

Brit

ANNUAL REPORT

2014-2015



BOARD OF RADIATION & ISOTOPE TECHNOLOGY



DEPARTMENT OF ATOMIC ENERGY



GOVERNMENT OF INDIA

BOARD OF RADIATION & ISOTOPE TECHNOLOGY



ANNUAL REPORT

2014-2015

CELEBRATING *the* PAST (SILVER JUBILEE *on* 1st March, 2014)

LIVING *the* PRESENT

PREPARING *for the* FUTURE

CONTENTS

Chapter 1:	<i>Executive summary</i>	01
Chapter 2:	<i>Descriptive Part</i>	08
Chapter 3:	R & D Activities of BRIT	23
Chapter 4:	HRD Programmes	32
Chapter 5:	Status of Plan Projects	43

Chapter 1:



Board of Radiation & Isotope Technology (BRIT), the unit of DAE, has shown remarkable growth in the year 2014 in providing socio-economic benefits derived from the use of radiation and radioisotope products and services in a variety of areas such as medicine, industries, radiation processing services, radioanalytical services and other isotope applications for industrial services. It celebrated its Silver Jubilee on March 1, 2014. The celebration was graced by the presence of eminent scientists of DAE, Dr. Anil Kakodkar, Former Chairman Atomic Energy Commission & Secretary to DAE and Dr. Sekhar Basu, Director, BARC & Chairman BRIT Board.



BRIT celebrated its Silver Jubilee on 1st March, 2014

Healthcare Applications

Radiopharmaceuticals Production (RPhP)

More than 23000 consignments of ready to use radiopharmaceuticals of Na¹³¹I for diagnosis and therapy of thyroid disorders, ¹³¹I-mIBG for neuroendocrine cancers, ³²P, ¹⁵³Sm and ¹⁷⁷Lu for bone pain palliation were supplied to various nuclear medicine centres and hospitals all over India.

Milestone production of 3Ci per batch of Na¹³¹I could be achieved with the product of denomination of 25mCi, 50mCi, 100mCi and 125mCi.

Total number of therapeutic treatments, based on supplies, are estimated to be 18960. This includes therapeutic doses of Na¹³¹I for the treatment of thyroid cancer and hyperthyroidism.

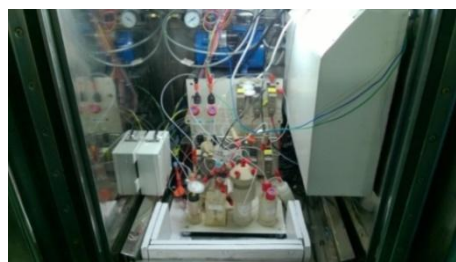
More than 73500 cold kits for formulation of ^{99m}Tc radiopharmaceuticals (15 Products; BRIT Code-TCK) were supplied to nuclear medicine centres.

A separate GMP compliant cold storage facility for *in-vivo* TCK cold kits is commissioned at RPhP, BRIT in June 2014.

Approx. 195Ci of ⁹⁹Mo, in form of Sodium Molybdate solution, for solvent extraction generator, and ⁹⁹Mo-^{99m}Tc Gel Generator were supplied. Approximately 400Ci of ⁹⁹Mo (1150 generators) in the form of Sodium Molybdate were supplied as alumina column generator (COLTECH). COLTECH generator of 1Ci capacity is also introduced.

More than 2,08,245 *In-vivo* diagnostic investigations are estimated to have been carried out this year with varied diagnostic radiopharmaceuticals, the major are, ^{99m}Tc based on cold kits and ⁹⁹Mo-^{99m}Tc generator systems.

Medical Cyclotron Facility (MCF), Parel continued the supply of PET radiopharmaceuticals such as ¹⁸F- FDG, ¹⁸F-FLT, ¹⁸F-NaF and ¹⁸F- FMISO to various hospitals in and around Mumbai. **Approx. 14444 patients benefitted with PET investigations.**



Module for sterile, injection grade [F-18]NaF

Approx. 5575 radioimmunoassay (RIA) and immunoradiometric assay (IRMA) kits amounting to carry out about **5,72,000 in-vitro investigations**, were supplied to various hospitals, research centres and immunoassay laboratories throughout India.

RIA products and RIA Laboratory are certified for ISO 9001:2008 and ISO 13485:2008 from United Kingdom Accreditation Services (UKAS).

QA, QC and Allied Services

Around 700 routine radiopharmaceuticals samples were analysed by QC. Cold kits for preparation of ^{99m}Tc -DMSA, ^{99m}Tc -MAA, ^{99m}Tc -Myoview and ^{99m}Tc -Exametazime were analysed **for outside agencies**, M/s DraxImage and GE Healthcare.

94 batches of TCK products were released after scrutiny of production & QC documents before their despatch.

Regional Centres at Delhi, Bengaluru, Kolkata, Jonaki Hyderabad continued supply of radiopharmaceuticals to surrounding Nuclear Medicine hospitals.

Labelled Compounds (LC)

Labelled Compounds Programme of BRIT continued the synthesis & supply of a variety of ^{14}C , ^3H and ^{35}S -labelled products and various types of Tritium Filled Self-luminous sources (TFS). More than 59500 TFS sources were supplied to defence establishments.

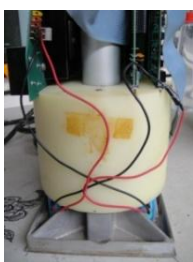
Radioanalytical Laboratory Services (RAL)



Radioanalytical Laboratory carried out more than 12000 tests on domestic commodities and 1100 tests on water samples (gross alpha, gross beta, ^{228}Ra & ^{228}Ra). Nearly 5300 water samples received from Punjab State were analyzed for the certification of uranium content alone. Five steel surveys were conducted for certification of surface radiation dose of ^{60}Co . 40 food samples were monitored for the presence of ^{137}Cs & ^{134}Cs , which were received from Japan.

Engineering Applications

Contract with Los Alamos National Laboratory USA for identification of source to repatriate US origin sources was completed for the five institutes in India.



RAPPKOFF, Kota continued processing, production and transportation of Cobalt-60 sources. Total activity of Co-60 processed in the year 2014 was 63.52 PBq (1717KCi).

Ten **Co-60** teletherapy sources (CTS) were supplied to different cancer hospitals India and also to Cancer Hospital, Zambia.

Fifty eight Irradiator sources were supplied with total activity of 12, 59,593 Ci. Eight **absorber rods** were unloaded and transferred to RAPPKOFF pool for irradiators and teletherapy sources.

More than 1200 Ir-192 and Co-60 Radiography sources were supplied to NDT users. Sc-46 and Cs-137 CMR sources were supplied to various organisations.

Radiation Technology Equipment

60 radiography cameras, ROLI-2 and ROLI-3 were supplied.

3 each of Gamma Chamber 5000 and Blood Irradiator 2000 are supplied to different universities and hospitals for various applications.

Engineering Design Development

Syringe Shield: BRIT has developed a syringe shield to be used as a protective gear in hospitals while administering $^{99m}\text{TcO}_4^-$ or its products (or any radioactive injectables) to patients.

Gamma Scanning Simulator Column (GSSC): A scale down model of Crude Distillation Units (CDU) as GSSC has been constructed at BRIT to simulate anomalies such as flooding, weeping, missing tray, tray misalignment and light foam / heavy foam formation and to train in finding out the faults.



Syringe Shield



Gamma Scanning Simulator Column

Gamma Radiation Processing Services (GRPS)

Radiation Sterilization Plant for Medical Products (ISOMED):

ISOMED facility has acquired the OHSAS 180001: 2007, EMS 14001:2004 and WHO-GMP certifications during 2014. It has designed and validated bar-coded, GMP Complaint computerised application package for commercial products from BRIT. **Cumulative volumetric figures for the current fiscal was 7370 Cubic Mtrs from the contract radiation processing services for terminal sterilization of healthcare products.**

Radiation Processing Plant, Vashi (RPP, Vashi):

About 2700 MT of spices and other products like nutraceuticals and colour pigments were processed. Since its inception, this facility has processed 30550 tons of products.

A facility which is approved by AERB has been set up for calibration of Nuclear Radiation Survey Meters and portable radiation monitoring of instruments at Vashi Complex.

BRIT in overseas market

BRIT participated in construction of Blood Irradiator for IAEA's Southern Tsetse Fly Eradication Project (STEP) at Addis Ababa, Ethiopia jointly with M/s. Symec. BRIT supplied 60 kCi Co-60 source and provided other services such as dosimetry, source loading pattern design etc.



**Southern Tsetse Fly Eradication Project
(STEP), Ethiopia**

Order from IFRB, Bangladesh was executed for supply of 55 kCi Co-60 source for PANBIT Irradiator and expert services provided for refurbishment of plant.

MOU for Radiation Processing Plants (RPP):

MoU was signed with M/s Raghuvansh Agrofarms Ltd and M/s Archon Healthcare Pvt. Ltd, for setting up Radiation Processing plant at Indore and Bavla, Ahmedabad respectively.

Two Radiation Processing plants, namely M/s Impartial Agro Tech (P) Ltd., and M/s Gujarat Agro Industries Corporation Ltd (GAIL), were commissioned at Unnao, Lucknow and Bavla, Ahmedabad in 2014.



**Inauguration of M/s GAIL, Bavla, Gujarat
by Chief Minister, Gujarat**



**M/s Impartial Agro Tech (P) Ltd., Unnao
inaugurated by Secretary, MoFPI**

Total number of Radiation Processing Plants commissioned in the private sector in the country under MoU with BRIT is now 12.

Isotope Application Services

AERB has granted Type B(U) Approval of ISOMED Cask Package and MHC cask was obtained.

BRIT in collaboration with BPCL could troubleshoot Catalyst Cracking Unit (CCU) by combining Gamma Scanning with ^{60}Co and Radiotracer Technique. It helped BPCL to take corrective actions immediately and avoid losses. Leakage detection in Mumbai-Pune Pipeline of Hindustan Petroleum Corporation Limited (HPCL) was carried out by using ^{99}Mo .

Supporting Services

Customer Support Services Cell (CSSC) and Customer Relations Cell (CRC)

Customer Support Services Cell (CSSC) continued to provide various kinds of support for the regular and uninterrupted supply of radioisotopes and allied products, radiation technology equipments to ~2000 user institutions in the healthcare, industries, research and agricultural sectors. The transportation of nearly ~100,000 consignments in a year of radioisotopes and allied products, majority of them by air was carried out successfully in an absolute safe manner. CRC at Radiopharmaceuticals Production, BRIT, Vashi found an increase in sales of ~ 35-40% as compared to the sales of radiopharmaceuticals in the past years.

Plan Projects

Project: DAE Medical Cyclotron Project : Radiopharmaceutical Facility.

Civil construction work is nearing completion and work for HVAC, electrical work, etc. are completed. It is expected that the installation of the Medical Cyclotron will start by June 2015.

Project: Integrated Facility for Radiation Technology

The project has been completed. A Hot cell has been constructed to handle 300 kCi Co-60 source.

Project: Indigenous HDR Brachytherapy Equipment (IHDR)

Progress: Two numbers of HDR treatment unit “KARKNIDON” installed at TMH & ACTREC for cold evaluation. Actual HDR source wire rope assembly fabricated at RLG with desired accuracy and production process is standardized. Purchase order for Treatment Planning Software has been placed.

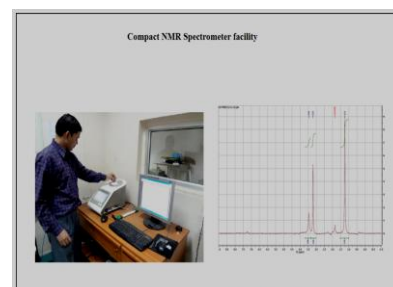
Project: “Setting up of Fission based ^{99}Mo Production Facility”

Project envisaged for setting up of a production facility for producing 300Ci (6 day pre-calibrated) /week ^{99}Mo , utilizing LEU targets. Order for plant and machinery has been placed and civil construction is in advanced stage.



