IAEA’s Technical Meeting on “Research reactor application for materials under high neutron fluence”

17 - 21 November 2008

Current status and perspectives of Nuclear reactor based research in Bangladesh

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Principal Scientific Officer
Bangladesh Atomic Energy Commission
Organogram
Bangladesh Atomic Energy Commission

1. Institute of Nuclear Science & Technology
2. Institute of Food & Radiation Biology
3. Reactor Operation & Maintenance Unit
4. Tissue Banking & Biomaterial Research
5. Nuclear Minerals Unit
6. Institute of Electronics
7. Institute of Computer Science
8. Central Engineering Facilities
9. Central Library
Institute of Nuclear Science & Technology
Nuclear Reactor available in Bangladesh:

Only a 3MW TRIGA Mark-II Research Reactor

Criticality Date:
14 Sept. 1986
Nuclear Reactor available in Bangladesh:

- **Fuel Element**
- **Graphite Dummy Element**
- **Control Rod**
- **Dry Central Thimble**
- **Rabbit Terminus**
- **Neutron Source**

Rabbit Room

Rotary Specimen Rack

Reactor core configuration
Reactor Tank
Nuclear Reactor available in Bangladesh:

Beam ports:

- PGNAA (under processing)
- Radial-2
- Radial-1
- HRPD (under processing)
- Tangential (NR)
- Thermal column (unutilized)
- Radial piercing (TAS-NS)
# Technical Data of BAEC TRIGA Reactor

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power output</strong></td>
<td>3 MW (thermal)</td>
</tr>
<tr>
<td><strong>Fuel moderator material</strong></td>
<td>U-ZrH$_{1.6}$</td>
</tr>
<tr>
<td><strong>$^{235}$U enrichment</strong></td>
<td>19.7 wt%</td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>Natural/Forced</td>
</tr>
<tr>
<td><strong>No. of fuel element</strong></td>
<td>100</td>
</tr>
<tr>
<td><strong>Coolant</strong></td>
<td>Demineralized water</td>
</tr>
<tr>
<td><strong>Core loading</strong></td>
<td>Fuel elements = 93; IFE = 02; FFCR = 05</td>
</tr>
<tr>
<td><strong>Control rod</strong></td>
<td>6 rods of B$_4$C</td>
</tr>
<tr>
<td><strong>Reflector</strong></td>
<td>Graphite</td>
</tr>
</tbody>
</table>
# Operation and Utilization Data

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours operated per day</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total hours operated</strong></td>
<td>7412</td>
</tr>
<tr>
<td>Hours at full power operated</td>
<td>2444</td>
</tr>
<tr>
<td><strong>Total burn—up</strong></td>
<td>15017 MWh</td>
</tr>
<tr>
<td>No. of irradiation request catered</td>
<td>1274</td>
</tr>
<tr>
<td>Radioisotope produced</td>
<td>87.01 Ci</td>
</tr>
<tr>
<td></td>
<td>($^{131}$I, $^{99m}$Tc, $^{46}$Sc)</td>
</tr>
</tbody>
</table>
## Neutron Flux (n.cm\(^{-2}\).sec\(^{-1}\))

<table>
<thead>
<tr>
<th>Position</th>
<th>Thermal</th>
<th>Epithermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCT</td>
<td>(7.53\times10^{13})</td>
<td>(3.81\times10^{12})</td>
</tr>
<tr>
<td>RSR (Lazy Suzan)</td>
<td>(1.39\times10^{13})</td>
<td>(6.59\times10^{11})</td>
</tr>
<tr>
<td>Pneumatic Transfer System</td>
<td>(2.64\times10^{13})</td>
<td>(1.23\times10^{12})</td>
</tr>
<tr>
<td>Tangential beam port</td>
<td>(1.32\times10^{7})</td>
<td>(2.18\times10^{5})</td>
</tr>
<tr>
<td>Radial piercing beam port</td>
<td>(1.2\times10^{5})</td>
<td>-</td>
</tr>
</tbody>
</table>
Present Reactor Operation Schedule

<table>
<thead>
<tr>
<th>DAY</th>
<th>SUN</th>
<th>MON</th>
<th>TUE</th>
<th>WED</th>
<th>THU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low Power Operation (NAA, NR) 250-500 kW</td>
<td>High Power Operation for RI Production, NS and NAA (3 MW)</td>
<td>Operator training</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Areas of Utilization

