

## **Annex 1: AERB's regulatory and safety functions envisaged under Sections 16, 17 and 23 of the AE Act, 1962 (Refer Paragraph 1.2)**

**Section 16 of the AE Act, 1962: Control over radioactive substances:** The Central Government may prohibit the manufacture, possession, use, transfer by sale or otherwise, export and import and in an emergency, transport and disposal, of any radioactive substances without its written consent.

**Section 17 of the AE Act, 1962: Special provisions regarding safety:**

- (1) The Central Government may, as regards any class or description of premises or places, being premises or places, in which radioactive substances are manufactured, produced, mined, treated, stored or used or any radiation generating plant, equipment or appliance is used, make such provision by rules as appear to the Central Government to be necessary - (a) to prevent injury being caused to the health of persons employed at such premises or places or other persons either by radiations, or by the ingestion of any radioactive substance; (b) to secure that any radioactive waste products resulting from such manufacture, production, mining, treatment, storage, or use as aforesaid are disposed of safely; (c) to prescribe qualifications of the persons for employment at such premises or places and the regulation of their hours of employment, minimum leave and periodical medical examination and the rules may, in particular and without prejudice to the generality of this subsection provide for imposing requirements as to the erection or structural alterations of buildings or the carrying out of works.
- (2) The Central Government may, as respects the transport of any radioactive substance or any prescribed substance specified by an order issued under this Act as being dangerous to health, make such rules as appear to be necessary to prevent injury being caused by such transport to the health of persons engaged therein and other persons.
- (3) Rules made under this section may provide for imposing requirements, prohibitions and restrictions on employers, employed persons and other persons.
- (4) Any person authorised by the Central Government under this section, may, on producing, if so required, a duly authenticated document showing his authority, enter at all reasonable hours any premises, or any vehicle, vessel or aircraft for the purpose of ascertaining whether there has been committed, or is being committed, in or in connection with the premises, vehicle, vessel or aircraft, any contravention of the rules made under this section.

- (5) In the event of any contravention of the rules made under this section, the Central Government shall have the right to take such measures as it may deem necessary to prevent further injury to persons or damage to property arising from radiation or contamination by radioactive substances including, without prejudice to the generality of the foregoing provisions, and to the right to take further action for the enforcement of penalties under section 24, the sealing of premises, vehicle, vessel, or aircraft, and the seizure of radioactive substances and contaminated equipment.

**Section 23 of the AE Act, 1962: Administration of Factories Act, 1948:** Notwithstanding anything contained in the Factories Act, 1948, the authority to administer the said Act, and to do all things for the enforcement of its provisions, including the appointment of inspecting staff and the making of rules thereunder, shall vest in the Central Government in relation to any factory owned by the Central Government or any authority or corporation established by it or a Government Company and engaged in carrying out the purposes of this Act.

**Annex 2 : Suggested inspection frequencies as per 'IAEA-TECDOC-1526'  
(Refer paragraph 5.2)**

Use	Inspection frequency (in years)
Dental radiography	5
Nuclear medicine	1-2
Radiotherapy	1
Diagnostic radiology – centres with complex equipment (e.g. computed tomography, interventional radiology, fluoroscopy, mammography)	2-3
Diagnostic radiology – centres with conventional X-ray equipment only	3-5
Industrial radiography	1
Irradiators (i.e. industrial)	1
Irradiators (i.e. research)	3-5
Radiation gauges	3-5
Well logging	1-3

**Annex 3: Data relating to regulatory inspection for nuclear medicine,  
nucleonic gauges and diagnostic radiology (X-ray equipment) conducted  
during the period 2005-06 to 2011-12  
(Refer paragraph 5.2.2)**

Diagnostic Radiology Facilities						
Year	Total No. of units	Frequency of inspection as suggested by IAEA	No. of units of RI mandated to be done	No. of RI conducted	shortfall in RI	%age of shortfall of RI
2005-06	40000	once in five years	8000	208	7792	97.40
2006-07	40000		8000	80	7920	99.00
2007-08	40000		8000	80	7920	99.00
2008-09	40000		8000	0	8000	100.00
2009-10	40000		8000	46	7954	99.43
2010-11	40000		8000	41	7959	99.49
2011-12	40000		8000	67	7933	99.16
<b>Total</b>	<b>280000</b>		<b>56000</b>	<b>522</b>	<b>55478</b>	<b>99.07</b>
Nuclear Medicine Centres						
2005-06	131	Biennial	66	40	26	39.39
2006-07	140		70	40	30	42.86
2007-08	145		73	40	33	45.21
2008-09	155		78	30	48	61.54
2009-10	177		89	41	48	53.93
2010-11	162		81	53	28	34.57
2011-12	179		90	62	28	31.11
<b>Total</b>	<b>1089</b>		<b>547</b>	<b>306</b>	<b>241</b>	<b>44.06</b>
Nucleonic Gauges						
2005-06	1386	once in five years	277	11	266	96.03
2006-07	1435		287	18	269	93.73
2007-08	1464		293	18	275	93.86
2008-09	1485		297	16	281	94.61
2009-10	1572		314	7	307	97.77
2010-11	1638		328	24	304	92.68
2011-12	1696		339	117	222	65.49
<b>Total</b>	<b>10676</b>		<b>2135</b>	<b>211</b>	<b>1924</b>	<b>90.12</b>

