GUIDELINES NO. AERB/RF-IGD/SG-1

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GOVERNMENT OF INDIA

AERB SAFETY GUIDELINES

NUCLEONIC GAUGES AND WELL LOGGING APPLICATIONS

ATOMIC ENERGY REGULATORY BOARD

AERB SAFETY GUIDELINES NO. AERB/RF-IGD/SG-1

NUCLEONIC GAUGES AND WELL LOGGING APPLICATIONS

Atomic Energy Regulatory Board
Mumbai-400 094
India

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Chief Administrative Officer
Atomic Energy Regulatory Board
Niyamak Bhavan
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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 provisions of the Atomic Energy Act, 1962. In pursuance of the objective of ensuring safety of members of the public and occupational workers as well as protection of the 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, therefore, has undertaken a programme of developing safety standards, safety codes, and related guides and manuals for the purpose. While some of these documents cover aspects such as siting, design, construction, operation, quality assurance and decommissioning of nuclear and radiation facilities, the 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 equipment, structures, systems and components of nuclear and radiation facilities. Safety codes establish the objectives and set 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. These documents are revised when necessary, in the light of experience and feedback from users as well as new developments in the field.

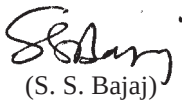
A large number of nucleonic gauges and well-logging devices are in use in India. The well logging devices incorporate relatively high activity neutron sources in addition to gamma sources. The nucleonic gauging devices, on the other hand, mostly incorporate low activity sources. The document specifies regulatory requirements as well as methodologies for compliance by end users and suppliers of nucleonic gauges and well-logging sources. It provides requirements for handling of the devices viz. manufacture/supply, procurement, receipt from the supplier, installation, operation, decommissioning and disposal of the disused sources. It also provides requirements of safety infrastructure from radiation safety and security considerations, personnel and their responsibilities.

Consistent with the accepted practice, ‘shall’ and ‘should’ are used in the ‘safety guidelines’ to distinguish between a firm requirement and a desirable option respectively. Annexures and bibliography are included to provide further information on the subject that might be helpful to the user(s).

This ‘safety guidelines’ has been prepared by specialists in the field drawn from the Atomic Energy Regulatory Board, Bhabha Atomic Research Centre and other

consultants. It has been reviewed by experts and the Standing Committee for Review and Revision of Radiation Safety Documents (SCRRRSD) and Advisory Committee on Radiological Safety (ACRS).

AERB wishes to thank all individuals and organisations who have prepared and reviewed this 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

Accident

Any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

Activity, A

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).

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 (see also 'Consent').

Capacity (Source Housing)

The maximum activity in becquerels specified for a given radionuclide that shall not exceed in a source housing or a source changer.

Commissioning

The process during which structures, systems, components and equipment of a nuclear

and radiation facility, on being constructed, are made functional and verified to be in accordance with design specifications and found to have met the performance criteria.

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.

Consignor

Any individual, organisation or government, which presents a consignment for transport, and is named as consignor in the transport documents.

Contamination

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

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.

Dose

A measure of the radiation 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 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:

$$E = \Sigma_T w_T . H_T$$

Where 'H_T' is the equivalent dose in tissue 'T' and 'w_T' is the tissue weighting factor for tissue 'T'.

Emergency

A non-routine situation that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human health and safety, quality of life, property or the environment. This includes nuclear and radiological emergencies and conventional emergencies like fires, release of hazardous chemicals, storms, tsunamis or earthquakes. It includes situations for which prompt action is warranted to mitigate the effects of a perceived hazard.

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).

Equivalent Dose (H_T)

The quantity 'H_T' is defined as

$$H_T = D_{T,R}.w_R$$

where '$D_{T,R}$' 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 $H_T = \Sigma w_R . D_{T,R}$.

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; either 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.

Ionizing Radiation Gauging Device (IRGD)

A mechanism designed and manufactured for the purpose of determining and/or controlling thickness, density, moisture, level, interface location, and/or qualitative or quantitative chemical composition. It should include radiation source, radiation shields, useful beam control mechanism and other components which form an integral part of the device to meet the requirements or specifications of standard specifications for 'Construction and Design of Nucleonic Gauges' (AERB/SS-2).

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.

Licensee

A person to whom regulatory consent is granted by the Competent Authority under the Rules.

NOC

A no objection certificate issued by the Competent Authority for import of radioactive material or a regulatory practice.

Package

The packaging with its radioactive contents as presented for transport.

Packaging

The assembly of components necessary to enclose the radioactive contents completely.

Personnel Monitoring

Determination or estimation of the dose received by a person from external and internal radiation.

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.

Radiation Facility

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

Radiation Generating Equipment

Device capable of generating radiation, such as X-rays, neutrons, electrons or other charged particles.

Radiation Incident

Any unintended event, including operating errors, equipment failures, initiating events, accident precursors, near misses or other mishaps, or unauthorised act, malicious or

non-malicious, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

Radiation Protection Survey/Radiological Survey

An evaluation of radiation safety, using appropriate radiation measuring instruments.

Radiation Surveillance

Measures that may be specified by the Competent Authority to provide adequate radiological protection either generally or in an individual case.

Radioactive Material/Radioactive Substance

Any substance or material, which spontaneously emits radiation in excess of the levels prescribed by notification by the Central Government.

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 materials 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

Any person who is so designated by the employer with the approval of the Competent Authority.

Rules

Atomic Energy (Radiation Protection) Rules, 2004.

Safety Guide

A document containing detailed guidance and various 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.

Sealed Source

Radioactive source material that is either permanently sealed in a capsule or is closely bounded and in solid form. The capsule or material of a sealed source shall be strong enough to maintain leak tightness under conditions of wear and tear for which the source was designed and also under foreseeable mishaps.

Security Survey

A detailed evaluation of facilities involving nuclear material or radioactive substances

for prevention and detection of and response to theft, sabotage, unauthorised access, illegal transfer or other malicious acts.

Source

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

Source Housing

Shielding provided in any device containing a sealed source, in order to:

- define the useful beam; and
- limit the stray radiation level outside the useful beam to the maximum permissible leakage levels, as specified by the Competent Authority.

Source Storage

A container of approved design in which the sealed sources are kept when not in use.

Special Form Radioactive Material

Either an indispersible solid radioactive material or a sealed capsule containing radioactive material and approved by the Competent Authority as special form radioactive material.

Stray Radiation Level

The total radiation level outside an IRGD being the sum of the leakage radiation through the shielding of the IRGD and radiation scattered by matter near the IRGD.

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.

Type A Package

A package designed to withstand normal conditions of transport without loss or dispersal of its contents or loss of shielding integrity. The radioactive material may be transported in a Type A package either in special form radioactive material or other form with the provison that the activity should not exceed the applicable limits specified by the Competent Authority in the AERB Safety Code for the Safe Transport of Radioactive Materials.

Type Approval

Approval, issued by the Competent Authority, based on evaluation of the device to ensure that it conforms to the safety standards prescribed by the Competent Authority.

Unprotected Source

Sealed source which, for use, is removed from a device and hence may not have mechanical protection from damage during use.

Unusual Occurrence

Any occurrence which has the potential to impair or impairs the plant safety, radiological safety, industrial safety and/or environmental safety.

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 'Safety Guidelines')

Manufacturer

A person engaged in commercial manufacture of IRGD that are designed in conformance with the applicable safety standards and having responsibilities prescribed by the Competent Authority. A manufacturer can also be a supplier.

Supplier

A person engaged in the supply of IRGD which are designed in conformance with the applicable safety standards and having responsibilities prescribed by the Competent Authority.

Well Logging

The practice of making a detailed record (a well log) of the geologic formations penetrated by a borehole, employing, where appropriate, suitable radioactive material for the purpose of making physical measurements. The log may be based either on visual inspection of samples brought to the surface (geological logs) or on physical measurements made by instruments lowered into the hole (geophysical logs). Well logging can be done during any phase of a well's history; drilling, completing, producing and abandoning. Well logging is performed in boreholes drilled for the oil and gas, groundwater, mineral and geothermal exploration, as well as part of environmental and geotechnical studies.

