ANNUAL REPORT

July 2020 – June 2021

BANGLADESH ATOMIC ENERGY COMMISSION

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Bangladesh Atomic Energy Commission

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Introduction

Bangladesh Atomic Energy Commission (BAEC) was founded in Feb. 1973 through the promulgation of Presidential Order 15 (PO-15) of 1973 with the objective of promoting peaceful applications of nuclear energy in Bangladesh. Now-a-days BAEC emerged as the largest organization for scientific and technological research especially in the field of nuclear energy in this country. The essentially goal-oriented research and development (R & D) programs in physical sciences, biological sciences, engineering sciences and nuclear power field have been undertaken in the light of the overall need of the country, so that the outcome of the activities can be directly contributed for socio-economic betterment in food and agriculture, industry, power, health or medicine and Environment protection.

Programs of BAEC are chosen in a manner so that the priority, aspiration and needs of the country are amply reflected in their execution. Notable services of BAEC include modern nuclear medicine services to mass people, specially to the poorest section of the society, protection of public health and the environment through radioactivity monitoring of all imported food items, practice of safety culture against all kinds of radiation hazards, sterilization of medicine and medical equipment, food preservation, development of high quality polymer materials, chemical analysis of industrial products for QC purposes, chemical analysis of food and Environ. samples for protection against pollution, industrial NDT and material testing services etc. In the last few years, the BAEC has undertaken the challenge of implementing the Rooppur Nuclear Power Project (RNPP) as one of its highest priority task.

The R & D programs of BAEC are executed through its different institutes, centres. The laboratories of all the institute/centres are equipped with state-of the-art facilities. The major facilities include 3 MW BTRR, 3MV Tandem Accelerator Facility, 3MV Van de Graff Accelerator, Two Co-60 gamma irradiator, Central Radioactive Waste Processing and Storage Facilities, Nuclear apparatus and scanning devices in National Institute of Nuclear Medicine and Allied Sciences (NINMAS) and 14 Institute of Nuclear Medicine and Allied Sciences (INMAS) located at different district headquarters, Radioisotope Production Laboratory, Radioactivity Testing and Monitoring Laboratory, air particle monitoring facility, Beach Sand Minerals Processing Pilot Plant etc. Apart from R & D activities, the following divisions of BAEC are playing vital role in executing various programs.

International Affairs Division (IAD): This division is playing a key role for maintaining liaison with many foreign countries and international organizations particularly International Atomic Energy Agency (IAEA) with a view of transferring the technology as well as developing human resources in the field of nuclear technology. This division is also in constant communication with IAEA in order to fulfill the country's obligation in matters related to Nuclear Safeguards and Non-proliferation of nuclear weapons. It also maintains liaison with other international bodies like RCA, Non-RCA, FTC, FNCA etc.

Planning and Development Division (PDD): This division is responsible for planning, development and execution of different ADP and special R & D projects.

Scientific Information Division (SID): This division is responsible for selection, collection, processing and providing information to a wide range of stakeholders concerned with the R & D activities and different services of BAEC.

Nuclear Safety, Security and Safeguards Division (NSSSD): This division is responsible for fulfilling the obligations rendered on operators under the signed international treaties, agreements, protocols and conventions related to safety, security, physical protection and safeguards of nuclear and radioactive materials.

Research and development (R & D) activities along with different service activities conducted during the period of July 2020 to June 2021 in the various fields of nuclear science and technology have been included in this report.

RESEARCH and DEVELOPMENT AND SERVICE ACTIVITIES

I. PHYSICAL SCIENCES

ATOMIC ENERGY CENTRE (AEC), DHAKA

Chemistry Division, AECD

Objective

The objective of this Division is to make significant contribution towards the scientific advancement and the socio-economic development of Bangladesh through different R & D programs of Bangladesh Atomic Energy Commission and unique and invaluable analytical services to potential individuals or group of entities from state level to end users.

Activities

1. Research and Development Work(S)

Advanced Analytical Chemistry

1.1 Participation in proficiency testing for the analysis of metallic contaminants in canned fish organized by FAPAS

S. B. Quraishi, T. R. Choudhury, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan and L. N. Lutfa

The Analytical Chemistry Laboratory (ACL) of Chemistry Division is an ISO/IEC 17025:2005accredited laboratory. According to the standards, in order to maintain the laboratory accreditation, it is mandatory to participate in the proficiency testing (PT)at least once in a year organized by any internationally recognized standard/reference laboratory and secure satisfactory results that ensure the quality of analyses, validity of the methods used and performances of analysts as well as the instruments. Therefore, the main objective of this program was to meet the criteria set by the ISO/IEC 17025 standard in order to maintain the laboratory accreditation. Analytical Chemistry Laboratory has participated in proficiency testing (PT) namely 'Metallic Contaminants in Canned Fish' by FAPAS, UK for the analysis of Cd, As and Hg in canned fish. The laboratory has secured satisfactory results for the quantification of trace elements quantified by different forms of Atomic Absorption Spectrophotometry (AAS) technique. The results indicate the capability of the laboratory to provide quality data for the quantification of trace elements in different food samples.

1.2 Renewal of accreditation certificate of analytical chemistry laboratory

S. B. Quraishi, T. R. Choudhury, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan and L. N. Lutfa

Quality assurance is a crucial part of any research and service activities and accreditation by a reliable body isa recognition of high performance as well as a criterion to offer trustable quality service. In Bangladesh, Bangladesh Accreditation Board (BAB) is the authorized body to issue accreditation certificate. ACL has achieved ISO/IEC 17025: 2005 certification from BAB in 2015 and has upheld its accreditation status continuously. The main objective of this program was to renewal of the certification and switch to the new 2017 version from its older 2005 version. The laboratory has reviewed its documentation, management and internal policy and has applied for the issuance of ISO/IEC 17025:2017 certification to BAB at the beginning of the fiscal year. In response, Bangladesh Accreditation Board (BAB) has visited the laboratory, reviewed the laboratory activities and performance and gave their observations along with various suggestions. The lab has acted accordingly through various up gradation in internal arrangement and policy, submitted the relevant documents and has received the newly issued ISO/IEC 17025:2017 certificate.

1.3 Efficiency analysis of eggshell and tea waste as low-cost adsorbents for crremoval from waste water sample

M. S. Rahman, P. S. Katha*, Z. Ahmed* and A. Acharjee

The study showed the nature of temperature variation between the green-roofed and bare-roofed buildings. Ten stations were chosen from the study area, where 20 buildings were studied, taking two neighboring buildings (a green- and a bare-roofed) from each station. Air temperature, relative humidity, and air velocity were collected from all floors and rooftops of the selected buildings. The Discomfort Index and Robaa Index

have been measured to detect the human comfort zone. Annual carbon sequestration by the plants of the green rooftops was assessed. Findings revealed a significant difference (1o ~ 3.5 °C) of the air temperature between the adjacent bare-roofed and green-roofed buildings. The thermal difference was significant during diurnal hours. The annual carbon sequestration in the green roofs ranged from 20.6 tC/ha to 125.4 tC/ha, whereas the equivalent CO_2 ranged from 84 to 460 t/ha.

*Department of Geography and Environment, Shahjalal University of Science and Technology, Sylhet.

1.4 Development of graphene-based adsorbent and its application in Cr^{3+} removal from tanning effluent

T. R. Choudhury, S. Ahmed*, M. Nurnabi *, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. B. Quraishi

Heavy metals such as Cr, Cu, Cd, Pb, Zn, Ni, Co, etc. cause severe water pollution which is a great concern to the environment and public health. The removal of heavy metals from wastewater is necessary for environmental protection and human health. This study is aimed to develop graphene-based adsorbent, Graphene Oxide (GO) for the removal of Cr^{3+} from chrome tanning effluent. The GO was prepared by modified Hummers' method. The developed adsorbents were characterized by Field Emission Scanning Electron Microscopy (FESEM), X-ray diffraction (XRD) analysis, and Fourier Transform Infrared Spectroscopy (FTIR). The influences of several variables such as pH, adsorbent dosage, ions concentration, contact time, and temperature were investigated through batch experiments. The data fitted well for both the Langmuir and Freundlich isotherm models. It was observed from the parameters, R^2=0.998, q_{max}=336 mg/g and R_L=0.098 for Langmuir and R^2=0.998, k_F=45.02 and n=2.232 for Freundlich, therefore the adsorption of Cr^{3+} onto GO followed both the models. The kinetic study showed that pseudo-second-order kinetics was fitted better than pseudo-first-order models. The thermodynamic analysis was also studied with Vant Hoff equation for the adsorbate. It was evident from the values of Gibb's free energy that the adsorption processes were exothermic and spontaneous. The metal ions loaded adsorbent was also regenerated and reused for further adsorbing Cr^{3+} from tanning effluent.

*Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Bangladesh

1.5 Preparation of calcium alginate-graphene oxide composite and its application for the removal of maxilon blue

T. R. Choudhury, D. M. M. Nabi*, M. Nurnabi* and S. B. Quraishi

Although graphene oxide (GO) showed excellent adsorption capacities for few model dyes and heavy metals, its application is limited due to high dispersibility in aqueous system. The aim of this study was preparation of non-dispersible calcium alginate-graphene oxide (CA-GO) composite, its characterization and application for adsorption of an industrial dye. The CA-GO composite was prepared by adding a mixture of GO with sodium alginate and $CaCO_3$ (SA: CaCO 3: GO = 10:2.5: 1) to 2% HCl. The prepared composite was characterised by SEM, XRD and FTIR analysis. The surface charge of the composite was also determined by zeta potential analysis. The adsorption properties of the composite were investigated for an industrially used cationic dye, Maxilon Blue (GRL) (MBG). Effects of dye concentration, contact time, adsorbent dosage, pH of dye solution and temperature on adsorption capacity of the composite were studied. The equilibrium of the process preferably followed Langmuir model. The theoretical maximum adsorption capacity was 1253.13 mg/g at pH 7.0. For the mechanism of dye adsorption, the data fitted perfectly with pseudo-second-order kinetic model. Thermodynamic studies revealed that the adsorption of MBG on CA-GO composite was spontaneous and physical in nature. The exhausted adsorbent was regenerated by simple treatment with 2% HCl followed by washing with demineralized water and the regenerated composite showed almost similar adsorption capacity.

*Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Bangladesh

Food Chemistry

1.6 Heavy metals in liquid milk: Source identification and potential human health risk assessment

S. B. Quraishi, M. A. H. Bhuiyan*, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. Sultana*

Milk is an ideal food and widely consumed across the country. However, the continual observation of the presence of heavy metals in all other food, it is urgent to know about their possible presence in liquid milk

and identify their sources. This work intends to quantify the heavy metals (Pb, Cd, Cr, As, Hg, Co, Ni, Mg, Fe, Ca, Zn, Cu) in liquid milk and identify their possible sources. Twenty samples of liquid cow milk have been collected from different sources of supply around the Dhaka city including Savar and Narsingdi area and analyzed for the presence of the target elements using different form of AAS. In addition, 10 cow feed samples including bran, cake, dry plant etc. from the same area that are used for cows, from where, the liquid cow milk samples have been collected, was brought into the laboratory and analyzed for the aforementioned elements. The findings have been submitted and awaiting for scientific publication.

*****Department of Environmental Sciences, Jahangirnagar University, Savar, Dhaka

1.7 Heavy metal accumulation in meat, liver, kidney of chicken and the potentiality of health risk

S. B. Quraishi, S. A. Mamun*, T. R. Choudhury, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and M. A. Islam*

Chicken is a highly consumed food, particularly in our country. It's organs like kidney, liver are often preferred over meat considering nutritional value. In this work, target was made to compare the deposition of heavy metals in different body parts of chicken and the associated health risks. Different types of chicken viz. native, layer and poultry were collected from local markets of Tangail and analyzed for the deposition of five heavy metals namely Lead (Pb), Cadmium (Cd), Chromium (Cr), Arsenic (As) and Mercury (Hg) in their meat, liver and kidney along with their feed using Atomic Absorption Spectroscopy (AAS). Among the organs, the highest concentration (mg/Kg) of Pb (3.87±0.98) and Cr (1.16±0.35) was found in meat, while Cd (0. 45±0.09) was in liver and As (0.29±0.06) and Hg (0.08±0.03) in kidney. Other than for Pb and Cr, the general trend of preferable deposit in soft tissues (liver and kidney) were in accord with reports. Except for mercury, all of these values exceeded maximum permissible limit. The report of the work has been submitted and work is going on for scientific publication.

*Department of Environmental Science, Mawlana Bhashani Science and Technology University, Tangail

1.8 Health risk assessment of Bangladeshi consumers to heavy metals via dietary intake of edible oil

S. B. Quraishi, T. Ferdoushy*, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and M. Haque*

To determine the concentrations of heavy metals in edible oils available in the market of Bangladesh and evaluate the associated human health risks to the consumers, edible soybean oil of twenty-one popular brands were collected from market. They were digested via wet digestion technique and analyzed for the presence Pb, Cd, Cr, As and Hg using the AAS technique. In addition to that, the samples were also analyzed for other potential trace elements using ICP- MS technique. The report of the work has been submitted and work is going on for scientific publication.

*Home Economics College, Azimpur, Dhaka

1.9 Evaluation of lead and chromium content in beef collected from five markets of Dhaka city and population health risk assessment

S. B. Quraishi, S. Mamun*, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and M. R. Akanda*

Beef is consumed worldwide as a good source of protein, fat as well as vitamin B, iron, zinc etc. There is a growing evidence that accumulation of heavy metals especially lead (Pb) and chromium (Cr) in beef are growing high. This study was done to estimate the content of Pb and Cr in beef. Fifteen beef samples were collected from five different markets and were analyzed for the presence of Pb and Cr in them. The concentration of Pb varied between 0.063 ± 0.009 to 0.845 ± 0.127 mg/Kg and the concentration of Cr varied between 0.05 ± 0.007 to 0.121 ± 0.018 mg/Kg. Except for Cr in beef of one market, all values were high compared to recommended value set by relevant standard bodies. The report of the work has been submitted and work is going on for scientific publication.

*Institute of Food and Nutrition Science, University of Dhaka, Dhaka

1.10 Levels and health risk assessment of heavy metals in dried fish consumed in Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and R. J. Rakib

Ten different types of widely consumed dry fishes (such as Harpodonneherius, Trichiuruslepturu, Pampuschinensis, Penaeusaffinis, Amblypharyngodonmola, Panna microdon, Ilishamegaloptera,

oiliadussumieri, Latescalcarifer and Gudusiachapra) were analyzed for Cr, Mn, Fe, Co, Cu, Zn, Se, Rb, Hg, Pb, Ni and As by *Energy Dispersive X-ray Fluorescence*(EDXRF). The concentration of the studied metals was found in the order of Fe>Zn>Hg>Cu>Se>Cr>Mn>Co>Rb>Pb, while As and Ni were found below the limit of detection. To assess the associated risk to human health via their consumption, health risk indices were calculated. The calculated Hazard Index (HI) for general population due to the detected heavy metals show below the maximum limit of 1 except for Hg to children. The carcinogenic risk showed values within the acceptable range for cancer risks (10^{-6} to 10^{-4}) and thus revealed no risk.

1.11 Elemental analysis of selected seven varieties of vegetable samples collected from a saline region of Bangladesh, Rampal area

S. Akter, Y. N. Jolly, M. J. Kabir, K. M. Mamun, N. Sultana and M. J. Abedin

This study, conducted with the identification of elements(Al, S, Cl, Ar, K, Ca, Sc, Ti, Cr, V, Mn, Fe, Co, Ni, Cu, Zn, Br, Kr, Sr, Zr, Ag, Te, I, Pb) present in selected seven vegetables samples namely, Basella alba, Spinaciaoleracea, Abelmoschusesculentus (L.), Ipomoea aquatica, Colocasiaesculenta, Amaranthus dubius, and Raphanussativus, showed the possible influence in the metal absorption by the vegetables grown in a saline region of Rampal area of Munshigonj district, Bangladesh using PIXE technique. The data acquisition setup is calibrated using a 2.5 MeV proton beam in the current ranges of 5nA to 15nA. The detector was used to measure the X-rays emitted during the irradiation. Data acquisition system-MAESTRO-32 used for measurement of the spectrum picks and concentration calculation has been done by GUPIX/DAN-32 software technique. K, Ca, and Fe were found to have the highest concentrations, while Pb exhibits the lowest concentrations but an alarming rate compared to reference materials. The findings were constructed with IAEA-V-10, IAEA-359, SRM 1515 (Apple Leave) and SRM 1573a (Tomato Leave) reference materials.

