Radiation Technologies & Applications

Board of Radiation & Isotope Technology (BRIT) supplies a vast array of high quality radioisotope products for medical and industrial use. Setting up of radiation processing plants in private sector and their sustenance by supplying Cobalt-60 activity has been exemplary in the last decade.

4.5 Healthcare

More than 65000 cold kits for formulation of $^{99m}$Tc radiopharmaceuticals (code-TCK: 11 Products) and 500 Ci of $^{99}$Mo for separation of $^{99m}$Tc were supplied. Nearly 15000 consignments of ready to use radiopharmaceuticals of $^{131}$I, $^{32}$P, $^{51}$Cr and $^{153}$Sm were supplied. The supply of injectable products $^{153}$Sm-EDTMP and $^{131}$I MIBG has increased considerably.

Over 620 consignments of Geltech generators and activity of over 160 Ci $^{99}$Mo were supplied in spite of the various reactor related problems. The revenue generated was over Rs 1.2 Crore.

The installation of the $^{99}$Mo/$^{99m}$Tc of high specific activity $^{99}$Mo Column generator facility has been completed. The trial production run and supply of the product generators to RMC, BARC started in December 2011. The project has been completed as per the schedule.

About 9000 radioimmunoassay (RIA) and immunoradiometric assay (IRMA) kits were produced and supplied. Two newly developed IRMA kits for human thyroid stimulating hormone (hTSH) and for human follicle stimulating hormone (hFSH) have been approved for production and supply.

Regional Center, BRIT at Delhi supplied around 57,000 mCi of various ready-to-use $^{99m}$Tc radiopharmaceuticals products at an estimated value of Rs. 24.50 lakh. Retail outlet for supply of cold kits in Delhi sold around 1100 kits valued as Rs. 29 lakh.

Regional Centre, Bangalore supplied 63,740 mCi of ready-to-use $^{99m}$Tc formulations carried out 238 RIA investigations. 773 TCK cold kits were sold through retail outlet. 325 blood bags were irradiated. 538 consignments were collected on behalf of various customers in the region.

Regional Centre, BRIT at Kolkata radiolabelled porphyrin derivatives with 67Ga and 111In in collaboration with Radiopharmaceutical section, BARC and VECC. 68Ga labeling of EDTMP was achieved with 100% radiochemical purity for development of a new PET Bone imaging agent. A new infection imaging agent using a cephalosporin antibiotic ($^{99m}$Tc-Cefuroxime) is developed in collaboration with Department of Nuclear Medicine, Indian Institute of Chemical Biology, Jadavpur and RRMC, VECC.
Regional Centre, BRIT Dibrugarh has been rendering RIA and IRMA diagnostic services for the benefit of North-Eastern region. More than 10,000 patients benefitted from these services in the region.

5 Deuterated NMR solvents were introduced as new products after MoU was signed with Heavy Water Board.

Custom synthesized $^{14}$C-radiolabelled Ammonium thiocyanate (500 mCi) and 25 Ci of Tritiated water were supplied to M/s ONGC for oil exploration studies.

Jonaki has improved its multiplex PCR based M. tuberculosis detection kit and a real time PCR kit for detection of M tuberculosis is in progress. This work is being done in collaboration with Radiation Medicine Centre, BARC. The retail outlet for TCK Cold kits supply realised a sale valued at Rs.153 lakhs.

Radio-Analytical Laboratory carried out more than 4500 tests on export commodities and 845 tests on domestic water samples (gross alpha, gross beta $^{226}$Ra & $^{228}$Ra). During the year 845 water samples were received for the assay of uranium content. 335 samples received from Japan, were also received for radioactivity assay and certification.

New products such as $^{177}$LuCl$_3$, $^{177}$Lu-EDTMP and cold kit of EDTMP were analysed by Quality Control for Radiopharmaceuticals Division, BARC. Quality Control Monographs for 17 products for incorporation in Indian Pharmacopeia were prepared and submitted to RPC for approval. HPLC procedures were developed for Radiochemical Purity analysis of $^{99m}$Tc- MDP, MIBI and CEA (Carcino Embryonic Antigen) monoclonal Antibody.

### 4.7 Industrial Applications

36 Industrial Irradiator sources containing 600 kCi of $^{60}$Cobalt activity were supplied to three radiation processing plants in country at SARC, Delhi, Microtrol, Bangalore and UML, Vadodara.

About 1000 $^{192}$Ir Radiography Sources were fabricated and supplied to various NDT users in the country. Two Gamma Chambers (GC-5000) and two Blood Irradiators were loaded with $^{60}$Cobalt activity.

Identification of Gamma Chamber pencils was carried out at SWRI San Antonio, USA. This unit was supplied to Uruguay in April 1972.

At Regional Centre at Kota (RAPPCOF), 38.80 PBq (1048 KCi) of Cobalt-60 activity was processed of which 30.48 (824 kCi) was transported in 9 shipments. Two Cobalt Teletherapy Sources (CTS) were prepared using indigenous pellets. 32 W-91 pencils containing 599 Kilo Curies were welded and tested as per AERB guidelines for sealed source fabrication.
The ISOMED facility has been operating with an average load availability factor 99% and average utilization factor of 95%. A total of 4659 Cubic meters of healthcare products were processed for terminal Sterilization.

During the current financial year, about 2438 MT of spices and other products were processed at radiation processing Plant at Vashi which is about 30% increase over the corresponding period last year.