ABBREVIATIONS

AERB	:	Atomic Energy Regulatory Board
IRGD	:	Ionizing Radiation Gauging Devices
NOC	:	No Objection Certificate
RPP	:	Radiation Protection Programme
RSO	:	Radiological Safety Officer
RSM	:	Radiation Survey Meter

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1. INTRODUCTION

1.1 General

Ionising radiation gauging devices (IRGD) also known as nucleonic gauges are widely used in industries to assure the quality of industrial products, optimise processes and save energy and materials. Thickness gauges are used to determine the thickness of industrial products such as metal sheets, plastic sheets and paper; level gauges are used for determining the fluid/material level in industrial processes, e.g. filling level in beverage cans; density gauges are used in determining the density of matter, e.g. soil in the construction of roads and moisture gauges in determining the moisture content in matter under investigation. Many of them are commercially available from several manufacturers in India and abroad.

Only those IRGD which are type-approved by Competent Authority are permitted to be marketed and used in India. Any manufacturer/supplier of an IRGD is required to obtain approval of the design of the IRGD from the Competent Authority. The activity of the radioactive material used in IRGD are typically of the order of a few GBq or X-ray operated at low kV (typically less than 150 kV). In view of the built-in safety of the IRGD and the low activity of the source, certain basic safety requirements in working with IRGD need to be implemented.

The oil and gas exploration industry uses wire-line logging to obtain a continuous record of a formation's rock properties. These can then be used to infer properties, such as hydrocarbon saturation and formation pressure, and to make further drilling and production decisions. Wire-line logging is performed by lowering a 'logging tool' on the end of a wire-line into an oil well (or borehole) and recording petrophysical properties using a variety of sensors. Information about the sub-soil strata such as porosity, salinity, moisture content and the presence of oil and natural gas can be obtained by well logging techniques. Some logging tools use a gamma source (^{137}Cs) and a neutron source (commonly used source: ^{241}Am-Be) together with appropriate detectors.

1.2 Objective

The objective of this 'safety guidelines' is to recommend methods of ensuring compliance with the regulatory requirements for radiological safety in working with IRGD/ well logging devices.

1.3 Scope

This 'safety guidelines' addresses only IRGD and well logging tools incorporating sources. This 'safety guidelines' excludes consumer products

incorporating exempt quantities of radioactive material notified by the Competent Authority. The methods of compliance with regulatory requirements apply only to those stipulated in the Atomic Energy (Radiation Protection) Rules, 2004, Atomic Energy (Safe Disposal of Radioactive Waste) Rules, 1987 and the notifications, orders, safety standards and safety guides issued thereunder.

2. SAFETY IN HANDLING IONISING RADIATION GAUGING DEVICES AND WELL LOGGING SOURCES

2.1 Handling of Gauging Devices

According to the Atomic Energy (Radiation Protection) Rules, 2004 the term 'handle' means manufacture, possess, store, use, transfer by sale or otherwise, export, import, transport or dispose of. This 'safety guidelines' considers the different phases of handling gauging devices, namely:

(a) Manufacture/supply of a gauging device

(b) Procurement of a gauging device

(c) Receipt of the device from the supplier

(d) Installation of the device

(e) Operation of the device

(f) Disposal of the source when it is no longer required

(g) Decommissioning.

The safety aspects of transport of the device either to a local facility or by export, disposal of the source and decommissioning of the installation are discussed in Sections 6, 7 and 9 of this 'safety guidelines'. The work practices to ensure compliance with the regulatory requirements at each phase are described in the paragraphs that follow.

2.2 Manufacture/Supply of a Gauging Device

A licence shall be obtained from the Competent Authority for manufacture/ supply of a ionising radiation gauging device.

2.3 Procurement of a Gauging Device

Prior to procuring an IRGD, the licensee should confirm with the supplier that the supplier has a valid type approval certificate issued by the Competent Authority in respect of the model which is to be procured.

2.4 Receipt of a Device from the Supplier

2.4.1 *Prior to Receipt of IRGD*

Prior to receipt of the device, the licensee should ensure that the concerned staff including the security staff are alerted about the expected date of arrival of the devices and that all necessary arrangements are made for the safe and secure storage of the devices.

2.4.2 *On Receipt of IRGD*

At the time of receipt of the IRGD at the licensee's facility, all measures should be in place to ensure that the devices would be readily received and safely stored. If the devices are received in a damaged condition, the matter should be brought to the notice of the consignor/supplier, the carrier and the Competent Authority. The device should not be left unattended. The device should be kept securely stored till experts arrive and further action is taken.

2.5 Installation of the Device

2.5.1 *Installation by Authorised Persons*

2.5.1.1 The IRGD should be installed by a person trained and authorised by manufacturer/supplier of the IRGD, at the earliest after receipt. The supplier should provide appropriate personnel monitor to the persons installing the IRGD. Persons handling neutron sources (e.g. well logging sources) should be provided with personnel monitors appropriate to neutron monitoring.

2.5.1.2 During the installation, radiation monitoring of the facility and the surrounding areas shall be carried out by the authorised representative of the supplier in the presence of the RSO of the user institution.

2.5.1.3 Upon completion of the installation, the authorised representative of the supplier should generate an installation report including any additional safety precautions to be followed by the user and a copy of the same should be submitted to the Competent Authority including dose details of the personnel involved in installation.

2.5.2 Intimation of Installation

Upon completion of installation of the IRGD the Competent Authority should be informed by the licensee.

2.6 Operation of the Device

2.6.1 *Prior to First Use of the Device*

Prior to the first use of the equipment and at intervals not exceeding twelve months, the equipment should be inspected to verify and confirm that the:

(a) source containment has all of its components intact and in an acceptable condition;

(b) radiation dose rate profile in the vicinity of the source containment conforms to the limits specified by AERB;

(c) shutter or source control mechanism, source assembly and retraction mechanism and any other safety features operate correctly and safely;

(d) radiation symbol, warning signs and labels are intact, appropriately marked and legible;

(e) the device performs satisfactorily when used in accordance with the manufacturer's instructions; and

(f) the location of the gauge has not been altered without the approval of the Competent Authority.

2.6.2 *Implementation of Safe Work Procedure*

The safe work procedure implemented in the institution should ensure that:

(a) no one is allowed to stay close to the gauge except when necessary to observe the operation of these gauges and the number of persons operating the IRGD is kept to a minimum,

(b) a radioactivity symbol and a warning sign reading "RADIATION KEEP AWAY" in English, Hindi, the local language and any other language deemed necessary is conspicuously displayed and properly located and maintained in a clean and legible condition in the vicinity of each IRGD installation **[Annexure- I],**

(c) the source(s) are kept locked in the shielded position whenever the IRGD are not in use,

(d) shutter 'ON/OFF' operation is checked periodically, particularly for continuous process monitoring gauges, which may require the shutter to be kept open for long duration, that is, days/months (since during operation, dust may be accumulated and cause the shutter to get jammed),

(e) a swipe test is carried out on those gauges containing radioactive source(s) at regular intervals not exceeding 12 months **[Annexure-II]**,

(f) the results of all radiation protection surveys and examinations of the equipment are recorded and retained,

(g) any radiation protective equipment provided to protect the workers and the public or any IRGD, is not interfered with, removed, altered, damaged or rendered ineffective, except for authorised purposes such as inspection, maintenance, repair and replacement,

(h) any method or working procedure adopted to reduce radiation exposure is not interfered with,

(i) if an employee observes or suspects a damage to or malfunction of any part of an IRGD (such as the shutter mechanism) which may

present a radiological hazard, the licensee is notified and the device is not used until it is inspected, repaired and operating correctly and safely in accordance with the provisions of this 'safety guidelines',

(j) all tools necessary for the safe operation of the IRGD and the handling of emergency are in good working condition,

(k) when work is required to be carried out in the vicinity of a gauge, the radiation exposure that could occur during or as a result of the work and due to any unforeseen circumstances is minimised, taking into account:

(i) radiation levels around the gauge;

(ii) locations where work is required;

(iii) duration of the work;

(iv) distance from the IRGD;

(v) provision of improvised shielding; and

(vi) possibility of unauthorised interference with the gauge.

(l) When not in use, the IRGD should be securely stored in the licensee's storage in accordance with the specifications of this 'safety guidelines'.

