounted for so that sufficient margin is available between the public dose limit and the site dose constraint and the actual radiation dose to the public during the operation of facilities is always within the limit. If the estimated dose exceeds the constraint, the utility should revise the dose calculation using site specific models and parameters to reduce the uncertainties and a proposal should be submitted to the

regulatory body. If this does not help, the designer should consider engineering improvements for reducing / eliminating the waste generation.

3.5 Approval of Dose Constraint

The applicant should ensure the availability of dose constraint for Facilities and Activities during siting or locating the facilities. Prior to the commencement of construction of any new facility, a proposal for the approval of dose constraint should be submitted to the regulatory body. The contents of the dose constraint proposal should include the following:

(a) Description of the proposed Facility(s) and Activities including layout and the information regarding other facilities located at the site, if any.

(b) Site specific information such as population distribution, food / dietary habits, land and water use, rainfall, environmental features (meteorological, geo-hydrological, geo-chemical aquatic and atmospheric dispersion parameters etc.) .

(c) Nature and characteristics of waste, waste treatment methods, expected volume and total activity of waste discharges/ disposals, maximum and average concentration of various radionuclides .

(d) Description of predictive models used, representative person, dose computation methodology, parameters used for dose computation, exposure pathways(including site specific parameters), predicted / estimated total dose to the public from the proposed source term .

(e) Proposed dose constraint (total predicted / estimated dose -internal and external -to the public from all exposure pathways such as atmospheric, aquatic and terrestrial) of the proposed Facilities and Activities;

(f) Information regarding public dose contribution from any other facility located at the site and the available dose constraint margin at the site .

(g) Regional dose contribution , if any .

(h) Name, Designation, Signature and Office Seal of the applicant.

Based on the review and assessment, a dose constraint for the facility should be assigned or the facility may be exempted from the requirements of a formal dose constraint. The dose constraint assigned during the initial phase of the facility should

be reviewed and revised based on the operating experience. To facilitate this, every facility after five years of operation and thereafter as and when necessary should review the dose constraint based on the operating experience or change in the regulatory criteria and obtain necessary approval from the regulatory body for the revised dose constraint.

3.6 Facilities and Activities regulated by multiple regulatory bodies

If a site is having Facilities and Activities regulated by different regulatory bodies, then each regulatory body should have an assigned fraction of the upper level site dose constraint (950 μSv/y) for allocation to the Facilities and Activities in their regulatory purview. The allocation of dose constraint among the regulatory bodies needs to be decided jointly for the purpose of effective regulation.

4. AUTHORISATION PROCESS

4.1 General

Facilities and Activities handling radioactive materials should have an authorisation for discharge / disposal of radioactive waste to the environment unless it is exempted by the regulatory body. Such authorisation includes particulars of solid, liquid and gaseous wastes that need to be discharged / disposed to the environment. The authorisation process may involve various review and assessment processes established by the regulatory body.

4.2 Assessment Process for Deciding the Need for an Authorisation

The need of radioactive waste discharge/ disposal authorisation should be decided based on the justification and hazard potential of Facilities and Activities. For justified Facilities and Activities, considering the potential of radiation hazards to the public and the environment, the regulatory body may exempt or decide the necessity of a radioactive waste discharge / disposal authorisation. The assessment process for deciding the need for radioactive waste discharge / disposal authorization is illustrated in Figure2.

