Lessons learned from the radiological accident in Mayapuri, New Delhi, India

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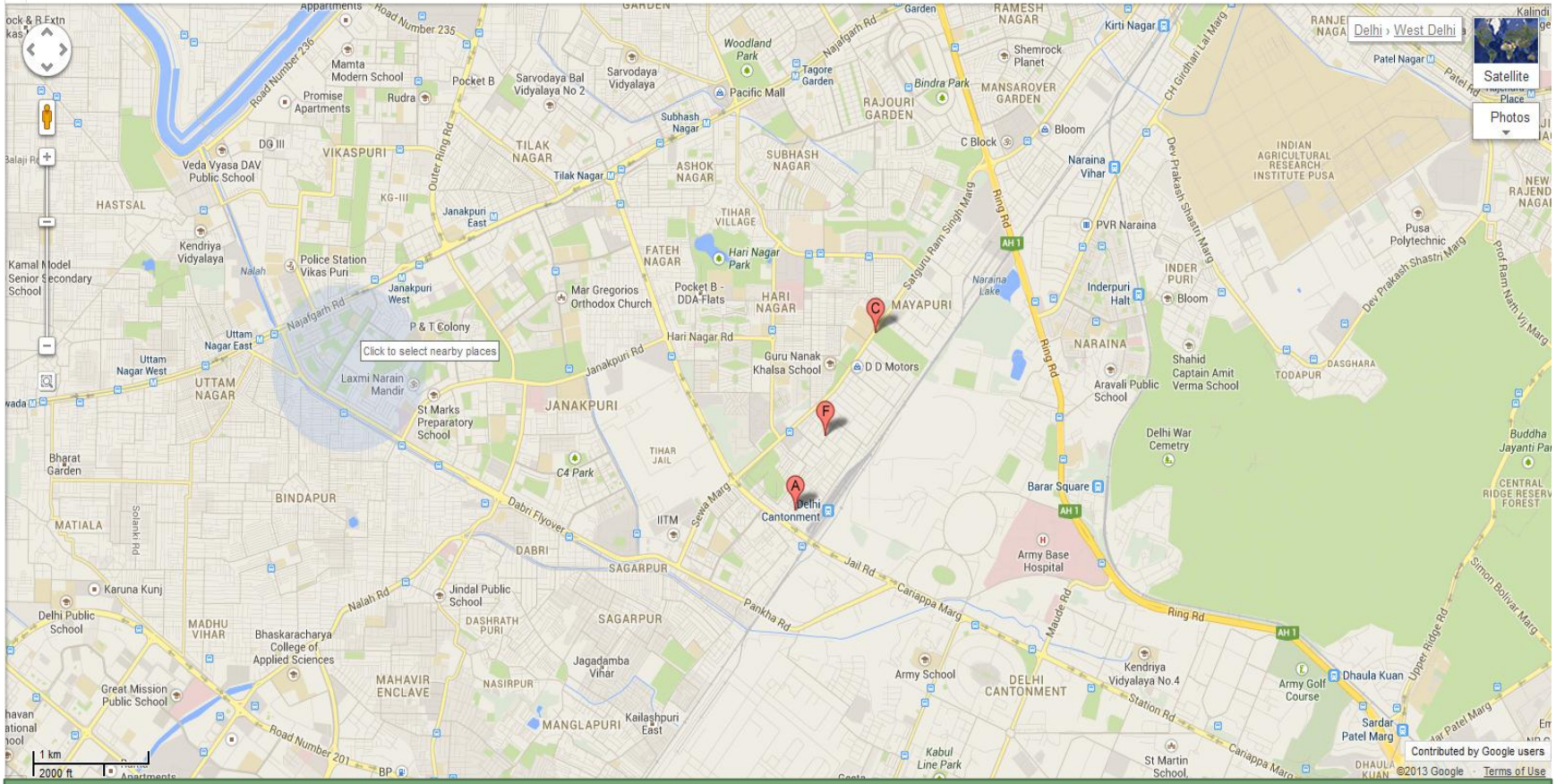
Mayapuri Industrial Area, New Delhi



Map of Mayapuri Scrap area, New Delhi

About Mayapuri, New Delhi

Mayapuri is a locality in West Delhi. It used to be a major hub of small scale industries, but following recent government sanctions, most of the heavy metal industries moved out. The place is now a combination of residential flats, metal scrap market, metal factories and automobile service stations.