Project: Advanced Facilities for Radiopharmaceuticals Production

The project scope comprises building of Advanced Radiopharmaceutical Manufacturing and testing facility for new generation Radiopharmaceuticals and enhancement of present production capacity. Civil



drawings has been finalized and process of procurement of equipment/machinery is in progress.

Project : Technology Development for Radiation Technology Equipment

Specifications for I-125 seed manufacturing plant have been finalized. Tender for the civil construction has been raised.

Chapter 2:

Descriptive Part



BRIT celebrated its Silver Jubilee on March 1, 2014 which was graced by the presence of eminent scientists of DAE, Dr. Anil Kakodkar, Former Chairman Atomic Energy Commission & Secretary to DAE and Dr. Sekhar Basu, Director, BARC & Chairman BRIT Board. The guests also included the Former Chief Executives of BRIT, Dr. N. Ramamoorthy and Shri J.K. Ghosh.





BRIT celebrated its Silver Jubilee on 1st March, 2014

1. Healthcare Services

The combined revenue from the supply of healthcare products and its services useful for *in-vivo* and *in-vitro* investigations, labelled compounds for varied research purposes, tritium filled sources for defence establishments and radioanalytical services provided by BRIT amounted for a total of Rs. 36.74 Crores upto December 2014.

1.1. Radiopharmaceuticals Production (RPhP)

Radiopharmaceuticals meant for *in-vivo* use are mainly for diagnostic and therapeutic purposes. Since they are meant for *in-vivo* use as pharmaceutical grade products, compliance to good manufacturing practices (GMP) is mandatory.

- Regular, uninterrupted, production and supply of radiopharmaceuticals, all over India, was continued. BRIT has developed new production processes and capabilities towards increasing the production capacity and quality of products which has enabled RPhP to enhance production frequency, production volumes and regularize the production of new products introduced during previous years. Nearly 2.5-7lakh patients, estimates calculated on very conservative basis, have benefitted from the radiopharmaceutical products supplied by BRIT.
- Approximately 670Ci of Na^{131}I and over 22000 consignments is processed, formulated and supplied to various nuclear medicine hospitals all over India in the form of solution and capsules. These are used for diagnosis and therapy of thyroid disorders.
- Thyroid cancer treatment with large dose Na^{131}I capsules is in one of the major challenges and towards this; milestone production of 3Ci per batch could be achieved with large dose Na^{131}I capsules. Denominations of 25mCi, 50mCi, 100mCi and 125mCi are produced and supplied for the thyroid cancer treatment.

- The revenue generated from the sale of Na^{131}I based radiopharmaceuticals alone is of the tune of Rs. 10.3 Crores upto 31st December, 2014.



Hot cell for ^{131}I -Nal Capsules at RPhP, Vashi

- As regular production, about 2500 consignments containing nearly 22.5Ci of ready-to-use radiopharmaceuticals of ^{131}I -mIBG, ^{32}P , ^{153}Sm and ^{177}Lu in the injectable form were supplied to various nuclear medicine hospitals all over India. Due to high demand from nuclear medicine doctors, the frequency of production and supply of ^{131}I -mIBG (both, diagnostic and therapeutic) used for neuroendocrine cancers and ^{153}Sm -EDTMP Injections used for bone pain palliation has been increased. Sale of all other therapeutic radiopharmaceuticals has resulted in the revenue collection of Rs. 35 Lakhs.
- Indigenously developed semi-automatic production facility for ^{131}I - mIBG therapeutic doses was updated for safe handling of ^{131}I -mIBG production and supply.



Indigenously developed semi-automatic production facility for ^{131}I - mIBG

- As a part of upgradation facility, Compact NMR for the analysis of synthesized organic ligands and denatured solvents and a separate GMP compliant cold storage facility for *in-vivo* TCK cold kits at RPhP, BRIT are commissioned in 2014-2015.
- Total number of therapeutic treatments based on supplies is estimated to be 18960 patients. This includes therapeutic doses of Na^{131}I for the treatment of thyroid cancer and hyperthyroidism.

- During the year 2014-15, more than 73500 cold kits for formulation of ^{99m}Tc radiopharmaceuticals (15 Products; BRIT Code-TCK) is processed, lyophilized and supplied to various nuclear medicine hospitals all over India generating the revenue of Rs. 5.54 Crores.



GMP compliant Cold Room Facility

- Nearly 195Ci of ^{99}Mo , in form of Sodium Molybdate solution, for solvent extraction generator, and in form of ^{99}Mo - ^{99m}Tc Gel Generator has been supplied. Approximately 400Ci of ^{99}Mo (1150 generators) in the form of Sodium Molybdate is processed and supplied as alumina column generator (New product-COLTECH) whereby BRIT could earn revenue of 3.55 Crores.
- During the year COLTECH generator of 1Ci capacity is introduced, this is in addition to earlier 300mCi, 500mCi & 600mCi capacity generators.
- **More than 2,08,245 *In-vivo* diagnostic investigations are estimated to have been carried out this year with varied diagnostic radiopharmaceuticals, the major one being, ^{99m}Tc based cold kits and ^{99}Mo - ^{99m}Tc generator systems.**
- To observe safety and increase reliability, the generator production facility and all other production areas in the RPhP and QC laboratories have been retrofitted with fire alarm system and smoke detectors.



Fire Alarm System and Smoke Detectors

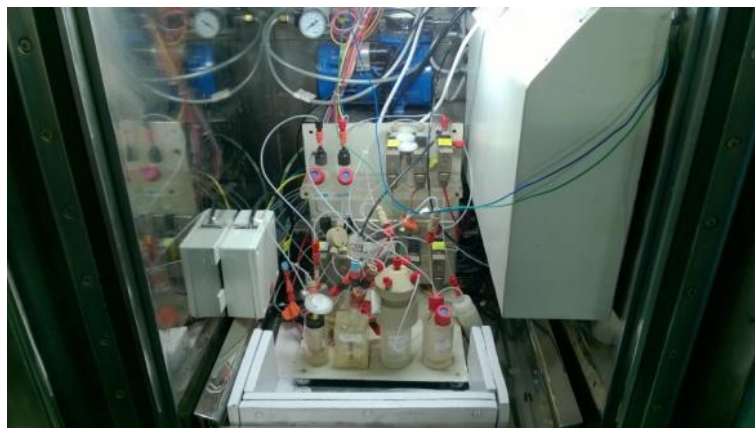
- A total number of about 5575 radioimmunoassay (RIA) and immunoradiometric assay (IRMA) kits to serve about **5, 72,700 *in-vitro* investigations** were supplied to various hospitals, research centres and immunoassay laboratories throughout India. The revenue earned by BRIT from the sale of RIA and IRMA kits for the year 2014-15 is about Rs. 1.1 Crores.

- RIA products and RIA Laboratory of RPhP, are certified for ISO 9001:2008 and ISO 13485:2008 from United Kingdom Accreditation Services (UKAS).



Certificate from UKAS for RIA Products and RIA Laboratory

- **The Medical Cyclotron Facility (MCF)**, Parel, located in the basement of Tata Memorial Annexe Building, continued supplying about 259 consignments of PET radiopharmaceuticals such as ^{18}F - FDG, ^{18}F -FLT, ^{18}F -NaF and ^{18}F - FMISO to various hospitals in and around Mumbai accounting for nearly 375Ci of radioactivity and generating the revenue of Rs. 6.06 Crores during the year 2014-15. **Approx. 14444 patients benefitted with PET investigations in the reported year.**



Indigenously fabricated module for preparing sterile, injection grade
[F-18] NaF

1.2. QA, QC Testing and Allied Services (QC & QA-RPhP)

Quality Control group is responsible for the analyses of various ready-to-use radiopharmaceuticals, radiochemicals, TCK cold kits, certifying the product and the timely release of QC reports. During the year 2014, following are the QC reports:

- **Routine analyses:** Around 700 radiopharmaceuticals samples were analysed and certified by QC during this period. The tests included physicochemical analyses,

sterility, tests, bacterial endotoxin tests and animal biodistribution. Additionally several kits were evaluated for stability beyond the assigned shelf life.

- **Testing service analysis:** The Certificates of analyses were provided for 12 Batches of the cold kits for preparation of ^{99m}Tc -DMSA, ^{99m}Tc MAA, ^{99m}Tc -Myoview and ^{99m}Tc -Exametazime, which were analysed for physico-chemical tests and animal biodistribution. The safety was tested by sterility and bacterial endotoxin tests. This service was provided for outside agencies, M/s DraxImage and GE Healthcare and the revenue thus generated was Rs.5.2 Lakhs.
- New tests such as disintegration tests for analyses of ^{131}I -NaI capsules of high denomination (50, 75,100 and 125mCi) were taken up as per pharmacopeial requirements. During the period under report, the analyses of batches of 50mCi trial batches of ^{131}I -NaI capsules have been completed.

Batch release was provided for 94 batches of TCK products by **Quality Assurance group** to the production group for dispatch after scrutiny of production and QC documents. Ready to use radiopharmaceuticals have been included in QA since October 2014 and release for the same is being provided after perusal of production and QC documentation.

1.3. Labelled Compounds (LC)

During 2014-15, Labelled Compounds Programme of BRIT continued the supply of more than 59500 sources of Tritium Filled Self-luminous sources of various sizes and shapes for defence establishments along with the custom synthesis & supply of a variety of ^{14}C , ^3H and ^{35}S -labelled products. The revenue earned during the year was about ~3 Crores.



View of Renovated Labelled Compounds Laboratory at BRIT, Vashi Complex



TFS sources of various sizes & shapes

1.4. Regional Centres for Radiopharmaceuticals (RCR's)

RCR, Bengaluru: During this period, Regional Centre, BRIT, Bengaluru supplied 74 Ci of ready-to-use $^{99m}\text{TcO}_4^-$ (Pertechnetate) to user hospitals and 900 cold kits were sold through retail outlet for the preparation of ^{99m}Tc -radiopharmaceutical formulation. Door Delivery of Radiopharmaceutical and cold kit was started in the month July 2014. They collected 258 consignments from BRIT Mumbai and distributed to different hospitals and diagnostic Centres in Bengaluru. Gamma Irradiation of 2277 blood bags was done and 592

consignments were collected from air cargo for the use at this regional Centre. Radioanalytical laboratory analyzed 136 samples for the measurement and certification of residual radioactivity in various commodities such as food items for human & animal consumption, medicine, steel and other miscellaneous items. The revenue earned by RCR, Bengaluru was around Rs. 26 Lakhs.

RCR, Delhi: Regional Centre, Delhi BRIT has supplied ~32Ci of clinical grade, ready to use ^{99m}Tc -radiopharmaceuticals injections in compliance with GMP & RPC for diagnostic nuclear medicine studies in Delhi & NCR Region. Retail Outlet supply of ~2500 TCK cold kits was utilized by nuclear medicine hospitals in Delhi and NCR Delhi along with hospitals at Jaipur, Lucknow etc. More and more hospitals are opting for our door-to-door delivery services, thus are getting benefitted by our customer friendly services that reflects in increased demand in BRIT radiopharmaceuticals at Delhi. Na^{131}I solution and capsules from BRIT, Mumbai has been delivered since April 2014 to various hospitals in Delhi. RCR, Delhi earned the revenue of ~ Rs 11.5 lakhs from door-to-door delivery services. A renovated class 10,000 lab is nearly complete and will be used for production of radiopharmaceuticals and labeled compounds.