#### **Annex 4: Incident of high radiation exposures in metal scrap market in Mayapuri, Delhi (Refer Paragraph 6.4.1.1)**

##### **Incident Reported**

**An incident involving high radiation exposure unfolded, when a message from Indraprastha Apollo Hospital, Delhi was received by Atomic Energy Regulatory Board (AERB) on 7 April, 2010. The message stated that a patient – a scrap dealer from the Mayapuri Industrial area- who was admitted in the hospital since 4 April developed symptoms suspected to be indicative of high radiation dose.**

##### **Immediate Follow Up**

**After confirming the information, within a few hours on the same day (7 April), two officers from AERB rushed to the Mayapuri area to assess the situation at ground zero. They carried out an extensive radiation survey in and around the scrap shop which belonged to the affected patient and identified the shops and adjoining areas where high radiation levels were prevailing. As an immediate measure, they provided shielding by covering the identified radiation hot spots to reduce radiation levels. The entire affected area was cordoned off.**

**On 8 April, in a joint effort, the officers of AERB, Emergency Response Centre of DAE, Narora Atomic Power Station (NAPS), National Disaster Response Force (NDRF) and Radiation Safety Systems Division of BARC, assisted by local police carried out combing operations through extensive radiation surveys. This led to the identification and recovery of most of the radioactive sources. The sources were safely recovered and transported to NAPS for safe and secure storage. By forenoon of 9 April, the area which was cordoned off earlier was cleared off radioactive materials and rendered safe as no unacceptable radiation levels in these areas were observed.**

**Following these events, a quick survey of the entire market area encompassing several hundred shops was carried out on 13 April to rule out the presence of additional sources. Elevated radiation level was noticed near another scarp shop, around 500 m away from the earlier shop. This led to recovery of two more radioactive sources. The sources were transported to the site of the NAPS for safe and secure storage.**

**Another occurrence came to light on 15 April after another shop owner of the same scrap market was admitted to a hospital in Delhi. A small Co-60 source was recovered from him.**

**While radiation surveys indicated absence of any more radiation sources some low level contamination left by dust particles of cobalt was detected in a number of spots.**

**An awareness programme was also conducted on May 6, 2010 for the Mayapuri scrap dealers on the safety aspects along with legal and regulatory requirements in possessing and handling radioactive sources.**

By May 2010 the entire Mayapuri scrap market area were cleaned up - including removal of contaminated soil-and declared open for public access and habitation. By June 14, 2010, the final clean up operations at the affected shop was completed and the shop was handed over to the owner by the police. Thereafter, concretization of the road in front of the affected shops was completed.

Throughout this period, AERB issued periodic press releases to allay the apprehensions of the public and apprise them of the situation in perspective.

Furthermore, a public Notice was also issued by AERB through leading newspapers about the legal/statutory and regulatory requirement of possession, handling and disposal of radioactive sources stating clearly that possession of radioactive sources without proper licence/ authorisation / registration is an offence.

A rating of Level 4 in the International Atomic Energy Agency (IAEA) International Nuclear and Radiation Event Scale was accorded to this incident. Information regarding the above incident was also provided to the Illicit Trafficking Data Base (ITDB).

#### Facts Emerging From Investigations

Investigations carried out at the site of incident, discussions with the affected personnel and the inspections carried out at NAPS by officers of AERB, Board of Radiation and Isotope Technology (BRIT) of DAE and Delhi police, it was established that the radioactive Cobalt-60 (Co-60) sources recovered from the Mayapuri scrap market in Delhi were from an old gamma cell (Model No 220) made by Atomic Energy Canada Ltd which was purchased by the Chemistry Department of Delhi University in 1969. The gamma cell was being used by a Chemistry professor till his retirement. Since then it remained disused in the same room for more than 15 years till it was auctioned by the Delhi University in Feb 2010 and reached the hands of the scrap dealer who purchased it through this auction.