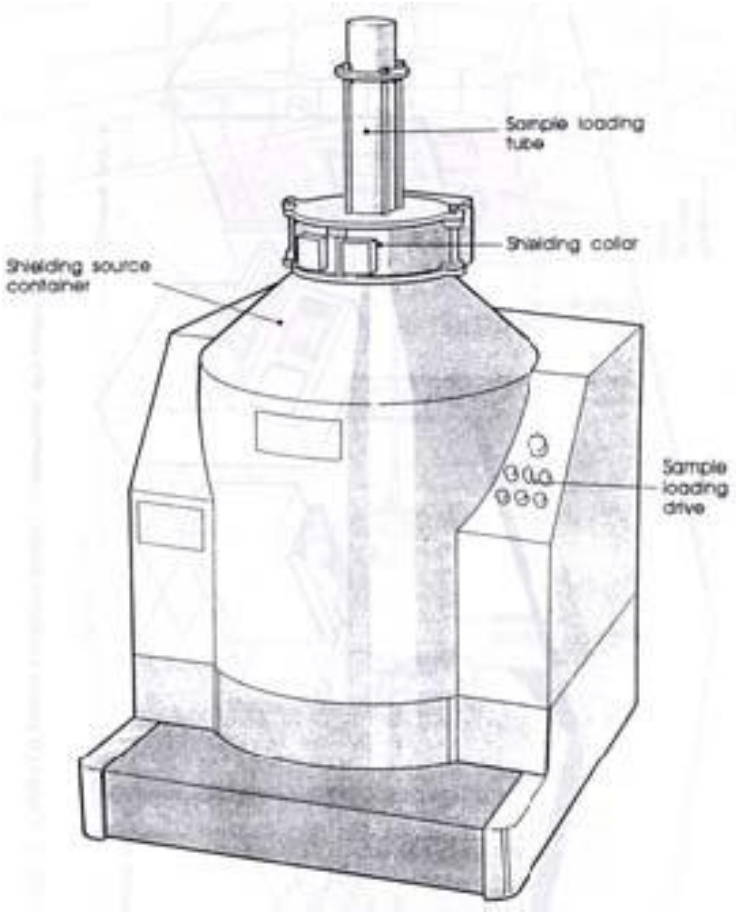
About Gamma Cell

According to the design of the facility and, particularly, the accessibility and shielding of the radioactive source) there are four categories of Gamma Irradiators are:

Category I: An irradiator in which the sealed source is completely enclosed in a dry container constructed of solid materials and is shielded at all times, and where human access to the sealed source and the volume undergoing irradiation is not physically possible in the designed configuration.