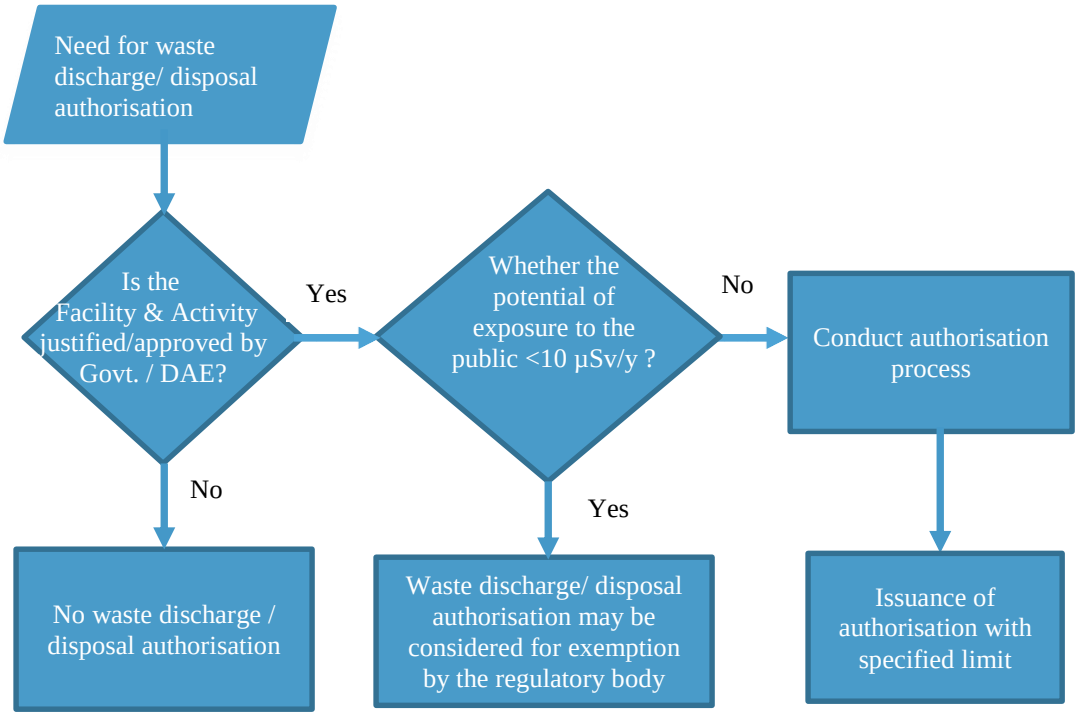

Figure 2: Assessment process for deciding the need for radioactive waste discharge/ disposal authorisation

The provisions for authorisation of radioactive discharge / disposal and exemption from the requirements of authorisation are applicable only to justified Facilities and Activities. The regulatory body may exempt the requirements of authorisation if the potential for radiation dose to the public from radioactive waste discharges / disposal practices are below the exempt dose criteria (10μSv/y). Such regulatory exemption may be generic or on case by case basis. The facilities should report immediately to the regulatory body for any deviations from the exemption criteria.

A prospective radiological environmental impact assessment addressing the projected dose to the public from the radioactive discharges/ disposal practices is a prerequisite for deciding the need for a radioactive waste discharge / disposal authorisation. Considering the potential radiological consequences associated with the Facilities and Activities, the regulatory body may exempt the requirement of a formal dose constraint and issuance of authorisation. To exempt the requirements of authorization, the applicant should submit a proposal to the regulatory body along with the radiological environmental impact assessment.

4.3 Graded Approach for Authorisation

Different types of radioactive wastes are generated from various Facilities and Activities. These may include simple facilities such as hospitals handling nuclear medicine procedure using radionuclides, research laboratories or more complex installations such as nuclear power plants, reprocessing plants, large research laboratories, radioisotopes production facilities and ore mining and processing facilities. The scope of authorisation should be commensurate with the potential of radiation risk / hazard potential associated with the facilities and their amenability to control the discharge / disposal through engineering and administrative measures. It should also take into account the potential for accidental releases of radioactive material to the environment and the associated radiological consequences. To facilitate a graded approach in the authorisation process, the Facilities and Activities are categorized into A, B and C considering the aspects listed in Table.