1.12 Health risk assessment of heavy metals through ten common foodstuffs collected from an area of ruppur nuclear power plant, Pabna, Bangladesh

M. S. Rahman, B. A. Begum, Y. N. Jolly, S. Akhter, M. J. Kabir, M. M. A. Molla*, M. Rakib-uz-Zaman* and S. M. A. Salam*

A huge construction work is going on at Ruppur Nuclear Power Plant (RNPP), Pabna district, Bangladesh, which has schedule for commissioning in 2023. Therefore, this study has been designed to assess the levels of selected toxic metals (V, Pb, Cr, Mn, Co, Fe, As, Ni, Cu and Zn) in some common foodstuff's samples, collected from the RNPP (Ruppur Nuclear Power Plant) area, Pabna district, Bangladesh. The results of this study showed that the concentrations for Mn, Cu, Zn, Pb and Fe were ranged from 100.88 to 75.46, 123.02 to 36.78, 49.75 to 11.99, 10.79 to 6.32 and 1533.09 to 132.39 mg/kg respectively. Thereafter, the experimental data for Mn, Cu, Zn, Pb and Fe was used for identifying MPI (metal pollution index) and HRI (health risk index) in the selected foodstuffs samples.

*Department of Applied Chemistry and Chemical Technology, University of Rajshahi

1.13 Potential human health risk assessment of trace and heavy metals through consumption of fishes from Noakhali fish market

M. S. Rahman, Y. N. Jolly, S. Akhter, M. J. Kabir, M. B. Hossain*, F. Tanjin* and B. A. Begum

Fish constitute a major source of heavy metals in food. The study aimed to determine the trace/heavy metalsin editable tissues of ten commercial fish species collected from Noakhali fish market. Trace and heavy metals such as Pb, Cr, Cu, Zn, Mn, Fe, Hg, Ni, Ca, Co, Se, Rb, Sr and as were detected by using Energy Dispersive X-ray Fluorescence (EDXRF) in Atomic Energy Center, Dhaka. The hierarchy of all mean concentration were: Fe (162.198 mg/kg)>Zn (113.326 mg/kg)>Ca (87.828 mg/kg)>Sr (75.139 mg/kg)>Cu (36.438 mg/kg)> Se (9.087 mg/kg)>Cr (7.336 mg/kg)>Mn (6.637 mg/kg)>Co (3.474 mg/kg)>Rb (1.912 mg/kg)>Hg (1.657 mg/kg)>Ni (1.467 mg/kg)>Pb (0.521 mg/kg)>As (BDL). To assess the health risk effects, estimated daily intake (EDI), target hazard quotient (THQ) and carcinogenic risk (CR) were conducted.

*Department of Fisheries and Marine Science, Noakhali Science and Technology University

1.14 Concentrations, source apportionment and potential health risk along with ecological risk of toxic metals in shrimp and aquaculture sludge of Bangladesh

T. R. Choudhury, S. Sultana*, M. B. Hossain*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. B. Quraishi

Heavy metals are a global concern, due to their potential toxic effect and ability to bio-accumulate in aquatic ecosystems, which might have a negative impact on human health through consumption of shrimp. Thus, a study has been carried out in order to measure the concentration of eight heavy metals in shrimp and associated sludge from three shrimp hatcheries in Bangladesh, identification of their probable sources, and assess the associated carcinogenic and non-carcinogenic risks from their intake. Fifteen shrimp and sludge samples were collected from the three hacharies and heavy metal concentrations in edible part (flesh) of shrimp samples were assessed with validated and accredited methods using Atomic Absorption Spectrophotometer (AAS) and appraised human health risk through consumption of these highly consumed shrimp. The study is under progress.

*Department of Fisheries and Marine Science, Noakhali Science and Technology University

1.15 Bioaccumulation of heavy metals in liver, gill, muscle of cultured and wild sea bass

T. R. Choudhury, T. Tahiti*, M. B. Hossain*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. B. Quraishi

The excessive uptake of essential and nonessential metals ends in accumulation in various tissues. Metals in higher concentration change the biological activities of the fish. Consumption of such metal-contaminated fishes by a human can cause serious health issue. Metals deteriorate the ecological balance of the aquatic environment because fish are at the end of the aquatic tropic level and they have a higher tendency to accumulate metals in their body. The aim of the present study was to investigate heavy metal bioaccumulation and alteration in hematological indices and nucleus morphology and in different organs like gills, liver and muscles of sea bass exposed with different concentrations of heavy metals. Samples of wild sea bass were collected from the Char Alekjander region in the heart of the Meghna River. Char Alexander is a sweet water beach near the market of the Alexander Municipality of Ramgarh, 33 km from the district of Rajkumar and 40 km from the district of Noakhali. And the cultured seabass samples were fetched from the fish market in the Noakhali district. A Varian AA240 atomic absorption spectrometer (AAS) with Zeeman background correction system equipped with a graphite furnace (GTA 120) was used to measure Cu, Zn, Fe, Mn, Ni, Pb, and Cd in the samples. The degree of metal contamination was evaluated by the determination of the contamination factor (CF), pollution load index (PLI), and etal pollution index (MPI) etc. According to this study, all cultured and wild fish had the lowest levels of metals in their muscles, while almost all fish species had the highest levels of Zn, Pb, and Cu in their livers and the highest levels of Pb, Cr, Cu, and Mn in their gills. Among the metals, concentration of Cd and as was almost similar of both cultured and wild species. The study is under progress.

*Department of Fisheries and *M*arine Science, Noakhali Science and Technology University

1.16 Analysis of residual antibiotics (tetracycline, chlortetracycline, and oxytetracycline) in different meat samples using high performance liquid chromatography (HPLC)

M. F. Ehasan, R. Sultana and A. R. M. Tareq

Meat is an important source of complete protein with all essential amino acids, highly bioavailable iron, zinc, selenium, and B vitamins, especially vitamin B_{12} in the diet. But the residual antibiotics in meat, dangerous for human health, are a great matter of concern. The aim of the present study is to investigate the quantity of different antibiotics in different meat sample in Bangladesh. An analytical method is developed for the determination of three tetracyclines (TCs e.g. Tetracycines, Oxytetracyclines and Chlorotetracyclines) by high performance liquid chromatography (HPLC) with UV detector. The mixture of mobile phase i.e. 10mM Phosphate buffer: Acetonitrile: Methanol is in the ratio of 77:18:5, column is C18, and UV wave length is 350nm. Several Runs of TCs are performed to separate the standard TCs. At different concentrations, 100, 200, 400 and 600 ppb, TCs standard solutions are run several times for the curve CCα and CCβ are also determined.

1.17 Chemical composition of the essential oils of moringa (Sojna) leaf produced in Bangladesh

A. R. M. Tareq, R. Sultana, M. F. Ehsan, A. Siddika* and A. K. M. A. Ullah

Moringa (sojna) is a plant that is native to areas of India, Pakistan, Bangladesh, and Afghanistan. It is also grown in the tropics. The leaves, bark, flowers, fruit, seeds, and root are used to make medicine. Moringa is an important food source in some parts of the world. The chemical constituents, such as volatile compounds of the leavesof moringa were identified by GC-MS. Moringa contains proteins, vitamins, and minerals. As an antioxidant, it seems to help protect cells from damage. The chemical compositions of the essential oil of Moringa (Sojna) leaf produced in Bangladesh were determined by GC-MS. Seeds were extracted by hydro-distillation process. The sample was collected and washed. 100g of each sample was blended well and subjected to hydrodistrillation for four hours. The distillate was collected nearly 2ml and further treated with Na_2SO4. The GC-MS analysis of Moringa (Sojna) showed the presence 46 phytochemical compounds. The major components were: 2,4-Imidazolidinedione, 5-[3,4-bis[(trimethylsilyl)oxy] phenyl]-3-methyl-5-phenyl-1-(trimethylsilyl)-(13.73%);Hexadecanoic acid, methyl ester- (9.99%); psi.,.psi.-Carotene, 3,3',4,4'-tetradehydro-1,1',2,2'-tetrahydro-1-hydroxy-1'-methoxy-(9.2%); Methyl (Z)-5,11,14,17-eicosatetraenoate-(7.23%); Cephalotaxine, 11-(acetyloxy)-,acetate (ester), (11.alpha.)-(5.86%); Canthaxanthin-(5.51%); Spiro[9,9'] difluorene, 2,2'-(2,5,8,11-tetraoxadodecane-1,12-diyl)- (2.56%); 3,7,11,15-Tetramethyl-2-hexadecen-1-ol-(4.46%); Pregn-4-ene-3,11-dione, 17,20,21 tris[(trimethylsilyl)oxy]-, 3-(O-methyloxime), (20S)- (2.16%) 3,9.beta.;14,15-Diepoxypregn-16-en-20-one, 3,11.beta.,18-triacetoxy-(2.28%); 3,8,12-Tri-O-acetoxy-7-desoxyingol-7-one- (1.99%); Isobutyl ether-(1.96%).