- Radioisotope Production
- Neutron Radiography
- Manpower Training
- Utilization of 3MW TRIGA RR
- Activation Analysis
- Academic Research
- Neutron Scattering
The objective of Radioisotope Production is to fulfill the local demand of short-lived medical radioisotopes and radiopharmaceuticals.
Radioisotope Production

Major Facilities of Radioisotopes Production

– Tc-99m generator production plant
– I-131 production plant
– I-131 Capsule production facility
– QA/QC facility
### Radioisotope Production

<table>
<thead>
<tr>
<th>Radioisotopes</th>
<th>Demand</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc-99m Generators (450 mCi)</td>
<td>18 generators/week</td>
<td>Some centres require weekly and others require fortnightly</td>
</tr>
<tr>
<td>Iodine-131 solution</td>
<td>~ 1Ci/week</td>
<td>For diagnosis of thyroid disorder and therapy of thyrotoxicosis</td>
</tr>
<tr>
<td>Iodine-131 Capsule</td>
<td>~ 1.5 Ci/week</td>
<td>Thyroid ablation Therapy</td>
</tr>
</tbody>
</table>

**Supply in 14 Nuclear Medicine Centres and four private hospitals**
Radioisotope Production

Tc-99m Production Facility

On-Line Control Software
Isotope Production

Tc-99m Generator

Shipment package of Tc-99m generator
Isotope Production

I-131 production facility

I-131 Capsule Production Facility
Neutron Scattering

Triple Axis Spectrometer
Present Scope of Research

- **Neutron Powder Diffraction Studies**
  For structural characterization of materials like metals, metallic oxides, alloys, ceramics, superconductors and various types of magnetic materials

- **Small Angle Neutron Scattering (SANS)**
  For determining shape, size and molecular weights of particles in various kinds of biological aggregates and polymers

- **Texture Studies**
  For identification of texture in industrial and structural materials
Neutron Diffraction Pattern of Ni-Zn Ferrite
Neutron Radiography

Neutron Radiography setup  Dark Room Facility

Nondestructive testing of various materials and quality control of industrial products
Neutron Radiography

Objectives:

• Detection of voids, cracks, internal continuity in materials and industrial products;
• Detection of defects and corrosion in aircraft spare parts;
• Determination of defects and water absorption behavior of building materials, wood and jute plastic composites;
• Study the boron deficiency in different types of plants, etc.
Activities

Using NAA technique we work on:

1. Elemental analysis of various sample matrices
2. Nuclear Data measurements
Activities

The activities of NAA laboratory are classified into four categories:

1. R & D works
2. Services
3. Projects
4. Academic collaboration
Example of R & D work

Case study-1
Example of R & D work

Launching of NAA lab: 1986

NAA Group

Elemental analysis \[\leftrightarrow\] Nuclear data measurements

3 MW TRIGA Reactor \[\rightarrow\] 14 MeV Neutron Generator
Example of R & D work

BAEC TRIGA Reactor

Radial piercing beam port

Triple Axis Spectrometer
Recently, we have opened a new arena by utilizing the same beam port for determination of neutron capture cross sections at a “rare” thermal energy (0.0536 eV) region using NAA technique.

The term ‘rare’ means that there are no experimental neutron capture cross-section data available at our investigated energy.
So far, we have successfully carried out two experiments in determining the neutron capture cross section for $^{186}\text{W}(n,\gamma)^{187}\text{W}$ and $^{71}\text{Ga}(n,\gamma)^{72}\text{Ga}$ reactions at thermal energy of 0.0536 eV.
In determining neutron capture cross section using NAA technique, several steps are involved:

- choice of neutron source
- sample preparation and irradiation
- gamma ray counting and peak analysis
- construction of full energy photo peak detection efficiency curve at reference position where true coincidence effects are negligible
- calculation of neutron flux and cross section
Example of R & D work

Choice of neutron source

Cross sectional view of the arrangement for monochromatization of reactor neutrons and experimental setup
**Example of R & D work**

**Sample preparation**

**Tungsten**
- Physical form: foil
- Purity: 99.99%
- Weight: 796 mg
- Size: 10 mm dia
  200µm thick
- Isotopic compositions:
  $^{180}$W(0.12%), $^{182}$W(26.49%)
  $^{183}$W(14.31%), $^{184}$W(30.64%)
  $^{186}$W(28.42%)