2.6.3 *Regular Area Monitoring*

When the device is in operation, radiation protection survey of the installation shall be carried out by the RSO. The purpose of monitoring should be to confirm that the:

(a) installation has not been tampered with;

(b) radiation levels around the gauge and at locations which are routinely occupied in the vicinity of the installations continue to be within limits;

(c) shutter of the gauge is kept closed when it is not in operation and during servicing and maintenance; and

(d) exposure due to the beta/gamma/neutron radiation, as applicable, do not exceed the annual dose limits prescribed by the Competent Authority following the principles of ALARA.

2.6.4 *Portable Gauges*

In respect of portable gauges:

(a) while the IRGD is in use, area around the gauge should be cordoned off up to a distance where the radiation level is less than 1 $\mu Sv.h^{-1}$, warning sign should be displayed and the site should be supervised by the RSO;

(b) when used in open areas, care should be taken to ensure that they are not kept in places where vehicles or other objects may damage them;

(c) appropriate arrangements should be made for securing the source assembly in the approved transport container; and

(d) upon completion of the day's work the gauge should be kept stored in a safe place in accordance with the provisions of Section 6 of this 'safety guidelines'.

2.6.5 *Time, Distance and Shielding*

The principles of time, distance and shielding should be utilised at all times in working with IRGD during normal and emergency conditions to ensure that the dose to individuals is kept low in conformity with the ALARA principle.

2.6.6 *Use of the Source*

The radioactive sources shall be utilised for the authorised purpose only.

2.7 Servicing, Maintenance and Repair

2.7.1 *Servicing and Maintenance of an IRGD*

The IRGD should be serviced and maintained regularly at the intervals specified by the manufacturer and that such servicing and maintenance should be carried out only by the manufacturer/supplier or their authorised representatives. Only original parts or those approved by the supplier should be used for replacement of parts.

2.7.2 *Persons Carrying out Service/Testing/Maintenance/Repair*

2.7.2.1 Service, testing, maintenance and repair of the gauge should be carried out only by a person who:

(a) is authorised to do so by the original supplier;

(b) is appropriately trained in the type of work being carried out;

(c) carries out the work with due regard to the manufacturer's recommendations and under the supervision of the RSO of the facility;

(d) where practicable, carries out that repair or maintenance in a workshop equipped to permit safe repair; and

(e) ensures that a radiation survey is conducted after any repair or maintenance to confirm that the dose rates do not exceed the prescribed limits.

2.7.2.2 A person undertaking repairs or maintenance work should keep records in accordance with any instructions that the Competent Authority may issue.

2.7.3 Repair and Maintenance Work of IRGD or Work near IRGD

If a significant amount of work is required to be carried out on or near an IRGD, the gauge may be removed, if required, from its fixed location for the duration of the work with due care to ensure that:

(a) the shutter of the gauge is closed during the removal of the IRGD;

(b) in case of shutter malfunctioning, adequate shielding should be provided in front of shutter during repair;

(c) it is verified with a radiation survey meter that the radiation beam has been turned off;

(d) the radiation levels are measured in areas where the employees are working; and

(e) the IRGD is handled safely.

2.8 Modification of IRGD

When a modification is introduced in the design specifications of the IRGD, type approval shall be obtained by the manufacturer/supplier from the Competent Authority, even if the modification does not alter the source housing.

2.9 Radiation Protection Programme (RPP)

2.9.1 *Elements of Radiation Protection Programme (RPP)*

In each facility handling an IRGD, a Radiation Protection Programme (RPP) including standard operating procedures commensurate with the work involving the IRGD should be prepared and implemented. The RPP should be formulated addressing all the safety related procedures to be implemented in the facility on a day to day basis. The elements of the RPP are included in **Annexure-III.**

2.9.2 *Integration of RPP with work practices*

2.9.2.1 The RPP should be duly integrated with other documented safety procedures and work practices that exist within the organisation.

2.9.2.2 Any modifications in the integrated safety procedures and work practices should not negatively impact the RPP.

2.9.2.3 The RPP should be reviewed and updated at appropriate intervals. It should reflect the changes in the equipment, operators or work practices which have a bearing on safety.

2.10 Training in Radiation Safety

Adequate training is essential to promote awareness of radiological safety and to ensure that work practices are followed. The following should be implemented:

(a) All employees who need training should be identified. Various levels of training will generally be required to suit the particular needs and responsibilities of each employee.

(b) Basic training information should be provided to employees.

(c) The training records should include information relating to the name of each person trained, the date on which the training was conducted and the details of the training material provided.

(d) Training should be included in the induction procedures for new employees.

(e) Periodic refresher training may be provided as deemed necessary by the licensee.

2.11 Prevention of Loss/Theft of Sources/Devices

In order to reduce the chances of a source being lost, the following measures should be implemented:

(a) When a gauge is installed, the advice of the supplier should be sought for safety and security of the source.

(b) The supplier's recommendations for maintenance and service of the gauge should be implemented.

(c) Installed gauges should be regularly inspected for security of mounting and deterioration of the source containment paying particular attention to fasteners that hold the source containment together.

(d) As far as practicable, the gauge should not be placed at risk of suffering damage due to any nearby equipment and where this cannot be avoided, the gauge should be kept under observation so as to ensure that the IRGD would not be lost.

(e) Radiation levels around the source containment should be monitored regularly (e.g. once in a fortnight). Any appreciable reduction in

dose rates that could indicate loss of a source should be investigated immediately.

(f) The licensee should consider all possible scenarios for loss of a source and develop appropriate response plans.

(g) The employer/licensee/RSO should maintain complete records of the locations of all radioactive sources under his control.

(h) Sources that are not in use should be securely stored and clearly labelled as containing radioactive material.

(i) Gauges that have been removed from service, should be kept safely and securely stored pending disposal as specified in this 'safety guidelines' to prevent loss of such gauges.

2.12 Source Inventory and Records

2.12.1 *Source Accountability*

The licensee shall be able to account for all radioactive sources procured by him at all times.

2.12.2 *Records of Radioactive Sources*

Records specified below should be maintained for each radioactive source within the control of the facility and made available for inspection by the AERB.

(a) procurement, installation, operation, service and maintenance, disposal and decommissioning of IRGD in their institutions including the names of their personnel who were engaged in operating the IRGD as well as dose records, if any.

(b) initial and on-going training of employees in relation to radiation safety matters;

(c) for each IRGD used in the facility:

(i) the location of the gauge within the radiation facility;

(ii) all identification numbers for the gauge;

(iii) name and address of the supplier and/or manufacturer;

(iv) the make and model of the gauge;

(v) classification of the gauge; and

(vi) serial number of the source-housing and that of the sealed source(s) contained within.

(d) for each source used in the facility

(i) the current location;

(ii) name and address of the supplier and/or manufacturer;

(iii) type of radioactive material physicsl/chemical form of the radioactive material;

(iv) AERB classification number or ISO classification number of sealed sources;

(v) activity of the source on specified date;

(vi) working life of the sealed sources recommended by the source manufacturers; and

(vii) day-to-day operation with the IRGD (log book).

2.13 Specific Additional Provisions for Well Logging Sources

2.13.1 Safe Work Practices for Handling Well Logging Sources

2.13.1.1 Individuals involved in well logging or other tasks that involve the use of neutron sources should wear dosimeters that will measure both gamma and neutron radiations so that the total cumulative exposure to these radiations can be assessed. The neutron sources used in well logging, typically ^{241}Am–Be, emit both gamma and neutron radiations that cannot be measured using a single instrument. Well logging service companies shall therefore use both gamma and neutron dose rate meters and to sum the separate measurements to fully determine external exposure.

2.13.1.2 The following safe work practices for handling well logging sources should be implemented, in addition to those specified for all IRGD:

(a) A radioactive source which has exceeded its recommended working life, as specified by the manufacturer, should not be used in well logging tools.

(b) The manufacturers' specifications and recommended operational limits for the well logging tools should not be exceeded (e.g. cables and cable tension measuring devices, should be in good operating condition).

(c) Any parts of the logging configuration necessary for normal retrieval of the source from the hole, which have exceeded their recommended working life, as specified by the manufacture, should not be used.

(d) Logging measurements should not be conducted unless the workers directly involved with using the tools are correctly wearing

appropriate personnel monitors and are in possession of a suitable, functioning and calibrated survey meter.

