REQUIREMENTS FOR DESIGN APPROVAL OF RADIOGRAPHY EQUIPMENT AND SOURCES

1.0 AERB carries out design approval as Type approval of IGRED, X-ray and Accelerator equipment in the radiological safety viewpoint.

2.0 The following requirements in respect of radiography equipment/exposure devices, source changers shall be complied with to qualify for type approval certification:

1) Any X-ray equipment, accelerator or gamma radiography exposure device/source changer shall be handled only after it is Type Approved by the Competent Authority. For import of the radiography unit, prior to granting Type Approval, the Competent Authority may grant a No Objection Certificate (NOC) and require that the unit be subjected to a thorough technical assessment for compliance with the prescribed Safety Standards.

2) For gamma radiography exposure device / source changer manufactured abroad, Type Approval shall be obtained by providing evidence of their conformance to AERB/RF-IR/SS-1 (Rev. 1) or an updated version thereof and evidence that the device has the approval of Type A/Type B(U)/(M) package design by the Competent Authority of the country of origin.

3) Exposure device shall need to be approved as package of appropriate type for transport in public domain. Where the type approval of the device is based on the source in special form, the gamma radiography source shall need to be certified as meeting the requirements of special form of radioactive material for transport in accordance with the requirements currently in force.

4) The manufacturer/supplier seeking type approval shall submit an application along with detailed drawings of the equipment/device and a report on safety analysis for type approval.

5) Safety analysis report shall provide evidence of compliance with AERB/RF-IR/SS-1 (Rev. 1), or an updated version thereof and with applicable requirements of this Section and the results of tests carried out on the prototype. The report shall provide evidence of the quality assurance (QA) programme.

6) Type Approval may be granted after evaluating the safety of the equipment/device, indicating therein the terms and conditions of the approval including the period of validity of the approval certificate.

7) Industrial Radiography Exposure Devices (IRED) such as X-ray equipment, accelerator or IGRED/source changer, or transport package shall not be manufactured or supplied after expiry of validity period specified in the type approval certification/package design approval unless the approval is revalidated.

8) IGRED/source changer, or transport package shall not be used after expiry of validity period specified in the type approval certification/package design approval unless the approval is revalidated.

2.1 Industrial Gamma Radiography Exposure Devices (IGRED)

2.1.1 General

The industrial gamma radiography exposure devices shall be capable of remote operation and control and shall be designed and built to comply with the AERB Safety Standard titled 'Industrial Gamma Radiography Exposure Devices and Source Changers', [AERB/RF-IR/SS-1 (Rev.1)] or equivalent international standard. Only an industrial gamma radiography exposure device or a source changer in respect of which approval of design has been duly accorded by the Competent Authority, shall be marketed, sold, transferred, procured and used, with prior approval of the Competent Authority

2.1.2 Source Housing

The IGRED is classified as portable, mobile or fixed, depending on its overall weight as specified in AERB/RF-IR/SS-1 (Rev.1). Shielding provided by the source housing shall be such that when the control mechanism is securely locked in its 'OFF' condition and a radiography source of maximum rated activity is in the housing, the leakage radiation outside the housing shall not exceed the levels given in the Table 2.1. In order to establish compliance, the radiation level at 5 cm from the surface of the IGRED shall be measured over an area of 10 cm^2 with no linear dimension greater than 5 cm. At 1 m, the area of measurement shall be not more than 100 cm^2 with no linear dimension greater than 20 cm. The levels are averaged over these measurement areas.

TABLE 2.1: LIMITS ON LEAKAGE RADIATION LEVELS

Class of IGRED	On the External Surface of Source Housing (mSv/h)	At 5 cm from External Surface of Source Housing (mSv/h)	At 100 cm from External Surface of Source Housing (mSv/h)
Portable	2	0.5	0.02
Mobile	2	1.0	0.05
Fixed	2	1.0	0.10

For a source changer the maximum radiation level on the external surface is 2 mSv/h and the corresponding limit at 100 cm is 0.1 mSv/h.