**Gallium**
- Physical form: Ga$_2$O$_3$
  (made in pellet)
- Purity: 99.99%
- Weight: 1.27 g
- Size: 1.2 cm dia
  0.13 cm thick
- Isotopic compositions:
  $^{69}$Ga(60.108 %)
  $^{71}$Ga (39.892 %)
Example of R & D work

**Irradiation**

Simultaneous irradiation of target and gold foil under the following conditions:

- Reactor power: 3 MW (during isotope production)
- Irradiation time: 5 h
- Neutron energy: 0.0536 eV

The cadmium covered gold foil and bare aluminum foil were also irradiated to check the effect of epithermal and fast neutrons.
Gamma ray counting and peak analysis

Counting
Tungsten: 10 hours
3 times
Gallium: 5 hours
3 times

Acquisition
Software: Maestro-32
ORTEC
Peak analysis
Software: Hypermet PC V5.12

Example of R & D work

ORTEC DSPEC Jr™ Digital gamma spectrometry coupled with Canberra HPGe detector of 15% relative efficiency and 1.9 keV resolution
Gamma ray spectrum of tungsten target

Example of R & D work
Example of R & D work

Gallium

Gamma ray spectrum of gallium target
Example of R & D work

Point sources used: $^{22}\text{Na}$, $^{57}\text{Co}$, $^{60}\text{Co}$, $^{54}\text{Mn}$, $^{133}\text{Ba}$, $^{137}\text{Cs}$ and $^{152}\text{Eu}$ Energy covered: 80.9 – 1408 keV

Efficiency curve at 30 cm distance from the detector surface

Construction of efficiency curve
# Nuclear Data

## Example of R & D work

<table>
<thead>
<tr>
<th>Nuclear Reaction</th>
<th>Half-life</th>
<th>Gamma Energy (keV)</th>
<th>Branching Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{186}\text{W}(n,\gamma)^{187}\text{W}$</td>
<td>23.72 h</td>
<td>479.55, 685.73</td>
<td>21.8, 27.3</td>
</tr>
<tr>
<td>$^{71}\text{Ga}(n,\gamma)^{72}\text{Ga}$</td>
<td>14.1 h</td>
<td>834.03, 629.96</td>
<td>95.63, 24.8</td>
</tr>
<tr>
<td>$^{197}\text{Au}(n,\gamma)^{198}\text{Au}$</td>
<td>2.695 d</td>
<td>411.8</td>
<td>95.5</td>
</tr>
</tbody>
</table>
Determination of neutron flux

In case of monoenergetic thermal neutrons, the flux $\phi(E)$ can simply be obtained as:

$$\phi(E) = \frac{A_{sat}}{\sigma(E_{peak})}$$

- $A_{sat}$ = saturated activity of gold foil
- $\sigma(E_{peak})$ = cross section at the peak neutron energy (68.5 barn at 0.0536 eV)

Assuming the self attenuation factor for gold foil at 0.0536 eV is negligible
Example of R & D work

**Determination of neutron flux**

\[
A_{\text{sat}} = \frac{N_p \cdot \lambda \cdot e^{+ \lambda t_d}}{\varepsilon \cdot I \cdot \frac{6.02 \times 10^{23}}{A_{\text{wt}}} \cdot w \cdot \theta \cdot (1 - e^{-\lambda t_i}) \cdot (1 - e^{-\lambda t_c})}
\]

Neutron flux for tungsten \( \sim 1.41 \times 10^5 \text{ n.cm}^{-2}\text{-s}^{-1} \)

Neutron flux for gallium \( \sim 1.73 \times 10^5 \text{ n.cm}^{-2}\text{-s}^{-1} \)
Determination of neutron cross section

\[ \sigma(E_{\text{peak}}) = \frac{A_{\text{sat}}}{\phi(E) \cdot F_g} \]

\( F_g = \text{correction factor for gamma attenuation within the sample} \)

\[ F_g = \frac{\mu x}{1 - e^{-\mu x}} \]

\( \mu = \text{linear attenuation coefficient (cm}^{-1}\text{)} \)
Results

We report new cross sections for

\[ ^{186}\text{W}(n,\gamma)^{187}\text{W} \text{ reaction} = 26.6\pm2.5 \text{ b} \]

\[ ^{71}\text{Ga}(n,\gamma)^{72}\text{Ga} \text{ reaction} = 2.75\pm0.14 \text{ b} \]