BRIT has long been involved and facilitating in setting up of radiation processing plants in private sector. Radiation Processing plant of Innova Agri BioPark, Malur was commissioned recently and a Radiation Processing plant at Hindustan Agrotech, Rahuri was inaugurated.

Two more MoUs for setting up of Radiation Processing Plant were also signed - one for M/s Maharashtra State Agricultural Marketing Board (MSAMB), Pune and the other for M/s MSV Laboratories Pvt. Ltd., Purab Medinipur, West Bengal.

BRIT has exported Gamma Chamber 5000 to National Institute for Physics & Nuclear Engg, Bucharest, Romania for US$ 140,000 FOB. BRIT has strengthened its presence in north – east India by supplying Low dose Irradiator at North Eastern Hill University (NEHU) Shillong for research purposes.

BRIT has added another model of ROLI in its fleet of radiography camera, a remotely operated hybrid shield camera with a capacity of 65Ci of $^{102}\text{Ir}$.

Gamma scanning of process columns was carried out at HPCL Vizag refinery for troubleshooting. The cause of malfunctioning was identified for an early remedial action. Radiotracer study was carried out in two oil wells of ONGC’s Gandhar oil field using tritium as tritiated water injected in one of the wells and carbon-14 as ammonium thiocyanate in the other. This is useful for taking decision on the enhanced oil recovery.

4.14 Supporting Services

The transportation of about 53,000 consignments of radioisotope and allied products, majority of them by air was carried out in a safe manner. Major transportation activities carried out during the year includes movement of kilocurie amounts of radioactive sources from RAPPCOF, Kota to Mumbai, and from Mumbai to respective destinations. Important information on the products, services, airway bill numbers for consignments, status of radiography cameras and various other activities of BRIT with minimum upload delay and nearly 100 percent uptime availability of its website.

Radioisotopes and allied products supplied by BRIT

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Item</th>
<th>Actual between April-December, 2011</th>
<th>Expected to be achieved April 2011 - March, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consignments</td>
<td>42300</td>
<td>≈ 53000</td>
</tr>
<tr>
<td>2</td>
<td>Total Activity</td>
<td>$762 \text{ kilo curies}$</td>
<td>≈ $1020 \text{ kilo curies}$</td>
</tr>
<tr>
<td></td>
<td>$^{60}\text{Co}$ Cobalt</td>
<td>724 kilo curies</td>
<td>≈ 965 kilo curies</td>
</tr>
<tr>
<td>3</td>
<td>Sale Value</td>
<td>Rs. 4320 lakh</td>
<td>Rs. 6000 lakh</td>
</tr>
</tbody>
</table>
Descriptive Part

CH 4 Radiation Technologies & Applications

Board of Radiation & Isotope Technology (BRIT) continued its mandate towards progress by regular production and supply of a vast array of high quality radioisotope products which include sealed radiation sources of activity ranging from few microcuries to millions of curies mainly for medical and industrial use; radiation technology equipment such as gamma radiography camera, gamma chamber units, Blood irradiators; radiopharmaceuticals, immunoassay kits, radiochemicals, labeled compounds, labeled biomolecules, $^{99m}\text{Tc}$ generators, ‘cold’ kits, oligo nucleotides, self-luminous compounds, etc. As a service provider, BRIT also operates plants for radiation sterilization of medical products (ISOMED) at Trombay; Radiation Processing Plant at BRIT Vashi Complex for radiation processing of spices and allied products, and runs Co-60 handling facility (RAPPCOF) at RAPS, Kota, JONAKI Laboratory at Hyderabad and has other Regional Centres located at Bangalore, Delhi, Kolkata and Dibrugarh. BRIT runs a Radio-analytical Laboratory at Vashi for detection of radioactivity in products for the benefit of various exporters and importers.

The various activities carried out by BRIT related to the production and supply of radioisotopes and allied products and radiation technology equipment for use in Healthcare, Industry, Agriculture and Research during the period of this report are as follows:

4.5 Healthcare

4.5.1. Radiopharmaceuticals

More than 65000 cold kits for formulation of $^{99m}\text{Tc}$ radiopharmaceuticals (code-TCK: 11 Products) were supplied to various Nuclear Medicine Centers. 300 Ci of $^{99}\text{Mo}$ (TCM-2) for solvent extraction and around 200ci of Mo-99 for Gel Generators was supplied to hospitals for separation of 99mTc. In addition to this various accessories of $^{99m}\text{Tc}$ solvent extraction generator system and other products were supplied. Nearly 15000 Consignments of ready to use radiopharmaceuticals of $^{131}\text{I}$, $^{32}\text{P}$, $^{51}\text{Cr}$ and $^{153}\text{Sm}$ were supplied to various Nuclear Medicine Centers. Majority of these contained $^{131}\text{I}$ radiopharmaceuticals, which amounted to about 450 Ci; over 15000 consignments. In general there has been a reduction in total radioactivity supplied because of short availability of raw material radioisotopes both locally, because of prolonged reactor shutdown and also because of global shortages of medical isotopes. The production and supply of $^{32}\text{P}$ as sodium orthophosphate was majorly due to unavailability of quality radioisotope$^{32}\text{P}$. The supply of following injectable products $^{153}\text{Sm}$-EDTMP and $^{131}\text{I}$ MIBG has increased to various nuclear medicine centers in India.

The ongoing contract work, of monoclonal antibody (ch TNT 1/B) labelling with $^{131}\text{I}$, for M/s Peregrine Pharmaceuticals Inc., USA, has been concluded.
The ongoing activity of production and supply of Geltech generators was continued and supplies to hospitals was maintained despite problems faced due to ageing plant (operational since past five years) and inability to undertake prolonged maintenance shut down on account of weekly production commitments. For the calendar year 2011, over 620 consignments of Geltech generators and activity over 160 Ci Mo-99 were supplied to nuclear medicine centres in the country and revenue generated was over Rs 1.2 Crore.