Source housing shall be so designed as to serve also as transport package (either Type A or Type B(U)/(M)), as appropriate. The activity limits for transport of radioactive material in a Type A package for some selected radioactive sources in special form are given in Table 2.2. The source housing shall comply with the applicable design requirements for Type A/Type B(U/M) package as specified in the requirements for the safe transport of radioactive material

TABLE 2.2: ACTIVITY LIMITS FOR SPECIAL FORM RADIOACTIVE MATERIAL

PERMITTED IN A TYPE A PACKAGE

Radionuclide	Activity Limit in

	TBq
^{60}Co	0.4
^{137}Cs	2.0
^{75}Se	3.0
^{170}Tm	3.0
^{192}Ir	1.0

2.1.3 Marking and Labelling

In addition to the permanent marking affixed by the manufacturer, as specified in AERB/RF-IR/SS-1 (Rev.1), the licensee shall affix on each IGRED a, legible, and clearly visible label displaying:

(i) chemical symbol of the radionuclide in the IGRED,

(ii) activity and the date on which this activity was measured,

(iii) manufacturer of the sealed source,

(iv) radiation symbol (trefoil symbol),

(v) serial number of the IGRED provided by the manufacturer and package design approval Identification number, provided by Regulatory Body, and

(vi) maximum leakage radiation level at 5 cm from the surface of the IGRED and the date of measurement.

2.1.4 Security and Safety

The IGRED shall have tamper-proof lock for physical security of the source to prevent unauthorised operation. It shall not be possible to operate the lock unless the source or source assembly is in the fully shielded position. The industrial gamma radiography IGRED shall incorporate the safety systems and the handling facilities specified in AERB/RF-IR/SS-1 (Rev.1).

2.2 Source Changer

2.2.1 Source Housing

Source changer shall comply with the requirements specified in AERB/RF-IR/SS-1 (Rev.1). Leakage radiation (on the surface, and at 1 m) with source(s) of maximum authorised activity in the source changer shall not exceed the levels specified in sub section 2.1.2.

2.2.2 Marking and Labelling

The licensee shall affix on each source changer a durable, legible, and clearly visible label displaying:

(i) number of sources, chemical symbol and mass number of the radionuclide(s) in the source changer,

(ii) activity and the date of measurement for each source,

(iii) manufacturer of the sealed source(s),
(iv) radiation symbol (trefoil symbol),
(v) serial number of the source changer and package design approval identification number, and
(vi) maximum leakage radiation level at 5 cm from the surface of the source changer and the date when it was measured

2.2.3 Security and Safety

Source changer shall have tamper-proof lock for physical security of the source and to prevent unauthorised operation. It shall not be possible to operate the lock unless the source or source assembly is in the fully shielded position. Measures to ensure proper and firm connection of the guide tube to the source changer shall be provided.

2.3 Sealed Source

The sealed source shall comply with the AERB Safety Standard 'Testing and Classification of Sealed Radioactive Sources', [AERB/SS-3 (Rev-1)] or equivalent. The radiography source shall at least meet requirements for 4-3-3-1-3 classification of AERB/SS-3 (Rev-1) as given in Table 2.3. The supplier of the source shall demonstrate compliance with the test requirements as specified in AERB/SS-3 (Rev-1).

TABLE 2.3: TEST CONDITIONS FOR 4-3-3-1-3 CLASSIFICATION OF SEALED SOURCES

S. No.	Test	Conditions
1	Temperature	-40°C (20 minutes), +400°C (1 hour) and thermal shock +400°C to 20°C
2	External pressure	25 kPa absolute to 2 MPa absolute
3	Impact	200 g* from 1 m
4	Vibration	No test
5	Puncture	10 g* from 1 m

* *g: acceleration due to gravity*

2.4 X-Ray Equipment

2.4.1 Selection of X-ray Radiography Equipment

Industrial X-ray radiography equipment shall be appropriate to the application for which it is intended with regard to the maximum X-ray energy and dose rate or maximum tube potential difference (kV(peak)) and maximum current (mA).

2.4.2 Design and Construction

2.4.2.1 The design of the industrial X-ray equipment shall meet the requirements of relevant current national and/or international standards.

2.4.2.2 The X-ray tube shall be contained in a housing that provides shielding from radiation in all directions other than the beam direction. The protective tube housing shall be so constructed that the stray radiation in any direction, averaged over an area of not more than 100 cm^2 with no linear dimension greater than 20 cm, shall not exceed 10 mGy in one hour at a distance of 1 m from the X-ray target when, with the beam portal shielded adequately, the tube operates at its peak kilovoltage (kVp) and maximum rated current at that kVp.

2.4.2.3 The X-ray tube shall incorporate filtration to increase the effective energy radiation.

2.4.2.4 A key switch shall be fitted to the X-ray control panel to prevent unauthorised use. The key shall be removable only when the switch is in the off position. The function of the key switch and its ON and OFF positions shall be clearly marked on the control panel.

2.4.2.5 X-ray ON and OFF controls shall be physically separate from the key switch. Their functions, and the ON and OFF positions, shall be clearly marked on the control panel.