RCR, Hyderabad (Jonaki): RCR, Hyderabad continues the production and supply of ^{32}P labelled nucleotides and also a few molecular biology kits and enzymes, for research in frontier areas of Molecular Biology, Biotechnology and Biomedical and drug discovery research of the country. It also markets ^{35}S labeled amino acids products produced at BRIT, Mumbai facility. Jonaki also supplies ^{99m}Tc -cold kits from BRIT, Mumbai to the nuclear medicine centers of Andhra Pradesh, through its retail outlet. Keeping in view of expanding the operation RC, BRIT, centralized radio pharmacy laboratory for supply of ^{99m}Tc as sodium pertechnetate, is ready and functional. Regular supply will be made based on the requirements. A total of revenue earned by RCR, Hyderabad is Rs. 1.4 Crores during the year 2014-15.

RCR, Kolkata & Dibrugarh: It is expected that the installation of the Medical Cyclotron will start by June 2015. TCM-AUTOSOLEX generator is a semiautomated $^{99}\text{Mo}/^{99m}\text{Tc}$ generator which work with low specific activity (n, γ) ^{99}Mo and ^{99}Mo - ^{99m}Tc separation is effected by using MEK solvent extraction were developed indigenously for the purpose at the Regional Centre, BRIT, Kolkata in collaboration with VECC with extended support and help obtained from BRIT, Mumbai and RMC, Parel, Mumbai. This generator is useful for centralised radiopharmacy at RRCM, VECC, Kolkata and RMC, Parel, and would be extended to other RCR's. About 215 TCK cold kits were sold this year 2014-15.



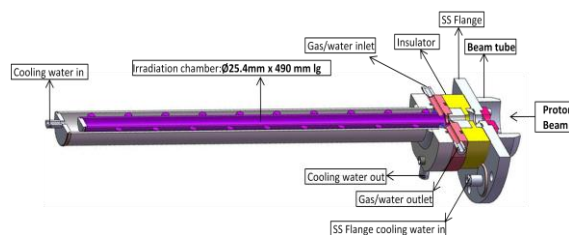
TCM-AUTOSOLEX Chemistry Module



The Electronic Control

For evaluation study of new ^{68}Ge - ^{68}Ga generator system, purification of ^{68}Ga elute from SnO_2 column, a new method of purification of the primary eluate of ^{68}Ga from the generator was standardized using a cation exchange resin. In the optimized method of purification the average yield of purified ^{68}Ga has been around $80.7 \pm 8.5\%$.

Production of ^{22}Na by proton irradiation of natural neon gas target [$^{22}\text{Ne}(p, n)^{22}\text{Na}$] was undertaken in VECC cyclotron. The radioisotope ^{22}Na finds application in many fields. It is widely used for calibration of dose calibrators, detectors and other nuclear instruments. It is a convenient source for calibration of PET cameras. ^{22}Na is also used in positron annihilation lifetime spectroscopy (PALS) to study voids and defects in solids.



Longitudinal cross-section of Ne Gas target chamber

The Regional Centre BRIT, Dibrugarh located at Assam Medical College & Hospital is rendering Radioimmunoassay and Immunoradiometric diagnostic services for the patients of the entire North-Eastern region. The revenue collected from RCR, Kolakata and RCR, Dibrugarh combined is estimated at Rs. 11.85 Lakhs.

1.5. Radioanalytical Laboratory Services (RAL)

Radioanalytical Laboratory is engaged in the measurement and certification of radioactivity content in commodities such as food items for human & animal consumption, water samples, environmental samples, steel and other miscellaneous items. Water samples are routinely analyzed for gross alpha/gross beta, uranium, ^{226}Ra and ^{228}Ra content, depending upon the requirement. ^{238}U , ^{232}Th , ^{226}Ra and ^{40}K contents are measured and certified in environmental samples such as coal, fly ash, soil rock phosphate, gypsum etc. Steel samples are generally tested for the presence of ^{60}Co contamination. Steel survey at factory sites and warehouses is carried out to monitor the surface radiation dose. During 2014-15, RAL has carried out more than 5500 tests on export/domestic commodities and 1100 tests on water samples (gross alpha, gross beta, ^{228}Ra & ^{226}Ra). Nearly 5300 water samples received from Punjab



state were analyzed for the certification of uranium content. Five steel surveys were conducted for certification of surface radiation dose and 40 food samples imported from Japan monitored for the presence of ^{137}Cs & ^{134}Cs were also analyzed and certified. As part the continuous improvement in quality of service offered to customers, the Radioanalytical Laboratory (Vashi) is in the process of obtaining NABL accreditation.

Radioanalytical Laboratory Services both, at Vashi Complex and RCR, Bengaluru, together performed approximately 12,209 analyses of food and water samples for the presence of radioactivity, and BRIT could earn revenue of Rs. 3.03 Crores.

2. Engineering Products & Services

The various engineering products and services offered by BRIT included the supply of more than 2000 kCi of radioactivity in various forms and for varied uses. The combined revenue for the engineering products and radiation processing services is estimated close to Rs. 41.26 Crores upto December 2014.

2.1. Sealed Sources:

Co-60 Teletherapy Sources for Cancer Hospitals: 10 teletherapy sources with total activity of about 85.5 kCi in the range of 130 and 168 RMM were supplied to various cancer hospitals in India. One of the Co-60 teletherapy source was exported to the Cancer Disease Hospital, Lusaka, Zambia. Seven decayed sources were unloaded from the teletherapy units and stored for fabrication of irradiator source. These sources were fabricated at RAPPCOF, Kota using Co-60 produced indigenously in nuclear power reactors. Total revenue generated is Rs.5.65 Crores.

Brachytherapy Sources Cancer Hospitals: 234mCi of Ir-192 and Pt wires were supplied as brachytherapy sources to various cancer hospitals.

Industrial Irradiator Sources: Irradiator sources with total activity of around 1259 kCi were supplied in nine consignments to various processing plants within the country and also exported.

Approximately 55 kCi and 60 kCi of Co-60 irradiator sources were supplied to IFRB, Bangladesh and Southern Tsetse Fly Eradication Project (STEP), Ethiopia respectively.

Total revenue earned from Co-60 Irradiator sources during the year was approximately Rs. 9.6 Crores.

Nearly 1000 kCi of Irradiator sources are planned to be supplied to various users by March 2015.



Southern Tsetse Fly Eradication Project (STEP), Ethiopia

Eight **absorber rods** were unloaded and transferred to RAPPCOF pool for the recovery of Co-60 source for fabrication of sources for irradiators and teletherapy machines.

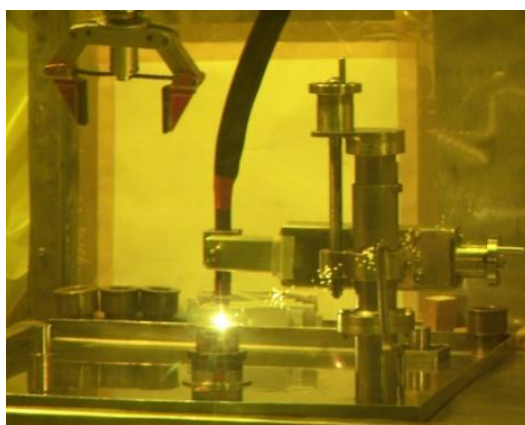
Ir-192 Radiography sources: Nearly 1233 radiography consignments of Ir-192 and Co-60 with total activity of approx. 52.8 kCi were supplied to various radiography customers in the country. The revenue earned from radiography source replenishment and other service offered by BRIT during the year was approximately Rs. 8.44 Crores.

Custom Made Sources (CMR): Custom Made Sources of **Co-60, Cs-137 and Sc-46** were supplied on request, for Nucleonic Gauges and other calibration uses. A total of 3.9 Ci of radioactivity was supplied for reference and custom made sources for revenue of Rs. 42.24 Lakhs.

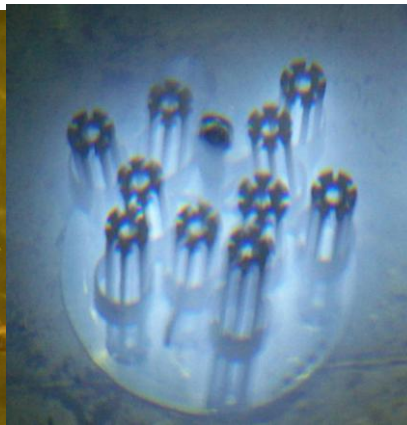
Contract with Los Alamos National Laboratory, USA, for identification of source to repatriate US origin sources was completed for the five institutes in India.



At RAPPKOFF, Kota, total activity of Co-60 which was processed during the year was about 63.52PBq (1717 KCi). Safe handling, transportation of adjuster rods from various reactors were transported to RAPPKOFF, Kota for processing of Cobalt-60 and subsequently transported for fabrication of sources at Mumbai and the necessary documentation of the records were performed. Twenty shipments of Co-60 with total activity of 54.67 PBq (1478 KCi) were transported. 74 Customized W-91 pencils with total activity of 2.23 PBq (60.35 KCi) were also fabricated and transported. The centre was also involved in the source loading operations of 60 kCi of Co-60 to Ethiopia and Cobalt Teletherapy Source to Cancer Hospital, Lusaka, Zambia.



Sealed source fabrication using tig welding inside hot cell



Cobalt sub-assemblies in storage pool

2.2. Radiography and other Radiation Equipment Devices

Supply of 60 new indigenous radiography camera model ROLI-2 and model ROLI-3, and servicing and inspection of BRIT manufactured as well as imported ROLI cameras were the highlights during the reported year. Apart from the above production of 50 nos each of ROLI-

2 and ROLI-3 cameras were carried out. Total revenue from the sales of radiography cameras and its services amounted to Rs.3.6 Crores.

Three units each of Gamma Chamber 5000 and Blood Irradiator 2000 are supplied to different universities for various applications in the country earning revenue of Rs. 2.2 Crores. Decommissioning of GC 900 from University of Kolkata and MS University, Baroda was also undertaken.

2.3. Engineering Design Development

Gamma Scanning Simulator Column (GSSC): A scale down model of Crude Distillation Units (CDU) as GSSC has been constructed at BRIT for demonstration and training of gamma scanning of CDU to detect anomalies such as flooding, weeping, missing tray, tray misalignment and light foam / heavy foam formation.



GSSC

Syringe Shield: BRIT is developing a syringe shield to be used as a protective gear in hospitals while administering $^{99m}\text{TcO}_4^-$ or its products (or any radioactive injectables) to patients.



Syringe Shield

2.4. Gamma Radiation Processing Services

(a) Radiation Sterilization Plant for Medical Products (ISOMED):

ISOMED facility, engaged in contract gamma radiation processing services for terminal sterilization of the medical products has processed 7758 m³ of products earning a revenue of Rs. 3.18 Crores. It has acquired the OHSAS 180001: 2007, EMS 14001:2004 and WHO-GMP certifications during 2014. Integrated **System Of Computer Aided Dosimetry (ISOCAD)**, a unique, bar-coded, GMP compliant software system for the dosimetry measurement has been designed and test validated at ISOMED. It is now available as a commercial product from BRIT and being sold to several gamma irradiators operational in the country.