These are the first experimental values at 0.0536 eV neutron energy for the tungsten and gallium targets
Neutron capture cross section for the $^{186}\text{W}(n,\gamma)^{187}\text{W}$ reaction

**Example of R & D work**

![Graph showing neutron capture cross section for $^{186}\text{W}(n,\gamma)^{187}\text{W}$ reaction]
Example of R & D work

Neutron capture cross section for the \(^{71}\text{Ga}(n,\gamma)^{72}\text{Ga}\) reaction

![Graph showing neutron capture cross section for \(^{71}\text{Ga}(n,\gamma)^{72}\text{Ga}\) reaction.](image)

- ENDF/B-VII
- JENDL-3.3
- This work
- Holden
- Simonits
- Gleason
- Pomerance
- Karadag
- Koester
- Mughabghab
- Ryves
- Harris
- Seren
Example of R & D work

Our technique is very simple to obtain data with good precision and accuracy

We can apply the technique for other targets

The results accepted for publications in the reputed report and journals is a testimony of our claim
Example of R & D work

“Utilization of Radial Piercing Beam port of TRIGA Reactor for Nuclear Data Measurements”


Internal Report INST-115/RNPD-27, April 2008

“Measurement of thermal neutron cross section for the $^{186}W(n,\gamma)^{187}W$ reaction by the activation technique”


Example of R & D work

Measurement of neutron capture cross section of the $^{71}$Ga(n,γ)$^{72}$Ga reaction at 0.0536 eV energy


Thermal neutron capture cross sections for the $^{152}$Sm(n,γ)$^{153}$Sm and $^{154}$Sm(n,γ)$^{155}$Sm reactions at 0.0536 eV energy


Example of R & D work

Case study-2
Case Study-2
Comparison of analytical results of Bay of Bengal Sediments with agricultural soils of Bangladesh
Example of R & D work

Sediment sampling points in Bay of Bengal
Example of R & D work

F.V. Seabird used for collecting Sediment samples from the Bay of Bengal.

GPS receiver

KC Kajak Corer for collecting muddy sediment
Table. Geographical position (latitude, longitude), depth of the sampling stations

<table>
<thead>
<tr>
<th>Station</th>
<th>Geographical position</th>
<th>Type of Sea</th>
<th>Ground Depth (m) *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>latitude</td>
<td>longitude</td>
<td></td>
</tr>
<tr>
<td>Station 01</td>
<td>22°06'54&quot; N</td>
<td>91°39'54&quot; E</td>
<td>Open</td>
</tr>
<tr>
<td>Station 02</td>
<td>21°37'10&quot; N</td>
<td>91°39'48&quot; E</td>
<td>Open</td>
</tr>
<tr>
<td>Station 03</td>
<td>21°22'38&quot; N</td>
<td>91°46'10&quot; E</td>
<td>Open</td>
</tr>
<tr>
<td>Station 04</td>
<td>20°52'10&quot; N</td>
<td>91°52'39&quot; E</td>
<td>Open</td>
</tr>
<tr>
<td>Station 05</td>
<td>20°30'56&quot; N</td>
<td>92°11'48&quot; E</td>
<td>Open</td>
</tr>
<tr>
<td>Station 06</td>
<td>20°37'48&quot; N</td>
<td>92°20'28&quot; E</td>
<td>Open</td>
</tr>
</tbody>
</table>

* Depth (m) of ground from where sediment was collected
Example of R & D work

Agricultural soil sampling

Soil sampling from sugar-cane and paddy field

Geological cross section of soil sampling area
Example of R & D work

QC of Analysis of Agricultural soils using NAA

IAEA Soil-7
Irradiation Channel: RSR of reactor
Irradiation time: 4 hours
γ-spectrometry: HPGe with DSpec
Counting time: 4000 sec
Decay time: 4 days
QC of analysis of agricultural soils using NAA

Example of R & D work
Example of R & D work

QC of Analysis

NIST Coal Fly Ash
Relative to IAEA-Soil-7

Ratio of Measured to Certified conc.
**Example of R & D work**

**Comparison of arsenic concentration determined by NAA and AAS in sediment**

<table>
<thead>
<tr>
<th>Sample code</th>
<th>NAA (mean of two folds)</th>
<th>AAS</th>
<th>Deviation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station-1</td>
<td>10.20</td>
<td>6.16</td>
<td>+ 40</td>
</tr>
<tr>
<td>Station-2</td>
<td>8.46</td>
<td>7.78</td>
<td>+ 8</td>
</tr>
<tr>
<td>Station-3</td>
<td>7.92</td>
<td>6.45</td>
<td>+ 19</td>
</tr>
<tr>
<td>Station-4</td>
<td>8.38</td>
<td>5.11</td>
<td>+ 39</td>
</tr>
<tr>
<td>Station-5</td>
<td>6.35</td>
<td>4.45</td>
<td>+ 30</td>
</tr>
<tr>
<td>Station-6</td>
<td>12.29</td>
<td>5.95</td>
<td>+ 52</td>
</tr>
</tbody>
</table>
### Example of R & D work

