PRESENT STATUS OF RADIOACTIVE WASTE MANAGEMENT IN BANGLADESH

Engr. Md. Ashraful Hoque
Dhaka, Bangladesh

Bangladesh Atomic Energy Commission

- Bangladesh Atomic Energy Commission (BAEC), a statutory body, was formed by the Presidential Order No. 15 of 1973, Section 6(1) of the order states that, “the functions of the Commission shall be to do all acts and things, including research work, necessary for promotion of peaceful uses of atomic energy including execution of development projects involving nuclear power stations and generation of electric power.
Organizations Involved in Public Exposure Control

Ministry of Science & Technology

Bangladesh Atomic Energy Commission (BAEC)

- Health Physics Division, Dhaka
- Health Physics & Radioactive Waste Management Unit (HPRWMU), AERE, Savar
- Radioactivity Testing and Monitoring Laboratory (RTML), Chittagong
- Nuclear Safeguard & Security Division, Dhaka

Bangladesh Atomic Energy Regulatory Authority (BAERA)

Independent Regulatory Body (2012)

Technical Support
Independent Regulatory Authority, Bangladesh Atomic Energy Regulatory Authority (BAERA), has been established on 12 February 2013 under the Ministry of Science and Technology. The former Regulatory Authority was Nuclear Safety and Radiation Control Division (NSRCD) under Bangladesh Atomic Energy Commission has been abolished. The Nuclear Safety and Radiation Control Act-1993 has been revoked, after enacting the new Act No 19 of 2012 entitled Bangladesh Atomic Energy Regulatory (BAER) Act 2012. The Bangladesh Atomic Energy Regulatory Authority (BAERA), is responsible for administering the following laws:

- Bangladesh Atomic Energy Regulatory (BAER) Act - 2012
Legislation:

- BAER Act-2012
- NSRC Rules-1997
- Radioactive Waste Management Policy-2011 (Preliminary Draft)

The Act requires a license to carry out any type of radiological or nuclear practice in the country.

The Rules prescribe the manner of obtaining a license.

BAERA is the Implementing Authority for the BAER Act-2012 and Rules 1997

BAERA: Bangladesh Atomic Energy Regulatory Authority (BAERA)

Basis: IAEA, ICRP, USNRC, ICRU, WHO publications
I. Bangladesh Atomic Energy Regulatory Authority (BAERA) Act- 2012

Chapter V: Transport and Waste Safety

Section 38: Management of Radioactive Waste and Spent Fuel

1. Responsibility of Waste Generator
2. Responsible authority (CWPSF, BAEC)
3. Responsibility of authority
4. Treatment and conditioning of waste
5. Management procedures of waste
6. Responsibility for SF management and security
7. Formulation of necessary regulations

Section 39: Transport of Radioactive Material

Details concerning the transport of radioactive material … to be issued by the Authority.
II. Nuclear Safety and Radiation Control Rules- 1997

Chapter X: Transport of Radioactive Material and Waste Management

Article 86- Transport of Radioactive Materials and Waste
   86.1- General requirements
   86.2- Information to regulatory authority
   86.3- Compliance with the rules

Article 87- Radioactive Waste Management
   (1) Compliance with the requirements for management
   (2) Disposal requirements
## Radiation Facilities in Bangladesh

<table>
<thead>
<tr>
<th>SL. No.</th>
<th>Facilities</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.</td>
<td>Nuclear Power Reactor</td>
<td>Proposed</td>
</tr>
<tr>
<td>02.</td>
<td>Research Reactor (3 MW TRIGA Mark II)</td>
<td>01</td>
</tr>
<tr>
<td>03.</td>
<td>Central Radioactive Waste Processing &amp; Storage Facility (CWPSF)</td>
<td>01</td>
</tr>
<tr>
<td>04.</td>
<td>Radioisotope Production Facility</td>
<td>01</td>
</tr>
<tr>
<td>05.</td>
<td>Neutron Generator (14 MV)</td>
<td>01</td>
</tr>
<tr>
<td>06.</td>
<td>Gamma Irradiator (Semi-commercial and Research)</td>
<td>03</td>
</tr>
<tr>
<td>07.</td>
<td>Accelerator Facility (TANDEM &amp; Van de Graff)</td>
<td>02</td>
</tr>
<tr>
<td>08.</td>
<td>Nuclear Medicine Center</td>
<td>20</td>
</tr>
<tr>
<td>09.</td>
<td>Radio-/Tele-/Brachytherapy Facility (Unit)</td>
<td>14</td>
</tr>
<tr>
<td>10.</td>
<td>Medical X-Ray</td>
<td>~ 4000</td>
</tr>
<tr>
<td>11.</td>
<td>Industry (Nucleonic Gauge and Well-logging)</td>
<td>60</td>
</tr>
<tr>
<td>12.</td>
<td>Research and Education</td>
<td>14</td>
</tr>
</tbody>
</table>
Sources of RW and Exposure in Bangladesh

