Title: Plan of Nuclear Spent Fuel and Waste Management in Bangladesh

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• **Official Name:** People's Republic of Bangladesh;
• **Area:** 147,570 km²;
• **Population:** 162 Million;
• **Density:** 1,100 per km²;
• About 90% of the population has access to electricity;
• Rooppur Nuclear Power Plant (RNPP) is the first nuclear power plant of Bangladesh, currently under construction;
• The RNPP has two units (1200MWe each) and first unit is expected to commence operation in 2023;
• Govt. is also considering another NPP in the southern part in the country.

*NPP-Nuclear Power Plant*
The administrative channel of Atomic Energy Research Establishment (AERE) is directly linked to the Chairman, BAEC and the channels for R&D activities of AERE are linked to the respective Member of BAEC.
Organization: BAEC

Major Infrastructures of BAEC:

1. 3 MeV Van De Graaff Accelerator Facility,
2. 3 MeV TANDEM Accelerator Facility,
3. 350 kCi & 50 kCi Co-60 Gamma Irradiators,
4. Reactor Physics and Engineering Laboratory,
5. Analytical laboratories including Isotope Hydrology laboratory
6. Radioisotope Production Laboratory,
7. Radioactive Waste Management Facility,
8. SSDL Facility, NDT Laboratory, NAA & NS Laboratories,
9. Neutron Powder Diffractometer and
10. Several Nuclear Medical Centers,
11. Medical Physics Institute, etc.

Nuclear Facilities (Reactor):

1. BAEC 3MW TRIGA Research Reactor
2. Rooppur Nuclear Power Plant Unit 1 & 2 (under construction)
Brief Description of BTRR

TRIGA
Training
Research
Isotope production
General Atomics

BTRR
**Brief Description of BTRR**

<table>
<thead>
<tr>
<th>Reactor Power (Thermal)</th>
<th>: 3 MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor Type</td>
<td>Mark-II (Tank type RR)</td>
</tr>
<tr>
<td>Construction Started</td>
<td>May 1981</td>
</tr>
<tr>
<td>First Criticality</td>
<td>14 September 1986</td>
</tr>
<tr>
<td>Fuel</td>
<td>Uranium 20% (wt) 19.7% U-235</td>
</tr>
<tr>
<td>Moderator Material</td>
<td>Zr-H, Water</td>
</tr>
<tr>
<td>Cladding Material</td>
<td>SS 304</td>
</tr>
<tr>
<td>Control Rod</td>
<td>B₄C</td>
</tr>
<tr>
<td>Coolant</td>
<td>Demineralized Water</td>
</tr>
<tr>
<td>Reflector</td>
<td>Graphite</td>
</tr>
<tr>
<td>Neutron Flux (Thermal)</td>
<td>7.46x10¹³ (n.cm⁻².s⁻¹)</td>
</tr>
<tr>
<td>Prompt –ve Temp Coefficient</td>
<td>1.07x10⁻⁴ Δk/k°C</td>
</tr>
</tbody>
</table>
Brief Description of BTRR

- **Fuel Elements**: 100 Nos.
  (93 STD +2 IFE + 5 FFCR)*
- **Graphite Dummy Element**: 18 Nos.
- **Dry central Thimble**: 1 No.
- **Rabbit Terminus**: 1 No.
- **Neutron Source**: 1 No.
- **Control Rod**: 6 Nos.
- **Fission Chamber**: 2 Nos.
- **Ion Chamber**: 2 Nos.

* STD: Standard; IFE: Instrumented Fuel Element; FFCR: Fuel Follower Control Rod
Areas of Utilization

- Experimental Reactor Safety Analysis
- Neutron Activation Analysis (NAA)
- Neutron Scattering (NS)
- Neutron Radiography (NR)
- Radioisotope Production
- Training
- Education
Recent Training Activities at CRR
Brief Description of BTRR

- There is a declaration from the US DOE that all US origin research reactor spent fuel generated within October 2016 will be taken away to the USA at their own cost within 2019;
- **The average fuel burn up of the BTRR is about 17%. So the reactor is possible to run for about next 10-20 years;**
- **BTRR facility does not have spent fuel till now;**
- Liquid waste produced in the facility will be processed and, if required, stored in the Central Radioactive Waste Processing and Storage Facility (CWPSF) at AERE campus;
- Three fuel storage racks have been installed inside the reactor tank to work as an interim storage for the used fuel elements. Capacity of each rack is 10 elements,
- **A fuel transfer cask and spent fuel storage facility will be constructed at the facility under an ADP project as soon as possible.**
ADP project:

CRR takes an ADP Project (Annual Development Program) with a view to strengthen reactors operational safety and utilization. The following systems will be upgraded/Install under the ADP at the reactor facility.