(e) It should be ensured that radiation monitors are in good working order.

(f) Workers should be provided with appropriate gamma and neutron personnel monitors for their exclusive use whilst using, calibrating, storing, transporting or working with well logging sources.

(g) Personnel radiation monitors should be promptly returned for assessment at the end of the monitoring period.

(h) Personnel dose records should be analysed to ensure that there are no abnormal exposure trends.

(i) Personnel radiation monitors worn by persons known or reasonably suspected to have received an effective dose in excess of 10 mSv in a monitoring period, should be assessed promptly and investigated and reported to the Competent Authority.

(j) For ensuring the security of the equipment during transport, appropriate arrangements should be made for securing the source assembly in the approved transport container.

(k) Persons not required to assist with the logging measurements should be excluded from the vicinity of the equipment prior to removing any source from its shielded transport container.

(l) The number of persons assisting with the operation of the logging should be kept to a minimum.

(m) The container housing the source should not be placed where it is likely to be damaged by vehicles or other heavy objects.

(n) The source(s) should not be removed from the transport container except to make a measurement or to carry out essential servicing.

(o) The time taken while transferring the source to and from the transport container and the tool should be kept to a minimum.

(p) The source should not be approached except when it is necessary to transfer the source.

(q) A tool incorporating radioactive sources should not be lowered into the borehole unless the condition of the borehole has been well established.

(r) Radioactive sources should be removed safely from the borehole as soon as logging is completed.

(s) The source(s) should be kept locked in the transport container when not in use.

(t) The borehole(s) should be kept covered at all times while source transfers are carried out above or nearby the borehole(s) to prevent the loss of a source down a borehole.

(u) Instructions should be displayed regarding appropriate techniques for the care of logging cables, including avoidance of kinking and corrosion, renewal of cable head termination, identification of various cable fault conditions; and inspection and replacement intervals and arrangements for the safe calibration, repair and maintenance of the equipment.

2.13.2 *Security for Well Logging Sources*

2.13.2.1 Adequate security should be provided for the well-logging sources. Security measures should take into account the security threat perceptions at the location of the well logging tools.

2.13.2.2 The physical security arrangements of well logging operations should include the following elements:

(a) Access control (e.g. biometric access); formal multiple barriers (e.g. sealed box for storage with lock and key arrangement).

(b) Video surveillance of storage area.

(c) In case of field operations in threatening geographical locations: availability of alert system (e.g. cameras for investigation and follow-up) as well as the procedure for communication in such cases.

2.13.2.3 Separate threat analysis should be done for radioactive sources handled off-shore and on-shore.

2.13.2.4 The applicable provisions of the AERB Safety Guides on 'Security of Radioactive Sources in Radiation Facilities' (AERB/RF-RS/SG-1) and 'Security of Radioactive Material during Transport' (AERB/NRF-TS/SG-10) should be incorporated in the security arrangements.

3. DUTIES AND RESPONSIBILITIES

3.1 Responsibilities of Various Agencies

This section specifies the roles and responsibilities of manufacturer/ supplier, employer, licensee, RSO, security personnel and persons working in the facility using IRGD. Responsibilities common to manufacturers, suppliers and users are listed in sub-section 3.2. Specific additional responsibilities of each of the above persons are discussed in the subsections 3.3 to 3.7.

3.2 General Responsibilities of Manufacturer/Supplier/Employer and Licensee of the Institution using IRGD/Well Logging Source

3.2.1 The Manufacturer/Supplier/Employer and Licensee of the institution using IRGD/Well logging source should ensure that:

(a) an RPP incorporating the applicable elements listed in Section 2 of this 'safety guidelines' is developed in coordination with the RSO and/or an expert whose services may be obtained for the purpose, reviewed and updated at appropriate intervals and implemented to ensure safety in all operations involving the IRGD;

(b) a duly qualified person is designated as RSO with the approval of the Competent Authority (The employer should appoint an RSO. Delegating duties to an RSO does not absolve the employer of his legal responsibilities for ensuring that those duties are carried out. The RSO should be a full time employee of the organisation);

(c) trained and qualified personnel are available;

(d) appropriate area monitoring and personnel monitoring facilities are provided as specified in Section 5 of this 'safety guidelines' and appropriate monitor capable of measuring beta and gamma contamination, as required, should also be available;

(e) all personnel authorised to work with the sources are properly instructed about the safe operating procedure including emergency procedures;

(f) radiation exposure received by workers and members of the public do not exceed the annual dose limits prescribed by the Competent Authority and conform to the ALARA principle;

(g) an appropriate emergency response action plan is prepared and implemented;

(h) an appropriate security plan is prepared and implemented as specified in this 'safety guidelines' and the AERB Safety Guide on 'Security of Radioactive Sources in Radiation Facilities' (AERB/RF-RS/SG-1);

(i) an appropriate facility for the storage of sources should be provided as specified in Section 6 of this 'safety guidelines'; and

(j) a robust system is in place to assure the safety and security of sources in his possession.

3.2.2 *Source Inventory*

The manufacturer/supplier/user should maintain an up-to-date source inventory as specified in Section 2 of this 'safety guidelines' and be able to account for the sources within his control at all times and maintain records.

3.2.3 *Details to be Submitted*

The following details should be submitted to the Competent Authority:

(a) lay out plan of installation location;

(b) emergency preparedness plan for the radiation facility where the IRGD would be handled; and

(c) security plan (for storage, operation and transport of the IRGD).

3.2.4 *Intimation of Change of Name*

(a) Any proposed change in the name of the institution/employer/licensee should be duly intimated to the Competent Authority.

(b) Any proposed change in the ownership of the organisation should be duly intimated to the Competent Authority.

3.3 Specific Additional Responsibilities of Manufacturer/Supplier

3.3.1 *Type Approval of IRGD*

3.3.1.1 An IRGD that contains a radioactive source shall not be supplied unless type approval of the device is obtained from the Competent Authority.

3.3.1.2 In order to obtain the type approval of a IRGD from the Competent Authority, the supplier should submit all relevant particulars in the format prescribed by the Competent Authority in compliance with AERB Safety Standard on 'Design and Construction of Industrial Ionising Radiation Gauging Devices' [AERB/SS/2 (Rev.1)] and any other details that may be required by the Competent Authority to assess compliance with the applicable requirements.

3.3.1.3 The supplier should possess documentary evidence to demonstrate that each radioactive source that is incorporated in the IRGD is designed and manufactured and tested in compliance with the approval certificate issued by the Competent Authority of the country of origin of the design of the source.

3.3.2 *Supply of IRGD*

3.3.2.1 An IRGD that contains a radioactive source shall not be supplied to any person unless that person has obtained a licence as specified in the Rules, from the Competent Authority to handle the IRGD.

3.3.2.2 The manufacturer's/supplier's facility should furnish the Competent Authority with details relating to the supply of IRGD and sources including the addresses of the licensees and the reference details of the authorisation/NOC issued by the Competent Authority. These details should be furnished twice in a year viz. in the first week of January and July.

3.3.2.3 Prior to the transfer of the IRGD, the supplier should provide the authorised user of the IRGD with

(a) copies of Competent Authority approval certificates in respect of the device and the source;

(b) confirmation that the source control mechanism fitted to the IRGD operates correctly;

(c) confirmation, by measurement, that the radiation pattern in the vicinity of the source container, tube housing or shielded enclosure, conforms to the pattern expected for the design, when a radiation source of maximum design activity is used;

(d) all the relevant information about the safety features of the IRGD together with operating and maintenance instructions to enable the user to safely and properly operate the IRGD; and

(e) an undertaking to take back the disused source to its country of origin of the source when the source is no longer required by the user or to make alternate arrangements with the approval of the Competent Authority for the safe disposal of the source, if the original supplier is not prepared to take the source back.

3.3.2.4 The supplier should maintain complete records relating to design, testing, approval certification, manufacture and supply details relating to the IRGD.

3.3.2.5 The supplier should ensure the safety and security of all sources that are kept stored in his premises and maintain an inventory of the sources in his possession.