Table: Aspects Considered in Categorisation of the Facilities and Activities

Sr.No.	Category of Facilities and Activities	Criteria for Categorisation	Examples of Facilities and Activities
1.	**A** (Authorisation of Exemption)	Facilities and Activities handling small quantities of radionuclides. The potential for annual dose to the member of public during normal operation should be $\leq$ 10µSv/y.	• Industries handling exempt sources • Radioimmunoassay • Health care laboratories • Research laboratories • Disposal of consumer products
2.	**B** (Authorisation of Clearance)	Facilities and Activities handling limited quantities of short-lived radionuclides. The potential for annual dose to the member of public during normal operation of these Facilities and Activities should be in the range of 10 to 100 µSv/y.	• Diagnostic and therapeutic nuclear medicine facilities • Isotope production laboratories • Radiochemical laboratories
3	**C** (Formal Authorisation)	Nuclear Fuel Cycle Facilities handling large quantities of radioactivity. The potential for annual dose to the member of public during normal operation of these facilities is likely to be in the range 10 to 300 µSv/y.	• Nuclear Power Plants and Research Reactors • Reprocessing Facilities • Waste Management Facilities • Ore Mining, Processing and Fuel Fabrication Facilities • Solid Waste Disposal Facilities

4.4 Authorisation of Exemption

The discharges / disposals from NORM facilities such as mines, mills and ore processing facilities may contain enhanced levels of naturally occurring radionuclides. Waste containing radionuclides of natural origin at an activity concentration less than 1 Bq/g for any radionuclide in the uranium decay chain or the thorium decay chain and

of less than 10 Bq/g for ^{40}K is not subjected to the requirements of waste discharge / disposal authorisation for moderate quantities of waste (a tonne) in planned exposure situations [9]. For radionuclides of natural origin, exemption of bulk amounts of material (> 1 tonne) should be considered on a case by case basis by using the dose criterion of 1 mSv in a year, commensurate with typical doses due to natural background levels of radiation. Ore mining and processing facilities where the activity concentration in the waste material of any radionuclide in the uranium or thorium decay chains is greater than 1 Bq/g or the activity concentration of ^{40}K is greater than 10 Bq/g, the discharges / disposal from such facilities should be controlled according to the regulatory requirements and applicable standards [9]. These Facilities and Activities should obtain approval of dose constraint and authorisation from the regulatory body for waste discharge / disposal practices.

4.5 Estimation of Exempt Activity for Discharge / Disposal

The exemption of certain category of the Facilities and Activities from waste discharge / disposal authorisation requirements are based on the effective dose criteria of 10 µSv/y. The maximum exempt activity to be discharged or disposed from a facility can be evolved from the following relation [17]:

Maximum exempt activity level (A_l) for discharge or disposal (Bq/y) $= \frac{10\mu Sv/y}{Effective\ dose\ per\ unit\ activity\left(\frac{\mu Sv}{Bq}\right) discharge\ or\ disposal}$

In case of more than one radionuclide, the rule of mixture should be followed so that the sum of the ratio of the total activity to the prescribed limit should be less than or equal to 1 i.e

$$\sum \left(\frac{A_1}{A_l}\right) \leq 1$$

where,

A_1 is the actual activity (Bq/y) discharge of individual radionuclide ; and

A_l is the prescribed discharge limit (Bq/y) for individual radionuclide.

However , in case of chemically toxic radionuclides , the concentration level prescribed by the relevant regulatory authority should be acceptable.

4.6 Authorisation of Clearance

Radiation facilities such as diagnostic and therapeutic nuclear medicine facilities, isotope production laboratories, radiochemical laboratories, radiopharmaceutical / healthcare facilities handling limited quantities of short- lived radionuclides should be

permitted to discharge / dispose radioactive waste through authorisation of clearance based on environmental radiological impact assessment. The radioactive discharges / disposals from these facilities are normally carried out to the local environment such as sewerage system, river, lake, building rooftop etc. The radiological consequence to the public from these discharges / disposal practices are normally in the range of 10 to 100 µSv/y. The authorisation of clearance may be generic or with specific conditions / requirements that should be fulfilled by the applicant for discharge / disposal practices. The authorisation of clearance generally specifies the acceptable concentration of radionuclides in environmental matrices at the discharge point and the applicant should comply with such requirements. The authorisation of clearance does not specify the total volume and activity for routine discharges / disposal. However, the facility should submit periodic (half yearly / yearly) report to the regulatory body regarding the quantities of radioactive discharge / disposal to the environment.