2.4.2.6 There shall be separate provision to terminate radiation generation automatically after pre-set time and manually at any time.

2.4.2.7 A red or amber indicator lamp shall be provided on the control panel and shall be automatically illuminated when the X-ray tube is energised. This lamp shall be duplicated on the X-ray tube housing and operate in parallel with its counterpart on the control panel and shall be visible from a distance of at least 10 m. An interlock shall be provided such that if either of the 'beam ON' indicator lamps fails, the X-ray tube cannot be energised, and replacement of the lamp will not automatically re-energise the X-ray tube.

2.4.2.8 The control panel shall be equipped with a device or devices indicating the X-ray beam energy and output in terms of the X-ray tube potential difference kVp and current (mA) or electron energy and dose rate, as appropriate, duration of exposure and X-ray beam status. Energising the X-ray equipment shall be key-controlled to prevent unauthorised use. For equipment that is used for open field radiography, the values indicated shall be clearly legible in bright sunlight.

2.4.2.9 The length of cable connecting the control panel with the X-ray tube shall meet the specifications given in Table 2.4 unless the X-ray equipment is within and operated from outside, an adequately shielded radiography enclosure:

TABLE 2.4: **LENGTH OF CABLE FROM CONTROL PANEL TO X-RAY TUBE AS A FUNCTION OF THE PEAK VOLTAGE**

Peak Voltage of the X-ray Unit	**Minimjm Length of the Cable from the Control Panel to the X-ray Tube (m)**
Up to 100 kVp	7
Up to 200 kVp	10
Up to 250 kVp	15
More than 250 kVp	20

2.4.2.10 X-ray equipment that is used for direct-viewing fluoroscopy shall be shielded such that during radiography, the stray radiation level at any position that can be occupied by any person does not exceed 10 µSv/h.

2.4.2.11 Fluoroscopic imaging devices shall be positioned such that the primary X-ray beam is totally intercepted, and the exposure configuration shall be arranged such that it is not possible for any part of the body of any person to be inserted into the beam.

2.5 Crawler Equipment

The crawler equipment shall comply with the following requirements:

2.5.1 The gamma radiography crawler shall comply with requirements specified in 2.1.2, and X-ray crawler shall comply with requirements specified in sub-section of 2.4.2, as applicable.

2.5.2 Means shall be provided for external indication of the crawler location in a pipeline. There shall be means to prevent exposure when the external position indicator fails to function as intended.

2.5.3 The width of useful beam on the pipe surface shall not be greater than 20 cm at the circumference of the pipe within which the crawler is operating.

2.5.4 It shall shut 'OFF' automatically in the event of any malfunction during use; that is, X-ray crawler shall switch off the beam and the gamma source shall retract to shielded position.

2.5.5 The crawler shall have a warning provision such as a horn fitted to it such that after the crawler has reached the exposure position, it shall automatically sound a warning for a period of 10 seconds immediately, prior to the commencement of the exposure. While the exposure is taking place, the horn shall continue to operate in a manner that is distinguishable from the 10 second warning.

2.5.6 The warning sound shall be loud and distinctive enough to be heard clearly above all other noise sources in the vicinity of the crawler.

2.5.7 An X-ray crawler, for which exposures are initiated by remote control or by an automatic device such as a trip wheel, shall have a safety device fitted to it which prevents the remote control or the automatic device from initiating an exposure unintentionally.

2.5.8 An X-ray crawler shall incorporate a safety device which disconnects power from the propulsion unit in the event of a malfunction during operation.

2.6 Accelerator Equipment

The accelerator equipment shall comply with the following requirements:

2.6.1 Protective tube housing shall be so constructed that the stray radiation at any direction other than the primary beam direction shall not exceed 0.5% of the primary output at a distance of 1meter from the target when, with the beam portal shielded adequately, the accelerate operates at its maximum energy and pulse rate frequency (PRF).

2.6.2 The design of the accelerator equipment shall meet the requirements of current national and international standards.

2.6.3 The high energy accelerator generating X-rays shall meet the requirements specified in sub-section 2.4 for X-ray equipment.

2.6.4 Key-controlled interlock shall be provided on the control console to prevent unauthorised use.

2.6.5 The beam limiting system of a portable/mobile accelerator equipment meant for use on shop floor or elevated locations shall restrict the primary beam divergence to a cone of not more than 30° apex angle.

2.6.6 An emergency push button shall be prominently located on the control panel to stop the radiation generation.

2.6.7 When radiation generation is stopped, either by an interlock or by action of emergency push button, it shall not be possible to restart unless the exposure control is reset manually.