**Column Generator Plant**

The work on project for the production of $^{99m}$Tc Column generator using high specific activity $^{99}$Mo is being carried out.

The installation of the facility is complete. Cold runs have been completed. Currently the trial production and supply of product generators to RMC has been started in DECEMBER 2011. This project has been completed as per the fifth plan schedule as planned.
4.5.2 Nuclear Medicine : Diagnostic & Treatment Service

A total number of about 9000 radioimmunoassay (RIA) and immunoradiometric assay (IRMA) kits were produced and supplied to various hospitals, research centres and immunoassay laboratories throughout India.

Regulatory approval for the regular production and supply of newly developed IRMA kit for human thyroid stimulating hormone (hTSH) was obtained from Radiopharmaceutical committee (RPC). The user-friendly kit formulation based on in-house produced magnetizable cellulose particles along with ready to use serum based standards was included in BRIT product list and is now available to the customers. In addition, IRMA kit for human follicle stimulating hormone (hFSH) based on in-house produced magnetizable cellulose particle separation system is also now made available to the customers.

Development of IRMA procedure for human C-peptide was initiated and optimization of the assay procedure was completed after identification, screening and sourcing of the raw materials. The work on the kit formulation for the large scale production and supply is in progress and will be completed within next year.

Regional Center, BRIT, Delhi carried out production and supply of around 57,000 mCi of various ready-to-use Tc-99m Radiopharmaceuticals injections (Tc-99m Pertechnetate, MDP, DTPA, GHA, DMSA (V), Mebrofenin and S-Colloid Injections) in compliance with GMP and RPC for Diagnostic Nuclear Medicine Studies in 21 hospitals in Delhi and NCR region. The value of supplied Tc-99m Radiopharmaceuticals is estimated as Rs. 24.50 lakh.
Retail outlet for supply of cold kits for preparation of various Tc-99m Radiopharmaceuticals was utilized by Nuclear Medicine hospitals in Delhi. Around 1100 kits valued as Rs. 29 lakh were supplied.

An alternate column based solid-phase extraction method is developed for production of Tc-99m for clinical applications. This prototype Tc-99m generator using low/medium specific activity Mo-99 molybdate will be useful for clinical work.

Regional centre, Bangalore supplied 63,740 mCi of ready-to-use ⁹⁹ᵐTc formulations carried out 238 RIA investigations. 773 TCK cold kits were sold through retail outlet. 325 blood bags were irradiated. 538 consignments meant for customers in Bangalore region were collected by the Bangalore centre on behalf of customers in the region.

Regional Centre of BRIT at Kolkata works in close collaboration with Radiopharmaceutical section, BARC, VECC, Kolkata and Indian Institute of Chemical Biology (IICB), Jadavpur.

Centre was partially successful in radiolabelling different porphyrin derivatives with ⁶⁷Ga and ¹¹¹In were. ⁶⁸Ge produced by internal alpha irradiation of electroplated Zn target for ⁶⁸Ge-⁶⁸Ga radiisotope generator was carried out for the first time in India using indigenously produced ⁶⁸Ge. The direct use of ⁶⁸Ga for radiolabelling of peptides is limited for clinical PET applications by large eluate volume, high [H⁺], ⁶⁸Ge breakthrough and potential metal ion impurities, ⁶⁸Ga eluate is purified using SnO₂ column generator. The purification of Ga-68 elute from the ⁶⁸Ge-⁶⁸Ga SnO₂ column generator in 1N HCl involved retention of ⁶⁸Ga on a cation exchange resin.

Ga-68-EDTMP used for PET Bone imaging agent was prepared with Ga-68 adsorbed on the cation exchange column by eluting with EDTMP (50mg). The yield of Ga-68 in EDTMP was 75-80% and radiochemical purity of ⁶⁸Ga-EDTMP was 100%. A New target holder for external irradiation with high beam current was fabricated. An electroplated Zn target was irradiated with 40 MeV alpha particles at a max beam current of 3.5 A. The irradiation was successful and no damage of the irradiated target was observed. A modification of the solvent extraction system in ⁹⁹Mo-⁹⁹ᵐTc- SOLKOL (Solvent and Column) Generator was introduced. A PC controlled SOLKOL generator was installed at BRIT, Mumbai. A new infection imaging agent using a cephalosporin antibiotic (⁹⁹ᵐTc-Cefuroxime) is developed and being evaluated for potential use as bacteria specific infection imaging agent. Animal imaging studies were done in collaboration with Department of Nuclear Medicine, IICB, Jadavpur and RRMC, VECC. Bio-distribution studies: were done in collaboration with Department of Nuclear Medicine, IICB, Jadavpur.

A new Tumor imaging agent ⁹⁹ᵐTc-HYNIC-TOC is developed. HYNIC-OCT (~5mg) was radiolabelled with ⁹⁹ᵐTc using SnCl₂ method. The RC Purity was found to be >95%. High uptake of ⁹⁹ᵐTc- HYNIC-TOC was found in kidney possibly due to presence of somatostatin receptor in kidney. Protein bound drug was found to be 41 % in the blood serum of rat (TCA method). A few freeze dried kits were prepared at BRIT Vashi Complex with HYNIC-OCT supplied to them. A new derivative of octreotide analog HYNIC-HIS₃-TATE and its ⁹⁹ᵐTc complex were developed. HYNIC-HIS₃-TATE was synthesized by using semi-automated peptide synthesizer at IICB, Jadavpur. After
HPLC purification the purity was greater than 98% and mass was found to be m/z (M+H)
* = 1158. Radiochemical purity of ⁹⁹ᵐTc complex was found to be more than 98%. The
studies showed that the compound is specific to somatostatin receptor however this
compound is less potent than ⁹⁹ᵐTc-HYNIC-OCT.