4.7 Criteria for Discharge / Disposal to Sewerage System

Diagnostic and therapeutic procedures involve use of short- lived radionuclides such as Iodine -131 (I-131) and Lutetium – 177 (Lu-177). The radioactive effluents including human excreta (urine) generated from these practices are discharged / disposed to the sewerage system based on the concept of 'dilute and disperse' the activity in a continuous sewerage system [18]. The requirement for storage prior to disposal in a delay tank should be evaluated considering site specific aspects and decided on a case- by- case basis. The following criteria are suggested for the discharge / disposal of radioactive effluents containing urine/excreta from these facilities:

(a) The maximum dose to the representative person from radioactive discharge / disposal to the sewerage system should be restricted to 100µSv/y.

(b) The design of discharge line / system should ensure that there should not be any hold up of active water in the discharge line / system during the discharge / disposal process.

(c) The concentration of radionuclides in sewerage water after complete mixing of the effluent with sewerage dilution water should not exceed the WHO[4][19] drinking water standard.

(d) The provisions for inactive sewerage water available from the hospital / premises should also be considered for dilution of activity. Adequate provisions should be established at the discharge point for the mixing of active and inactive effluents generated from the facility.

(e) There is no need to specify the authorised limit in terms of total activity and volume for discharge / disposal of radioactive human excreta such as urine from the diagnostic and treatment facilities to the municipal sewerage system. However, an authorisation of clearance for the purpose should be obtained from the regulatory body to facilitate the discharge / disposal practices.

(f) The radiation dose rate at any point on the sewerage - line should be less than 1µSv/hr. The holdup / accumulation of activity above 370 MBq of I-131 equivalent for more than 10 hours at any point on the sewerage discharge line should be avoided to prevent undesirable external radiation exposure.

(g) The hospital should conduct radiation survey of the drainpipe. Adequate cleaning and flushing of drainpipe should be carried out to keep the radiation dose rate less than 1µSv/hr.

(h) The hospital should submit a periodic report (half yearly / annually) to the regulatory body addressing the total radioactive disposal / discharge to the sewerage system, radionuclide content in municipal sewerage water (Bq/ml), STP sludge (Bq/g) and the radiation dose to the sewerage worker and the public.

[4] The WHO drinking water standards are derived for a guidance dose value of 100µSv/y. It is 10Bq/L (0.01MBq/m^3) for I-131. Though there is no practice for using municipal sewage water for direct drinking purpose, owing to the high solubility of I-131, subsequent discharge from STP to river or sea is expected to have the potential for ingestion dose through water intake. If the final discharge from the STP is to a river then 10 times above value (both concentration and activity) and in case of sea then 100 time above the above value may be permitted depending on the nature of aquatic media(river / sea) , if required.

(i) The environmental monitoring and surveillance of sewerage system should be carried out by the Environmental Survey Laboratory (ESL) / accredited radiological laboratories/ Radiation Safety Officer (RSO) of the facility.

4.8 Formal Authorisation

Category C facilities generally handle large quantities of radioactive material and have potential for radiological consequences if the discharge / disposals are not controlled through administrative and engineering measures. These facilities require to have a formal authorisation from the regulatory body prescribing the waste particulars and the discharge / disposal limits. The authorisation process of these facilities involves the following steps:

(a) Establishment of dose constraint and discharge / disposal limit commensurate with the scope of Facilities and Activities.

(b) Submission of application to the regulatory body in prescribed forms for radioactive waste discharge / disposal authorization.

(c) Review and assessment of application by the regulatory body.

(d) Inspection of the proposed Facilities / Activities if required by the regulatory body.

(e) Issuance of radioactive waste discharge / disposal authorisation by the regulatory body.

The waste discharge / disposal authorisation encompasses particulars of waste to be discharged / disposed to the environment, authorisation conditions, waste monitoring requirements, limits, reporting criteria and environmental monitoring and surveillance programme.