Comparison of chromium concentration determined by NAA and AAS in sediments

<table>
<thead>
<tr>
<th>Sample code</th>
<th>NAA (mean of two folds)</th>
<th>AAS</th>
<th>Deviation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station-1</td>
<td>96.18</td>
<td>107.9</td>
<td>-12</td>
</tr>
<tr>
<td>Station-2</td>
<td>88.11</td>
<td>117.8</td>
<td>-34</td>
</tr>
<tr>
<td>Station-3</td>
<td>114.5</td>
<td>93.54</td>
<td>+18</td>
</tr>
<tr>
<td>Station-4</td>
<td>145.1</td>
<td>98.17</td>
<td>+32</td>
</tr>
<tr>
<td>Station-5</td>
<td>144.2</td>
<td>67.88</td>
<td>+53</td>
</tr>
<tr>
<td>Station-6</td>
<td>130.6</td>
<td>92.90</td>
<td>+29</td>
</tr>
</tbody>
</table>
**Comparison of cobalt concentration determined by NAA and AAS in sediments**

<table>
<thead>
<tr>
<th>Sample code</th>
<th>NAA (mean of two folds)</th>
<th>AAS</th>
<th>Deviation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station-1</td>
<td>18.11</td>
<td>18.61</td>
<td>- 3</td>
</tr>
<tr>
<td>Station-2</td>
<td>17.06</td>
<td>25.01</td>
<td>- 47</td>
</tr>
<tr>
<td>Station-3</td>
<td>17.09</td>
<td>18.43</td>
<td>- 8</td>
</tr>
<tr>
<td>Station-4</td>
<td>17.82</td>
<td>14.19</td>
<td>+ 20</td>
</tr>
<tr>
<td>Station-5</td>
<td>16.58</td>
<td>13.77</td>
<td>+ 17</td>
</tr>
<tr>
<td>Station-6</td>
<td>18.88</td>
<td>9.38</td>
<td>+ 50</td>
</tr>
</tbody>
</table>
### Example of R & D work

#### Comparison Sediments with soils using NAA

<table>
<thead>
<tr>
<th>Element</th>
<th>Sediments Bay of Bengal mg/kg</th>
<th>Agricultural soils mg/kg</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>8.933</td>
<td>6.32</td>
<td>Sed&gt;soil (41%)</td>
</tr>
<tr>
<td>Cr</td>
<td>120</td>
<td>103</td>
<td>Sed&gt;soil (17%)</td>
</tr>
<tr>
<td>Co</td>
<td>17.59</td>
<td>18.77</td>
<td>Sed&lt;soil (6.3%)</td>
</tr>
<tr>
<td>U</td>
<td>2.970</td>
<td>4.978</td>
<td>Sed&lt;soil (40%)</td>
</tr>
<tr>
<td>Th</td>
<td>15.12</td>
<td>19.96</td>
<td>Sed&lt;soil (24%)</td>
</tr>
<tr>
<td>Sb</td>
<td>0.829</td>
<td>0.682</td>
<td>Sed&gt;soil (22%)</td>
</tr>
<tr>
<td>Mn</td>
<td>538</td>
<td>727</td>
<td>Sed&lt;soil (26%)</td>
</tr>
<tr>
<td>Ti</td>
<td>0.457 %</td>
<td>0.459 %</td>
<td>Sed&lt;soil (0.4%)</td>
</tr>
</tbody>
</table>
Conclusion

High concentrations of

- U and Th in agricultural soil may be due to use of chemical fertilizers like Triple Super Phosphate (TSP), Gypsum, Diammonium phosphate (DAP), etc.

- As, Sb and Cr in Bay of Bengal sediments due to marine pollution
Case Study-3
Monitoring of Environmental Contaminants due to Shipbreaking

Just Started!!!
What is Ship breaking?