The civil work for DAE Medical Cyclotron at the regional centre at Kolkata which was
held up for 2 years has resumed and it is expected to be completed by June 2012.

Regional Centre at Dibrugarh continues rendering its RIA and IRMA diagnostic services
for the benefit of North-Eastern region. These services are offered to a long chain of
hospitals in the region more than 10,000 patients benefitted from these services in 2011.

4.3.2 Nuclear & Biotechnological Tools

4.3.2.1 Labelled Compounds

Labelled Compounds Programme of BRIT is involved in the synthesis and supply of a
variety of ¹⁴C, ³H and ³⁵S-labelled products, oligonucleotides (DNA primers) and
ready-to-use non-radioactive (cold) kits meant for nucleic acid labeling. All these
products are powerful and versatile tools and are used as radiotracers in diverse
investigations in the fields of biology, agriculture, medicine and chemistry.

Labelled Compounds Programme is also involved in the production and supply of tritium
filled sources of various types for defence applications. These sources are used for the
illumination of military gadgets and instruments.

Custom-synthesis of various radiolabelled compounds using Carbon-14 and tritium
radioisotopes was also regularly carried out to meet the specific requirements from
researchers.

In addition to the above, the section has carried out the method development for the
preparation of some deuterated NMR solvents having deuterium abundance >99%, as
part of the MoU signed by BRIT with Heavy Water Board. Five such solvents, prepared
both by BRIT and HWB are launched for commercial supply.

Details of the products dispatched during the year 2011-12 is given below*.
(Corresponding data for the year 2010-11 is also given for comparison).

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Total No. of Consignments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 2011-12*</td>
</tr>
<tr>
<td>¹⁴C-products</td>
<td>14</td>
</tr>
<tr>
<td>³H-products</td>
<td>23</td>
</tr>
<tr>
<td>³⁵S-products</td>
<td>57</td>
</tr>
<tr>
<td>Kits</td>
<td>01 (20 Nos.)</td>
</tr>
<tr>
<td>Oligonucleotides</td>
<td>13 (204 Nos.)</td>
</tr>
<tr>
<td>Custom synthesis/TLS</td>
<td>03</td>
</tr>
<tr>
<td>TFS &amp; TTS (Tritium Sources)</td>
<td>25 (6594 Nos.)</td>
</tr>
<tr>
<td>¹⁴C-urea capsules</td>
<td>03 (180 Nos.)</td>
</tr>
<tr>
<td>Taq DNA Polymerase</td>
<td>02 Nos. (15000 U)</td>
</tr>
</tbody>
</table>
Highlights

1. Custom synthesis and supply of $^{14}$C-radiolabelled Ammonium thiocyanate (500 mCi) and tritiated water (25 Ci) to M/S. ONGC.
2. Carbon-14 labelling of Tulsi plant by growing in a medium containing carbon-14 radioisotope for Haffkine Institute, Mumbai.
3. Identification of tritiated baicalein (a cardio protector) in tritiated Arjun sal.
4. Launching of selected deuterated NMR solvents for commercial supply.

4.3.2.2 JONAKI Laboratory at CCMB Campus, Hyderabad

Jonaki has entered in the field of Molecular Diagnostics two years back with gel based PCR detection kit for MTb. This gel based PCR detection kit has since been improved by standardizing multiplex PCR based M. tuberculosis detection kit. The performance of this kit has been evaluated by corporate hospitals and will be subjected to validation by drug authorities for approval as diagnostic kit.

Real time PCR kit for detection of M tuberculosis based on the BRIT’s patented Real time PCR chemistry developed at Jonaki laboratory is in progress. The RTPCR kits when introduced, will make an impact in the diagnostic area since hospitals now prefer real time based detection rather than the conventional PCR method. All the more BRIT kits would carry a validation report based on the locally prevalent type of MTb population. This work is being done in close collaboration with Radiation Medicine Centre, Parel.

In addition to the above product development Jonaki Lab produces and supply $^{32}$P labelled nucleotides, Molecular diagnostic kit for MTB Detection and other molecular biology research needs such as Taq DNA polymerase enzyme, Nucleic acid Isolation kits etc. which are required for Molecular Biology, Biotechnology and Biomedical and drug discovery research. Jonaki also markets $^{35}$S labelled amino acids produced by Labelled compounds, BRIT, Vashi. Retail out let for TCK Cold kits for nuclear imaging is successfully managed and Jonaki we cater to all the nuclear medicine centres in Andhra Pradesh and to other places on request. Annual Sales value for Jonaki is Rs.152.76 lacs during the year.

4.3.2.3 Radio-Analytical Laboratory, Vashi Complex, Navi Mumbai

Radioanalytical Laboratory is engaged in the measurement and certification of man-made residual radioactivity in commodities such as food samples, animal feed supplements, steel, water and soil samples and other miscellaneous items. Food items are monitored for the presence of $^{137}$Cs & $^{134}$Cs. In addition to these two isotopes, presence of $^{131}$I is also monitored in food items imported from Japan. Water samples are routinely analysed for gross alpha/gross beta, uranium, $^{226}$Ra and $^{228}$Ra content, depending upon the requirement.
During April -December 2011, RAL has carried out more than 4500 tests on export commodities and 845 tests on domestic water samples (gross alpha, gross beta $^{226}$Ra & $^{228}$Ra). During the year 845 water samples were received for the assay of uranium content.