The whole event came to light when the gamma cell was dismantled by local workers at the metal scrap shop, leading to the highly radioactive Co-60 pencil sources coming out of the cage, causing unwarranted high exposure to seven persons (who were admitted to various hospitals in Delhi with radiation induced symptoms) of whom one succumbed to radiation sickness.

#### Regulatory Enforcement Actions Taken

All the radioactive sources originally present in the gamma cell of the Delhi University were recovered and accounted for their number and source strength. These sources will continue to remain in safe and secure custody of the Department of Atomic Energy. Recovery of the entire inventory present in the gamma cell was confirmed by counting of the recovered cobalt slugs in the hot cells in BARC.

The unauthorized disposal of the gamma cell by the Delhi University as a scrap is in violation of the Atomic Energy (Safe Disposal of Radioactive Waste) Rules, 1987 and the RPR 2004. In view of this, AERB issued a show cause notice to the Delhi University and in the interim, advised the university to suspend forthwith all activities involving the use of radiation sources. The preliminary response submitted by the University is currently under review by AERB.

Reinforcement of Regulatory Mechanism and other

Following the Mayapuri incident, following actions have been initiated by AERB to reinforce and further strengthening of its regulatory enforcement mechanism:

- Sensitizing all the academic, medical and R&D institutions to undertake inventory of radiation sources under their possession and review their existing safety procedures.
- Issuing guidelines and stipulations regarding the use and disposal of radioactive sources and making the training on radiation emergency management to be part of curriculum in medical education.
- Improving and intensifying the public awareness on legal, regulatory and general safety requirements vis-à-vis radioactive sources by way of issuing notices through print media and knowledge sharing through its website.
- Further strengthening the AERB database system of records on source inventory.
- Pursuing with the State Governments for the formation of Directorate of Radiological Safety and enhancing the coverage and effectiveness of inspections of radiation facilities all over the country.
- Instituting the Regional Regulatory Centres (RRC) in the country. RRC in East and South have been formed already. Formation of RRC in North is planned in the immediate future.
- Based on lessons learnt from this experience the system of response to radiation source related emergencies is further strengthened in collaboration with National Disaster Management Authority (NDMA).

Though not directly related with this incident, following additional actions are being pursued:

- Ongoing program to install radiation detection equipment at all sea ports is being re-emphasized.
- Metal recycling industry has again been mobilized to install radiation detection equipment at various processing points in handling of scrap metal.

### Annex 5: Details of 'unusual occurrences' relating to 15 cases which were not recovered/found (Refer Paragraph 6.4.2)

Sl.No	Period	Details of the event
1	November 2011	M/s Petrocon Engg. & Inspection Co., Navi Mumbai reported an incident involving theft of Industrial Gamma Radiography Exposure Device (IGRED) model Delta-880 which was kept inside a four wheeler. In spite of extensive search operation conducted by M/s Petrocon Engg. & Inspection Co., and local police, exposure device could not be recovered so far. The main cause of the incident was the improper storage of the radiography exposure device.
2	January 2011	Theft of 15 nucleonic gauge sources took place from M/s Durgapur Steel plant (DSP), Durgapur. The sources were stolen by breaking the source storage room. In the search that followed, two were recovered from scrap shops at Durgapur. The main cause of the incident was the improper storage of the disused nucleonic gauge sources. AERB directed DSP to enhance their efforts to trace the remaining 13 nucleonic gauge sources and initiate corrective measures for the security of the sources in their possession.
3	October 2010	An incident of missing of five nucleonic gauges from M/s National Aluminum Company Limited (NALCO), Damanjodi, Koraput, Orissa, was reported on 5 October 2010. The five gauges were found to be missing after they were dismantled and stored for safe disposal. A show-cause notice was issued on 21 October 2010. M/s NALCO replied to show cause notice vide letter dated 2 November 2010. Efforts are still on to locate and recover the sources.
4	July 2009	On 29 July 2009, a vehicle containing IGRED model Roli-1 belonging to M/s. Indian NDT Centre (INDTC), Ghaziabad was snatched by robbers while travelling from Ghaziabad to Dehradun for carrying out radiography work. The missing IGRED could not be located despite extensive surveys.
5	September 2008	A radiographer boarding a train at Hazrat Nizamuddin railway station in New Delhi carrying an IGRED reported that it was stolen from him. The devices, and the sources within, were never found.
6	May 2008	Loss of a decayed radiography source from Perfect Metal Testing and Inspection Agency in Kolkata.
7	August 2007	An IGRED was stolen from General Industrial Inspection Bureau in Jamshedpur. The source could not be recovered 'in spite of extensive search operations by using high sensitivity radiation survey instruments'.
8	2006	A trainee radiographer and his assistant left an IGRED in an auto rickshaw. The machine was never recovered.
9	November 2006	An IGRED was stolen from a radiography agency after the machine was left lying unattended outside a dark room. The missing IGRED was never located.