4.9 Authorised Limit

The activity limits for discharges / disposal of radioactive wastes may be derived from the dose constraint or it can be evolved from the design and/or operating experience of Facilities or Activities. In either of the cases, it can be correlated to the dose per unit release of a radionuclide for a particular site based on the following relation [7]:

$$ALi = \frac{AD_i}{CD_i}$$

where

AL_i is the authorised limit (Bq/y) ,

AD_i is the assigned dose constraint for a particular radionuclide (µSv/y) , and
CD_i is the computed dose per unit release for that radionuclide for the particular site (µSv/y per Bq/y).

The authorisation generally includes the particulars of waste such as important radionuclides, volume, activity and concentration of radionuclides that may be discharged / disposed off to the environment or transferred to a waste management agency to facilitate treatment and disposal. The authorised limits should have adequate margin to take care of operational flexibility including deviation from normal operation. While deciding the margin, consideration should be given for the operating experience of same or similar facilities, deviation from normal operation / events for example an increase in atmospheric discharges from a nuclear power plant during anticipated operational occurrence, maintenance etc. Operational experience from similar facilities can provide useful information for optimisation and deciding operational margin.

The authorised limits should be specified for individual radionuclides or groups of radionuclides depending on the estimation and feasibility of measurement of the individual radionuclides, the significance of the radionuclides in terms of dose to the representative person and as performance indicator that provides early indications of important changes in the operational status of the facility.

Authorised limit for group of radionuclides rather than individual radionuclides may be appropriate when the radionuclides share similar characteristics so that they can be measured with gross counting techniques. The use of scaling factors may be applied for certain radionuclides that cannot be promptly analysed as part of routine measurements at nuclear installations. The scaling factors should be established based on sufficient number of detailed measurements and characterization of the effluents using appropriate methods with adequate detection limits. The effluents characterization should be reviewed periodically to ascertain any changes in the radionuclide composition with respect to the discharge / disposal process.

Airborne discharges from nuclear installations are often grouped as noble gases, tritium, halogens or iodine isotopes and particulates *(half-life>20 min)*. The grouping reflects different ways of sampling and quantifying the discharges and also dosimetric considerations such as noble gases result in external exposure to the whole body; iodine

isotopes result in thyroid doses via ingestion & inhalation and particulates usually present a potential hazard of inhalation or ingestion to the organs and tissues of the body etc.

The grouping may also be extended to include gross alpha and gross beta activities. When limits are specified for groups of radionuclides measured by gross alpha or gross beta counting, the discharge limits for the group should be set on the basis of the characteristics of the radionuclide that gives the highest dose per unit activity discharges / disposal or the realistic composition should be established for all conditions of operations of the facility.

To maintain the radioactive waste discharges / disposal within the authorised limits, the facility should establish suitable administrative and engineering control measures which should be part of the operating procedures. The administrative measures should include the operational constraint and the stipulation established by the facility for discharge / disposal of radioactive wastes.

4.10 Conditions of Authorisation

The authorization for radioactive waste discharge / disposal / transfer should specify conditions, reporting criteria, period of validity and provisions for regulatory review or amendment. The validity of authorisation should be decided on case-by-case basis and is generally between 1 and 5 years. The authorization should include conditions such as (a) submission of periodic reports (quarterly, half yearly and yearly) to the regulatory body pertaining to the radioactive waste discharge / disposal / transfer, (b) reporting of deviations / violation of authorisation conditions within specified time frame, and (c) reporting of any significant increase in dose rate or concentrations of radionuclides in the environment due to waste discharge / disposal activities.

The authorization conditions, if any, for facilities such as hospitals, industrial applications or laboratories handling small amount of activities should be simple and adequate enough to take care of large numbers of such facilities. The reporting criteria and/ or the submissions of waste disposal / transfer reports if any from these facilities should be half yearly or yearly, depending upon the nature of the Facilities and Activities involved.