In addition to above, 335 samples imported from Japan, were also received for radioactivity assay and certification.

**Quality Control Program**

QCP is responsible for the analysis of various ready-to-use radiopharmaceuticals, Technetium cold kits, certifying the product for release of QC reports. A total of 480 batches were analyzed in 2011 which also included 195 ready to use radiopharmaceuticals kits.

New products such as $^{177}$LuCl$_3$, $^{177}$Lu-EDTMP and cold kit of EDTMP were analysed by Quality Control for Radiopharmaceuticals Division, BARC. Quality Control Monographs for 17 products for incorporation in Indian Pharmacopeia were prepared and submitted to RPC for approval.

Use of HPLC as an alternate method for analysis of $^{131}$I-mIBG was approved and method for determination of specific activity of $^{131}$I-mIBG was published in the Journal of Labeled Compounds and Radiopharmaceuticals 2011. HPLC procedures were developed for Radiochemical Purity analysis of $^{99m}$Tc- MDP, MIBI, and CEA monoclonal Antibody. A 3 week Hospital Radiopharmacy Course for DRM and DMRIT trainees was conducted. A Biological Safety Cabinet Class III is established at BRIT Animal House QC personnel were a part of DAE Group Achievement Awards for $^{131}$I mIBG, $^{18}$F-FDG and Cold kits on TRODAT and HSA.

**Quality Assurance**

91 Batch records of TCK products have been documented. Digitization of all the batch records initiated and is in practice. QA implementation in ready to use radiopharmaceuticals has been initiated with IOM-1. Calibration work was performed on radiation counters with C& I group.

**4.5.3. Nuclear Medicine: Cancer diagnostic & treatment services**

**Co-60 Teletherapy Sources**: Two numbers of teletherapy sources were supplied to different hospital with total activity 185 and 146 RMM. Another 13 numbers of sources are ready for supply. 8 numbers of decayed sources were unloaded from the teletherapy units and stored for fabrication of irradiator source.

**Industrial Applications**

**4.7.1. Radioisotope Sources.**
36 numbers of Irradiator sources were supplied to following Irradiator with total activity of 600 kCi

SARC, Delhi - 200 kCi
MICROTROL, Bangalore - 200 kCi
UML, Vadodara - 200 kCi

814 Ir-192 Radiography Sources ranging from 20 Ci to 70 Ci with a total activity of 31 kCi, 8 Co-60 Radiography Sources ranging from 20 Ci to 100 Ci with a total activity of 388 Ci and 1 Tm-170 radiography source with 5 Ci activity were fabricated and supplied to various NDT users in the country.

Following Custom made Radiation Sources for Nucleonic Gauges and uses were made:

Co-60: 13 sources with activity of 1978 mCi
Cs-137: 5 sources with 4705 mCi
Eu-152: 1 source with 33 mCi of activity

Two Gamma Chambers (GC 5000) were loaded with 14000 curie of $^{60}$Co- Cobalt activity each with total of 28000 Ci. Two Blood Irradiator (BI 2000) were loaded with 808 Ci of $^{60}$Co-Cobalt each with total activity of 1600 Ci. One Cs-137 kit (CSA) with 579 mCi of Cs-137 and 100 cm of Ir-192 + Pt Wire with activity of 643 mCi were also supplied. Identification of Gamma Chamber pencils at SWRI, SAN ANTONIO, USA. This unit was supplied to Uruguay in April 1972.

At regional centre at Kota, i.e. RAPPCOF, a total activity 38.80 PBq (1048 KCi) of Cobalt-60 was processed of which 30.48 (824 kCi) was transported in 9 shipments.

Two Cobalt Teletherapy Sources (CTS) were prepared using indigenous pellets. For the same cobalt pellet capsules were cut and pellets were recovered. Procedure for cutting and recovery of pellets and their handling was as per the guidelines approved by regulatory committees. After loading the pellets in inner CTS capsule it was welded and tested as per the AERB guidelines for sealed source fabrication. 32 W-91 pencils containing 599 Kilo Curies were welded and tested as per AERB guidelines for sealed source fabrication.

4 Pellet Absorber rods were transported from NAPS to RAPPCOF following strict radiation safety guidelines. Absorber rods were discharged in RAPPCOF pool. A team of RAPPCOF went to Shriram Applied Research Centre (SARC), Delhi for source loading. Source loading was successfully done as per the loading pattern.

4.7.2. Gamma Radiation Processing Services (GRPS)

4.7.2.1. Radiation Sterilization Plant for Medical Products (ISOMED)

The Facility had been operating in full compliance with the statutory guidelines with an average load availability factor 99% and average utilization factor of 95%. A total 4659 Cubic meters of healthcare products were processed for terminal Sterilization between
April 2011 to November 2011 thus generating revenue of 191.5 lakhs. Different suppliers to the nuclear industry for thermal insulations/power cables/paints/instrumentation devices etc. availed themselves of the gamma radiation processing services of the facility for meeting the stipulated requirements of radiation performance qualification.

As part of the regulatory approval procedures, the operating license of the facility has been renewed by AERB from July 2011, up to June 2014. GMP plan of the facility has been accorded formal approval by the Food and Drug Administration (FDA) – Bandra, Maharashtra.