3.4 Specific Additional Responsibilities of the Employer

The employer of the institution authorised to use the IRGD/Well logging source shall:

(a) obtain from the Competent Authority a licence as specified in the Rules to handle an IRGD sources;

(b) procure only an IRGD that is type approved by the Competent Authority;

(c) provide radiation monitoring devices including area monitors in the case of users of high activity (hundreds of GBq or more) gamma sources and well logging sources. In addition to area monitors the personnel monitors need to be provided for gamma and neutron monitoring, as appropriate;

(d) not transfer the ownership of any source without the approval of the Competent Authority; and

(e) ensure decommissioning and safe disposal of disused sources with the approval of the Competent Authority.

3.5 Specific Additional Responsibilities of the Licensee

3.5.1 *Licence to Handle an IRGD*

3.5.1.1 A licence in the form of Registration, as specified in the Rules shall be obtained from the Competent Authority by a person who proposes to procure an IRGD.

3.5.1.2 In the case of import of a device/well logging source, prior to placing a firm order for the import, the prospective user shall obtain a 'No Objection Certificate (NOC)' from the Competent Authority for the import of the source.

3.5.2 *Information Dissemination*

3.5.2.1 The licensee should provide instruction on working safely with IRGD to his personnel at the induction and subsequently as deemed necessary.

3.5.2.2 Instruction may need to be more frequent where safety requirements are amended.

3.5.3 *Operational Safety*

3.5.3.1 The licensee should ensure that:

(a) radiation dose received by workers and members of the public:

(i) do not exceed the dose limits specified by the Competent Authority; and

(ii) are kept as low as reasonably achievable (ALARA);

(b) an audit is carried out once in six months of radioactive sources and of their locations, and a copy of the results of this audit in the prescribed format is submitted to the Competent Authority;

(c) permanent physical barriers, locks, safety interlocks, warning notices and other safety features are provided wherever necessary to ensure the safety of personnel and the safety and security of the IRGD;

(d) radiation warning labels and notices of appropriate form and size are prominently displayed on or adjacent to the IRGD and at the entrance to the storage area where IRGD are kept stored pending installation or during maintenance. Such labels and notices should be made of material resistant to weather and corrosion, dust and fumes that are likely to be present, maintained in a clean and legible condition and securely attached and should be removed only when the source has been permanently removed from the location;

(e) the Competent Authority is informed about change of RSO;

(f) the approval of the Competent Authority is obtained before disposing of any radioactive source;

(g) the Competent Authority is notified immediately of an unusual occurrence involving the IRGD/source such as:

(i) loss of an IRGD source or a well logging source getting jammed in boreholes;

(ii) functional impairment of a shutter or source control mechanism;

(iii) occurrence of any extreme natural event, (e.g. fire, flood, earthquake or similar event);

(iv) failure to account for a source;

(v) a gauge being damaged/ suspected of being damaged; and

(vi) the results of radiation monitoring being in excess of the prescribed limits;

(h) following any unusual occurrence involving the IRGD/source:

(i) the gauge, if any functional impairment has occurred, is not used until the function of the shutter or source control mechanism is thoroughly tested and restored to normal condition;

(ii) the gauge is inspected and, if necessary, tested to verify that neither the gauge nor the radiation source is damaged;

(iii) the gauge and all of its associated safety features are fully functional before allowing the gauge to be used; and

(iv) the gauge is not used until it is repaired and operating correctly and safely in accordance with the provisions of this 'safety guidelines';

(i) the gauge is used, stored, transported, routinely maintained, serviced or repaired in accordance with the provisions of this 'safety guidelines';

(j) the details of any repair or corrective actions taken are recorded and retained;

(k) the results of all radiation protection surveys and examinations of the equipment are recorded and retained; and

(l) in the event of loss of source, measures to locate the source(s) are implemented and the source inventory is reconciled through authentic record verification methods.

3.5.3.2 The licensee should ensure that records are maintained as specified in sub-section 2.12.

3.5.3.3 The licensee should furnish information about the receipt of IRGD and source in the prescribed format within 10 days after receiving the device(s) and submit the installation report in the prescribed format within 10 days after installation of the IRGD.

3.5.3.4 The licensee should advise the employer about the modifications in working condition of a pregnant worker.

3.6 Responsibilities of the RSO

The RSO should ensure that:

(a) implement the safe procedure for operation of the device specified in sub-section 2.6 of this 'safety guidelines';

(b) develop, in coordination with the licensee, the Radiation Protection Programme of the organisation and detailed working rules and emergency procedures including provisions for the safety and security of the sources during handling and storage adopted for use in accordance with this 'safety guidelines';

(c) seek the advice of the manufacturer/supplier regarding any detailed conditions for the use of the IRGD in the facility;

(d) on receipt of an IRGD, measure the radiation levels around it and confirm that the measured radiation levels are within the limits prescribed in the AERB Safety Standard No. AERB/SS/2 (Rev.1) or its current version and if the limits are exceeded, the RSO should inform the supplier and not use the IRGD until and unless it is reconditioned or replaced by one satisfying the regulatory requirements;

(e) during installation of the IRGD, conduct a radiation protection survey of the device, record the readings in a log book and learn from the installation staff about the details of operation of the IRGD, particularly the safety features;

(f) before bringing the source to the exposure 'ON' position, people who are not required to work with the IRGD move away from the vicinity of the gauge to a distance where the radiation level is less than 1 $\mu Sv.h^{-1}$;

(g) source(s) are brought to the exposure 'ON' only when required;

(h) issue and collect any personnel monitors which may be used, including neutron monitoring badges in the case of users of well logging sources;

(i) keep the licensee informed of the radiation safety status of the practice;

(j) furnish the safety status report in the prescribed format twice in a year viz. in the first week of January and July;

(k) employees are duly instructed so that they:

  (i) acquaint themselves with, and comply with all notices and warning signs displayed and all instructions issued for their own safety and the safety of others with the requirements of the RPP of their facility;

  (ii) refrain from careless or reckless practice or action likely to result in a radiation hazard to themselves or others;

  (iii) report to the RSO any difficulties with working procedures or defects in equipment which may have caused or are likely to cause a radiation hazard, including the actual or potential loss of a radioactive source and any accident or potentially hazardous situation that may come to their notice;

  (iv) provide to the employer information about their previous occupations including radiation work, if any;

(v) use any personal protective equipment provided to them and devices or equipment to assess their personal radiation dose, where applicable;

(vi) do not interfere with, remove, alter, displace, damage or render ineffective, any equipment or radiation protective device provided to protect the employee or other persons, or interfere with any method or working procedure adopted to reduce radiation exposure, except for authorised purposes of inspection, maintenance, repair, modification or replacement;

(vii) do not remove or in any way interfere with the radiation source(s).

(l) require that a female worker, on becoming aware that she is pregnant, notifies the employer, licensee and Radiological Safety Officer in order that her working conditions may be modified, if necessary.

3.7 Responsibilities of Security Personnel

The security personnel have the responsibility to ensure that before an IRGD/ source enters or leaves the premises, the matter is duly referred to the RSO, licensee and the management to confirm that the source is properly accounted for. If a source is stolen or lost, the security personnel should provide all necessary support to the RSO and the other staff in locating the source. It is the responsibility of the security personnel to take part in the development of the security plan and the emergency response plan of the facility and take part in implementing the plans.

4. RADIATION INCIDENTS

4.1 Management of an Incident

In formulating the Radiation Protection Programme (RPP), the licensee (i.e. manufacturer/supplier/user institution) should develop contingency arrangements detailing the action to be taken following all reasonably foreseeable incidents. The incidents considered for IRGD with source should include shutter getting jammed while in use or remaining open when not in use, fall from a height, fire accident involving an IRGD, theft/loss/ misplacement, unauthorised disposal as scrap and auctioning, damage to a portable IRGD and source getting stuck in a well or logging tool.

4.1.1 The employer/licensee/RSO shall, within 24 hours after the incident, inform the Competent Authority:

(a) that the incident has occurred;

(b) of the steps that have been taken to rectify the situation; and

(c) of the details of any radiation doses known, or suspected to have been received by any person.

4.1.2 In case of loss/theft of an IRGD/well logging source the employer/licensee/ RSO shall lodge a formal complaint with the local police authorities.

4.1.3 Following an incident, the employer/licensee/RSO should:

(a) investigate the incident and initiate follow-up actions;

(b) submit a brief report within 2 days followed by complete, detailed report of the incident, including the preventative action to avoid a recurrence of such incidents, to the Competent Authority within 7 days;

(c) decontaminate the affected area, if necessary; and

(d) review and verify whether the corrective actions have been implemented.