ISOCAD Software main page



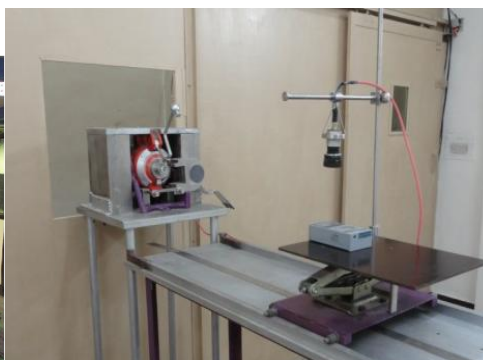
ISOCAD in operation

(b) Radiation Processing Plant, Vashi (RPP, Vashi):

- ❖ During the current year, 2014-15, about 3900 Tons of spices and other products were processed. New type of products like nutraceuticals and colour pigments were added after sample irradiation and post irradiation analysis. 5000 numbers of sterile surgical drapes were supplied to BARC Hospital.
- ❖ QA activities at RPP include the following: Plant commissioning dosimetry at Industrial Gamma Irradiator of Southern Tsetse Fly Eradication Project (STEP), Addis Ababa, Ethiopia is completed in June 2014. 3mM Ceric–Cerous sulphate dosimeters (Dose range: 1.0 - 6.0kGy) manufactured by BRIT as per ISO/ASTM 51205 were used for the dosimetry experiments. The dosimetry was carried out to set the process parameter for irradiating diet blood for Tsetse flies in the Kaliti Tsetse Mass Rearing and Irradiation Centre, STEP, Ethiopia.
- ❖ Plant re-commissioning dosimetry of Panoramic Batch Gamma Irradiation facility at Institute of Food and Research Biology, Savar, Dhaka completed for sterilization of medical products in November 2014.
- ❖ Supply of 3, 5 and 15 Mm ceric-cerous sulphate dosimeters to SriLanka, Bangladesh and Ethiopia.
- ❖ Revenue generation during current financial year 2014-15 is 3.3 Crores. Since its inception, this facility has processed 30550 tons of products. Revenue earned by the supply of dosimeters, dosimetry systems and other associated systems is expected to be approximately Rs. 40 Lakhs.



Product loading station



Calibration laboratory for radiation monitors

A facility has been set up for calibration of Nuclear Radiation Survey Meters at Vashi Complex. It will cater to calibration requirements of portable radiation monitoring instruments in the range of 0.5 mR/h to 5 R/h. The laboratory is approved AERB and has started providing calibration services for in-house requirement.

(c) New MOU for Radiation Processing Plants (RPP):

MoU was signed with M/s Raghuvansh Agrofarms Ltd and M/s Archon Healthcare Pvt. Ltd, for setting up Radiation Processing plant at Indore and Bavla, Ahmedabad respectively. Two Radiation Processing plants, namely M/s Impartial Agro Tech (P) Ltd., and M/s Gujarat Agro Industries Corporation Ltd, were commissioned respectively at Unnao, Lucknow and Bavla, Ahmedabad in 2014. With this, the total number of Radiation Processing Plants commissioned in the country under MoU with BRIT has gone up to 12.



**Inauguration of M/s GAIL, Bavla, Gujarat
by Chief Minister, Gujarat**



**M/s Impartial Agro Tech (P) Ltd., Unnao
inaugurated by Secretary, MoFPI**

2.5. Isotope Application Services

Isotope Application Services Group of BRIT offered its valuable services to various industries.

BRIT in collaboration with BPCL could troubleshoot Catalyst Cracking Unit (CCU) by combining Gamma Scanning with ^{60}Co and Radiotracer Technique. This service helped Bharat Petroleum Corporation Limited (BPCL) immensely to plan the shutdown and take necessary corrective actions and thereby saving several crores of rupees by minimising the downtime.



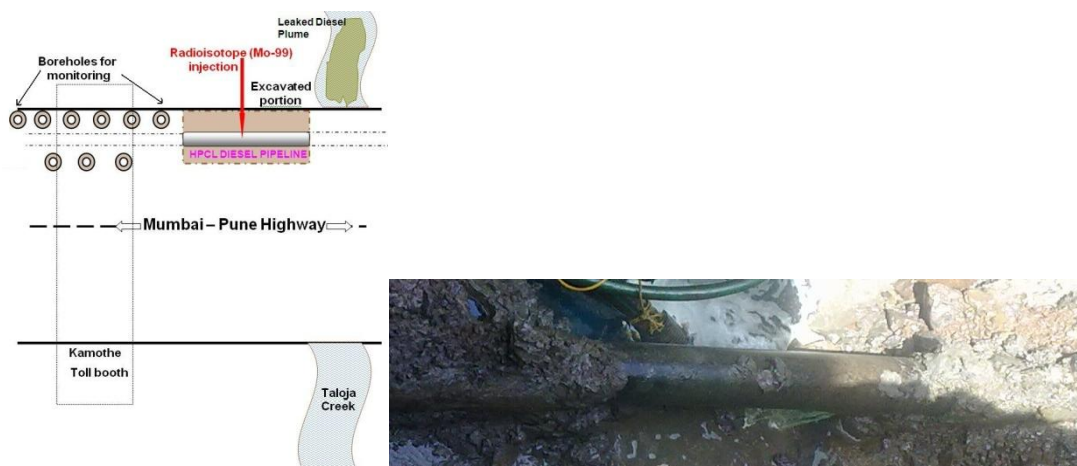
Radiotracer handling for gamma scanning

Radiotracer technique was used for leakage Detection in Heat Exchangers at Bharat Oman Refineries Limited (BORL), wherein, high sulphur content in products was observed and indicated a leak in one or more than one heat exchangers.



Arrangement of detector in collimator

Leakage detection in Mumbai-Pune Pipeline of Hindustan Petroleum Corporation Limited (HPCL) was undertaken by BRIT. Radiotracer ^{99}Mo was used to successfully locate the leak location. The results helped HPCL to repair the leak and restore the pumping operations on immediate basis.



- 161Ci of ^{60}Co Sources from one gamma chamber were recovered and transferred to detachable Mobile Hot Cell (MHC) storage cask inside the cell in presence of AERB representative to demonstrate MHC operations to recover low activity sources.
- **AERB has granted Type B(U) Approval of ISOMED Cask Package and MHC cask was obtained.**
- Portable Research Irradiator (PRI) was redesigned to enable it to be used as Low Dose Irradiator, facilitating the research work targeted to study the gamma radiation effect at low dose rates. Safety analysis Report for Type B(U) certification prepared and certification obtained. Safety analysis Report (SAR) for Type A certification prepared. Type 'A' certification was obtained to house 10Ci of ^{60}Co source in PRI. The unit is ready for loading and operation.
- Conceptual design for PANBIT irradiator: Dose Uniformity, Throughput and Shielding calculations of a conceptual Batch Irradiator being designed for 100 kCi of ^{60}Co was completed. ^{60}Co Source loading patterns were designed for nine spice irradiators situated at different locations in India.

3. BRIT Website:

BRIT website provided regular updates on various programs and activities related to developments in BRIT. Customer oriented reports were uploaded on website almost on daily basis enhancing co-ordination and communication with the customers.

4. HRD activities of BRIT

Apart from the services towards the commercialization of radioisotope activities in healthcare, industries and radiation processing, BRITians are also involved in human resource development programmes. These comprises of taking part in not only imparting training to post graduate students and research scholars from different colleges and universities in all sectors of BRIT programme, but also they are active in participating in various workshops and conferences.

5. Sales turnover in 2014-2015

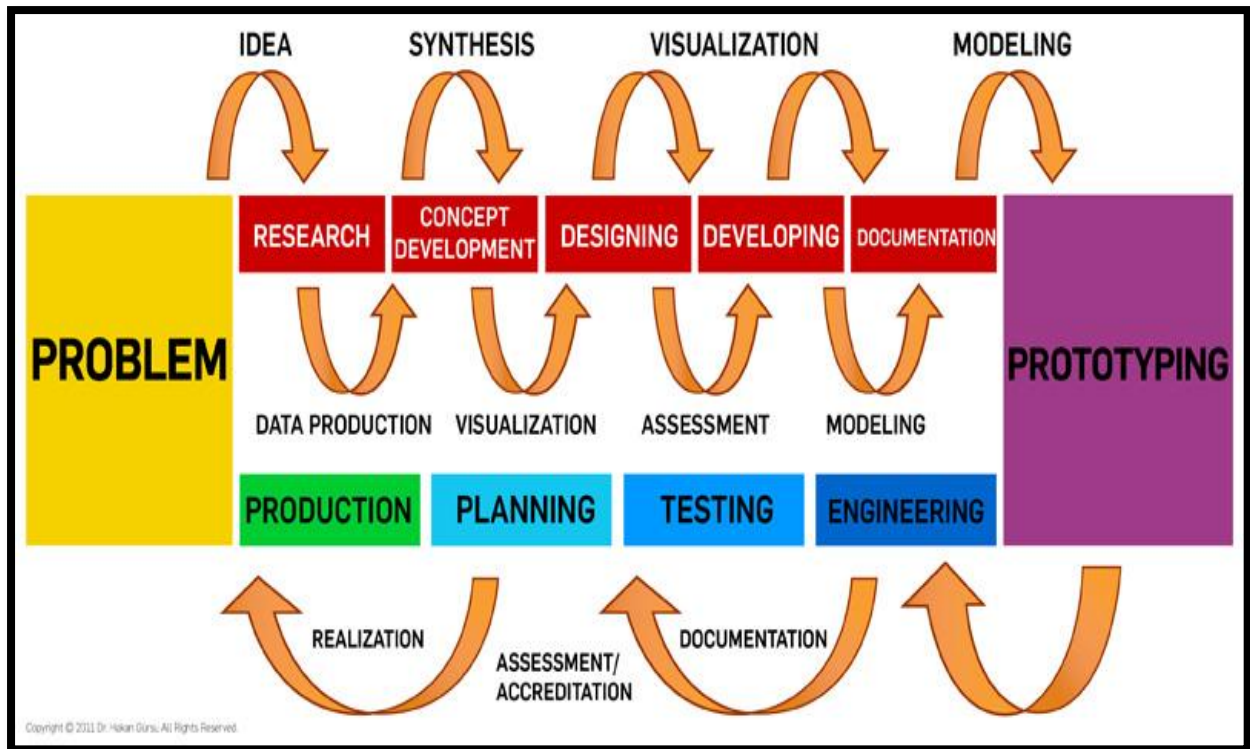
Radioisotopes and allied products supplied by BRIT

Sl. No.	Item	Actual between April – December, 2014	Expected to be achieved April 2014 – March 2015
1	Consignments	75336	~ 100000
2	Activity	1200 kCi	~ 2200 kCi
3	Total Sale	₹ 60.44 Crore	₹ ~ 90 Crore

BRIT is expected to meet its targeted turnover of Rs. 90 Crores during 2014-15 as against Rs. 80.02 Crores achieved last year.

Chapter 3





[A] Development work carried out at Design & Development Section of Engineering Division of BRIT

1. High Dose X-ray based laboratory Irradiator:

BRIT has already designed and manufactured the low dose X-ray based laboratory Irradiator which uses a 160 kV X-ray tube with a maximum operating current of 5mA. This can be used for very low dose applications such as small animal cell research and stem cell studies.

Development work: BRIT is planning for **high dose X-ray based irradiator** by using higher rating X-ray tubes of 225 kV with a maximum operating current of 30mA. The dose rate expected from this will be comparable to the existing Gamma Chambers and Blood Irradiators. The main feature of this new Irradiator will be its compact size, higher irradiator volume and light weight.



2. ROLI-2 Radiography Exposure Device:

Currently, BRIT has ROLI-2 exposure devices that can carry maximum 65Ci of Ir-192 for carrying out radiography works.

Development work: BRIT is developing ROLI-4 that can carry 120Ci Ir-192. Tungsten is used as primary shield to keep the radiation level within permissible limit. The main design feature is that the S-bend is provided in the tungsten itself which removes the gap generated between tungsten and S-bend steel tube.



3. Syringe Shield:

The syringe shield (2.0mL) has been designed by BRIT for reducing the occupational radiation exposure to its users. The shield is made up of tungsten and a lead glass window around the syringe. This provides clear visibility of the syringe contents and is being currently tested at BRIT animal house for administering injection to animals. Since very small amounts of radioactivity are used for injecting the radiopharmaceuticals to small animals for studying its biodistribution or for injecting the patients for nuclear medicine scans, 1.0mL syringes, which are appropriately shielded, would be more appropriate. 1mL and 5 mL syringe shield are being developed and expected to be launched in next six months. With the advent of this syringe shield, these can be used for wide applications.

4. BLC 200 Transportation Casks:

BLC-200 is being designed by upgrading BLC-125 from 125 kCi to 200 kCi of Co-60. Tungsten has been utilized as a shielding material to keep the radiation level within permissible limit. The shielding analysis has been completed. The thermal analysis is being carried out. The development of BLC-200 can reduce the number of transportation required for carrying radioactive material more than 125 kCi at a time.