Contextually the facility has recently received the compliance note from the World Wide Quality Management System of M/s. Johnson & Johnson (Medical) – Ethicon-USA in respect of contract radiation processing services for terminal Sterilization of their products.

4.7.2.2 Radiation Processing Plant, Vashi (RPP, Vashi)

Radiation Processing Plant, Vashi is providing gamma radiation processing services for spices, ayurvedic raw material, healthcare products and pet feed etc. to more than 150 customers from all over the country. Ten new customers for spice, ayurvedic raw material and pet feed were registered with the facility during this period.

During the current financial year, about 2438 MT of spices and other products were processed till November 2011 which is 29.4% increase in quantity over the corresponding period last year (1885 MT). Revenue generation till November 2011 is about 146.74 lakhs which is about 12% more than the revenue generated in corresponding period last year (131 lakhs). This year the plant is expected to process around 3000 MT spices and allied products yielding revenue of about 190 lakhs. Since its inception, this facility has processed about 18,338 tonnes of products realizing revenue of about Rs. 979.74 lakhs.

Source replenishment was carried out to enhance source strength from 350 kCi to 500 kCi to cope up with the increased demand for radiation processing. Product scanning machine has been installed and commissioned to screen incoming products for detection of security threatening materials inside packaging.

Approval was obtained from FDA, Maharashtra for sterilization of health care products in the facility. Surveillance Audits for ISO-9001:2008 (Quality Management Systems) and ISO-22000:2005 (Food Safety Management Systems) were carried out and found to be in full compliance with the requirements of the standards.
4.7.2.3 New Radiation Processing Plants in Private Sector

BRIT has been involved in setting up of radiation processing plants in private sector. Radiation Processing plant of Innova Agri BioPark, Malur is commissioned. A radiation processing plant at Hindustan Agrotech Rahuri was inaugurated.

Radiation Processing plant at Innova Agri Bio-Park, Malur is commissioned.

A view radiation processing plant at Hindustan Agrotech Rahuri

Two new MOU for setting up of Radiation Processing Plant were also signed, one for M/s Maharashtra State Agricultural Marketing Board (MSAMB), Pune and the other for M/s MSV Laboratories Pvt. Ltd., Purab Medinipur, West Bengal.
MOU signed with M/s Maharashtra State Agricultural Marketing Board, Pune
4.7.3. Radiation Technology Equipment

4.7.3.1. Gamma Chamber GC 5000

During the current financial year Gamma Chamber GC 5000 has been supplied to Following Institutes/organizations.

- BRIT has exported Laboratory Research Irradiator, Gamma Chamber 5000 to National Institute for Physics & Nuclear Engg, Bucharest, Romania for US$ 140,000 FOB. It has been sent by Cathay Pacific Airlines to Paris and from Paris to Bucharest by Road. The order was received through IAEA. The unit has been installed.

- Gamma Chamber GC 5000 supplied and installed at Mangalore University
• Gamma Chamber GC 1200 supplied and installed at Inter University Accelerator Centre, New Delhi

• BRIT has strength its presence in north – east India by supplying Low dose Irradiator at North Eastern Hill University (NEHU) Shillong for research purposes.

• Gamma Chamber GC 5000 has been made ready for dispatch to Berhampur

• Compact single bag blood irradiator has been designed and fabricated. It has hybrid shielding of Tungsten - Lead and can be loaded with 275 Ci of Co-60.

4.7.3.2. Radiography Camera ROLI-1 & III

BRIT supplied 72 radiography exposure devices up December 2011. It is expected to sell another 15 cameras by March 2012.

384 ROLI cameras were serviced up to December 2011 and another 130 cameras will be serviced before March 2011. 722 decayed sources were removed between April December 2010. Another 270 sources will be disposed off by March 2011. 693 imported cameras were inspected by December 2011.

By March 2012 another 250 imported cameras will be inspected.

BRIT has added one more model ROLI – II in its fleet of radiography camera. It is remotely operated hybrid shield camera with capacity of 65Ci of Ir-192.

The camera has been approved as Type B(U) by AERB after successful test of accidental conditions of transport at ARAI, Pune

4.7.3.3. Blood Irradiator
The production and supply of Blood Irradiator BI 2000 has been pursued further.

- BRIT has Supplied and installed Blood Irradiators/LDI for Tata Memorial Centre, Kolkata,
- 2 nos of BI 2000 are made ready for dispatch to CMC Vellore
- It is expected that few more Blood Irradiators will be supplied in this financial year

4.7.3.4 Install & Operate Irradiator

Cold commissioning of Install and Operate Irradiator is completed. Irradiator will be used for radiation processing of frozen Marine products, spices, flour and medical products. It has 200 litres of irradiation capacity and can be loaded with 400 kCi of Co-60 source. Irradiator is so designed that its main cask can be used as irradiator as well as transportation cask.

4.7.3.5. QA of Sealed Sources, Radiometry Scanning and Irradiation Services

Target holder assembly designed and fabricated at REPF workshop of BRIT for production of new medical radioisotopes of Copper, Tcnicium, Rhenium, Iodine etc at Medical Cyclotron Facility, Parel.

ROLI 1 cameras were tested at the REPF workshop and the Radiological lab of BARC. Density measurements were carried out on cobalt-59 pellets and slugs and also chemical analysis and XRF analysis were carried out for the acceptance of the material for irradiation.

All the sealed sources were subjected to the various quality control checks before release.