4.2 Special Provisions for Well Logging Operations

4.2.1 In the event of retrieval of a source stuck in a well, the RSO should check the integrity of the source after retrieval from the well.

4.2.2 In well-logging facilities, where a person is known or suspected to have received a radiation dose in excess of 10 mSv as a result of an incident, the licensee/supplier should send the personnel monitoring device, including neutron monitoring badges, of the concerned persons for urgent dose assessment, to respective monitoring laboratories.

5. RADIATION MONITORING

5.1 General Radiation Levels

The radiation levels at any accessible location near the installation or storage of IRGD/well logging sources shall not exceed 1 $\mu Sv.h^{-1}$. Acceptable radiation levels may be estimated for compliance with the dose limits taking into account the appropriate occupancy factors.

5.2 Monitoring Devices

5.2.1 *Personnel Monitoring*

5.2.1.1 The employer should provide an appropriate personnel monitoring device to each authorised person who:

(a) installs, removes or performs maintenance on a IRGD/nucleonic gauges;

(b) undertakes service or repair of a IRGD/nucleonic gauge; and

(c) requires personnel monitoring as assessed by the RSO.

Persons identified above should be provided with personnel monitors by their respective employers.

5.2.1.2 Personnel monitoring devices capable of measuring gamma and neutron radiations should be used by workers handling well-logging sources.

5.2.1.3 Personnel monitoring is generally not required in facilities operating IRGD other than well logging sources, except when the activity of the gamma source is high (hundreds of GBq or more), if it is frequently required to remove the source from the shielded container for operational/cleaning purposes, as could happen in a working environment that would cover the source with soot or dirt which would interfere with the sensitivity of the detector.

5.2.2 *Area Monitoring*

5.2.2.1 The employer should ensure that adequate number of duly calibrated appropriate portable radiation survey meters are available and used.

5.2.2.2 Fixed area/zone monitors should be installed in well logging source storage facilities and IRGD manufacturing/calibration facilities.

5.2.2.3 Each radiation survey meter should be checked against a known source (e.g. placing the monitor close to the surface of the IRGD/source container when the source is in shielded condition) prior to each use to ensure that it is operating in the correct manner.

5.2.2.4 The radiation survey meter should:

(a) have sufficient measurement range to measure 1 $\mu Sv.h^{-1}$ to 50 or 100 $mSv.h^{-1}$, as appropriate to the radioactive sources used in IRGD; and

(b) continue to provide visible and/or audible indication, when radiation levels exceed the maximum reading in any measurement range.

5.2.2.5 Radiation survey meters should be calibrated:

(a) prior to initial use;

(b) at an intervals not exceeding 24 months;

(c) following damage or repairs; and

(d) when calibration is indicated by their performance.

The calibration of a radiation survey meter should be traceable to the national standard laboratory recognised by the Competent Authority.

6. STORAGE AND TRANSPORT OF RADIOACTIVE MATERIAL

6.1 Storage of IRGD/Sources

6.1.1 *Safe Storage*

If there is likely to be a time lapse between the receipt of the IRGD and its installation, adequate arrangements should be made by the licensee for the safety and security of the IRGD. No person other than the RSO and the licensee should be permitted access to the area where the IRGD/source is stored. It should be ensured by the licensee that no dangerous goods such as explosives, corrosives and inflammables are stored in the proximity of IRGD/sources. During the period of storage of the IRGD/source a record of the details of the persons entering the storage room should be maintained. If the IRGD/source is damaged or stolen or any other emergency situation arises during storage, appropriate action, as specified in this 'safety guidelines' should be duly implemented.

6.1.2 *Safety and Security of Storage*

6.1.2.1 An IRGD containing a radioactive source should be safely and securely stored if it:

(a) is not required for immediate use/supply; or

(b) has been removed from service for a temporary period; or

(c) has been removed from service permanently, pending disposal.

6.1.2.2 When in storage, the source assembly should be fully retracted into the shielded position, with shutter or source control mechanism in the 'beam off' position and the shutter closed.

6.1.2.3 A permanent record of the gauges kept in storage of the supplier's facility and the user institution, should be maintained by the licensee in the respective storage facilities.

6.1.2.4 The IRGD should be clearly labelled indicating the identity of the source and its activity on a specified date. A radiation warning symbol with an appropriate legend should also be displayed.

6.1.2.5 The IRGD should be stored such that the likelihood of damage to the gauge is minimised.

6.1.2.6 The room where one or more IRGD/sources are stored should:

(a) be of solid construction and made of durable materials capable of physically securing the equipment;

(b) be designed, located, constructed and shielded so that:

(i) the radiation level at any accessible place outside the store would not exceed 1.0 $\mu Sv.h^{-1}$;

(ii) the dimensions of the room would allow handling of the IRGD through appropriate mechanical means.

(c) be kept locked and under the control of the licensee;

(d) be subject to strict access control;

(e) not be used for other than the intended purposes; and

(f) display, when an IRGD/source is in the storage room, a conspicuous notice bearing the radiation warning symbol and instructions to contact the licensee and the RSO in the event of an emergency involving the IRGD.

6.1.2.7 The storage for IRGD should not be located in an area prone to flooding or other potential hazards that may damage the storage room and/or its contents.

6.1.2.8 Well logging sources, when in the field but not in use, should be stored in the permanent storage room.

6.1.2.9 The layout of the room where well logging sources would be stored when not in use should have the approval of the Competent Authority.

6.2 Transport of IRGD/Well Logging Source

6.2.1 *Safety Requirements for Transport of Radioactive Material*

If it is required to relocate/transfer the IRGD/well logging source from one place to another, prior approval shall be obtained from the Competent Authority. Upon bringing the IRGD/source back to the original place, the Competent Authority should be duly informed. Transport of an IRGD/source shall be made in compliance with the requirements for the safe transport of radioactive material prescribed in the AERB Safety Code for Safe Transport of Radioactive Material, (AERB/SC/TR-1/Rev.1 or its updated revision). Typically an IRGD is designed to satisfy the design requirements of a Type A package prescribed in the AERB Safety Code for Safe Transport of Radioactive Material.

6.2.2 Specific Safety Precautions during Transport of IRGD/Well Logging Source

During the transport of the IRGD/well logging source, it should be ensured that:

(a) the source control or shutter mechanism in the source container is locked in the 'beam off' position;

(b) the package is monitored to ensure that the useful beam is properly attenuated with the shutter or source control mechanism in the 'beam off' position; and

(c) the IRGD/well logging sources is packed in an outer shipping container that is of strong and rigid construction.

7. **DISPOSAL**

7.1 Disposal of a Source

A source should be safely disposed of either after completion of its useful life or if it gets damaged in an accident or when it is no longer required by the user. A decayed source or any source, in the possession of the institution, which is no longer in use, should be returned to the original supplier with the prior approval of the Competent Authority. If it is not possible to send the source back to the original supplier due to any unavoidable circumstances, the licensee should arrange for safe disposal of the source in India with the prior approval of Competent Authority. Radioactive material should be disposed of only in an authorised facility, as specified in para 7.2.

7.2 Approval for Disposal of a Source

7.2.1 *Approval from Competent Authority*

The source or the IRGD containing the source should never be disposed of as a normal waste. The licensee shall obtain prior approval from the Competent Authority for the safe disposal of the source. In addition, specific prior approval shall be obtained by the licensee from the Competent Authority for the safe transport of the radioactive material. The conditions specified by the Competent Authority for the safe disposal of the source should be adhered to by the licensee. The procedure to be followed for safe disposal of sources is as follows:

7.2.1.1 Procedure for export of a source back to the supplier enter for exporting the source back to the supplier outside India, prior approval for export of source shall be obtained by the licensee from the Competent Authority. In addition, the applicable regulatory requirements for the safe transport of the radioactive material through the domestic leg as well as overseas should be duly complied with.

7.2.1.2 In the case of disposal of sources in India, upon obtaining approval from the Competent Authority, complete information on removal of the source from the source container should be provided to the authorised disposal facility prior to dispatch of the source. The source may be dispatched for disposal only after obtaining the due clearance from the authorised disposal facility. In addition, the regulatory requirements for the safe transport of the radioactive material shall be duly complied with. Upon receipt of the source at the disposal facility the Competent Authority should be informed by the licensee so that the national source inventory can be updated.