[B] Research & Development Carried out at Sealed Sources and Logistics Division of BRIT

- 1. Fabrication of HDR Sources using Ir-192.** Many dummy sources are fabricated and tested in the HDR unit developed by TD Group of BRIT and finalized the design.
- 2. Fabrication of the Teletherapy sources** is normally carried out using the imported Teletherapy activity with specific activity greater than 250 Ci/gm. As our Indian power reactors at Rajasthan are working with high capacity and availability factors, specific activity up to 200 Ci/gm are obtained. Because of this import of the activity for these sources is stopped saving us the foreign exchange. Also the cost is considerably reduced for supply to hospitals which will help in reducing the treatment cost for the cancer patients. After approval of the AERB, 12 teletherapy sources are fabricated with the indigenous activity and kept ready for supply.
- 3. High flux positions are identified in DHRUVA reactor for producing the Co-60** activity with specific activity greater than 300 Ci/gm in three years time. Arrangement for the irradiation and recovery are finalized.
- 4. Special Form approval for the 26 types of source designs is obtained from the Atomic Energy Regulatory Board.**
- 5. Type approval for two new designs, BC-188 SW and CS-BI of the source pencils were obtained from AERB.**
- 6. Identification of USA origin radiation sources were carried out at five institutions** for repatriation to USA after entering into a contract with LANL, USA.
- 7. Expansion of RAPPCOF**, a new project is proposed in this five year plan for augmenting the capacity for the fabrication of irradiator and Teletherapy sources. At BARC, Vizag, proposals are being finalized the **“Isotope Processing laboratory” in co-ordination with Reactor Group, BARC.**

Future Program

1. Collection of US origin sources at BRIT and after recovery repatriation is being planned in consultation with LANL, USA.
2. Supply of Cs-137 sources for the blood irradiator in coordination with WMD, BARC.

3. Supply of HDR sources for Karknidhaan.

[C] Research & Development Work carried out at Radiopharmaceuticals Programme of BRIT

1. **Microwave assisted synthesis of $^{125}/^{131}\text{I}$ labeled mIBG**

$^{125}/^{131}\text{I}$ -mIBG can be synthesized by Cu^{2+} catalyzed nucleophilic exchange reaction in aqueous medium. Most of the nucleophilic exchange reactions involve high reaction temperature and long heating time. Under these reaction conditions, both radiochemical purity and labeling efficiency are reduced. The use of microwaves provides fast heating of the chemicals above their boiling points thus enhancing the reaction rates and significantly reduces the reaction times in comparison with conventional heating. Generally, using microwave heating reduces the degradation reactions thereby enhancing yields. In our study, mIBG would be labeled with $^{125}/^{131}\text{I}$ via nucleophilic isotopic exchange reaction in presence of Cu^+ and heating the reaction mixture using a microwave chemical synthesizer for 3-4 minutes. Due to the shorter heating time, the microwave heating method significantly reduces radiochemical and chemical impurities.

The study is in progress.

2. **Spectrophotometrical methods for determination of tellurium (Te) content in ^{131}I NaI solution.**

Na^{131}I solution is prepared by dry distillation method from irradiated tellurium dioxide. This solution is likely to be contaminated with tellurium while pharmacopeias specify tellurium content to be $< 5 \mu\text{g/mL}$. A procedure is being developed for determining tellurium content in Na^{131}I solution spectrophotometrically.

Further studies being continued.

3. **Study on decomposition of sodium thiosulphate with respect to increased radioactive concentration of Na^{131}I solution.**

Sodium thiosulphate is a reducing agent and used in Na^{131}I formulation to minimize radioactive decomposition of Na^{131}I solution. The rate of Na^{131}I radioactive decay and degradation of Sodium thiosulphate is not linear and hence it is necessary to estimate and optimize the sodium thiosulphate concentration in the product so that radiochemical purity is maintained during the entire shelf period.

Further studies are in progress.

4. **Synthesis and evaluation of mesoporous nano alumina as an adsorbent matrix for ^{99}Mo - $^{99\text{m}}\text{Tc}$ generator in BRIT.**

A new mesoporous nano alumina using aluminium isopropoxide and glucose as precursor was synthesized. The synthesized material was evaluated for its sorbent capacity with respect to molybdenum and was found to be ~150 mg per gram of alumina in static condition.

Further experiments are underway to standardize the synthetic methodology and reproducibility of the sorbent capacity.

5. Evaluation of ^{99}Mo - $^{99\text{m}}\text{Tc}$ generator based on mesoporous nano alumina in BARC

The above synthesized mesoporous alumina is being evaluated using ^{99}Mo activity. ^{99}Mo - $^{99\text{m}}\text{Tc}$ generator has been prepared in BARC using nano alumina and loaded with 500 mCi of (n, γ) ^{99}Mo . **The elution of generator has been carried out and further analysis of eluate is under progress.**

6. Kit for the preparation of $^{99\text{m}}\text{Tc}$ -HSA Macro aggregated albumin ($^{99\text{m}}\text{Tc}$ -MAA)

Work on the kit for $^{99\text{m}}\text{Tc}$ -MAA has been carried out. The particle size of the kit formulation has been evaluated. The radiochemical purity of the kit formulation when labeled with $^{99\text{m}}\text{Tc}$ -Pertechnetate is >90%. The performance of the lyophilised kit prepared is satisfactory with respect to radiochemical purity and particle size and number.

The bio-distribution of the product is underway.

7. Synthesis and evaluation of no carrier added (nca)- ^{131}I -mIBG.

nca- ^{131}I -mIBG is mIBG having specific activities similar to iodine specific activities (15.2 Ci/mg). This amounts to roughly an increase of present obtained specific activities to 50 times. nca- ^{131}I -mIBG injection is highly beneficial in the case of therapeutic treatments. In low specific activity product a large amount of ligand in millimoles is injected which may displace the nor-epinephrine from the tumor cell thereby stimulating a pharmacological response. Also, a large inactive ligand in low specific activity product gets transported across the cell which saturates the further uptake of the active ligand. Hence the uptake is more in nca- ^{131}I -mIBG where the weight content is very less. In this respect, nca- ^{131}I -mIBG has been synthesized from mBBG. The two have been resolved using RP-C18 support. nca- ^{131}I -mIBG was then evaluated in neuroendocrine tumor cell lines.

In-Vitro Cell Uptake Studies

The propagation of Human Neuroblastoma cell lines (SK-N-SH and IMR-32) brought from NCCS, Pune were carried out. Cells were subcultured in surface adherent flasks and propagated in the incubator at 37 °C with 5% CO₂ level. Cells were stored in cryovials at -80°C as well as in liq. Nitrogen for long term storage with a density of 1×10^6 cells/ml. These cell lines were seeded for performing experiments. These cell lines were used for carrying out in- vitro

uptake studies of radiolabelled ^{125}I -mIBG which mimics ^{131}I -mIBG. The uptake studies were carried out with ^{125}I -mIBG of different specific activities (i.e. No Carrier Added, 1mCi/mg, and 0.1mCi/mg). Uptake of mIBG was seen in SK-N-SH cells which indicated the uptake of ^{125}I -mIBG by neuron-specific uptake-1 mechanism. A human neuroblastoma cell line IMR-32 was also used in the in-vitro study for the uptake of ^{125}I -mIBG. Since it is a receptor negative cell line the uptake was less compared to receptor positive cell line i.e. SK-N-SH. Desipramine which is a norepinephrine transporter re-uptake inhibitor was used to carry out the blocking studies with ^{125}I -mIBG of said specific activities. The uptake decreased in presence of desipramine as expected. The results indicate affinity of nca- ^{131}I -mIBG for NET transporter. Also, comparison with varying concentrations of carrier added- ^{125}I -mIBG showed that uptake reduces with decreased specific activity of ^{125}I -mIBG indicating the usefulness of nca preparation for therapeutic use.

Further experiments of the same cell lines have been planned with $^{99\text{m}}\text{Tc}$ -DMSA and $^{99\text{m}}\text{Tc}$ -HYNIC TOC.

8. Synthesis and evaluation of $^{99\text{m}}\text{Tc}$ analogue of ^{131}I - mIBG for its potential use in neuroendocrine tumor imaging.

^{131}I -mIBG is a known radiopharmaceutical used in the diagnosis of neuroendocrine tumors. However, ^{131}I lacks the desired characteristics of a diagnostic radionuclide, hence, molecules labeled with $^{99\text{m}}\text{Tc}$ which possesses ideal diagnostic radionuclide characteristics is preferred. In this respect a $^{99\text{m}}\text{Tc}$ analogue of mIBG employing $^{99\text{m}}\text{Tc}$ -4+1 chemistry was synthesized, characterized and evaluated. The work involved preparation of appropriate precursor followed by labeling via $^{99\text{m}}\text{Tc}$ -4+1 strategy. $^{99\text{m}}\text{Tc}$ -4+1 complex was then evaluated in neuroendocrine tumor cell lines. Preliminary cell uptake studies showed uptake similar to nca- ^{125}I -mIBG. This transport was specific as the uptake reduced with desipramine blocking.

Further in vivo experiments in nude mouse are in progress to evaluate the real potential of the labeled $^{99\text{m}}\text{Tc}$ complex in comparison with nca- ^{125}I -mIBG.

9. Production and supply of ^{177}Lu radiochemical from BRIT Vashi complex

^{177}Lu is emerging world-wide as a useful therapeutic radionuclide due to its suitable nuclear characteristics and convenient labeling chemistry. In this respect, ^{177}Lu as a radiochemical $^{177}\text{LuCl}_3$ is in regular supply from BRIT for more than three years. Currently, this is being supplied from BARC to limited nuclear medicine centers in India. Since, the radiochemical is supplied in sterile injection form; hence it requires stringent production facilities and rigorous quality check before its release for the end patient use. Hence, the processing of ^{177}Lu activity will be carried at the BRIT facility in Vashi, which is well equipped for handling sterile formulations. In this respect, an approval from AERB has been obtained.

Currently, 10 Ci of activity handling has been permitted by AERB for supply to Nuclear Medicine Centres.

The product is likely to be in supply within six months.

10. Initiation of work on ^{177}Lu -DOTA-TATE preparation for somatostatin receptor positive NETs

$^{177}\text{LuCl}_3$ is used at the hospital end for preparation of a therapeutic radiopharmaceutical ^{177}Lu -DOTA-TATE, which is used in patients for the treatment of neuroendocrine tumors expressing somatostatin receptors. In this regard, the product is planned to be developed in BRIT shortly and its proposal for RPC approval would be raised in next one year.

R&D activities of Technology Division of Radiopharmaceuticals Programme:

1. Setting up of Medical use fission based ^{99}Mo production facility

- Design Engineering review of processing Equipments/facility to be completed.
- Supply of major equipments expected. Partial commissioning of plants/equipments also planned.
- Civil construction to be completed fully excluding electrification & external pathway/horticulture.
- Design, drawing & prototype fabrication of LEU target to be completed.

2. Indigenous High Dose rate Brachytherapy Equipment (HDR)

- Remaining 5 Nos. of HDR treatment units will be made.
- Devoted TPS will be developed for deployment to Hospitals along with HDR units.
- Active Ir-192 source will be made & dose mapping will be done.
- Clinical trials of HDR units will be completed.
- Units will be supplied to hospitals as per demand, for regular use for the cancer treatment

3. Advanced Facilities for Radiopharmaceuticals Production (AFRP)

- Major works involving civil construction, AC and ventilation related to construction of first floor of RPL.
- Procurement of fume hoods etc for handling of new generation radioisotopes such as ^{177}Lu etc.
- In-cell gadgets, pneumatic equipment, peristaltic pumps, auto-dispense, etc.
- Special software's.
- Procurement of equipments such as UPLC/ HPLC/ Ion chromatograph.
- Site clearance & rearrangements of existing lab.