- Ref: IAEA Safety Series No. 107 [5],

Schematic diagram of Category-I Self contained dry source storage irradiator

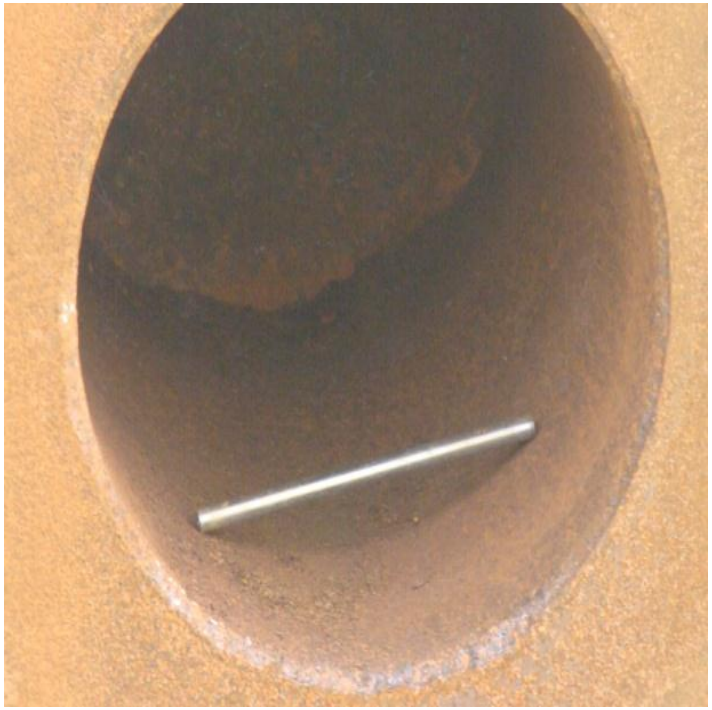


Category –I Gamma Irradiator of Model Gamma Cell 220

Description of Gamma Cell involved in the accident

- Gamma Cell (Model- GC 220)
- Manufactured by M/s Atomic Energy Canada Ltd. (AECL))
- The GC purchased by one of the Departments of a University from M/s AECL in 1969.
- The equipment has a cylindrical cage placed in with 16 pencils (which has a capacity to hold a maximum of 48 numbers of pencils), shielded by approximately three tonnes of lead.
- Each pencil had 7 number of Co-60 slugs and 2 number of dummy spacers. Total activity content of the cell having 112 slugs (16 x 7) was 147.186 TBq (3978 Ci) as of Aug-Sep 1969.
- Activity content in the pencils ranged between 6.15 – 10.21 GBq (166 – 276 Ci) and activity content in the slugs ranged between 740 – 3219 GBq (20 – 87 Ci).
- In April 2010, total activity content estimated as 688.2 GBq (18.6 Ci). Activity content in the pencils is between 29.6 – 48.1 GBq (0.8 – 1.3 Ci) and activity content in the slugs ranged between 3.39 – 20.20 GBq (0.09 – 0.75 Ci).

Photographs of actual source cage and pencil recovered



Accident Handling –Three Phases

Sr. No.	Phase of emergency	Action
1	Initial phase	Emergency first response
2	Accident control phase	Radiation protection
3	Post-emergency phase	Clean-up

Initial Phase

- April 7, 2010 (Afternoon)- Message received by the AERB, from a reputed hospital located in New Delhi, stating that one person, aged 32 years, owner of a metal scrap shop in Mayapuri Industrial Area, New Delhi had been admitted on April 4, 2010. The message also stated that the patient had symptoms indicative of suspected exposure of radiation and requested advice on further course of action.
- Advised on proper medical management of the radiation victims based on the symptoms, bio-dosimetry and follow-up.
- Officers from AERB visited the place immediately with radiation detection equipment and monitored the radiation levels at various locations (scrap shops)

Radiation Level observed 2/2

Location	Radiation level (mSv/h)
On the entrance of identified scrap shop	10 - 15
Inside a shop adjacent to identified scrap shop	0.25 - 0.45
Inside a shop located rear side of identified shop	20
Inside of another scrap shop located about 300 m from identified shop	15-45

Accident Control Phase 1/3

- April 8, 2010 –
  - On site planning for Emergency handling as various agencies involved
    - Suitable radiation monitoring instruments (Teletector, radiation survey monitors, Isotope identifier, etc.)
    - Personnel dosimeters
    - Personnel Protective Equipments, Decontamination kits, First Aid Box, etc.
    - Source handling equipments, Source container (shielded flask), etc.
  - Identification of area
  - Identification of source location (close proximity)
  - Cordoning off area
  - Verification of radioisotope identified (Co-60)

Accident Control Phase - I

- Source recovery Operation (Phase –I, April 8-9, 2010)
- Radioactive sources recovered
  - 4 pencils sources,
  - 3 gunny bags and
  - one drum containing radioactive scrap

This operation started at night of April 8, 2010 and continued till the afternoon of April 9, 2010

All these recovered radioactive material was transported to the nearest authorised waste disposal agency for safe storage and further investigation.

Accident Control Phase -II

- Source recovery Operation (Phase –II, April 13-14, 2010)
- Radioactive sources recovered
  - One pencil source,
  - one cylindrical source cage of dia. ~25 cm with a source pencil still in intact condition in one of the slots one drum containing radioactive scrap

This operation started at night of April 13, 2010 and continued till early morning of April 14, 2010

All these recovered radioactive material was transported to the nearest authorised waste disposal agency for safe storage and further investigation.

Accident Control Phase -III 3/3

- Source recovery Operation (Phase –III, April 16-17, 2010)
- Radioactive source recovered
  - One Co-60 slug from a wallet,

This source was transferred into shielded flask using remote handling tong safe and transported to the nearest authorised waste disposal agency for safe storage and further investigation.