BRIT has modified and enhanced capacity of its main transportation cask BLC from 100kCi to 125 kCi Co-60. The new cask was subjected to actual test at ARAI, Pune as per type B(U) requirements of national and international standards of safety for transportation and has been approved by AERB. The New cask (BLC-125) will be used for the supply of Irradiator sources.
4.7.3.6. Isotope Application Services

Gamma scanning of process columns in petroleum refineries, petrochemicals and chemical industries has a great techno-economic impact. Gamma scanning of various process columns has been carried out in HPCL Vizag refinery (Crude distillation units; viz. CDU1 vacuum and CDU3 atmos) for troubleshooting. The cause of malfunctioning was exactly pinpointed which helped refinery engineers to take an early remedial action. For recording base data of the scans in the two columns (viz. CDU2 vacuum and atmos) when they are working satisfactorily signature scanning was carried out which will be useful in future troubleshooting of the columns.

Radiotracer study was carried out in two oil wells of ONGC, Gandhar oil field. Tritium as tritiated water was injected in one of the water injection wells and carbon-14 as ammonium thiocyanide in the other. Oil water samples will be drawn from various surrounding production wells. The samples will be assayed using liquid scintillation counter. Appearance of the radiotracer in specific production will give information about the hydrodynamics of the injected water in the oil reservoir. This is useful for taking decision on the enhanced oil recovery.
Pipe scanner initially developed at REPF workshop (housing ~5 mCi 137Cs) for scanning a reflux return pipe of oxidation reactor at RIL, Hazira could pinpoint the cause of liquid hold up and inefficient heat transfer. Later, modified scanner made of SS and tungsten collimators was used for scanning different pipelines from crude distillation unit carrying product to the fractionator. This helped in pinpointing the reduced thickness of the pipeline as vulnerable.

4.14. Supporting Services


As the nodal agency for sales co-ordination & logistics, Customer Support Programme continued to provide support for the regular and uninterrupted supply of radioisotopes & allied products and radiation technology equipment to about 2000 user institutions in the healthcare, industrial, research and agricultural sector.

During the year 2011-12 BRIT continued serving its customers and made it more convenient for its customers to interact with the officials of BRIT and regulatory authorities in matters relating to procurement and use of radioisotope products and equipment. The retail outlet for supply of cold kits set up for the benefit of nuclear medicine user institutions in and around Mumbai continued serving customers bringing in a revenue of approximately Rs. 16 lakhs.

The transportation of about 53,000 consignments of radioisotope and allied products, majority of them by air was carried out in a safe manner. Major transportation activities carried out during the year includes movement of kilocurie amounts of radioactive sources from RAPPCOF, Kota to Mumbai, Mumbai to Vadodara, Delhi, Vasai and Ambernath; and teletherapy sources from Mumbai to various cancer hospitals in the country and Gamma Chamber and Blood Irradiator units to various research centres and hospitals.

BRIT website provided information on the products, services and various activities of BRIT. The website continued to provide prompt information on the airway bill numbers for the despatched products and a regular update on the status of radiography cameras besides the important customer oriented messages. Website is updated on a daily basis and includes ordering forms for the customers besides information on scientific aspects. Proposal for making BRIT website GIGW compliant is being finalized with NICSI.

Radioisotopes and allied products supplied by BRIT

<table>
<thead>
<tr>
<th>Sr.N o</th>
<th>Item</th>
<th>Actual between April-December, 2011</th>
<th>Expected to be achieved April 2011 – March, 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Consignments</td>
<td>42300</td>
<td>≈ 52400</td>
</tr>
<tr>
<td>2</td>
<td>Activity</td>
<td>762 kilo curies</td>
<td>≈ 1020 kilo curies</td>
</tr>
<tr>
<td></td>
<td>60Cobalt</td>
<td>724 kilo curies</td>
<td>≈ 965 kilo curies</td>
</tr>
<tr>
<td>3</td>
<td>Sale Value</td>
<td>Rs. 4320 lakh</td>
<td>Rs. 6000 lakh</td>
</tr>
</tbody>
</table>
4.14.2. Engineering Services

Engineering services provided the vital infrastructure and utility services to BRIT and BARC facilities at Vashi Complex, Project House at Deonar and ISOMED at Trombay.

Efficient operation & Maintenance of the two 22 KV substations at Vashi complex led to achieve a unity power factor that saved Rs. 15 to Rs.20 Lakhs by way of incentive from MSECDL. Services are also provided for maintenance of electrical equipments like window A/cs, lighting fixtures and Telephone exchange. A centralized workshop caters support for minor fabrication and repair requirements. The workshop is equipped with two EOT cranes for the heavy duty material handling. Civil, Cosmetic & Horticultural maintenance and pest control system support is also provided by engineering services.

Status of the Plan Projects

X Plan Projects

BRIT has taken up several projects for execution under the plan project scheme. All these projects have been aimed to enhance its capacity for the development of new products, improvement in quality and also development of infrastructural facilities. Under the X Plan, in the three major projects, progress has been made as given below:

Integrated Facility for Radiation Technology (IFRT)
Revamping and Augmentation of Infrastructural Facility (RAIF)
DAE Medical Cyclotron at Kolkata

- Project: Integrated Facility for Radiation Technology (IFRT)

Objective of the project is to set up a Hot Cell at BRIT Vashi Complex for handling, storage and fabrication of sealed sources up 300 kCi of Co-60. The financial outlay of the project is Rs. 1805 lakh.