4. Isotope Processing Laboratories, Vizag (IPL)

- PSAR for all three labs namely RPL, LCL & Fission Moly processing labs to be drafted & submitted to BARC.
- Proposed labs building plan to be discussed & drawing to be prepared for all three labs & submitted for Architectural design by BARC.

General activity of TD:

1. Design development of Semi automatic dose measurement device for I-131 solution.
2. Development of Vertical column type remote operated Crimper & De-Crimper for production plants.

Note: Beside above, regular responsibilities of TD includes Maintenance of isotope Production plants in RPL & LCO, radioactive waste management, round the clock AC & ventilation ,clean room operation, developmental activities of RPL W/S, Arrangements of special packing materials for packing of radioactive consignments and supporting production logistics of RPL lab.

[D] Development Work Undertaken by Isotope Application Services:**1. Mobile Hot Cell Commissioned**

Mobile hot cell (MHC) is a CKD type hot cell for recovery of radiation sources from unused radiation equipment. Cold commissioning of cell was already completed. 161 Ci Sources from one gamma chamber were recovered and transferred to detachable MHC storage cask inside the cell in presence of AERB representative to demonstrate MHC operations to recover low activity sources. In-house weather cover was fabricated and installed over cell.

2. AERB has granted Type B(U) Approval of ISOMED Cask Package and MHC cask with cage.**3. Portable Research Irradiator**

PRI redesigned from Cesium based to 20Ci of Co-60 source to enable it to be used as Low Dose Irradiator facilitating the research work targeted to study the gamma radiation effect at low dose rates. Safety analysis Report (SAR) for Type B(U) certification prepared and certification obtained. Safety analysis Report (SAR) for Type A certification prepared. Type A certification was obtained to house 10Ci of Co-60 source in PRI. The unit is ready for loading and operation.

4. Feasibility of irradiating cables for cross-linking using gamma rays

Large diameters cables which cannot be processed by e-beam. Preliminary study and design of irradiator was carried out to see the feasibility of irradiating cables using gamma rays. Optimization of design of an irradiation system using ⁶⁰Co sources is being done. Trial cable irradiations were done.

[E] Developmental Work carried out at Radiation Processing Plant at Vashi Complex**Use of Low Dose Potassium Dichromate Dosimeters**

Gamma radiation processing of medical and food products has emerged as an important industrial process for sterilization of healthcare and hygienisation of food products in our country. This is evidenced by the increased number of irradiation plants, successfully operating in the country. At present 14 plants in the private sector and 3 plants belonging to Department of Atomic Energy are operating commercially for radiation sterilization & food irradiation. The customer availing radiation processing services will often require, as a quality control measure, that the absorbed dose in the material is measured accurately using a suitable dosimeter system and documented. Board of Radiation & Isotope Technology (BRIT) provides dosimetry services for these plants which include plant dosimetry, supply of Ceric-cerous dosimeters and dosimetry system.

The dosimeters covering high (8-45 kGy), medium (5-15 kGy) and low (1-6 kGy) dose based on the ceric cerous sulphate system is manufactured and supplied by Board of Radiation and Isotope Technology to various commercial gamma irradiators in India for use in medical and food irradiation. Fricke dosimeters are generally used to measure the absorbed dose range of 20-400 Gy in low dose food irradiation plant. Presently dosimeters manufactured by BRIT cover dose range of 1- 45kGy. For covering low dose range 0.25-1.0 kGy industrial user depends on imported dosimetry system, which is costly. Hence work on the development of low dose dichromate based dosimetry system was undertaken. The standardization of dosimeter solution is already done. Studies are carried out for the dose response, pre irradiation stability, accuracy of dosimeters and traceability of dosimeters is established with National Standard Laboratory, B.A.R.C at plant level. Now this low dose potassium dichromate dosimeters covering dose range of 0.2 to 1.0 kGy are ready for use in commercial food irradiation plant. Now BRIT is fully geared to provide the dosimetry services to irradiation facilities for wider dose range of 20 Gy to 25 kGy.

Chapter 4



HRD Activities of BRIT

4.1. HRD activities of Radiopharmaceuticals Production (RPhP) and Its Quality Control Section (QC-RPhP):

Training imparted

- Hospital Radiopharmacy course was conducted during September 16, 2014 to October 1, 2014 for DRM/DMRIT trainees. Lectures and practicals were conducted during the course. All RPhP and QC staff actively participated in conducting this course. 15 candidates were trained.

- **RIA workshop for doctors and clinicians was conducted in BRIT from March-18 to March-29 2014. Lectures and practicals were conducted by BRIT-BARC staff members. 9 Trainees attended the workshop.**
- Three M.Sc., (Biotechnology) students from Pillai's College of Arts Commerce and Science, New Panvel, underwent three months project training in QC-RPhP, BRIT as a part of M.Sc curriculum. The three projects and the respective guides were, 'Estimation of ligand concentration in cold kits for preparation of ^{99m}Tc injectables', under Dr. Sangeeta Joshi, whereas, "Identification and isolation of organism from technetium generator lab" and "Identification and isolation of organism from technetium cold kits lab" both were under the guidance of Smt. Chanda Arjun.
- A student of Advance diploma in Technical and Analytical Chemistry from MET, Institute of Medical Sciences, Bandra underwent four months training in "NMR profiling of some ligands used in radiopharmaceuticals." This work was carried out in the newly procured bench top 60 MHz NMR under the guidance of Dr. D. Padmanabhan.
- Two M.Sc., (Biotechnology) students from Pillai's College of Arts Commerce and Science, New Panvel, underwent three months project training in RPhP, BRIT as a part of M.Sc curriculum. The two projects and the respective guides were, "Uptake studies of ^{125}I meta iodo benzyl guanidine (mIBG) in neuroblastoma cell line SK-N-SH", under Dr. Shubhangi Mirapurkar, and "Uptake studies on no carrier added ^{125}I -meta iodo benzyl guanidine (mIBG) in neuroblastoma', was under Shri. Krishna Mohan.
- Two M.Pharm (Pharmaceutics) students from C.U.Shah College of Pharmacy, Santacruz, (W) Mumbai, worked on "Estimation of testosterone levels in rat serum samples" under the guidance of Mr.Krishna Mohan and Dr. Vrinda. P.C.
- Four B.E. (Mechanical Engineering) students from Saraswati Education Society , Group of Institution, Faculty Of Engineering, Bhivpuri Road-Karjat, worked on the project " Upgradation of mIBG Processing Setup" for a period of six months under the guidance of Mr. Chetan Kothalkar.
- Ph.D student and Senior Research Fellow doing a BRNS Project from Mangalore University, Mangalore was working on the project entitled "Radioiodination of C-peptide and development of an assay" for a period from June 2012-March 2014 under the guidance of Dr.Vijay B.Kadwad.
- B.Pharm student from Pune College of Pharmacy (Bhartiya Vidyapeeth), Pune, worked on "Quality Control Analysis of Sodium ^{131}I -Iodine solution and capsules" under the guidance of Dr. D. Padmanabhan for the period of one month from 26th May 2014 to 27th June 2014.

- Three M.Sc.(Biochemistry) students from SIES College of Arts, Science and Commerce, Sion(W), Mumbai worked on, 'Methodology and Sensitivity of RIA in T₃, T₄, TSH and Insulin;', under the guidance of Dr.Vijay B.Kadwad for the period of 5 months from 3rd June,2014 -30th October,2014.
- Ph.D student from Mangalore University, allocated to BRIT, is working on the project entitled "Development of nanoparticle based biomolecule probes for detection and management of diseases" for a period from September 2014-October 2016 under the guidance of Dr.Vijay B.Kadwad.
- M.Pharm (Pharmaceutics) student of C. U. Shah College Of Pharmacy, S.N.D.T. University, Santacruz(W), Mumbai, is working on a project entitled "Development of In-vitro Cell Uptake Procedures For Evaluation of Radiopharmaceuticals for Neuroendocrine Tumours" for the period of 7 months from 15th Nov-2014 to 15th May 2015 under the guidance of Dr. Shubhangi Mirapurkar.
- M.Pharm (Pharmaceutics) student of C. U. Shah College Of Pharmacy, S.N.D.T. University, Santacruz(W), Mumbai, is working on a project entitled "Development and Evaluation of Kit for ^{99m}Tc – MAA (Macroaggregated Albumin) as Lung Perfusion Imaging Agent" under the guidance of Dr. R. Vanaja & co-guided by Smt. Archana Ghodke for the period of 7 months from 15th Nov-2014 to 15th May 2015.
- One student of third year degree in Mechanical Engineering of Thakur College of Engineering, Thakur village, Kandivli(E), Mumbai was given one month "In-plant training program" under the supervision of Mr. Chetan Kothalkar from December 2014 to January 2015.
- One Junior Research Fellow from Bombay College of Pharmacy , is working on BRNS project "Radiotracers for developing and evaluating targeted nano particle based herbal drug delivery system for treatment of tuberculosis" [Primary Investigator –Dr.Alka P. Mukne), Primary collaborator Dr. Grace Samuel and Shri.V.V. Murhekar].

Lectures given by staff outside BRIT

1. One day workshop on "Role of Nuclear Medicine in Health Care" at CU Shah College of Pharmacy (SNDT Women's university) on 17th September 2014. Lectures were given by the following staff of RPhP
 - **Shri. S.S.Sachdev on "Role of Nuclear Medicine in Health Care";**
 - **Shri. Prabhakar. G. on "Radiopharmaceuticals other than ^{99m}Tc".**
 - **Dr.Kiran Mehra, on "^{99m}Tc Radiopharmaceuticals".**

- **Dr. Vrinda Prashant on “Immunoassay principles practice & applications”**
- 2. Invited talk “New Initiatives by BRIT.” was given by Shri. S.S. Sachdev at symposium, **“Applications of Radioisotopes and Radiation Technology in modern *medicine*: diagnosis, therapy and research”** conducted by CMC Ludhiana and NAARI, 2014.
- 3. Shri. S.S. Sachdev delivered a lecture on **“An Overview of BRIT”** at BARC training school, NFC, Hyderabad 2014.
- 4. Invited talk on "Radiotracers for Research in Oncology" was given by Shri. S.S. Sachdev *in* Seminar on **"Radioisotope & Radiation- A tool in Scientific Research"**, Centre for Application of Radioisotopes and Radiation Technology, Mangalore University, Mangalore 2014.
- 5. Smt. Jayula Sarnaik has participated as faculty member at 89th DAE- IANCAS National workshop on Radiochemistry and Application of Radioisotopes held at Tujiram Chaturchand College, Baramati, Maharashtra, during 15 – 20 December, 2014 and delivered a lecture on **“Applications of radioisotopes in healthcare”**.
- 6. Dr V.B. Kadwad delivered an invited talk on **“Application of RIA in medicine”** at “Special Lecture Series Programme on Life sciences”, conducted by Karnataka Science and Technology Academy at Mangalore University on 29.10.2014.
- 7. Dr. Tarveen Karir was one of the resource staff for an IANCAS Workshop at P.G. Department of Applied Physics, S.D. College (Lahore) Ambala Cantt., Haryana, held during October 6-11, 2014. She delivered a lecture on **‘Application of Radioisotopes on Healthcare’ and ‘RIA practical’s’** for five working days.
- 8. Dr.D.Padmanabhan delivered a talk on **“How to write a Research Proposal”** for Post graduate Students, Research Scholars and Teaching Faculties at Department Uka Tarsadia University at Bardoli, Surat District on November, 14th, 2014.