<b>10</b>	November 2006	A nucleonic gauge was reported to be missing from a coal washery that had not been in operation since 2003. It was reported that the electronic parts associated with the gauge were stolen in 2005. Despite 'extensive radiation detection surveys' around the plant and in all scrap yards in the unspecified city, the material was never found.
<b>11</b>	May 2005	Two exposure devices were lost from a user's premises and were never recovered.
<b>12</b>	August 2005	An employee of a radiography agency steals an pigtail from a rival radiography agency in Mumbai and throws it into the Vashi creek. The source was thought to have flowed down to the sea, and was never recovered.
<b>13</b>	July 2002	A radiography camera was lost while being carried by a radiographer on a public bus. The device was either stolen or slipped from the improperly locked luggage compartment, and was never traced.
<b>14</b>	2001	A density gauge was lost in a coal washery, and never retrieved.
<b>15</b>	2000	A 'premier medical hospital' lost a radiation source due to 'procedural lapses'. Despite systematic search, the AERB was unable to recover the source.

Source : Annual Reports of AERB

## Annex 6: Duties and functions of Radiological Safety Officers under various rules

(Refer Paragraph 6.5)

### Atomic Energy (Radiation Protection) Rules, 2004 (Rule 22)

The Radiological Safety Officer shall be responsible for advising and assisting the employer and licensee on safety aspects aimed at ensuring that the provisions of these rules are complied with.

The Radiological Safety Officer shall:-

- carry out routine measurements and analysis on radiation and radioactivity levels in the controlled area, supervised area of the radiation installation and maintain records of the results thereof;
- investigate any situation that could lead to potential exposures;
- advise the employer regarding (i) the necessary steps aimed at ensuring that the regulatory constraints and the terms and conditions of the licence are adhered to; (ii) the safe storage and movement of radioactive material within the radiation installation; (iii) initiation of suitable remedial measures in respect of any situation that could lead to potential exposures; and (iv) routine measurements and analysis on radiation and radioactivity levels in the off-site environment of the radiation installation and maintenance of the results thereof;
- ensure that (i) reports on all hazardous situations along with details of any immediate remedial actions taken are made available to the employer and licensee for reporting to the competent authority and a copy endorsed to the competent authority; (ii) quality assurance tests of structures, systems, components and sources, as applicable are conducted; and (iii) monitoring instruments are calibrated periodically.
- assist the employer in (i) instructing the workers on hazards of radiation and on suitable safety measures and work practices aimed at optimizing exposures to radiation sources; and (ii) the safe disposal of radioactive wastes; and (iii) developing suitable emergency response plans to deal with accidents and maintaining emergency preparedness;
- advise the licensee on (i) the modifications in working condition of a pregnant worker; and (ii) the safety and security of radioactive sources;
- furnish to the licensee and the competent authority the periodic reports on safety status of the radiation installation; and
- inform the competent authority when he leaves the employment.

**Atomic Energy (Safe Disposal of Radioactive Waste) Rules , 1987 (Rule 13)**

- to advise the employer regarding the safe handling and disposal of radioactive wastes and on the steps necessary to ensure that the operational limits are not exceeded;
- to instruct the radiation workers engaged in waste disposal on the hazards of radiation and on suitable safety measures and work practices aimed at minimising exposures to radiation and contamination, and to ensure that adequate radiation surveillance is provided for all radiation workers and the environment;
- to carry out such tests on conditioned radioactive waste, as specified by the competent authority;
- to ensure that all buildings, laboratories and plants wherein radioactive waste will be or are likely to be handled/produced, conditioned or stored or discharged from, are designed to provide adequate safety for safe handling and disposal of radioactive waste;
- to assess the radiation protection instruments required for an installation and to keep such instruments in use under proper calibration;
- to help investigate and initiate prompt and suitable remedial measures in respect of any situation that could lead to radiation hazards;
- to ensure that reports on all hazardous situations (including situations of the type referred to in rule 14 or as laid down by the competent authority regarding operational limits) along with details of any immediate remedial measures that may have been initiated are made available immediately to his employer and a copy thereof to the competent authority;
- to ensure that the provisions of the Radiation Protection Rules, 1971 are followed properly.