8. EMERGENCY RESPONSE PLANS AND PREPAREDNESS

8.1 Emergency Situations

The occurrence of any one or more of the following situations may be deemed to constitute an emergency:

(a) Receipt of a IRGD from the supplier in a damaged condition

(b) Loss or theft of or damage to the IRGD/nucleonic device due to accidents (e.g. fall from a height, fire, explosion) during storage pending installation or after decommissioning pending disposal/ operation/servicing/ maintenance

(c) Failure of shutter during operation / servicing / maintenance

(d) Source getting stuck resulting in increased radiation level around the IRGD

(e) Unauthorised disposal of the IRGD containing a source

(f) Loss or theft of or damage to the nucleonic device due to accidents during transport of the nucleonic devices

(g) Any other off-normal situation with a potential to result in exposure of individuals to radiation.

8.2 Elements of Emergency Preparedness

The important elements of emergency preparedness are the following:

(a) Emergency organisation within the institution

(b) Emergency Response Manual [sample given in **Annexure-IV**]

(c) Communication system

(d) Education and Training in emergency situations

(e) Emergency exercises.

8.3 Training in Emergency Preparedness

All the employees working in the institution should be educated about emergency situations. They should be informed that the potential radiological consequences of an emergency situation involving an IRGD are limited because of the design and construction standards of gauges and the low activity of sources used. The employees should be trained in emergency handling. They should be instructed as follows:

(a) Report any abnormal situation which you may observe

(b) Do not Panic

(c) Follow the instructions given by the Chairman of the Emergency Response Committee (ERC)

(d) Avoid stampede

(e) Avoid crowding at the affected site

(f) Act as directed by the RSO.

9. DECOMMISSIONING

9.1 Decommissioning of the Installation

The location where the IRGD was installed can be released for use for other purposes only after decommissioning the IRGD installation. For decommissioning an IRGD installation, prior approval shall be obtained from the Competent Authority. A radiological protection survey of the location where the IRGD was used should be conducted by the RSO to confirm that the radiation/contamination levels are within limits specified by the Competent Authority.

9.2 Prohibition of Abandonment or Disposal

Employer/licensee shall not abandon an IRGD or well logging source. He/she shall not dispose of the source of an IRGD without obtaining the prior approval of the Competent Authority.

9.3 Re-use of Sources

A person shall not reuse a source from an IRGD without obtaining the prior approval from the Competent Authority.

9.4 Relocation of IRGD

The IRGD shall not be relocated without obtaining the prior approval from the Competent Authority.

ANNEXURE-I

CAUTION PLACARD AT IRGD INSTALLATIONS - SPECIFICATIONS

At each IRGD installation, a caution placard should be provided with appropriate legends inscribed on it. The relevant specifications are listed below:

(a) The caution placard shall be made up of metal.

(b) The placard shall be fixed on to a permanent structure within a distance of 300 mm from the gauge.

(c) Sufficient number of placards shall be installed so that any person approaching the gauge from any direction would be able to see a placard and be cautioned.

(d) The size of the placard shall be adequate to contain the inscriptions prescribed below in the required languages and it shall not be less than 300 mm x 300 mm.

(e) The position for fixing the placard shall be so selected that there are no physical obstructions to reading it.

(f) The inscription on the placard shall be in conformity with the following provisions:

(i) The placard shall carry a legend reading:

RADIATION KEEP AWAY

RADIOACTIVE SOURCE WITHIN THE GAUGE: ……. (e.g. ^{60}Co)

ACTIVITY OF THE SOURCE: ……..... Ci/Bq

AS ON: ……..... (date)

(For X-ray gauges) THIS DEVICE GENERATES RADIATION WHEN ENERGIZED - KEEP AWAY

FOR WORKING NEAR THE GAUGE PRIOR PERMISSION FROM THE RSO SHOULD BE OBTAINED IN EMERGENCY CONTACT :……..…….....(Name)

…… (Telephone)

(ii) The inscription shall be in all languages (English, Hindi and Regional language) as deemed necessary at the plant.

(iii) The inscriptions shall be painted on the metal placard.

(iv) The size of any letter/character in the inscription shall not be less than 25 mm.

(v) A radioactivity/X-ray symbol shall also be painted alongside the legend.

(vi) The radioactivity symbol shall be in conformity with the international standards, viz. a circle within a trefoil in magenta colour against yellow background.

The caution placard shall also be displayed at the entrance door of the source storage room and at other appropriate locations outside source storage room.

ANNEXURE-II

SWIPE TEST PROCEDURE

A swipe test on the exterior of a fixed radiation source is used to indicate whether any radioactive material has leaked from the radioactive source contained within the IRGD.

Note: User should carry out swipe of only the accessible surface of the IRGD and not the actual source, also well logging container without source. The area over which swipe is to be collected should be at least 100 cm^2. The swipe samples should be sent to an appropriate laboratory for determining the radioactivity collected on the swipe samples. The results of the analysis should be obtained from the laboratory and the records maintained by the licensee. If the radioactivity collected from any sample is in excess of 185 Bq (5 nCi), the matter should be brought to the notice of the Competent Authority and such directive as may be issued by the Competent Authority should be duly implemented by the licensee.

II.1 Required Items

(a) A piece of dry cotton wool or material such as a piece of filter paper to serve as test swab

(b) Distilled water

(c) Surgical gloves

(d) Forceps or tongs with rounded edges

(e) Plastic bags for covering the forceps or tongs during use

(f) Plastic bags that can be closed and sealed

(g) A contamination monitor appropriate to the source within the IRGD/ well logging source, in good working condition.

II.2 Method of Taking Swipe

(a) Wear the gloves on both hands

(b) Moisten the swipe test swab with distilled water

(c) Cover the tongs with the plastic bag intended for the purpose

(d) Swipe outer accessible surfaces of the source housing softly

(e) Check the swab for gross contamination by bringing it carefully to within 10 mm of the contamination meter window. If a consistent increase in count rate is observed when the swab approaches the

window then contamination is likely to be present and steps should be taken to prevent spreading of contamination. The tongs are likely to be contaminated. Place tongs and/or forceps into another plastic bag and seal it with a caution label.

(f) The swabs should be packed in a bag. The bag should be sealed and labelled.

(g) Each swab should be packed in a plastic bag which should again be packed in another plastic bag.

II.3 Packaging Procedures

(a) The swabs to be sent for contamination check should be placed in a container such as a cardboard or plastic box. It could be transported as an excepted package provided the requirements specified in the AERB Safety Code for Transport of Radioactive Material, AERB/NRF-TR/SC-1 (Rev. 1) or its updated revision for excepted packages are duly fulfilled.

(b) The description of the swipe samples should be placed in an envelope with appropriate reference to the package in which the swipe sample is transported.

(c) The package should be dispatched in accordance with the requirements specified for excepted packages in the AERB Safety Code for Transport of Radioactive Material, AERB/NRF-TR/SC-1 (Rev. 1) or its updated revision.

ANNEXURE-III

IMPORTANT ELEMENTS OF A RADIATION PROTECTION PROGRAMME OF A FACILITY HANDLING IRGD

The Radiation Protection Programme (RPP) developed by an institution should be commensurate with the work involving the IRGD/well logging sources carried out in the institution. For example, the RPP for a facility handling a single IRGD housing a low activity beta source may be very simple while that for a facility handling well logging sources and for one manufacturing IRGD may need to be elaborate. The RPP should include the following elements:

(a) The procedure for correct and safe methods of handling IRGD, particularly, density/moisture measurements on the surface and at various depths with portable gauge

(b) Availability of radiation survey meters, protective equipment and personnel monitoring devices to meet the requirements of the Rules

(c) The methods for determining that all radiation survey meters are in good working condition and procedure for getting the survey meters calibrated at least once in two years

(d) Arrangements for personnel monitoring, where required, including:

  (i) the accredited personnel monitoring agency;

  (ii) type of personnel monitor (gamma/neutron) to be worn;

  (iii) wearing position;

  (iv) procedure for ensuring that personnel monitoring devices are promptly submitted for assessment after use following the monitoring period;

  (v) requirements for storage of personnel monitors when not in use; and

  (vi) the storage location of the control monitor.