4.11 Authorisation for Waste Transfer for Treatment and Disposal

Some facilities may need to transfer or transport radioactive waste to waste management facilities for treatment and disposal. The waste management agency may be local, details or a centralized facility established for the purpose. In such situation, the waste generating facilities should obtain an authorisation from the regulatory body for transfer / transportation of radioactive waste to the waste management agency. The waste management facilities should also have an authorisation from the regulatory body for acceptance of radioactive waste, treatment and disposal. The onsite transfer / transport of radioactive waste should be as per the approved procedure established by the facility. The offsite transfer / transport of radioactive waste should be as per the transport regulatory requirements established by the regulatory body [20].

4.12 Special Authorisation

Radioactive waste to be discharged/ disposed from a facility may deviate at times from the waste particulars specified in the authorization. This deviation may include the waste discharge/ disposal exceeding authorized limits or the generation of type of waste other than that specified in the authorization or discharging through routes other than that specified in the authorisation. For approval of such cases, the facility should take special authorization in advance for planned activities and post-facto in case of unplanned / incidental event from the regulatory body. The application for special authorisation should include particulars of special radioactive wastes, method of treatment / conditioning, waste volume, category of the waste, radionuclides present, total activity, details of packaging / container, specific activity, dose rate on the surface of waste package, mode of disposal, location of disposal and the safety assessment including the radiological consequence to the public and the environment. The regulatory body may grant special authorisation on case-by-case basis with stipulations / conditions as necessary.

4.13 Amendment and Renewal of Authorization

The amendment or renewal of the radioactive waste discharge / disposal authorization should be based on the request received from the authorized person. For any change in the existing authorisation including waste particulars, the authorised person should make an application / proposal to the regulatory body with appropriate justification for

the required amendment. Similarly, the authorised person should put up an application / proposal to the regulatory body three months before the expiry of existing authorisation for renewal of the existing authorisation. Any decision regarding the amendment or renewal of an existing authorization should consider regulatory actions such as inspections, safety reviews and feedback from operational performance, violations if any of limits and conditions and reports on incidents, if any.

4.14 Discharge / Disposal of Decommissioning or Remediation Wastes

Decommissioning of nuclear / radiation facilities or remediation of a radioactively contaminated areas may generate large amount of radioactive waste having various types of radionuclides in varying concentrations. The organisations responsible for decommissioning / remediation activities should establish adequate facilities and system for management of decommissioning or remediation waste [21].

The waste should be characterized based on the activity content as per the criteria established by the regulatory body. Segregation of wastes at collection stage should be aimed to ease treatment process. Based on the activity content, a graded approach should be followed for storage, treatment, and disposal of radioactive waste. The organisation responsible for the decommissioning / remediation activities should aim to recycle or re-use the low-level radioactive materials / wastes to the extent possible. The criteria specified by the regulatory body should be used for exemption or clearance of radioactive wastes.

The low-level solid wastes generated from these activities may be disposed off to the environment such as natural depressions, excavated trenches, existing excavations, etc. based on the activity content and the radiological impact assessment. The low-level liquid wastes generated from decontamination activities can be directly discharged after ensuring compliance to the limit stipulated by the regulatory body [24, 25]. The organisation responsible for radioactive waste disposal should put up an application / proposal to the regulatory body for obtaining an authorisation for waste discharge / disposal activities. The authorisation for discharge/ disposal of radioactive wastes generated from decommissioning / remediation activities may be issued on case-by-case basis considering radiological impact on the public and the environment.

4.15 Disposal of Radioactive Consumer Product Waste

Radioactive consumer products after their useful life can be disposed as conventional waste provided the activity contents of the disused consumer products are within the level of exemption or clearance level prescribed by the regulatory body. The disused consumer products with radioactivity above these levels are subject to regulatory control including disposal. The handling, storage or disposal of significant quantities (activity above the exemption/clearance level) of consumer products or recycling / re-use of disused consumer products are subject to the approval / clearance from the regulatory body on a case- by- case basis [22].

5. MONITORING AND CONTROL

5.1 General

The facilities discharging radioactive waste to the environment and disposing solid waste should ensure that the safety requirements and the conditions specified in the authorizations are met. Monitoring of radioactive waste including discharges / disposal and the environment is an important aspect for demonstrating compliance with these requirements.