1.18 Phytochemical analysis of trapanatans (water chestnut) using GC-MS technique

M. F. Ehasan, R. Sultana, A. Siddika*, A. K. M. A. Ullah and A. R. M. Tareq

Trapanatans (Water chestnut) is an important medicinal plant of the Trapaceae family. The aim of the present study is to investigate the phytochemicals of methanol extract of Trapanatans (Water chestnut) for feasibility study of raw materials production in medication purposes. The sample was collected, washed and dried in oven over 60°C, then it was crushed for homogenization. After crushing about 5.0g sample was taken into 50mL methanol and refluxed for 2.5 hours at 65°C. The extracted samples were pre-concentrated to 1-2 mL by evaporating concentration using nitrogen gas. The GC-MS analysis of Trapanatans (Water chestnut) showed the presence 77 phytochemical compounds. The study conducted the presence of carotenoid, terpinoid, phenolic, alcoholic, sterol, organic acid and alkane derivatives in collected Trapanatans (Water chestnut). The major compounds were found namely, Octadecamethyl-Cyclononasiloxane (6.55%), Isobutyl ether (6.16%), Canthaxanthin (5.38%), 4-Pyrimidinamine, 5-methyl-N-(trimethylsilyl0-2-[9trimethylsilyl)oxy]-(5.04%), psi.,.psy.-Carotene, 3,4-didehyro-1,2,7,8-tetrahydro-1-methoxy-2-oxo-(4..17%), 3,9. Beta., 14, 15-Diepoxypregn-16-en-20-one, 3, 11. Beta., 18-triacetoxy-(4.03%), 1,1,2-triacetoxyethane (3.81%), 6,6'-Diacetyl-7,7'-dihydroxy-2,2',4,4',5,5'-hexamethoxy-1,1'-binaphthalene (3.65%), Cyclooctasiloxane, hexadecamethyl- (3.44%), and 1-(Nitromethyl)-cyclohexanol (2.26%) etc.

1.19 GC-MS analysis of methanoic extract of jam bark (syzygiumcumini)

R. Sultana, M. F. Ehasan, A. Siddika*, A. K. M. A. Ullah and A. R. M. Tareq

Jam (Syzygiumcumini) is an important medicinal plant of the Myrtaceaefamily. The seeds and bark are well known in the Far East for the treatment of dysentery and in the control of hyperglycaemia and glycosuria in diabetic patients. The juice of the bark is considered good for treating wounds and enlargement of the spleen. The aim of the present study is to investigate the phytochemicals of methanol extract of Jam (Syzygiumcumini) bark. The sample (Jam bark) was collected, washed and dried in oven over 60°C, then it was crushed for homogenization. After crushing about 5.0g sample was taken into 50mL methanol and refluxed for 2.5 hours. The GC-MS analysis of Jam Bark (Syzygiumcumini)showed the presence 74 phytochemicals. The study conducted the presence of carotenoid, terpinoid, phenolic, alchoholicsterol,organic acid and alkane derivatives in collected Jam (Syzygiumcumini) bark. It also has been studied to identify all above mentioned compounds by using Gas Chromatography-Mass spectroscopy (GC-MS) technique. The identified compounds were: Alcoholic 49.35%, Steroids 6.96%, Carotinoid 5.01%, Terpenoids 3.57%, Antioxidant 1.59%, Alkaloids 3.24%, Ester 2.16%, Ketone0.72% and Silane 1.58%.

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Atmospheric and Environmental Chemistry

1.20 Stabilization of coal mine waste and its practical application as a road subgrade

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan and L. N. Lutfa

Sub-grade is a term used in transport engineering to mean the material used in making the base of a road. This project aims to determine the quality of coal mine waste and check its suitability as a sub-grade material in near future. Under this project 3 liquid samples collected as a mixture containing 15% fly ash and 9% lime with fresh water have been analyzed for the presence and quantification of Pb, Cd, Cr, As, Hg, Mn, Co, Fe, Cu and Zn with atomic absorption spectroscopy. This will reveal the quality of the proposed material for its intended use and help to decide for necessary modifications.

1.21 Comprehensive Assessment of trace metals in water, sediment and fishs pecies from the Padma river, Bangladesh

S. B. Quraishi, A. K. M. A.Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and J. Tajri*

Padma is the longest river of Bangladesh and it is suspected that with time, its extent of pollutionis rising. The current work was adopted to analyze the quality of fish, water and sediments from Padma River in terms of trace metal contamination. Under this project, 3 fish, 3 water and 3 sediment samples from each of 6 different locations, making total 18 fish, 18 water and 18 sediment samples have been collected from different places along the Padma river. The study was carried out to assess the concentration of seven trace metals (Pb, Cd, Cr, Hg, Ni, Cu and Zn) in water, sediment and muscle of six fish species (Xenentodoncancila, Mugilcorsula, Glossogobiusguiris, Mystusaor, Mastacembelusarmatus and Mastacembeluspancalus). Atomic absorption spectrometer (AAS) was used to analyze the metal concentrations in the samples after acid digestion. The highest trace metal concentrations were found in sediment, followed by fish and the lowest in water. The concentrations of trace metals in the water samples were not only very low but also below hazard risk. The concentrations of Pd, Cd, Cr, Hg, Ni, Cu and Zn found in river sediments were 4.44-13.88, 0.04-0.11, 15.09-59.08, 0.02-0.16, 37.23-14.19, 9.52-39.41 and 21.27-73.86 mg/kg dw respectively. The higher concentrations found in sediments reveals the fact that sediment works as a sink for trace metals. The average concentrations of Pd, Cd, Cr, Hg, Ni, Cu and Zn found in the fish species were in the range of 0.213-0.419, 0.01-0.025, 1.170-75.409, 0.017-0.182, 0.033-0.739, 0.226-1.514, 2.722-13.959 mg/kg ww respectively.

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1.22 Analysis of soil, water and sediment under the project 'assessment for selecting suitable place for the construction of nuclear power plant in southern Bangladesh'

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam and M. M. Hosen

The government of Bangladesh (GOB) has decided to set up a NPP at the southern part of the country. However, such a construction needs stable soil and other environmental parameters. This work was undertaken to find out the quality of soil, water and sediment of probable places for NPP construction in terms of inorganic elements and establish a baseline data for future use in the corresponding project.Under this project, 27 soil, 28 water and 9 sediment samples have been collected from 1) Kumirmra, Barguna, 2) Nishanbari (east), Taltoli and 3) Nishabari (west), Taltoli in the first phase and 18 soil, 18 water and 9 sediment samples have been collected from 4) Moudubi, Rangabali and 5) Char Mantaj, Rangabali have been collected in the second phase. The samples have been processed, digested and were analyzed for the presence of Pb, Cd, Cr, As, Hg, Fe, Mn, Ni, Cu and Zn. The results have been processed and the test report has been sent to the project director. The technical report regarding the findings is under preparation and will be published soon.

1.23 Assessment of water and sediment quality in the upstream of Shitalakshya river and its impact on public health

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and B. Ahmed*

This study was carried out to assess the level of concentration of nine alarming heavy metals (Pb, Cr, Cd, Hg, As, Mn, Ni, Cu, and Zn) in sediment and water samples of Shitalakshya using different pollution indices and

statistical techniques to determine the ecological risk during the monsoon period in the upstream of Shitalakshya river. Samples were collected on Sep. 2020 from 10 sites of upstream of the Shitalakshya, Narayanganj. The concentrations of trace metals were determined by using atomic absorption spectrometer where average concentrations of these metals were observed in descending order Mn>Cr>Cu> Ni>Zn>Pb in water and Mn>Zn> Ni>Cr>Cu>Pb>As>Hg>Cd in sediment. The concentrations of heavy metals in water were within the DOE standard limit, portrayed that water from this river during the wet season was safe for using in different purposes. But the concentration of few metals (Cr, Mn, Ni, Cu. and Zn) in sediment exceeded the permissible limit set by USEPA which could be detrimental for sediment biota and aquatic environment.

*Department of Environmental Science, Bangladesh University of Professionals

1.24 Assessment of water and sediment quality in the downstream of Shitalakshya river and its impact on public health

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. Islam*

The present study investigated the concentrations of heavy metals of the surface water and sediments of Shitalakshya river to understand the level of contamination and their distribution. Nine metals (Pb, Cd, As, Hg, Cr, Ni, Cu, Mn and Zn) were analyzed in order to determine the concentration. The average value of heavy metals followed a general trend of Mn>Cr>Ni>Pb>Cu>Zn>As in water and in sediment. Concentration of Cd and Hg in water were found below detection limit in all sampling station. However, significantly higher concentration of PbMn and Zn were found in a particular location of the study area. The heavy metals contamination were evaluated by applying index of Heavy Metal Evaluation IndexHEI), Heavy Metal Pollution Index (HPI), Degree of Contamination (Cd) and Nemerrow Pollution Index (Ni) for water and for sediments were assessed by Geoaccumulation (Igeo), Contamination factor (Cf), Degree of contamination (Cd), Pollution load index (PLI) and Potential ecological risk index (PERI).