(e) Roles and responsibilities and details of any additional duties of personnel to meet the requirements for the safety and security of the IRGD/sources during use, storage and transport and emergencies

(f) Control of an incident involving an IRGD

(g) Mechanisms for implementation and review of the RPP, including the arrangements for provision of expert advice in radiation protection

(h) Occasions on which radiation surveys and contamination tests are to be carried out

(i) Tests for measuring non-fixed surface contamination, where appropriate

(j) Methods for conducting radiation surveys, swipe tests **[Annexure- II]** and any other examination required by the Competent Authority, and for reporting and recording results

(k) Methods of prevention of loss of sources and methods of detection and recovery of lost sources

(l) Measures to be implemented in the event of an emergency

- (i) Conditions of licence and any special instructions issued by the Competent Authority
- (ii) Procedure for calibration, repair and maintenance of the gauge
- (iii) Procedure for calibration and use of the radiation survey meter
- (iv) Records of repairs and maintenance of the gauge
- (v) Contact addresses and telephone numbers of persons to be contacted in an emergency
- (vi) Regular inspection of all equipment including:
  - (a) source containers or housings;
  - (b) survey meters;
  - (c) labels; and
  - (d) markings.
- (vii) Action to be initiated when an IRGD/well logging source is no longer required and procedure for safe disposal of a disused radioactive source
- (viii) Any other site-specific information that may have a bearing on radiation safety.

ANNEXURE-IV

MODEL EMERGENCY RESPONSE MANUAL

An emergency response manual (ERM) for a facility handling IRGD incorporating beta/gamma sources is likely to be brief and simple. However, the ERM for a facility handling well logging sources would need to be more detailed. This is only a sample ERM where a limited number of emergency scenarios have been addressed. The ERM developed by the facility should include all possible realistic emergency scenarios and devise the action plan for each such scenario.

The following action plans for the emergency scenarios should be implemented by the RSO/licensee. In all cases, intimate AERB regarding the emergency within 24 hours of its occurrence.

IV.1 Emergency Scenario: Receipt of an IRGD/nucleonic device from the supplier in a damaged condition

(a) Contact the carrier and check how the device was damaged

(b) Inform AERB, and the supplier/manufacturer of the device that the IRGD was received in a damaged condition

(c) Measure the radiation level around the device and record the observations

(d) If the measured levels are in excess of the prescribed limits, report the matter to AERB. Provide adequate shielding and transfer the IRGD in an exclusive storage room.

(e) Ensure that adequate security is provided to the IRGD until the emergency is terminated.

(f) Act as advised by AERB, for safe disposal of the device if the device along with source is damaged.

(g) If the device is examined by the supplier and thereupon declared safe for installation and operation, or after the device has been safely removed from the premises or safely installed terminate the emergency.

(h) Inform AERB regarding the termination of the emergency.

IV.2 Emergency Scenario: Loss or theft of IRGD or Disposal of the nucleonic device as scrap

(a) Inform the police and lodge a First Information Report.

(b) Take steps to trace the device by appropriate means by searching premises of nearby scrap dealers.

(c) Provide photograph of source housing to scrap dealers.

(d) Brief the scrap dealers about the consequences of radiation hazard and safety philosophy, time, distance and shielding.

(e) Intimate AERB regarding the emergency.

(f) In case of suspected radiation exposure to any of the personnel of the institution, seek advice from AERB.

(g) Upon ensuring that the device has been traced and regained or that it is safe for installation and use or disposal, terminate the emergency.

(h) Intimate AERB regarding the termination of the emergency.

IV.3 Emergency Scenario: Damage to the IRGD/nucleonic device due to accidents
(e.g. Fall from a height, fire or explosion)

(a) Rescue the injured, if any.

(b) In case of fire or explosion contact the fire department for help.

(c) Fight fire; if there is a fire accident; from upwind direction.

(d) Segregate the IRGD/nucleonic device under the supervision of the RSO.

(e) In case of damage to the device, measure the radiation level around the device and record the observations. If the measured levels are in excess of the prescribed limits, report the matter to AERB.

(f) Intimate AERB regarding the occurrence of the emergency.

(g) Upon ensuring that the arrangements have been made for the safe disposal of the device or confirming that it is safe for installation and use, terminate the emergency.

(h) Intimate AERB regarding the termination of the emergency.

IV.4 Emergency Scenario: Failure of shutter during operation/servicing/ maintenance

(a) Arrange for temporary shielding in front of the shutter of the gauge immediately with suitable shielding material of adequate thickness. In case of damage to the device, measure the radiation level around the device and record the observations. If the measured levels are in excess of the prescribed limits, report the matter to AERB.

(b) Inform the manufacturer/supplier of the device about the observed condition of the device (The IRGD should be repaired only by authorised Servicing Engineers).

(c) Intimate AERB regarding the occurrence of the emergency.

(d) Upon ensuring that the IRGD is safe for use, terminate the emergency.

(e) Intimate AERB regarding the termination of the emergency.

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Dates of meeting: July 30, 2014 September 22, 2014

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Date of meeting: March 26, 2015

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LIST OF REGULATORY SAFETY DOCUMENTS ON NUCELONIC GAUGES AND WELL LOGGING APPLICATIONS

Safety Series No.	Title
AERB/SC/G	Regulations of Nuclear and Radiation Facilities
AERB/SS/2 (Rev.1)	Design and Construction of Industrial Ionising Radiation Gauging Devices
AERB/SS/3 (Rev.1)	Testing and Classification of Sealed Radioactive Sources
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AERB/RF/SG/G-3	Consenting Process for Radiation Facilities
AERB/RF/SM/G-3	Regulatory Inspection and Enforecment in Radiation Facilities

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SPP

A large number of nucleonic gauges and well-logging devices are in use in India. The well logging devices incorporate relatively high activity neutron sources in addition to gamma sources. The nucleonic gauging devices, on the other hand, mostly incorporate low activity sources. The document specifies regulatory requirements as well as methodologies for compliance by end users and suppliers of nucleonic gauges and well-logging sources. It provides requirements for handling of the devices viz. manufacture/supply, procurement, receipt from the supplier, installation, operation, decommissioning a Nucleonic gauges can be found everywhere where extreme conditions would mean the end for any other measurement technology. Thatâ€™s because nucleonic devices measure contactlessly, which makes the measuring systems wear free and practically maintenance free as well. However, since this technology uses radioactive radiation, safety is the top priority.Â Indeed, to this day, some areas of application do not allow any alternative to nucleonic measurement. This is because only measurement technology using gamma radiation is completely unaffected by high vessel pressures, corrosive media, extreme temperatures or problematic physical product characteristics and able to continuously deliver exact and reliable measuring results. Degree/Diploma s tudents to Well Logging Applications Class. G666 / Winter 2013â€“â€œDiploma in Petroleum Geology a nd Hydrogeologyâ€-â€ Core Course â€. G666 / Spring 2014â€“ â€œDiplom a in Applied Geophysicsâ€- â€ Core Course â€.Â Well-logs data of a pilot borehole located in the Algerian Sahara are used for the training, where the modified hidden weight optimization (MHWO) algorithm is used. Generalization to a second borehole located in the neighbourhood of the pilot borehole clearly shows that the implanted MLP machine using the MHWO can greatly improve reservoir characterization. Nucleonic gauges find many non-destructive applications in industry for in situ determination of thickness, density and composition of materials, for measurement and control of process material in closed containers, for analysis of ores and minerals, well logging, etc. There are about 850 institutions in India, using more than 6000 gauges for different applications. It is mandatory for these institutions, particularly those which are in possession of gamma and neutron sources, to. have personnel trained in radiation safety and duly approved by the competent authority. To cater to this need, RP Applications of gauges in industry Gamma gauges transmission Beta gauges transmission and backscatter Neutron gauges Well logging Lecture notes: Instructions for the lecturer/trainer. 4 What is a Nuclear Gauge? Device used in numerous industries, mostly in process control and quality control. Consists basically of a shielded radiation source and a radiation detector The radiation interacts with the examined material before reaching the detector, supplying real-time data. Detector Material Flow Shutter Control Shielding Source Shutter (Closed).