- After 25-30 years ships are at the end of their sailing life
- These ‘End of Life Vessels’ are sold and dismantled to recover the valuable steel
When started this idea?

➢ In the 1970s shipbreaking was concentrated in Europe

➢ Performed at docks, it was a highly mechanised industrial operation

➢ But the costs of upholding environmental, health and safety standards increased, the shipping industries moved to developing Countries
What’s the situation in Bangladesh?

- Bangladesh is dependent on ship breaking for its domestic steel requirements.

- The ship breaking industry is not subject to any environmental laws or health and safety regulations for workers.

- Chittagong ship breaking yards are highly polluted coastal belt of 20 km.
What’s the situation in Bangladesh?
How does shipbreaking pollute the environment?

- About 95% of the ship consists of steel coated with paint containing lead, cadmium, organotins, arsenic, zinc and chromium.

- Ships also contain a wide range of other hazardous wastes, PCBs, asbestos, residual oil, etc.

In Bangladesh, ships containing these materials are being cut up by hand, on open beaches, with no consideration given to safe and environmentally friendly waste management practices.
How does shipbreaking pollute environment?

A worker working barefoot without any protective footwear

Workers carrying a piece of broken steel without any hand gloves
How does shipbreaking pollute environment?

Heavy metals

- The workers can have toxic effect from heavy metals like cadmium, organotins, arsenic, zinc and chromium which may find in many parts of ships such as in paints, coatings, anodes and electrical equipment.

- Marine environment can also be contaminate.

- Exposure can result in lung cancer, cancer of the skin, intestine, kidney, liver or bladder. It can also cause damage to blood vessels.
How does shipbreaking pollute environment?

Persistent Organic Pollutants (POP's)

- Shipbreaking activities are a source of lethal POPs.

- POPs are chemicals that are highly toxic, remain intact in the environment for long periods.

- POPs become widely distributed geographically, bioaccumulate through the food web, accumulate in the fatty tissue of living organisms and pose a risk of causing adverse effects to the human population, wildlife and the environment.
How does shipbreaking pollute environment?

Asbestos

- Asbestos was used in old ships as a heat insulator

- As there are no asbestos disposal procedures, during scrapping, workers and the surrounding environment are exposed to the asbestos fibers

- Exposure to asbestos fibers (even in very low concentrations) especially through inhalation may cause cancer and asbestosis.
How does shipbreaking pollute environment?

**Oil pollution**

➢ As a result of breaking the ships, oil residues and the other refuses are being spilled, mixed with the sea water and left floating along the entire seashore.

➢ Oil films on water reduce the exchange of oxygen and carbon dioxide across the air-sea interface which is harmful to aquatic life.
How does shipbreaking pollute environment?

Indiscriminate expansion of ship breaking activities poses a real threat to the coastal inter-tidal zone and its habitat.
What’s our progress?

We have collected samples from the workers working in 5 different shipyards:

- 20 hair samples
- 20 nail samples

From the same 5 shipyards we have also collected:

- 15 soil samples (3 samples from each yard)
What’s our progress?

We are doing this research work in collaboration with Chittagong University.
Services

Internal (without fee)

Different research Group of BAEC

For thermal, epithermal and fast neutron flux mapping in different irradiation locations;
Irradiation capsules development;
Improvement of irradiation conditions for RI production, etc.

External (with fee)

Arsenocosis patients

DoE, Govt. & NGOs, Universities, etc.
Services

Arsenocoisis patients
## As concentration in hair of some arsenocoiosis patients

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Patient Identity</th>
<th>Referred by Doctor</th>
<th>Arsenic Conc. µg/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mrs. Parveen Begum, age: 26Y, P.S.: Bhanga, Dist.: Faridpur</td>
<td>Dr. Mir Nazrul Islam, Consultant Dermatologist, BIRDEM Hospital</td>
<td>36.4±1.5</td>
</tr>
<tr>
<td>2</td>
<td>Mr. Nasir Uddin, age: 35Y, P.S.: Brahman Para, Dist.: Comilla</td>
<td>Dr. Mansurul Alam, Department of Dermatology &amp; STDs, Chittagong Medical College &amp; Hospital</td>
<td>5.31±0.32</td>
</tr>
<tr>
<td>3</td>
<td>Mis Amena, age: 16Y, P.S. and Dist.: Chandpur.</td>
<td>Prof. Dr. A.Z.M. Maidul Islam, Head of Skin &amp; V. D. Department, BSMM University</td>
<td>4.3±0.33</td>
</tr>
</tbody>
</table>