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1.25 Collection of baseline data of chemical concentration of various components of rooppur nuclear power plant construction area

S. B. Quraishi, Y. N. Jolly, J. kabir, S. Akter, T. R. Choudhury, A. K. M. A. Ullah, M. N. Alam, K. M. Mamun, M. M. Hosen, M. A. Maksud, S. R. Khan and L. N. Lutfa

Nuclear power is a wonder of modern day and widely held as a safe and reliable source of energy. Bangladesh has started its journey as a member of nuclear power club through the construction of a nuclear power plant (NPP) at Rooppur, Pabna. After construction, NPP has the potential to influence the ambience of its surroundings. Hence, although best precautions are being taken leaving no chance for any such occurrence, it is essential to have pre-construction data of the ambience of the NPP to be used as a baseline data. The current project has been undertaken to find out chemical concentration of various components of the environment including water, soil, sediment, food etc. collected from the NPP area to form a baseline data for future purpose. A roadmap has been made for year around sample collection from the area of 30 Km radius around the Rooppurnuclear power plant (RNPP), their processing, preparation and analysis in the laboratory and reporting to the stakeholders. As per the roadmap, sample collection has begun from Feb. 2021 for winter season. More than 160 samples including water, soil, sediment, vegetables, fish, beef, cow milk, grass etc. have been collected. Most of the samples have already been prepared and their analysis for the presence of the desired elements including but not limited to Pb, Cd, Cr, Ni, Cu, Fe, Mn, Zn, Co, Hg etc. is ongoing on a continuous basis. Planning for sample collection of next seasons is already underway while the report of analysis of some item like water and soil is ready to be delivered to the stakeholders.

1.26 Characterization of landfill leachate of matuail landfill site, Dhaka south city corporation and photodegradation experiment

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and S. Akter

This study was carried out to characterize the landfill leachate from matuail sanitary landfill site by measuring the physicochemical and biogeochemical propertiesand heavy metal content. Elemental concentration of leachate samples was measured by using X-Ray fluorescence (XRF). Potassium (K) was found in the highest

concentration. Ca, Fe, Br, Rb, Cu was present in considerable amount. A trace amount of Sr, Co, As, Pb, Cr was found in the leachate sample. The changes in dissolved organic matter under the natural sunlight condition was also evaluated l and found physicochemical properties like pH of the sample changed from 8.02 in the raw sample to 8.34 after photodegradation of five days, Total dissolved solids (TDS) changed from 665 (mg/L) to 90 (mg/L), Total organic carbon (TOC) changed from 677.8 (mg/L) to 445.5 (mg/L).

1.27 Contamination level and ecological risk of trace metals in salt marsh sediments of marine ecosystem in Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and R. J. Rakib

The study was carried out toassess the extent of metal contamination (Fe, Ca, Ti, K, Sr, Rb, Zr, Zn, Cu and Pb), in sediments from salt marsh ecosystem, of the Bay of Bengal, Bangladesh to evaluate the ecological risk due to sediment contamination by trace metals, and to identify the sources of trace metals using correlation matrix and multivariate statistical techniques. The range of trace metalsin sediment (mg/kg) followed the decreasing order: Fe (25020-35176)>Ca (8679-16323)>Ti(2678-3340)>K (23680-16770)>Sr (138.32-209.64) >Rb(124-186.57)>Zr (96.21-161.35)>Zn (37.71-44.95)>Cu (36.51-51.66)>Pb (1.35-10.42). The concentration of trace metals were found within the standard limits except Fe, Cu and Rb, which can occasionally be associated with adverse biological effects. Contamination level and ecological risk were evaluated using contamination factor (CF), Enrichment factor (EF), geo-accumulation index (I_{geo}), pollution load index (PLI) and potential ecological risk index (PERI). Multivariate statistical technique was employed to classify the metal sources. The results showed that Fe was significantly enriched in sediment. Ecological risk factor illustrated a pollution-free condition in the study area.

1.28 Evaluation of effect of industrial waste water on fish anabas cobojius

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and M. Mehnaz

This study conducted to determine physical (electrical conductivity, turbidity and temperature) and chemical (pH, dissolved oxygen, total dissolved solids and salinity) characteristics of the point-source industrial wastewater and determination of the toxicological effects at different concentrations of industrial wastewater on fish species at juvenile stage and estimation of heavy metals concentration of the wastewater as well as the fish (flesh) . To assess the probable human health risk for consuming those fish species some risk indices were also calculated. The point-source industrial wastewater collected from Shilpi Plastic and Rubber Industries Ltd., Lalbagh, Dhaka, Bangladesh, The average pH, DO, EC, TDS, salinity, turbidity and temperature (mean ± SD) of point-source industrial wastewater were found to be 8.57±0.30, 4±0.44, 675±10.58, 592±13, 0.32±0.27, 3.67±0.71, 35.99±0.08 respectively. Fish toxicity experiment results revealed that mortality rate was 100% during 24 hour-exposure in industrial wastewater. Concentrations of heavy metals (Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Sr, Hg and Pb) in wastewater and their bioaccumulation in fish (flesh) were determined using Energy Dispersive X-ray Fluorescence (EDXRF) spectrometry. Target hazard quotient (THQ) values for Zn and Hg surpassed 1 for 3 days/week and 5 days/week exposure level, respectively and target cancer risk (TR) value in context of Pb was found in the range of 10^{-6} to 10^{-4} for exposure to wastewater indicating carcinogenic risk.

1.29 Appraisal of agricultural potentiality and contamination status of soil at selected wetlands in the northeastern basin of Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and A. Rahman

This study evaluated the agricultural sustainability of the wetland basin and measures the distribution of soil properties and elements inthe soil. The status of metals with source identification was also evaluated. The distribution of soil nutrients and metals in the soils of Sylhet basin of Bengal Delta was investigated with a view to evaluating the agricultural suitability and contamination status. The major soils of the wetlands revealed slightly acidic to neutral condition with high organic matter and cation exchange capacity indicates the agricultural viability. Trace metals have been reported to be in a balanced condition exhibiting synergistic and antagonistic relationships. EF and Igeo values followed the order Zn>Ti>Fe>Zr>Mn>Rb>Cu. Principal Component analysis (PCA), using Varimax rotation with Kaiser Normalization, and CA revealed that anthropogenic factors are responsible for the current contamination in wetland soils.

1.30 Trace metal contamination of commercial fish feed and farmed fish in central coast, Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and R. J. Rakib

The study was conducted to measure the concentration of trace elements viz: Ni, Cu, Zn, Pb, Cr and Mn in commercially available fish feed and farm cultured fish collected from the central coastal area of Bangladesh (Noakhali and Laxmipur district) and their potential health impact on consumer. Twelve varieties of commercially available fish feed samples randomly collected in triplicate, from twelve fish farms and a farmed fish namely, *Oreochromis mossumbicus* was also collected. The samples were analyzed for trace elements Ni, Cu, Zn, Pb, Cr and Mn using EDXRF technique. Level of trace elements in fish feed and fish species were compared with safe value suggested by different agencies to give a picture of their contamination level.EDI, HQ, cancer Risk (CR) were calculated to evaluated probable risk associated with the trace metal due to consumption of the fish species. Multivariate statistical analysis was done to find out the possible source of trace elements as well.

1.31 Evaluation of heavy metal contamination level, their source apportionment and ecological risk in wetland sediment of coastal coast, Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and F. H. Pingki

Present study deals with the determination of the heavy metal pollution status and assessment of associate ecological risk due to contamination of the wetland sediment of coastal coast, Bangladesh A total of 20 sediment samples have been collected from 5 different points viz: Estuary, Mangroves, Mid flats, Sand flats, and Salt marsh in two different seasons (dry and wet) and analyzed for heavy metal (K, Ca, Ti, Fe, Mn, Cu, Zn, Rb, Sr, As, Pb) using EDXRF technique. Different geochemical indices like Enrichment factor (EF), Contamination factor (CF), Geo-accumulation index (Igeo), Pollution load index (PLI) have been calculated to assess the pollution status of sediment. Multivariate statistical analysis (Pearson's correlation, PCA, CA) was applied to identify spatial variability among the sites and Ecological risk assessment was done as well. The work is in Progress.