**Threat Category II:**
- Research Reactor (1 Nos.)

**Threat Category III:**
- Commercial Gamma Irradiator
- Central Radioactive Management and Storage Facility
- Radiotherapy Facilities
Sources of RW and Exposure in Bangladesh

Threat Category IV

- INMs
- RIP Facility
- Industry, Research & Education and Medical X-rays
NORM & TENORM Waste Generating Source

- Coal Mines
- Ship Breaking and Metal Recycling Area
- Beach Sand Minerals
- Oil and Gas Exploration
Sources of Radioactive Waste

**Medicine:** Public and private hospitals, Institutes of Nuclear medicine centers (INMs), Radioisotope production division, medical X-rays etc.

**Industry:** Industrial radiography/NDT, Nucleon gauge, Gas mantle, Oil and gas exploration facilities etc.

**Research & Education:** Operation and maintenance of 3 MW TRIGA MARK II Research Reactor (RR), Food irradiation, Plant breeding, Insect extermination, Accelerators, Universities etc.

**NORMs:** Coal & gas exploration, Beach sand minerals, Water purification plant etc.
<table>
<thead>
<tr>
<th>Isotope</th>
<th>Half-life</th>
<th>Rad Type</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine-125</td>
<td>60 d</td>
<td>$\gamma$, $\beta$</td>
<td>Radioimmunoassays (RIA)</td>
</tr>
<tr>
<td>Iodine-131</td>
<td>8 d</td>
<td>$\beta$</td>
<td>Thyroid cancer and imaging</td>
</tr>
<tr>
<td>Molybdenum-99</td>
<td>66 h</td>
<td>$\beta$</td>
<td>Generator of Tc-99m</td>
</tr>
<tr>
<td>Rhenium-186</td>
<td>3.8 d</td>
<td>$\beta$</td>
<td>Imaging</td>
</tr>
<tr>
<td>Technetium-99m</td>
<td>6 h</td>
<td>$\gamma$</td>
<td>Imaging</td>
</tr>
<tr>
<td>Cobalt-60</td>
<td>5.27 yr</td>
<td>$\gamma$</td>
<td>Radiotherapy</td>
</tr>
<tr>
<td>Processes</td>
<td>Use</td>
<td>Radioisotope</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Thickness of coatings, weight, moisture content etc.</td>
<td>Gamma emitters: Co-60, Cs-134, Cs-137, Sr-90, Am-241 etc.</td>
<td></td>
</tr>
<tr>
<td>Chemical Processing</td>
<td>Density, Sp. Gravity, Pipe thickness, Corrosion, Wear</td>
<td>Gamma; neutron sources Am-Be or Am-241</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Moisture content, location of reinforcing bar etc.</td>
<td>Gamma; neutron sources Am-Be or Am-241</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Gas</td>
<td>Column scanning, level measurement etc.</td>
<td>Gamma; neutron sources Am-Be</td>
<td></td>
</tr>
<tr>
<td>Road Research</td>
<td>Soil moisture measurements</td>
<td>Neutron sources Am-Be, Cf-252 etc.</td>
<td></td>
</tr>
<tr>
<td>Nondestructive Test</td>
<td>Weld, valves, parts, pressure vessels, aircraft structures etc.</td>
<td>Co-60, Cs-137, Ir-192 etc.</td>
<td></td>
</tr>
</tbody>
</table>
Radioactivity Waste Types

The generated wastes are...