Location of source identified

SOURCE SEARCH OPERATION
0:30 hrs, April 9,2010

SOURCE SEARCH OPERATION
4:30 hrs, April 9,2010

Preparation for source recovery
5:10 Hrs, April 9, 2010

Shielded flask being brought closer to source using crane for safe transfer, 5:40, April 9, 2010

Scrap with source transferred in shielded flask, 6:15, April 9, 2010

Another source in the form of pencil recovered, 8:30 April 9, 2010

Another source found in a vessel, 9:00 Hrs, April 9, 2010

Source received from the vessel, 9:15 Hrs, April 9, 2010

Finally the truck is ready to depart for authorised waste disposal facility for further investigation and safe disposal, 12:15 hrs, April 9, 2010

Co-60 pencil identified, 02:00 hrs, April 14, 2010

Source cage identified, 03:00 hrs April 14, 2010

Wallet containing Co-60 slug, 02:00 hrs April 17, 2010

Slug (Co-60, 0.75 Ci) which was inside the purse , April 17, 2010

Post Emergency Phase – Decontamination Operation

Because of cutting exercise of Co-60 slugs, there was a spread of radioactive contamination around the identified shop

Operation carried out in three phases:

Phase I	May 15-16, 2010
Phase II	May 22-24, 2010 and
Phase III	June 14-18, 2010

In this entire operation more than 400 kg of contaminated soil and 100 kg of scrap were recovered and safely disposed off at nearest authorised disposal site

Contaminated soil being collected, May 15, 2010, Overnight operation

Scrap being checked for contamination, May 16, 2010

After excavation contaminated soil collected in drum, May 16, 2010

Concretized 3” thick inside the affected shop, May 16, 2010

Scrap being scanned, May 22-24, 2010

Contaminated scrap detected, May 22-24, 2010

Team involved in operation, May 22-24, 2010

Affected road concretized after decontamination, June 14-18, 2010

Radiation level observed in decontamination operation

- Before decontamination – spots (10-50Sq cm.)
  – 41 spots (100-500 µSv/hr on contact) – on road
  _ 5 spots (1000-2000 µSv/hr on contact) – inside the shop

- After decontamination and concretization – Background level

Notification to IAEA (INES)

- On April 22, 2010, a notification of the event was communicated to IAEA and a provisional rating of Level -3 (incident) on International Nuclear and Radiation Event Scale (INES) was assigned.

- On July 17, 2010, another notification of the event was sent to IAEA and a final rating of Level -4 (accident) on the INES was re-assigned.

Investigation on origin of source 1/2

- Till April 16-17, 2010, the exact application of the source as well as its origin was not known.
- A visual inspection in a hot cell and inspection by autoradiography technique of the sources indicated that the source must have originated from a Gamma Chamber.
- It also revealed that the source cage has 48 slots and the dimensions of the source pencils are entirely different from the indigenous pencils.
- The visual inspection also revealed that there were cut marks on the recovered slugs.

Investigation on origin of source 2/2

- After a long interaction with the victims of radiation exposure and showing photographs of GCs, one of the victims recognized the Gamma Cell and informed that such object was cut by one of the scrap dealer in Mayapuri.
- The scrap dealer was identified and on subsequent interrogation it was revealed that this GC was procured by the scrap dealer through an auction from one of the Universities.
- Officer from AERB immediately visited this University and confirmed the statement given by scrap dealer.

Accountability of source and its activity

- It was confirmed by matching the records/data of obtained from:
  - University
  - Supplier of Source
  - AERB records

Accountability of radiation sources, May 3-4, 2010

Accountability of radiation source, May 3-4, 2010

Medical management of radiation victims

S.No.	Name	Estimated dose due to single exposure (Gy)	Dose assuming protracted exposure of 1-2 days (Gy)
1	Person A	3.7	6.8
2	Person B	0.6	0.9
3	Person C	0.4	0.6
4	Person D	1.6	2.8
5	Person E	1.8	3.1[a]
6	Person F	1.2	3.0
7	Person G	1.3	2.3

[a] Person died due to radiation sickness

Conclusion and Lessons learned

- Negligence of the management of the licencee
- Non-compliance with the National Regulations
- Unauthorized disposal of radiation source violating statute for safe disposal of radiation sources by the University
- An eye opener for users of radiation sources in the country and particularly the academic institutions, the regulatory body, other concerned agencies and the general public