1.32 Source identification of elements, ecological and human health risk evaluation by pollution indices in the largest mangrove ecosystem, Sundarban

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and R. J. Rakib

The present study aimed to determine the trace and heavy metal contamination levels in water, sediment samples and estimate the corresponding ecological and human health risks. Trace and heavy metals were determined by EDXRF method and found in the following sequenced in sediment sample (mg/Kg) as: Fe (31500)>Mn (281)>Sr (208)>Zn=Cu (77)>Co (6)>Pb and in water sample (µg/L) as: Fe (33.5)> Sr (0.6)>Cu (0.3)>Zn (0.22)>Pb (0.15)>Mn=Co (0.05). Sediment was moderately polluted by copper based on the calculated value of pollution indices like the degree of contamination (Cd=3.6 to 5.42), geo-accumulation index (I_{geo}=0.07 to 0.33). The human health hazard index (HI) was 2.61×10^2, 2.06 × 10 and 2.06 × 10 for children, adult male and female respectively.

1.33 Heavy metal accumulation and phytoremediation potentiality of some selected mangrove species in ship breaking area, Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun, N. Sultana, N. C. Bairagi and S. R. Karmakar

The present study was conducted to determine contamination level of heavy metals (Fe, Mn, Cu, Zn, As, Pd, Co, Rb, Sr) in soil and selected mangrove plants collected from the ship breaking area, Chittagong using EDXRF. Enrichment factor (EF), Contamination factor (CF), Geo-accumulation index (Igeo), Pollution load index (PLI) have been calculated to assess the pollution status of soil and multivariate statistical analysis (Pearson's correlation coefficient, PCA, CA) were also calculated to find the possible source of origin. Transfer factor of heavy metal from soil to plant was also calculated to find out translocation capacity of the studied plant species on special emphasis to assess their phytoremediation potentiality. Sample preparation and irradiation of the samples were completed. Data analysis and interpretation are in progress.

1.34 Heavy metals in coastal wetland sediment of Bangladesh: levels, source and toxicity risks

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun, N. Sultana and J. Sultana

The study was carried out to determine heavy metals in soil samples of wetland and assess the pollution level, potential sources and probable ecological risk associated due to heavy metal contamination**.** A total of 30 Soil samples collected from coastal wetland in pre-monsoon (15) and post monsoon (15) period of 2020. Eleven (11) heavy metals K, Ca, Ti, Mn, Fe, Ni, Cu, Zn, Sr, Rb and Pb were determine using the nuclear analytical technique EDXRF available in Atmospheric and Environmental Laboratory of Chemistry Division, AECD. The extent of pollution has been evolved by calculating some contamination indices (EF, CF, Igeo, PLI) and ecological risk assessment. Statistical analysis like Pearson correlation, Principal Component Analysis (PCA), Cluster analysis (CA) have been done to find out the possible sources and the impact on direct human exposure via inhalation, ingestion and dermal contact of soil dust was evaluated as well. The work is in progress.

1.35 Impact of solid waste with special emphasis on heavy metals contamination on surrounding environment of Amin bazar landfill site, Dhaka, Bangladesh

Y. N. Jolly, J. kabir, S. Akter, K .M. Mamun and I. Jahanara

This study was conductedto determine heavy metal concentration in solid waste sample collected from Amin Bazar landfill site, Dhaka, Bangladesh and evaluate its impact on Environment and Human health. A total of 10 soil samples from landfill site of Amin Bazar, Dhaka and surroundings were collected and analyzed by EDXRF system to determine K, Ca, Fe, Co, Ni, Mn, Cu, Zn, As, Pb, Sr, Rb. Sample preparation and Sample irradiation are completed. Further works are in progress.

1.36 Heavy metal contamination on soil, water, plants fishes around some industrial areas of Bangladesh and its impact on human health and environment

Y. N. Jolly, J. kabir, S. Akter, K. M. Mamun and A. F. Ruma

The study was carried out to measure the level of heavy metals in soil, effluent, plant and fish samples collected from industrial area and their probabilistic risk assessment on environment and human body. Nine (9) of each soil, fish, plant and effluent samples were collected from Cement and Textile Industry area and analyzed using EDXRF. Sample preparation and sample analysis have been done. Further calculations are in progress.

1.37 Exposure to household air pollutants and endothelial dysfunction in rural Bangladesh

B. A. Begum, M. H. Shahriar*, M. A. H. Chowdhury* and H. Ahsan*

This study was designed to measure exposure to HAP (particulate matter [$PM_{2.5}$], carbon monoxide [CO], and black carbon [BC]) for 48 hours of 200 healthy nonsmoker adult females who used biomass fuel for cooking. Exposure to $PM_{2.5}$ and BC were measured using personal monitor, RTI MicroPEM (RTI International, NC) with an internal filter that had been both pre- and post-weighed to capture the deposited pollutants concentration. Lascar CO logger was used to measure CO. Endothelial function was measured by forearm blood flow dilatation response to brachial artery occlusion using RHI based on peripheral artery tonometry. A low RHI score (< 1.67) indicates impaired endothelial function. This study revealed that the average 48 hours personal exposure to $PM_{2.5}$ and BC were 144.15 μg/m3 (SD 61.26) and 6.35 μg/m3 (SD 2.18), respectively. Interquartile range for CO was 0.73 ppm (0.62-1.35 ppm).

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1.38 Study on the variance of air pollution by black carbon and fine particulate matter with the change of climate in Dhaka city, Bangladesh

B. A. Begum, M. A. M. Sarkar, M. Hasan and M. S. Rahman

For this study, fine particulate matter ($PM_{2.5}$) and black carbon (BC) were collected from a semi residential site located at Dhaka University campus in every winter season from 2015 to 2019 using gant sampler. This study revealed that the changes in mass concentration of $PM_{2.5}$ and BC were changed with changes of meteorological data (i.e. humidity, wind speed, temperature and visibility) in the study periods from 2014 to 2018. It was observed that major amount of $PM_{2.5}$ component was BC (%), which might be responsible to increase the atmospheric temperature. It was also found that the mass concentration of PM2.5 and BC were

correlated with the changes of vehicles number in Dhaka City for the same study periods. On the other hand, it was observed that the mass concentration of particulate matter was reduced for the highly developed brick kilns in Dhaka City.

1.39 Investigation of trace and heavy metals in total suspended particles at Barishal division, Bangladesh

B. A. Begum, M. Hasan, M. A. M. Sarkar and M. S. Rahman

In this research work, air sampling was done by using Air Metrics MiniVol to determine the concentrations of some Particulate, Trace and heavy metals at different location of Barishal Division, Bangladesh. PM filters were analyzed by ICP-OES method and a total 14 heavy metals were identified. The mean concentrations of this heavy metals can be arranged in this order- Ca(922.45)>Na(645.83)>Fe(557.29)>Mg(219.91)>Zn (139.00)>Si(109.95)>P(86.81)>Pb(78.13)>Cr(16.78)>Mn(13.31)>Ni(11.69)>B(11.57)>Li(8.68)>Cu(3.13) ngm^{-3} respectively. Multivariate statistical methods such as Pearson Correlation Coefficient, Principal component analysis (PCA) and Cluster analysis (CA) identified 4 distinct group of heavy metals which are strongly correlated and these three analyses shows that (Na-Zn-Cr) has made a cluster with the (Cu-Pb), Similarly (Mg-P-Mn-Ca-Fe) formed another cluster, finally (Si-Li-B) made another cluster.

1.40 Characterizing temporal variability of BC/$PM_{2.5}$ ratio and its relationship with meteorological parameters in Dhaka city, 2014-2020

B. A. Begum, M. Hasan, M. A. M. Sarkar and M. S. Rahman

Fine particulate matter ($PM_{2.5}$) and black carbon (BC) were collected from a semi residential site located at Dhaka university campus. Seasonal variations of PM2.5 and BC were also studied. It has been observed that in winter both $PM_{2.5}$and BC has maximum concentrations and the mean concentrations were measured to be 60 μgm^{-3} for $PM_{2.5}$and for BC it was 9.5 μgm^{-3}. Temporal variability of BC /$PM_{2.5}$ ratio shows that the maximum ratio was 0.797 in 2016 and minimum ratio was found to be 0.01 in the year 2018. Temporal trend (μgm^{-3}/year) in BC concentrations from 2014 to 2020 was -0.48 μgm^{-3}/year and the 95% confidence intervals in the slope from -0.86 to -0.11 μgm^{-3}/year.