- Low and Intermediate level (LIL)

The radionuclide involved are:

Radioactivity Waste Types (2)

The wastes are mainly –

1) Spent ion-exchange resins, graphite, lead and polythene plugs, contaminated vials, hand gloves, plastic syringes, tissue papers, shoe covers, protective clothes, plastic and metallic wares, spent and disused SRS, activated carbon, liquid effluents etc.
Management Procedures (1)

**Facilities:** Hospitals, INMs, RR and RI

**Production Facility**

**Waste Type:** Liquid Waste

- Wastes with very short-lived Isotopes are controlled by onsite storage (delay-decay/dilute-disperse) and then discharged if exemption limit is satisfied.
- Practices are continued under periodic review of the Regulatory Body.
Management Procedures (2)

Liquid Sources (Long Lived)

- Waste with long-lived isotopes are collected and stored at the Interim-storage facility of CWPSF to reach at the exemption limit set by the Regulatory Body.

- A limited amount of liquid waste is processed for demonstration purpose using the liquid rad waste processing unit (IEX-cum-Ultra filtration).
Solid Waste:

Facility: Hospitals, INMs, RR, RI Production Facility, Industries etc.

- Wastes with short-lived isotopes are stored onsite for delay-decay and the burnable wastes are then incinerated if exemption limit is satisfied.

- Unburnable solid waste are collected, segregated and stored at the Central Radioactive Waste Processing and Storage Facility (CWPSF).
Long-lived Disused SRS (e.g., Co-60, Cs-137 etc.) and unsealed sources (e.g., Ra-226) are collected, processed and stored in the interim storage facility of the CWPSF.

NORMs are yet to bring under proper regulatory control. However, they are under occasional monitoring.
Waste Processing and Storage Facility

**CWPSF:** Central Radioactive Waste Processing and Storage Facility.

**Aim:** Pre-disposal management of RWs (collection, handling, transportation, treatment, conditioning and interim-storage).

**Design:** IAEA generic design and recommendation.


**Officially Started:** 2005

**Total Area:** 12,000 Sq-ft

**Capacity:** ~50 Years
Central Radioactive Waste Processing & Storage Facility (CWPSF), at Savar, Dhaka, Bangladesh
Waste Processing Facility

Cementation Unit

Compactor (1 Unit)

Sorting Box (2 Units)

Compressible and Non-compressible Waste
Liquid Waste Processing Facility

IEX-cum-UF Unit
Interim Waste Storage Facility

Main Interim-Storage Room (Drums, Packages)

Spent Sealed Radioactive Source (SRS) Room
Collection and Transport of Radioactive Waste

RWs are Collected and Transported obeying relevant National and International Rules and Regulations
## Inventory of Unsealed Liquid Radioactive Wastes Stored at the CWPSF

<table>
<thead>
<tr>
<th>Date of Collection</th>
<th>Waste Type</th>
<th>Radionuclide</th>
<th>Volume (Litre)</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/2/2008</td>
<td>Liquid</td>
<td>Unidentified</td>
<td>27</td>
<td>RR</td>
</tr>
<tr>
<td>22/2/2011</td>
<td>Liquid</td>
<td>Unidentified</td>
<td>4</td>
<td>RIPD</td>
</tr>
<tr>
<td>16/2/2012</td>
<td>Liquid</td>
<td>Unidentified</td>
<td>38</td>
<td>RR</td>
</tr>
<tr>
<td>1/7/2012</td>
<td>Liquid</td>
<td>Unidentified</td>
<td>30</td>
<td>RR</td>
</tr>
<tr>
<td>6/8/2012</td>
<td>Liquid</td>
<td>Unidentified</td>
<td>1</td>
<td>RNPD</td>
</tr>
<tr>
<td>4/2/2012</td>
<td>Liquid</td>
<td>Unidentified</td>
<td>9</td>
<td>RIPD</td>
</tr>
</tbody>
</table>
## Inventory of Unsealed Solid Radioactive Wastes Stored at CWPSF