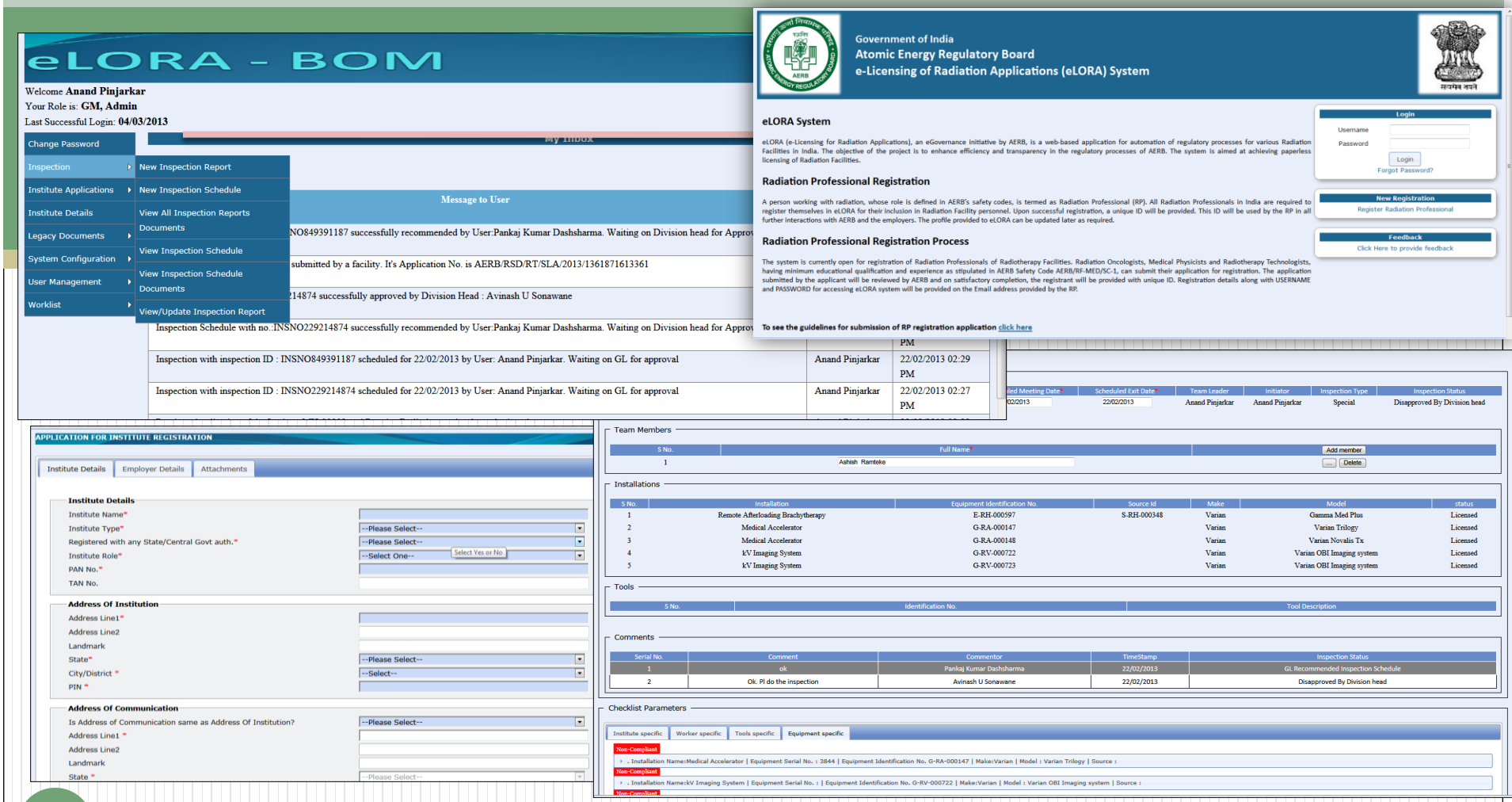
Follow-up Actions

- Verification and updating inventory of radiation sources being used in the country
- Spread of awareness on regulatory requirements by way of issuing notices through print media
- Training programmes on safe use and secure management of radiation sources were conducted at various educational and research institutes
- Regulatory inspections of radiation facilities have been significantly enhanced

Follow-up Actions condt....

- eLORA (e-Licensing of Radiation Applications) system is being implemented by AERB for automation of regulatory processes associated with the use of ionizing radiation in India.
- The objective of this project:
  - Bring better transparency
  - Enhance efficiency
  - Electronic document management
  - Workflow Automation
  - Management Information
  - Decision Support

(e-Licensing of Radiation Applications)



Thank You