Training Programme attended by Staff

1. Shri.S.S. Mali was nominated to attend **“Orientation Programme for Drivers”** at ATI Mumbai held on 15-17 January
2. Smt. Shalaka Paradkar was nominated to participate in a Hindi Programme **“Sanyukta Rajabhasha Smanvaya Samithi”** at ATI, Mumbai held during February 10-12, 2014
3. Dr. Sangeetah Joshi, Smt. Geetha Rajagopalan, Dr. P.C. Vrinda, Dr. Yojana Singh, Smt. Preeti Nair and Shri. Mohar Singh were nominated to attend two days programme on **“Hindi Karyashaala”** at BRIT Vashi Complex on 20/6/14 and 21/6/14.

4. Dr. Anupam Mathur, Dr. Vijay Kadwad and Smt. Chanda Arjun attended a workshop on “**Intellectual Property Rights**” at V.S. Bhavan, Mumbai, held on 3-12-2014.
5. Dr. Sangeeta Joshi, Manager, QC-RPhP, participated in NIAS-DST Training Programme for Women Scientists on ‘**Science for Progress in India: Innovations in Technologies**’, during February 10-14, 2014 at Bengaluru.
6. Shri. Chetan Kothalkar attended five days training program on ‘**Project Management**’ in Shailesh J. Mehta School of Management, IITB, Powai, Mumbai,

Publications:

- Specific activity determination and stability studies of therapeutic ^{131}I -mIBG radiopharmaceutical.
V. V. Murhekar, Anupam Mathur, G. Prabhakar, Barakha P. Karkhanis, Neelam S. Pilkhwal, B. K. Tiwari, D. Padmanabhan, Grace Samuel, S.S. Sachdev
J Radioanal. Nucl. Chem. 302/2 (2014) 883-888.
- Feasibility of in-house Sterilization of Laboratory Plastic Consumables Using 2MeV Electron Beam Facility.
Chanda Arjun, K. P. Rawat, S A Khader, D. Padmanabhan, KSS Sarma, Grace Samuel
J Radioanal Nucl Chem 302/2 (2014) 989-992.
- Standardisation of radioimmunoassay for human insulin employing magnetisable cellulose particles.
Rasmi RR, Shenoy KB, Sarnaik J, Kadwad VB, Somashekarappa HM, Sivaprasad N
J. Radioanal. Nucl. Chem. 302: (2014) 1271-1275.
- Development of a simple method for the immobilisation of anti-thyroxine antibody on polystyrene tubes for use in the measurement of total thyroxine in serum.
Rani Gnanasekar, Shalaka Paradkar, Vijay Kadwad, Ketaki Bapat, Grace Samuel, S.S. Sachdev, N. Sivaprasad
J. Radioanal. Nucl. Chem. 302/3 (2014) DOI 10.1007/s10967-014-3829-z.
- Development of ^{68}Ga labeled fatty acids for their potential use in cardiac metabolic imaging.
Akanksha Jindal, Anupam Mathur, Usha Pandey, H.D. Sarma, Pradip Chaudhari, Ashutosh Dash
Journal of Labelled Compounds and Radiopharmaceuticals, 57/7(2014) 463-469.
- A study on nitroimidazole $^{99\text{m}}\text{Tc}(\text{CO})_3$ complexes as hypoxia marker: some observations towards possible improvement in *in vivo* efficacy.
Madhava B. Mallia, Suresh Subramanian, Anupam Mathur, H.D. Sarma, Sharmila Banerjee
Nuclear Medicine and Biology, 41 (2014) 600-610.

- Synthesis of ^{99m}Tc (4+1) Analogue of $^{123/131}\text{I}$ -mIBG for possible use in Neuroendocrine Tumor Imaging.
Navin Sakhare, Soumen Das, Anupam Mathur, V.V. Murhekar, R. Krishna Mohan, G. Prabhakar, S.S.Sachdev
Nuclear Medicine and Biology, 41/7 (2014), 624-25.
- Studies on separation and purification of fission ^{99}Mo from neutron activated uranium aluminium alloy.
Ankita Rao, Abhishek Kumar Sharma, Pradeep kumar, M.M. Charyulu, B.S. Tomar, K.L.Ramkumar
App. Rad. & Isotop. 89 (2014) 186-191.

Presentations in Conferences and Abstract Publication

- “Antidiabetic, antihyperlipidemic and antioxidant activity of ethyl acetate fraction of *Vernoniaanthelmintica* Willd. seeds in streptozotocin-induced diabetic rats.”
Dnyaneshwar M. Nagmoti, Archana Juvekar, Jayesh Dhodi, Jayula Sarnaik, Vijay Kadwad, Satbir Singh Sachdev
Poster presentation at the “42nd Annual Conclave of Research Society for the Study of Diabetes in India – (RSSDI) (2014).
- “Radioimmunoassay procedure for human insulin based on magnetizable particles”.
R.R.Rasmi, K.B.Shenoy, JayulaSarnaik, V.B.Kadwad, H.M.Somashekarappa N.Sivaprasad
Conference Proceedings, of “DAE-BRNS Fifth Symposium on Nuclear Analytical Chemistry (NAC-V)”, (2014) pp- 312-313.
- “Different Radioiodination Methods for C-Peptide Compared: Potential use as a tracer in RIA”.
R.R. Rasmi, K.B.Shenoy, JayulaSarnaik, V.B.Kadwad, H.M. Somashekarappa
Abstract Publication in Conference Proceedings of "South Regional Conference of the Association of Clinical Biochemists of India (2014) pp: 68.
This presentation received best poster award.
- “Characteristics of liquid waste generated during production of ^{125}I labelled RIA & IRMA kits at BRIT”.
A.S. Chindarkar, S.V. Chavan, D.K. Sawant, Vijay Kadwad, JayulaSarnaik, S.S.Sachdev, K.Narayani, Amit. K. Verma and R.K.Gopalkrishnan
Abstracts Book, 31st IARPNC-2014, (2014) pp-303.
- “Selection of matched pair of monoclonal antibodies in the development of C-Peptide IRMA “.
Rasmi RR, Shenoy K B, Vijay Kadwad, JayulaSarnaik, H.M. Somashekarappa, S.S. Sachdev
Abstracts, 46th Annual Conference SNMICON 2014, pp 22.
This presentation received best oral paper award
- “Development of crimp top polymer vial for the transport of short lived radionuclide”,
Chetan Kothalkar, Tukuna Muni, Niteesh Kumar, A.C Dey, S.S. Sachdev, Sudipta Chakraborty, A. Dash, D.I. Sawant
Abstracts Book, 31st Annual Conference of IARPNC-2014, (2014) pp-246.
- “Design and Development of Type-A package for ^{99}Mo - ^{99m}Tc Coltech generator”.

Chetan Kothalkar, Niteesh Kumar, Tukuna Muni, A.C. Dey, S.S. Sachdev
Abstracts Book, 31st Annual Conference of IARPNC-2014, (2014) pp-245.

- “Evaluation of shielding integrity of newly constructed therapeutic Na¹³¹I capsule (IOM-5) hot cell using Na¹³¹I solution source”
S.V. Chavan, A.S. Chindarkar, D.K. Sawant, S. Ravi, Kiran S. Mehra, D.N Chaudhary, Richa Tiwari, Anand Gaurav, S.S. Sachdev and R.K. Gopalakrishnan
Abstracts Book, 31st Annual Conference of IARPNC-2014, pp-215.
- “An improved formulation of high dose Na¹³¹I therapeutic capsules”.
A. Thulasidhasan, Richa Tiwari, Anand Gaurav, Kiran S. Mehra, Ravi Seshan S.S. Sachdev
Abstracts, 46th Annual Conference SNMICON 2014, pp 44.
- “Uptake studies of In-house produced no carrier added ¹²⁵I-meta iodobenzyl guanine (nca-MIBG) in neuroblastoma cell line SK-N-SH”.
R.Krishna Mohan, Shubhangi Mirapurkar, Soumen Das, Anupam Mathur, G.Prabhakar, V.V.Murhekar, S.S. Sachdev
Abstracts, 46th Annual Conference, SNMICON 2014, pp 46.
- Spectrophotometric Estimation of DTPA in Cold Kits Supplied by BRIT.
Sangeeta Haresh Joshi, Regal Fernandez, Pramod Dodke, Grace Samuel.
Abstracts, 46th Annual Conference, SNMICON 2014, pp 45.
- Development of *in vitro* bacterial uptake test for ^{99m}Tc-Ciprofloxacin.
Barakha P. Karkhanis, V. V. Murhekar, Kiran S. Mehra, D. Padmanabhan, Grace Samuel, S. S. Sachdev
Abstracts, 46th Annual Conference, SNMICON 2014, pp 41.
- Preparation and evaluation of lyophilized kit for preparation of ^{99m}Tc-Macroaggregated Albumin for lung perfusion imaging.
Archana Ghodke, R. Vanaja, Sangeeta Joshi, R. Krishnamohan, S.S.Sachdev
Abstracts, 46th Annual Conference, SNMICON 2014, pp 119.
- Stability Studies of Therapeutic ¹³¹I-meta-Iodobenzylguanidine(¹³¹I-mIBG) using High Performance Liquid Chromatography (HPLC).
V. V. Murhekar, Anupam Mathur, Neelam S. Pilkhwal, G. Prabhakar, D. Padmanabhan, S.S. Sachdev
Abstract Publication in ‘Third International conference on Application of Radiotracers and Energetic Beams in Sciences’ (ARCEBS-14), (2014) pp 41.
- Development of Reverse Phase Thin Layer Chromatography (RP-TLC) method for determination of radiochemical purity of ^{99m}Tc-Mebrofenin,
Murhekar, V. V., Pilkhwal, N. S., Padmanabhan, D., Saraswathy, P., & Samuel, G.
Eur J Nucl Med Mol Imaging 40 (2014) S320.
- Feasibility of in-house Sterilization of Laboratory Plastic Consumables Using 2MeV Electron Beam Facility.
Chanda Arjun, K. P. Rawat, S A Khader, D. Padmanabhan, KSS Sarma, Grace Samuel
Abstract Publication in ‘Third International Conference on Application of Radiotracers and Energetic Beams in Sciences’ (ARCEBS-14), (2014) pp. 143.

4.2. HRD activities at MCF, Parel, Mumbai:

Training imparted

- ❖ MCF is routinely involved in providing apprenticeship training to DRM, DMRIT and DNB students admitted in RMC.
- ❖ MCF also trains staff deputed from other nuclear medicine and cyclotron facilities for hands-on training in radiation safety monitoring during cyclotron operations and F-18 radiopharmaceuticals preparation.
- ❖ In future, MCF would be the centre for training cyclotron operators to qualify as AERB-certified Medical Cyclotron Radiation Safety Officers (RSO's).

Publications and Presentations (Abstract Publication)

- ❖ Sep-Pak assisted automated one-pot synthesis of 18F-FLT using 3-N-BOC-DMTr protected Nosyl Thymidine precursor.
A. Mitra, C. Rajesh, T. Upadhye, Y. Pawar, V. V. Murhekar, M. G. R. Rajan
Paper accepted in Annual Congress of the European Association of Nuclear Medicine (EANM-14).
- ❖ Limulus Amebocyte Lysate Testing: Adapting It for Determination of Bacterial Endotoxin in ^{99m}Tc-Labeled Radiopharmaceuticals at a Hospital Radiopharmacy.
Arpit Mitra, Sangeeta Joshi, Chanda Arjun, Savita Kulkarni, and Ramakrishna Rajan
J. Nucl. Med. Technol. 42 (2014) 278-282 (10.2967/jnmt.114.146779).
- ❖ Depyrogenation of Glass Vials using 2MeV Electron Beam by Reflection and Scattering Method.
A.Mitra, Chanda.A, K.P.Rawat, S.A.Khader, C.Sunil, S.Kulkarni, K.S.S.Sarma, D.Padmanabhan, G.Samuel, M.G.R.Rajan
Abstract Publication in 'Third International Conference on Application of Radiotracers and Energetic Beams in Sciences' Proceedings ARCEBS 2014, Volume 4, pp. 114.