5.2 Waste Monitoring and Environmental Surveillance

Radioactive waste should be monitored, classified and categorized as specified by the regulatory body. It should be treated / conditioned and monitored prior to the discharge / disposal. The authorised person should establish appropriate waste monitoring and environmental surveillance programme commensurate with hazard potential of the Facilities and Activities. The monitoring programme should be adequate to demonstrate compliance with the regulatory and safety requirements and the records should be made available for verification as and when required. The environmental monitoring and surveillance should be carried out by an accredited laboratory established for the purpose. The facility should maintain the waste and environmental monitoring records as specified by the regulatory body.

5.3 Regulatory Compliance

The radioactive waste discharges / disposal activities should be carried out as per the authorisation. The authorised person should review the waste discharge / disposal activities and ensure compliance with the authorisation requirements. Any deviations from the authorisation should be intimated to the regulatory body within five days with adequate justification / explanation / clarification along with safety assessment and review by the authorised person.

5.4 Inspection and Enforcement

Inspection for waste management activities including discharges and disposals is required for ensuring compliance with the authorisation requirements. The inspection programme should include verification of organization's records such as waste monitoring data, environmental monitoring data and periodic reports including waste discharges / disposal / transfer etc. in line with the authorisation requirements.

In case of any non-compliance of regulatory requirements, enforcement actions should be taken as per the established procedures considering nature of violation and safety implications. The enforcement actions of the regulatory body may range from a stern warning to suspension of operations, to revocation or withdrawal of the authorization, depending on the nature of violation(s).

6. QUALITY ASSURANCE PROGRAMME

6.1 General

Appropriate quality assurance programme (QAP) needs to be established for assessment of dose constraint and authorisation process. Where multiple organisational involvement exists, the interfaces among the involved organisations, communication and co-ordination among the organisations including regulatory bodies are to be established during the approval of dose constraint and the authorisation process.

6.2 Variability and Uncertainty for Dose Constraint

Development of dose constraint involves various steps including use of environmental / meteorological parameters and predictive models. Site specific data and standard models should be used for the assessment of radiation dose to the representative person. The dose assessment and dose constraint should take into account the possible uncertainties in the dose computation. When insufficient information or data are available, conservative assumptions should be used.

6.3 Retention of Records and Transfer of Information

The authorised person should ensure that the radioactive waste discharges / disposal records should be maintained for a period stipulated by the regulatory body. The retention period of records may vary depending on the nature of the Facilities and Activities or the half-lives of the radionuclides involved. The record should be maintained in multiple form and should be easily retrievable as and when required.

In the case of solid waste disposal facilities, the responsibility for managing the waste disposal facility may get transferred from one organization to another. In such cases, the records of information about the facility related to safety and environmental protection should be made available to the successor organization. Information on waste disposal facilities should be transferred to successive generations in case of requirement of long term safety supervision.

Appendix I

Typical Dose Constraint for various Facilities and Activities for Discharges or Disposal of Radioactive Waste

S.No.	Radioactive Waste Discharge or Disposal Practices from various Facilities and Activities		Typical dose constraint (μSv/y) for Facilities and Activities	Remarks
1	Authorisation of Exemption		< 10	The regulatory body may assign dose constraint within the specified range considering radiological environmental impact assessment
2	Authorisation of Clearance		10 to 100	
2	Ore mining and processing facilities		10 to 300	
3	Fuel fabrication facilities at various capacities		10 to 300	
4	Nuclear power plants at various power levels		10 to 300	
5	Reprocessing facilities at various capacities		10 to 300	
6	Integrated nuclear fuel cycle and waste management facilities		10 to 300	
7	Research reactors depending on capacities		10 to 100	
8	Radioactive waste management facilities		10 to 100	
9	Radiation facilities (Industrial, medical, research etc.)		10 to 100	
10	Near surface solid waste disposal facilities	Operation	10 to 50	
		Post Closure	10 to 300	
11	Solar evaporation facility		10 to 100	
12	Incineration facility		10 to 100	

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