<table>
<thead>
<tr>
<th>Date of Collection</th>
<th>Waste Type</th>
<th>Radionuclide</th>
<th>Volume (m³)</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/10/2004</td>
<td>Contaminated cloths, tissue papers, hand gloves, vials, syringes etc.</td>
<td>$^3$H</td>
<td>2.25</td>
<td>ICDDRB</td>
</tr>
<tr>
<td>3/4/2006</td>
<td>Contaminated syringes, vials, crucible, saline tubes, hand gloves, polythene etc.</td>
<td>Mixed</td>
<td>~ 1</td>
<td>RIPD</td>
</tr>
<tr>
<td>19/4/1993-16/2/2012</td>
<td>Contaminated hand gloves, shoe covers, polythene, poly bags etc.</td>
<td>Mixed</td>
<td>~ 1.5</td>
<td>RR</td>
</tr>
<tr>
<td>18/4/1993-16/11/2012</td>
<td>Irradiation vials, contaminated hand gloves, cloths, dusters, polythene, shoe covers/plastic shoes, poly bags etc.</td>
<td>Mixed</td>
<td>0.5</td>
<td>RNPD &amp; HPRWMU</td>
</tr>
<tr>
<td>19/4/1993-7/2/2013</td>
<td>Resin</td>
<td>$^{60}$Co, $^{65}$Zn, $^{137}$Cs, $^{64}$Mn</td>
<td>~ 0.5</td>
<td>RR</td>
</tr>
</tbody>
</table>
## Inventory of Sealed Radioactive Sources

<table>
<thead>
<tr>
<th>Waste ID</th>
<th>Radio-Nuclide</th>
<th>Date of Receiving at CWPSF</th>
<th>Activity (GBq)</th>
<th>A/D Values</th>
<th>Source Category</th>
<th>Origin of the Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS_SS_UN_1</td>
<td>$^{137}$Cs</td>
<td>09-08-1999</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>NICRH</td>
</tr>
<tr>
<td>HS_SS_P_2 HS_SS_P_3</td>
<td>$^{226}$Ra</td>
<td>01/10 2000</td>
<td>35.60 35.60</td>
<td>0.445 0.445</td>
<td>4 4</td>
<td>MCHs, NMCs, AECD</td>
</tr>
<tr>
<td>HS_SS_UN_4</td>
<td>$^{137}$Cs</td>
<td>26-06-2004</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>DMCH</td>
</tr>
<tr>
<td>HS_SS_UN_5</td>
<td>$^{60}$Co</td>
<td>08-06-2005</td>
<td>49813</td>
<td>605.80</td>
<td>2</td>
<td>CMCH</td>
</tr>
<tr>
<td>HS_SS_UN_6</td>
<td>$^{60}$Co</td>
<td>08-06-2005</td>
<td>43871</td>
<td>533.53</td>
<td>2</td>
<td>DMCH</td>
</tr>
<tr>
<td>HS_SS_UN_7</td>
<td>$^{60}$Co</td>
<td>06-06-2008</td>
<td>30213</td>
<td>544.76</td>
<td>2</td>
<td>RMCH</td>
</tr>
<tr>
<td>HS_SS_UN_8</td>
<td>$^{60}$Co</td>
<td>07-06-2008</td>
<td>30213</td>
<td>544.76</td>
<td>2</td>
<td>RnMCH</td>
</tr>
<tr>
<td>HS_SS_UN_9</td>
<td>$^{60}$Co</td>
<td>10-06-2008</td>
<td>30736</td>
<td>555</td>
<td>2</td>
<td>OMCH</td>
</tr>
<tr>
<td>HS_SS_UN_10</td>
<td>$^{60}$Co</td>
<td>13-06-2008</td>
<td>30625</td>
<td>553.56</td>
<td>2</td>
<td>BMCH</td>
</tr>
<tr>
<td>RS_SS_UN_1</td>
<td>$^{60}$Co</td>
<td>14-06-2006</td>
<td>165679 0.241</td>
<td>2302.86 0.00221</td>
<td>1 5</td>
<td>IFRB RRL, Roads &amp; Highways</td>
</tr>
<tr>
<td>RS_SS_UN_3</td>
<td>$^{137}$Cs</td>
<td>30-06-2009</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