This project is in advance stage of execution as civil construction for administrative building, water pool, Radiometry room and
Hot Cell has been completed. Installation of crane and ventilation system is in progress. Project is expected to be completed as per schedule.

2. Project: Revamping & Augmentation of Infrastructural Facilities (RAIF)

The project is proposed for Revamping and Augmentation of Infrastructural Facilities of BRIT at Vashi to enhance infrastructural support for production facility. The major activities of the project is to procure instruments and equipment for revamping and augmenting production, quality and safety of operations and personnel. Financial outlay of the project is Rs. 1592 lakhs and completion date is March 2011.

Civil construction for install and operate irradiator is completed and clean room facility has been commissioned. Apart from this procurement of equipment is in progress and Automated Column Scanning system has been procured and also mobile Hot Cell has been fabricated and supplied. Fabrication of installed and operate irradiator is completed and supplied. Project is completed.

3. Project:: DAE Medical Cyclotron Project: Pharmaceuticals Facility

A medical cyclotron facility is being installed at VECC, DAE, and Kolkata for the production of PET and SPECT radioisotopes to be used for diagnostic and therapeutic purposes. Major equipment including hot cells has been procured. Isotope for establishing procedure for production is being procured.

XI Plan Projects

Apart from the XI Plan project there are 5 more projects which are proposed for execution under XI Plan. These projects are aimed towards development of new products, improvement in quality of existing products and improvement in manufacturing processes. One number project “Production facility of medical grade Fission Moly has been added and has been approved.

Brief description of the XI plan projects is given below:

1. Project : Integrator Irradiator Development Project

Estimated Cost: Rs.300 lakhs

Objectives

To upgrade safety and security features in the RPP, Vashi and ISOMED facilities and to set up an Irradiator Training Facility for training of personnel for operation of irradiator.

Progress: Following work has been carried out:
Access control system installed at Vashi.
System for vehicle tracking system has been installed
Early fire warning system for ISOMED is procured
Aerosol generator has been designed and fabricated
Pamcrash software for safety evaluation of cask has been procured.
Single bag blood irradiator has been fabricated and supplied
Scale down model of Medical sterilizer has been fabricated and supplied


Estimated Cost: Rs. 750 lakhs.

Objectives.

Setting up of a new automated facility for production of Mo-99 Tc-99m Column Generators using high specific activity Mo-99.

The installation of the facility is complete. Cold runs have been completed Currently the trial production and supply of product generators to RMC has been started in DECEMBER 2011. This project has been completed as per the fifth plan schedule as planned.

3. Project: Construction of State-of–the-Art Immunoassay Facility

Estimated Cost: Rs. 205 lakhs.

Objectives.

Development of building up of infrastructure for coated tube technology and state of the art Laboratory with GMP/GLP compliance with a special focus on contract manufacturing.
Development and building up of infrastructure for immunoassay based on non-isotopic labels.
Development of diagnostic kits for infectious diseases.

Progress: Procurement of following equipments needed for development of isotopic/non-isotopic assays has been completed.

Spectrophotometer
Dehumidifier
Multi-well RIA counter
Laboratory has been refurbished partly
BT reader
RO water system
T3 antibody

4. Project: Construction of State-of-the-Art GLP and GMP
Estimated Cost: Rs. 340 lakhs.

Objectives.

Upgradation of the laboratory for GLP and GMP compliance by following:

a. Removal of the existing corroded 20 years old fume hoods, cut and disposal through WMD.
b. Installation of new fume hoods
c. Wear resistant laboratory flooring of Laboratory.
d. Furnish the lab and facelift office for aesthetic look.
e. Introduce the state of he art synthesis facility, enhance the analytical evaluation, quality control of he labeled compounds. Introduction of microwave synthesis and introduction of instrumental analysis.
f. Augmentation of oligo-nucleotides synthesis facility.
g. Setting up of state of the art lab for C-14 urea capsule production and
h. Setting up of low background counting lab food analysis.

Progress: Following work has been carried out

- Decontamination of working tables and fume hoods in two laboratories is completed
- Order placed for procurement of stainless steel fumehoods (12 Nos), new working tables, flooring, paneling etc.
- HPLC instrument is procured
- UV spectrophotometer and Portable liquid scintillation is procured.
- Refurbishment of Lab is in progress.
- 12 nos of Fume hoods fabricated and supplied

5. Project: Indigenous HDR Brachytherapy Equipment (IHDR)

Estimated cost: Rs. 800 lakhs

Objectives:

a) Establishing the complete process and facilities for fabrication of Ir-192 HDR sources for regular production.
b) Development of indigenous, remote operated high dose rate (HDR) brachytherapy equipment including necessary treatment.

Progress:
First prototype of IHDR has been successfully developed, unit received on March 2011. Extensive Cold trials are being done. Problem encountered during cold trials and specific suggestions of the users are to be implemented in next unit due to be received in
Jan'2012. Miniature I-192 source assembly for IHDR has been developed & AERB approval obtained.


A new project “Setting up of Medical use Mo-99 production (LEU fission based) facility”, under XI plan has been sanctioned for BRIT by Atomic Energy Commission. Project is scheduled to be completed by 2014.

Estimated Cost Rs. 128 crore

Objectives
- Mo-99 production (LEU fission based) facility
- Supply Fully indigenous column generators to various diagnostic centres and hospitals in the country.

Progress:
The site clearance has been obtained from AERB and the designs for the building are finalized. Coordination is being done with Reactors Group and Nuclear Fuels Group, BARC for LEU (Low Enriched Uranium) targets design and fabrication. Two part tender has been floated and techno commercial bid has been opened.