1.41 Study of the effects of meteorological conditions on the concentrations of particulate matter ($PM_{2.5}$) and black-carbon (BC) in Dhaka city, Bangladesh

B. A. Begum, M. Hasan, M. A. M. Sarkar and M. S. Rahman

In this research work, the mass concentrations of $PM_{2.5}$ and BC were measured. Statistical analysis shows that $PM_{2.5}$ has min-5.104, max-96.391, mean-29.61, median- 26.64 and for BC it was 1.103, 14.357, 6.67, 5.787 (ugm^{-3}) respectively. The mean BC/PM2.5 ratio was found to be 0.256. BC/$PM_{2.5}$ ratio varies from 0.01 to.70 during the study period. Then the influences of meteorological parameters such as- (temperature, relative humidity, wind speed, wind direction and rainfall) on $PM_{2.5}$ and BC mass concentrations have been studied. Temporal and Seasonal variations of $PM_{2.5}$ and BC were also studied. From the time variation analysis, it was observed that in winter both $PM_{2.5}$ and BC have high mass concentrations and it falls down gradually during the summer time.

1.42 Assessment of ambient air quality in Dhaka city and sources of pollutant identification

B. A. Begum, M. Hasan, M. A. M. Sarkar and M. S. Rahman

Sampling for particulate matter (PM) was done between Sep. 2019 to Aug. 2020 at a residential site (Atomic Energy Centre, AEC) in Dhaka.PM sampling was per for med using a GENT sampler, which collect samples in two size fractions: $PM_{2.5}$ and $PM_{2.5\text{-}10}$.A total no of 128 fine samples were analyzed for mass, black carbon (BC) and elemental compositions. Mean $PM_{2.5}$ and BC concentration was found to be 77.06 μgm^{-3} and 15.52 μgm^{-3} respectively. The impact of wind speed, wind direction, humidity, ambient temperature and rainfall on particulate matter was also studied which shows $PM_{2.5}$ and BC both makes negative correlation with the meteorological variables. It was found that more than 49.5%ofthefine particle mass comes from anthropogenic sources such as brick kilns biomass burning, and motor vehicles.

1.43 Identification of sources of $PM_{2.5}$ at Farmgate area, Dhaka using reconstructed masscalculation and statistical approaches

B. A. Begum, M. Hasan, M. A. M. Sarkar, S. Akhter*, R. Rahman*, T. R. Choudhury, Y. N Jolly, S. Akter and M. S. Rahman

$PM_{2.5}$ samples collected from the site and were gravimetrically measured and the elemental and BC analyses of these samples ($PM_{2.5}$) were performed using PIXE/PIGE and Reflectance methods, respectively. From enrichment factor calculation, anthropogenic contribution of different elements (i.e., Na, Mg, Al, Si, S, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Br and Pb) has been identified. The EF values of Mn, V and Ni are found to be 5.09, 7.33 and 9.16 respectively indicating that there were some anthropogenic contributions. This study revealed that toxic heavy metals (i.e., Cr, Mn, Fe, Co, Ni, Cu, Zn and Pb) concentrations in the samples were varied significantly (%RSD: 44% to 145%) and presented non-homogeneously in different sampling times, which suggesting that these heavy metals, i.e., Cr, Mn, Fe, Co, Ni, Cu, Zn and Pb might come in the samples due to anthropogenic activities.

1.44 Cardiovascular morbidity and mortality associations with biomass and fossil-fuel-combustion fine-particulate-matter exposures in Dhaka, Bangladesh

B. A. Begum, M. M. Rahman* and P. K. Hopke*

The objective of this study was to investigate the respective roles of fossil-fuel- and biomass-combustion particles in the $PM_{2.5}$ relationship with cardiovascular morbidity and mortality using tracers of sources in Dhaka, Bangladesh. Results provide insight into the often-observed levelling of the $PM_{2.5}$ exposure-response curve at high-pollution levels. Methods: A time-series regression model, adjusted for potentially confounding influences, was applied to 340 758 cardiovascular disease (CVD) emergency-department visits (EDVs) during Jan. 2014 to Dec. 2017, 253 407 hospital admissions during Sep. 2013 to Dec. 2017 and 16 858 CVD deaths during Jan. 2014 to Oct. 2017. However, the relationship of $PM_{2.5}$ with morbidity and mortality effect slopes was less steep and non-significant at higher $PM_{2.5}$ concentrations (during crop-burning-dominated exposures) and varied with $PM_{2.5}$ source.

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1.45 Characterization and source apportionment of elemental species in $PM_{2.5}$ with especial emphasis on seasonal variation in the capital city "Dhaka", Bangladesh

B. A. Begum, M. Hasan, M. A. M. Sarkar, S. S. Bhuiyan*, Z. Ahmed* and M. S. Rahman

In total, 89 fine atmospheric particulate matter ($PM_{2.5}$) samples were collected from Dhaka City, and the concentration of over 18 elements present in $PM_{2.5}$was analyzed using accelerated based ion beam analysis (IBA) methods (PIXE and PIGE). The $PM_{2.5}$concentration for the whole year ranged from 5.27 to 105 μg/m3 with an annual average (±std.) value of 32.7 ±20.3 $\mu g/m^3$. A significant seasonal variation of $PM_{2.5}$, black carbon (BC) and elemental concentrations were observed with their highest values during winter followed by pre-monsoon, post-monsoon and monsoon respectively. Among the $PM_{2.5}$-hosted elements, the concentration of S was found to be the highest value (1.2 ±0.8 $\mu g/m^3$), possibly due to excessive use of sulfur- containing fuel.

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1.46 Impact of green roof on human comfort level and carbon sequestration: A microclimatic and comparative assessment in Dhaka city, Bangladesh deciphering the origin of Cu, Pb and Zn contamination in school dust and soil of Dhaka, a megacity in Bangladesh

M. S. Rahman, M. Hasan, M. A. M. Sarkar, S. Kumar*, N. Saha* and B. A. Begum

This study revealed that dust contained higher concentration of metal(oid)s than soil, and the Azimpur Govt. Girls School and College was identified as the most contaminated site. The enrichment of school dust with Cu, Zn and Pb were strictly related to the dense population and substantial traffic activity in the study areas. Arsenic content in school soil was several folds higher than its concentration in the upper crust. Natural and anthropogenic activities possibly posed a synergistic effect on such high soil As. The multivariate statistics suggested that Cu, Zn and Pb were likely to be originated from traffic-related activities, while Zr, Fe, Ti and Rb from natural sources, and K, Sr and Ca from industrial activities. The hazard index (HI) values were lower

than unity, suggesting no possible non-cancer health risk. Arsenic posed a lifetime carcinogenic risk to the population in the study area through soil ingestion and dermal adsorption.

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1.47 Investigation of heavy metals in indoor air dust at an industrial area Savar, Bangladesh

M. S. Rahman, M. Hasan, M. A. M. Sarkar, Y. N. Jolly, S. Akter, N. A. Kamal*, R. Rahman*, T. R. Choudhury and B. A. Begum

Indoor air dust samples from households near industrial area of Savar, Zirani bazar were collected and analysed by XRF which indicated that concentration of toxic materials was found in sequence of Ca>Fe>K>i>Zn >Mn>Zr>Sr>Rb>Cu>Pb >Co. Strong correlation was observed between the pairs of Mn-Co (r =0.80) and Sr-Fe (r = 0.657). Statistically significant relationship was also observed between pairs of Rb-Sr, Pb-Mn and Zr-K that indicated these metals may originate from the same sources. The potential ecological risk index shows these metal have low risk in that area. The non-carcinogenic and carcinogenic health risks were calculated which indicated that children are more vulnerable for non-carcinogenic effects whereas the values of cancer risk for both the child and adult are below the acceptable limit of European Union (10^-6 to 10^-4 per year).

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1.48 Elemental analysis in surface soil and dust of roadside academic institutions in Dhaka city, Bangladesh and their impact on human health

M. S. Rahman, M. Ullah*, Y. N. Jolly, S. Akhter, M. J. Kabir, A. Salam* and B. A. Begum

The elemental (Ca, Fe, K, Ti, Sr, Zn, Zr, Rb, Cr, Ni, Pb and Cu) concentration in soil and dust samples were analyzed by XRF technique. The metals concentration in dust and soil samples followed the following order: Fe>Ti>Sr>Zn>Zr>Rb>Pb>Cu and Fe>Ti>Zr>Sr>Rb>Zn>Cu>Pb>As, respectively..Conversely, the contamination levels of heavy metals were assessed based on the geo-accumulation index (I_{geo}), enrichment factor (*EF*) and contamination factor (CF). Subsequently non-carcinogenic health risk was determined using lifetime average daily dose (*LADD*). The non-carcinogenic health risk was found to be more prominent for children than that for adults. No significant carcinogenic health risk was found in the study area.