4.3. HRD activities from Labelled Compounds include:

Training imparted

- ❖ Post graduate students were trained in the field of radiolabelled compounds production, quality control and radioanalytical techniques involved in the measurement or radionuclide content in water samples and other commodities.
- ❖ Lectures, including invited talk regarding production and applications of radiolabelled compounds were given to participants of RSO training conducted by AERB.

Publications and Presentations (Abstract Publication)

- ❖ 'Evaluation of ^{14}C -Urea Breath Test using indigenously produced ^{14}C -Urea capsules and a modified method for trapping exhaled breath: a pilot study', *Tiwari, Bijaynath P.; Nistala, Srinivas; Patil, Sanjay P.; Kalgutkar, Deepak P.; Jaychandran, Narath; Chander, Harish; Basu, Sandip*
Nuclear Medicine Communications, 35/3 (2014) p.325-330.
- ❖ A simple one-pot synthesis of [1- ^{14}C]-Glycine, *S. P. Patil, S. G. Chemate, R. K. Sahu, N. Jayachandran, Harish Chander*
Abstract accepted for presentation in NUCAR 2015 symposium to be held in February 2015.
- ❖ Measurement of Natural Radioactivity in Animal feed Supplements Samples by Gamma-Ray Spectrometry.
C. V. Sontakke, A. N. Thamke, K.Devika, N. Jayachandran, Harish Chander
Abstract accepted for presentation in NUCAR 2015 symposium to be held in February 2015.
- ❖ Purification of tritiated folic acid by reversed phase high performance liquid chromatography.
Deepak B. Kalgutkar, Ranajit Kumar Sahu, Harish Chander
Abstract accepted for presentation in NUCAR 2015 symposium to be held in February 2015.

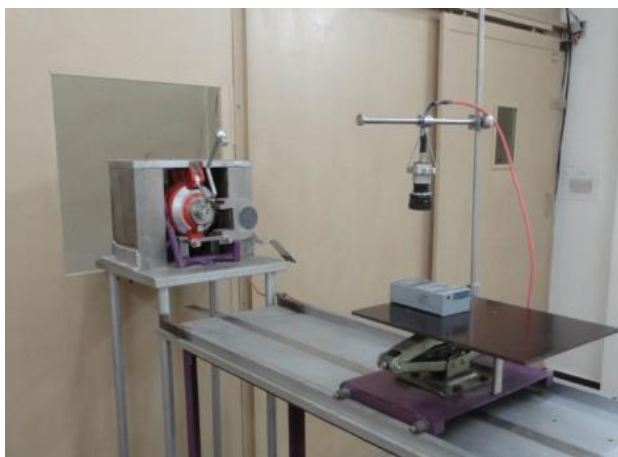
4.4. HRD activities from RCR, Delhi includes:

- ❖ Dr. Teena Goel delivered a lecture at the CME on “**Radiation safety in the practice of nuclear medicine, radio pharmacy and radionuclide therapy**” held at INMAS, New Delhi.
- ❖ Dr. Teena Goel also attended the workshop on “**Leadership in health and development sectors**” at Indian Institute of Public Health, Delhi.
- ❖ Shri. Pankaj Johri attended the short term training course on ‘**Safety aspects in the research applications of ionizing radiation**’.
- ❖ Dr. Teena Goel and her staff also **conducted practical's related to the handling and safe disposal of radioactivity for the naval personnel visiting INMAS, New Delhi.**

4.5. HRD activities from Radiation Processing Plant, Vashi

- ❖ Three weeks in-plant training was conducted for a batch of trainee operators for Radiation Processing Facilities.
- ❖ As a part of support for R & D activities, cable samples were irradiated up to 1000 kGy for radiation test qualification.

- ❖ A seminar on “Recent Trends in Radiation Processing of Food Products” was organized by BRIT in association with National Association for Applications of Radioisotopes and Radiation in Industry (NAARRI) during September 19-20, 2014 at Golden Tulip Hotel, Lucknow. About 50 participants from the Radiation Processing fraternity consisting of facility operators, designers, entrepreneurs, regulatory body attended the seminar. The focus of the seminar was on the current trends in radiation processing of food products from the technology perspective and business economics standpoint.
- ❖ A facility has been set up for calibration of Nuclear Radiation Survey Meters at BRIT- Vashi Complex. It will cater to calibration requirements of portable radiation monitoring instruments in the range of 0.5 mR/h (minmum) to 5 R/h (maximum). The laboratory is approved by Atomic Energy Regulatory Board (AERB) in accordance with the Rule-29 of Atomic Energy (Radiation Protection) Rules, 2004. It has started providing calibration services for in-house requirement, BARC and to outside parties on commercial basis.



Calibration laboratory for radiation monitors

4.6. HRD activities from RAPPKOFF, Kota

Papers Presented:-

1. Radiation Protection Aspects in Production, Processing and Transportation of Cobalt-60 sources from Reactor to customer.
T. M. Ashraf, S. A. Tariq & K.V.S. Sastri
Paper Presentation at 31st Indian Association of Radiation Protection (IARP) National Conference-2014 held on March 19-21, 2014 at Bhabha Atomic Research Centre (BARC), Mumbai.
2. The Scope and Development of Indigenous Cobalt-60 Teletherapy Sources.
S. A Tariq, T. M Ashraf, B. Pintu, D. Paul, K.V.S Sastri.
Paper Presentation at 35th Annual Conference of Association of Medical Physicist of India (AMPICON-2014) held on November 20-22, 2014 at Rural Medical college, Loni (Bk), Maharashtra, India.

3. Radiological and Operational Challenges in Fabrication of Cobalt-60 Teletherapy Sources from Reactor to Customer.

T. M. Ashraf, S. A. Tariq & K.V.S. Sastri

Paper Presentation at International Conference on Medical Physics, Radiation Protection and Radiobiology (ICMPRPR2K15) in Conjunction with Annual conference of Association of Medical Physicist of India (Northern-Chapter) AMPI-NC-CON-2015 to be conducted at SMS Medical College, Jaipur, Rajasthan, India on February 20-22, 2015.

CHAPTER 5

Building under construction 2014



GMP Compliant Cold Room for TCK products



Plan Projects

1. “Setting up of Fission based ^{99}Mo Production Facility”,

Project no. 11-IND-BRIT-4.05-0100.

The production process of fission based ^{99}Mo is a sophisticated technology. It is similar to a small scale “back end nuclear fuel cycle” of a nuclear power plant, involving handling of large scale of activity, having scores of long/short lived isotopes and all kind of radioactivity namely Alfa, Beta and Gamma. With the completion of this plant of BRIT, DAE will be able to meet long standing requirement of health care

sector, by producing most crucial isotope ^{99}Mo (n, f). Indigenous production of ^{99}Mo will bring about stability in the current uncertain market and bring down the cost of ^{99}Mo - $^{99\text{m}}\text{Tc}$ generator considerably. It will also facilitate the growth of nuclear medicine in India and finally, larger section of the patients would be benefitted due to availability of high-tech diagnostic procedures at affordable rate.

This project consists of setting up of a State-of-the Art GMP compliant facility capable of producing 300Ci (6 day pre-calibrated) /week ^{99}Mo , utilizing LEU targets. The scope includes commissioning of set of modern hot cells equipped with manipulators, in cell equipments, radiation surveillance instrumentation and data logging system, special AC & ventilation system, waste management equipments, civil construction of building and setting up of world class quality control labs, modern security system, construction of new building at approved site in ISOMED Complex, BRIT near South Gate BARC, etc.

After the site clearance by AERB, the design documents for the building have been submitted to AERB. As per requirements of security and safety authorities, the work of construction of new RCC boundary wall for the complex, new security watch tower is over and installation of new security and surveillance equipment is ongoing. The work on civil construction of laboratory building is nearing completion. The work on installation of facilities for waste management, electrical supply, water supply etc. is progressing.

The procurement of the production plant, on turnkey basis, is progressing. During the year, enhanced and revised sanction for the project was received from DAE. With enhanced sanction, a purchase order has been released in favor of M/s INVAP, Argentina for design, fabrication, supply, installation and commissioning of facility. Work on design of LEU targets for irradiation in Dhruva is in progress.

Building under construction 2014



Building under construction 2014



2. Advanced Facilities for Radiopharmaceuticals Production

Project no. XII-I&M-BRIT-402

. The project envisages asset built up for overall improvement of technical capabilities of BRIT to meet the advanced needs of Nuclear Medicine. The project scope comprises of building Advanced Radiopharmaceutical Manufacturing and testing facility for new generation Radiopharmaceuticals with radioisotopes using ^{90}Y , ^{177}Lu , ^{89}Sr , ^{131}I , ^{32}P , ^{153}Sm . etc . Also the present production capacity of radiopharmaceuticals and services from RPL, Navi Mumbai and Jonaki Hyderabad would be enhanced under this project.

Highlights of achievement (Upto December 2014)

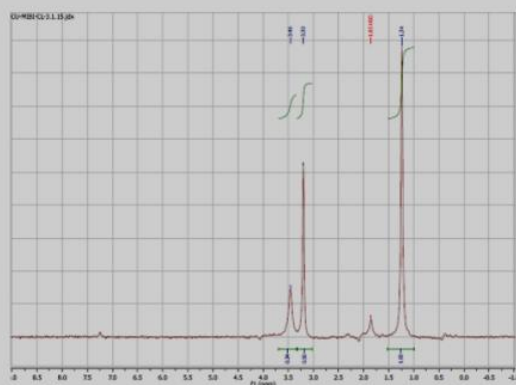
- ❖ **Design for construction of the first floor laboratory space over the RPL extension building: Work is in progress**
- ❖ **Design and Engineering drawing for new radioactive sump tanks or hold up tanks at RPL and LC are finalised**
- ❖ **Fire alarm system in all labs/rooms in RPL and LCL is installed.**
- ❖ **High end instruments like HPGe detector with lead shielding, dose calibrators, COMPACT 60MHz PROTON NMR SPECTROMETER, have been commissioned and are being regularly used for checking quality compliance of raw materials and products.**
- ❖ **Effluent Treatment Plant commissioned.**
- ❖ **GMP compliant Cold room for storage of TCK cold kits has been commissioned and operational.**



High Purity Germanium spectrometer facility



Compact NMR Spectrometer facility



3. Project: Integrated Facility for Radiation Technology (IFRT Control System)

Centralized control and display system is installed for IFRT facility. Redundancy is provided in terms of PLC & Relay based logic. Radiation interlock is provided for hot cell door & external transfer drawer opening. Sequential startup and stopping of air exhaust and supply blowers are provided for maintaining negative pressure in the facility. The control system facilitates centralized display and logging of radiation area monitors, fire alarm system and water pool management system and 24 X 7 surveillance of facility using CCTV monitoring.



Control Panel for IFRT Facility



Control Post & Radiation In-cell monitor for Hot cell door interlock



Control Post for Air Ventilation System



Control Post for ETD Interlock

The project has been completed. A Hot cell has been constructed to handle 300 kCi Co-60 source.

4. Project: Indigenous HDR Brachytherapy Equipment (IHDR)

Progress: Two HDR treatment units of “KARKNIDON” installed one each at TMH &

ACTREC for cold evaluation. Five units have been cold evaluated at Vashi. Actual HDR source wire rope assembly fabricated at RLG with desired accuracy and production process is standardized. Trial runs are taken in treatment units. Data being generated prior to hot production of ^{192}Ir miniature source for KARKNIDON. Modified SS Applicator & adopter assembly is developed.



KARKNIDON

5. Project : Technology Development for Radiation Technology Equipment

This project comprises of designing, manufacturing and commissioning of a State-of-the-art Iodine-125 Seed manufacturing plant at BRIT, Vashi Complex, Navi Mumbai, on **TURN KEY** basis. These seeds would be useful for Prostate Cancer Brachytherapy after its implantation for localized prostate cancer.

Specifications for I-125 seed manufacturing plant have been finalized. Tender for the civil construction has been raised.