**Total No. of Sealed Sources: 27**

**HS:** Hospital Source, **SS:** Sealed Source, **IS:** Industrial Source, **ES:** Educational Institution Source, **RS:** Research Institutional Source, **P:** Processed, **UN:** Unprocessed.
Waste management principles:

a) Protection of Human Health
b) Protection of the Environment
c) Protection beyond National Borders
d) Protection of future Generations
e) National legal framework
f) Control of Radioactive Waste Generation
g) Radioactive Waste Generation and Management Interdependencies
h) Safety of Facilities
Government of Bangladesh will manage the radioactive waste and spent fuel in such a way as to avoid imposing undue burdens on present and as well as future generations;

Government of Bangladesh will follow the Fundamental Safety principles of IAEA for the management of radioactive waste and spent fuel and will abide by all international agreements to which Bangladesh is a party;

The government of Bangladesh will establish the legislative and regulatory framework regarding the safe management of radioactive waste and spent fuel. The framework will include a system for authorizing radioactive waste management activities of new nuclear power program. Government shall support for the development of an effectively independent regulatory body to enforce the legislation and regulations, and issue authorizations;
Every generator of radioactive waste and spent fuel shall be responsible for safe and secure management of radioactive waste until the waste is accepted by the waste management organization. The generator of radioactive waste shall pay for the safe management of its waste. However Government will be responsible for bearing the cost for the management of ownerless waste and orphaned sources;
The authorization holders of the facilities generating radioactive waste will adopt measures for minimizing the generation of radioactive waste taking into account the matter of interdependencies among all steps in radioactive waste generation and management;

The regulatory body shall ensure safe control of all radioactive waste and spent fuel that are generated and shall also be responsible for the verification of compliance with regulatory requirements;
The government of Bangladesh will establish a national waste management organization and technical infrastructure responsible for the safe management of radioactive waste and spent fuel in the country. Until such organizations is established, Bangladesh Atomic Energy Commission (BAEC) shall be responsible for safe management of low and intermediate level radioactive waste (LILW) and spent fuel and is authorized to charge fee from the generators of radioactive waste;
Radioactive Waste Management Policy (5)

- The government of Bangladesh will make arrangements for providing resources (financial, technical and human) so as to sustain the waste management organization and the regulatory body, and for the implementation of the radioactive waste management strategy;

- The waste management organization will prepare a strategy detailing arrangements for the long term management of radioactive waste and spent fuel in Bangladesh;

- Radioactive waste and spent fuel shall not be imported or exported unless or otherwise approved by the government as per national law;
Radioactive Waste Management Policy (6)

- All radioactive waste management and spent fuel related activities shall be conducted in an open and transparent manner and public shall have access to information regarding waste management;

- Decision-making on scientific information, risk analysis and optimization of resources shall be based on proven scientific information and recommendation of competent national and international institutions dealing with radioactive waste and spent fuel management;

- Where there is uncertainty about the safety of an activity, a conservative approach shall be adopted;
The government shall create opportunities to develop people’s understanding, skills and general capacity concerning radioactive waste and spent fuel management. The government shall establish infrastructure for interim storage of High Level Radioactive Waste (HLRW) and spent fuel on and/or off site of the nuclear installations before sending back to the vendor country/country of origin or as per agreements with the vendor country.

The government shall make appropriate arrangements to ensure the safe handling and storage of the HLRW and spent fuel before sending back to the vendor country/country of origin.
Future Plan

I. RW & SF Management Policy
   ➢ Development and Finalization of National Radioactive Waste/SNF Management P&S Considering the Proposed NPP

II. DSRS and SHARS Management
   ➢ Building up capabilities in DSRS and SHARS conditioning and disposal

III. Reliable and Quality RWM
   ➢ Development of capabilities and infrastructure for a software-based waste inventory system for reliable and quality waste management program
Future Plan

IV. Management of Decommissioning Waste

- Building up capabilities (infrastructure & HR) for the management of Decommissioning waste from RR

V. Near Surface Repository for LIL RW

- Building up Capabilities for-
  - Near surface repository (NSR) design for LIL waste
  - Site-selection study for NSR for LIL waste
Thank you very much