Normal value of As in human hair is less than 1 µg/g
### Services

**As concentration in hair of some arsenocoisis patients**

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Mrs. Sabina Zaman, age: 34Y, P.S. and Dist.: Gopalganj</td>
<td>Prof. Dr. A.Z.M. Maidul Islam, Head of Skin &amp; V. D. Department, BSMM University</td>
<td>25.5±5.1</td>
</tr>
<tr>
<td>5</td>
<td>Mr. Zahirul, age: 32Y, P.S.: Faridganj, Dist.: Chandpur</td>
<td>Dr. Kamrul Hasan Zaigirder, Skin &amp; STD’s. Department, BSMM University, Dhaka</td>
<td>3.64±0.41</td>
</tr>
<tr>
<td>6</td>
<td>Mr. Jahangir Hossain, age: 26Y, P.S. and Dist.: Chandpur</td>
<td>Dr. Mir Nazrul Islam, Consultant Dermatologist, BIRDEM Hospital</td>
<td>1.73±0.14</td>
</tr>
</tbody>
</table>
Projects

1. IAEA TC project: BGD/8/018 “Isotope techniques for mitigating arsenic in ground water (NAA component)”
   - Recently completed

2. ADP of Bangladesh Govt. Project: Strengthening the Utilization of TRIGA Reactor
   - On going

3. ADP (BGD Govt.) Project: Strengthening the Utilization of 3MW TRIGA Mark-II Research Reactor
   - On going
Academic Collaboration
Current students in NAA lab

**Ph.D.**
1. M. A. Hafiz – Dept. of Physics, BUET
2. Md. Matiur Rahman - Dept. of Physics, Jahangirnagar University
3. Rezaur Rahman – Dept. of Physics, Jahangirnagar University
4. M.M.H. Chowdhury - Dept. of Physics, Jahangirnagar University

**M.Phil.**
1. M. A. Salam - Dept. of Physics, Jahangirnagar University
2. M. A. Rouf – Dept. of Physics, BUET

**M.Sc.**
1. Md. Kamal Hossain– Dept. of Physics, Chittagong University
2. Ratneshar - Dept. of Physics, SUST
3. Saifur – Dept. of Env. Sciences, Jahangirnagar University
4. A. Kadir - Dept. of Env. Sciences, Jahangirnagar University
5. Amina Khatun - Dept. of Physics, Jahangirnagar University
Future Trend

# Although the BAEC TRIGA reactor has been operating since 1986, but because of several limitations its optimum utilization could not be achieved yet.

# The radial beam ports 1 & 2 and thermal column are still lying unutilized.

However, in order to optimize its utilization, several initiatives have taken.
Future Trend

A high resolution powder diffractometer (HRPD) is being installed at the radial beam port-1 under an ADP (Annual Development Program) Project financed by the Government of Bangladesh.

Expected Resolution:
\[ \Delta d/d \sim 1.5 \times 10^{-3} \text{ at } 2\theta \approx 80^\circ \]

Scanning Range \((2\theta)\): \(\approx 120^\circ\)

A pattern recording Time: 6-8 h

Schematic Diagram of Proposed HRPD
Future Trend

A digital neutron radiography setup is being installed at the tangential beam port under the same ADP project.
Future Trend

# A project has also been submitted under the ADP program for installation of PGNAA.

# The present analog console of the reactor will be replaced by a digital one under an ongoing ADP project.

# The establishment of $^{99m}$Tc kit production laboratory is also under process in the frame work of a separate ADP project.
Conclusion

Since its establishment, the BAEC TRIGA reactor has been utilized without any major incident.

However, a few minor incidents sometimes hampered the operation of the reactor.

For instance, the N-16 decay tank (DT) leakage problem that arose due to pitting corrosion at several areas of the DT caused by rainwater suspended the operation of the reactor at high power level for about 4 years (from 1997 to 2001).
Conclusion

With limited facilities, different utilization groups have been trying for proper utilization of BAEC TRIGA reactor in both fundamental research and service purposes.

But, in reality, the neutrons generated in the reactor core cannot be exploited efficiently using the present experimental facilities and, as a result, the optimum utilization of the BAEC TRIGA reactor is not being possible.
Conclusion

Under these circumstances, it is strongly felt that measures have to be taken up so as to update and extend the laboratory facilities with the help of national and international strategic partners.
Thank you