- To increase operating life of the BTRR for about 15 to 20 years by implementing ageing management of different systems/components of the reactor facility;
- Design and development of spent fuel transfer cask;
- Build a new spent fuel storage facility;
- Renovation and modernization of old area radiation monitoring systems with digital display at the reactor facility, etc.
- Upgradation of digital control console system, etc.
Brief Description of BTRR

Organization Structure of CRR (Changed on 12 January, 2015)

AERE : Atomic Energy Research Establishment
CRR   : Center for Research Reactor
INST  : Institute of Nuclear Science & Technology
• Rooppur Nuclear Power Plant (RNPP) will be the country's first nuclear power plant,
• It is located at Rooppur, Pabna District, 140 km west of Dhaka, in the northwest of the country,
• The first of two units are an under construction,
• It is being built by the Russian Rosatom State Atomic Energy Corporation,
• Rooppur NPP project activities would be accomplished fulfilling the requirements of internationally established management system to achieve safety goals in connection with the design, construction, commissioning, operation and maintenance,
• The two units generating 2.4 GWe are planned to be operational in 2023 and 2024.
National and Legal Framework

- Nuclear Safety and Radiation Control (NSRC) Rules, 1997;
- In May 2012 the government enacted an Act entitled “Bangladesh Atomic Energy Regulatory Authority Act” (in short, BAER Act-2012) for establishing an effective independent Regulatory Body as well as for introducing Nuclear Law in the country;
- Establish the legislative and regulatory framework incorporating nuclear power program for the safe management of radioactive waste (RW) and spent nuclear fuel (SNF);
- National Policy of Bangladesh for the Management of Radioactive Waste and Spent Nuclear Fuel has been passed by the cabinet in October 2019;
- Provisions of the BAER Act-2012 cover nuclear safety, waste management, security and safeguards of nuclear as well as radioactive materials and also ensure civil liability for nuclear damage in the event of an accident.
BAEC has plan to store TRIGA spent fuel in the spent fuel storage pool for cooling at the facility and send it to USA;

For the purposes of implementing the national policy and establishing a national strategy for radioactive waste and spent nuclear fuel management, Bangladesh shall follow the latest guidelines of the International Atomic Energy Agency regarding the relevant definitions and classifications, if necessary.

A Waste Management Company (RWMC) will be established under BAEC. Until a separate RWMC is formed “Bangladesh Atomic Energy Commission (BAEC)” will be responsible for the management of RW generated from activities other than operation and maintenance of NPP.
Bangladesh is committed to develop and enforce necessary legal framework for ensuring implementation of this National Policy so as to fulfill the obligations as described below:

• All facilities generating RW and SNF shall adopt measures for minimizing the generation of RW and SNF both in terms of volume and activity. Reuse and/or recycling of radioactive materials shall be considered and implemented in compliance with relevant radiation protection and safety standards;

• RW and SNF shall not be imported;

• Priority will be given to send back SNF generated from the NPP to the fuel supplier;

• Disposal of RW in dedicated facilities duly licensed will be the ultimate end-point for the safe and sustainable management of any type of RW with the exception of exempted waste as per BAERA Act, 2012, NSRC RULES-1997 and international standards;

• In-situ disposition will be adopted as the final end-point for NORM management;
National Policy of Spent Fuel and Waste Management

• Interdependences among all steps in the predisposal management of radioactive waste, as well as the impact of the anticipated disposal option, shall be appropriately taken into account;

• National radioactive waste classification will be established in compliance with the BAERA Act, 2012, NSRC RULES-1997, the IAEA system and as required according to the necessity;

• All RW and SNF management activities will be conducted in an open and transparent manner. The public will have access to information regarding RW and SNF management while having due regard to security and proprietary information basis.
BAEC follow the US NRC codes and the NUREG documents for TRIGA reactor facility.

- According to that licensee of the BTRR would require to prepare a detailed decommissioning plan and submit it to the regulatory authority along with the license termination application,
- Decommissioning plan will be submitted during the fag end of the operational life of the reactor facility,
- To obtain a license from the regulatory authority of Bangladesh (BAERA), a decommissioning plan, including an environmental impact assessment, must be prepared according to the regulatory authority rules (NSRC SRO No. 205-Law/1997) (Schedule 6, item 16.c).
National Policy of Spent Fuel and Waste Management

Layout diagram of Reactor building.
Layout diagram of AERE Central Radioactive Waste Processing and Storage Facility (CWPSF).
The BAEC has certain challenges which need to be addressed:

- Collection of TRIGA Fuel;
- Collection of spare parts for digital console;
- Construction of spent fuel storage facility;
- Cost estimation of spent fuel management;
- Preparation of DPP for decommissioning project,
Future Works and Challenges

High Power New Research Reactor Project:

- A Technical Survey Project is undertaken to the Government to establish a new high power multipurpose research reactor including sophisticated material testing facility which is important for NPP.

- The other utilization area of the new research reactor are -
  - production of radioisotope for medical and industrial purposes,
  - to achieve the self-sufficiency in nuclear research
  - to establish a national facility for silicon doping to produce semiconductor for electronics industries,
  - Boron neutron capture therapy facility for cancer treatment,
  - Training and education,
  - gemstone coloration for jewelry industry
Conclusions

- BAEC TRIGA Research Reactor has been operated safely for various peaceful applications in the field of nuclear technology,

- Several modification, rectification and upgrading works were carried out so as to strengthen operational safety of the reactor,

- BAEC has prepared National Policy of Bangladesh for the Management of Radioactive Waste and Spent Nuclear Fuel,

- BAEC highly appreciates the assistance of the IAEA and other international stakeholders for their continued supports for addressing various safety related issues associated with the operation and utilization of the BTRR and construction of NPP of Bangladesh.
Thank you for your kind attention !!