*Department of Chemistry, Dhaka University

1.49 Concentration and human health risk assessment of heavy metals in groundwater from around the area of ruppur nuclear power plant, Pabna district, Bangladesh

M. S. Rahman, B. A. Begum, M. M. A. Mollah*, S. M. A. Salam*, M. A. B. Siddique** and M. R. Zaman*

Ruppur nuclear power plant (RNPP) is under construction in the study area, which has schedule for power production in 2023. Therefore, the concentrations of Pb, Cd, Cr, Fe, Mn, As, Ni, Cu, and Zn in the groundwater samples were determined using AAS. This study revealed that the concentrations of heavy metals in groundwater samples for this study area in decreasing order was as follows: Mn>Fe>Pb>Cr>Cd respectively. As, Ni, Cu, and Zn concentrations in the water samples were found to be below detection level. The level of target hazard quotient (*THQ*) in ingestion in the study area followed the order: Mn > Cr > Pb > Cd > Fe respectively.

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1.50 Hydrogeochemical evolution of shallow and deeper aquifers in central Bangladesh: Arsenic mobilization process and health risk implications from the potable use of ground water

M. S. Rahman, M. Bodrud-Doza*, M. Hasan and B. A. Begum

This study revealed that the measured As concentration (0.01-1.46 mg/L with a mean of 0.12 mg/L) exceeded the maximum permissible limit of Bangladesh and WHO for drinking water. The estimated carcinogenic risk of As exceeded the upper benchmark of 1 × 10-4 for both adult and children, and health threats from shallow groundwater were more severe than the deeper water. The vertical distribution of As resembled Fe and Mn with their higher concentrations in shallow Holocene aquifers and lower in deeper pleistocene aquifers.

Speciation calculation indicated the majority of groundwater samples were oversaturated with respect to siderite, calcite, and dolomite, while undersaturated with respect to rhodochrosite.

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1.51 Groundwater hydrogeochemistry and probabilistic health risk assessment through exposure to arsenic-contaminated groundwater of Meghna floodplain, central-east Bangladesh

M. S. Rahman, M. Hasan, N. Saha* and B. A. Begum

Dissolved As concentration was ranged from 0.002 to 0.36 mg/L and Monte Carlo simulation-based probabilistic estimation of cancer risk suggested that; (1) ~ 83% of the waters exceeded the higher end of the acceptable limit of 1 ×10_4; (2) the probability of additional cases of cancer in every 10,000 adults and children were on average ~9 and ~5, respectively; (3) adults were more susceptible than children; and (4) ingestion was the main pathway of As poisoning and the contribution of dermal contact was negligible (<1%). However, hydrogeochemical investigations on the sources and mobilization mechanisms of As suggested that the reductive dissolution of Fe and Mn oxyhydroxides was the principal process of As release in groundwater.

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1.52 Spatiotemporal nexus between vegetation change and extreme climatic indices and their possible causes of change

M. S. Rahman, A. R. M. T. Islam*, H. M. T. Islam* and M. K. Khatun*

Detrended fluctuation analysis (DFA) and Morlet wavelet analysis (MWA) were employed to evaluate the possible future trends and decipher the existing periodic cycles, respectively in the time series of NDVI and climate extremes. Besides, atmospheric variables of ECMWF ERA5 were used to examine the casual circulation mechanism responsible for climatic extremes of Bangladesh. The results revealed that the monthly NDVI is positively associated with extreme rainfall with spatiotemporal heterogeneity. Warm temperature indices showed a significant negative association with NDVI on the seasonal scale, while precipitation and cold temperature extremes showed a positive association with yearly NDVI. The DEA revealed a continuous increase in temperature extreme in the future, while no change in precipitation extremes.

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1.53 Ecological risk assessment of heavy metals in the sediments of two major sea ports, Bangladseh

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The purpose of this study was to assess of the potential ecological risk index by some metals in sediments in the two major sea ports to understand the level of potential risks to the marine ecosystem. The results will be the scientific basis for building control and mitigation measures during material dredging and submerging in the sea area of Bay of Bengal. Sediment samples were collected from the ten stations of the two dominant sea ports along the ship flow from shoreline to the material submerged zone in Bangladesh namely Chittagong port and Mongla port, which are away from one another and are engaged with different shipping activities. The total concentrations of some heavy metals including lead, cadmium, Chromium, arsenic, copper, zinc, iron etc were analyzed by using atomic absorption spectrophotometry. The experimental results indicated that there were significant and positive correlations between various heavy metals studied. The geo-accumulation index (I_{geo}), the potential ecological risk index (RI), and the degree of contamination (C_d) were calculated for evaluating the risks of heavy metal in sediment samples. The findings of this study might be useful for making appropriate management strategies to prevent or decrease pollution by heavy metal at the seaports.

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1.54 Accumulation of heavy metals in insects, fish and prawn of coastal areas of Sitakunda upazila and their histo-pathological evidence in brain and ovary

T. R. Choudhury, J. Sultana*, M. Begum*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L.N. Lutfa and S. B. Quraishi

Accumulation of trace metals in aquatic ecosystems have up stretched public apprehension to all over the world due to their high potential to enter and accumulate in food chains. Trace metals are environmentally ubiquitous, freely dissolved and transported by water, and readily taken up by fish and other aquatic

organisms. The intent of the study was extensively involved on health risk assessment of coastal people of Bangladesh, based on certain trace metals contamination and their spatial and temporal distribution in some commercial fishes, crustaceans along with environmental media. The research was conducted to determine six trace metals concentration; Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb) and Zinc (Zn) in insects (*Periplaneta Americana*, *Chrysomyamegacephala*), fish (*Lates calcarifer*), malacostracan (*Penaeus monodon*), water and sediments collected from coastal area of Sitakundaupazila. The analysis of metals showed that except As, all the metals concentration was higher in all samples. The accumulation power of Zn was higher in all samples especially it was highest in the insect samples. Most of the values of As were below the detection limit. The levels of trace metals also compared with the standards of WHO and FAO. Except As and Cd, all the values were higher than the permissible limit. Pearson correlation matrix revealed that these metals inter-element relationship was positive and might have originated from the same sources. Pb and Cr, Pb and Cu, Pb and As, Cr and Cu, Cr and As, Cu and As showed positive and highly significant correlation. Box plot analysis revealed only sediment sample showed fluctuation between two elements. Geo-accumulation trends of these metal concentrations were Zn>Cu>Pb>Cr>Cd. The studied area was moderately polluted. The tissue from insects (*Periplaneta Americana*, *Chrysomyamegacephala*), fish (*Lates calcarifer*), malacostracan (*Penaeus monodon*) were taken to prepare histo-pathological slides. Histopathological study was done to know the efficacy of heavy metals in tissue levels. Histo-pathological observation revealed the deposition of heavy metals, tissue damage, vacuolization, neural aggregation in brain and ovary of insects and only brain in fish and prawn. Thus, continuous monitoring of these toxic trace elements in seafood and immediate control measure is recommended.

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1.55 Metal pollution in ecosystems, ecotoxicology studies and risk assessment in the marine environment

T. R. Choudhury, K. Jannat*, M. Begum*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. B. Quraishi

The inputs of metals to the environment from anthropogenic activities is complicated to distinguish as there are very large natural inputs from the erosion, wind-blown dust, volcanic activity and forest fires. Atmospheric and river inputs, dredging spoil, direct discharges, industrial dumping and sewage sludge are some of the important contributors to metal pollution, which lead to the release of metals to the marine environment. The objective of this study was determination of bioacummulation in biota, as well as abiotic and biotic factors affecting their bioavailability as well as the use of bioindicator organisms for the biomonitoring of metals in the environment and the related toxicity mechanisms and ecological effects of heavy metal pollution.The concentration of heavy metals accumulated inwater, sediment, insects (viz. *C. megacephala*and *P. americana*), crustaceans (viz. *P. monodon* and *S. serrata*), mollusk (viz. *S. pharaonis*) and marine fish (viz. *L. calcarifer*) collected from Kuakata, Patuakhali were determined. Metals were detected by using flame, hydride-generation atomic absorption spectrophotometer and graphite furnace atomic absorption spectrophotometer (Varian AA240FS). Less concentration of metals was measured in water except Cr. Sediment samples contain the highest concentration of metals. As sediment naturally contains trace elements, geoaccumulation index of sediments showed that the sediment was uncontaminated at this concentration of different metals. *P. monodon*, *S. serrata*, *S. pharaonis*and *L. calcarifer* contains low quantities of these metals. The levels of heavy metals were compared with standards of WHO and FAO, showed that, the concentration of metals was within the permissible level for food and meat recommended by WHO. Insects were used as model organisms that served as bio indicator of ecosystem. *C. megacephala*and *P. americana*accumulated high concentration of metals suggesting plausible metal pollution in terrestrial ecosystem.*C. megacephala*indicated that this species is more sensitive with a high concentration of metals. Tissue from brain and ovary of *C. megacephala*, brain of *P. Americana*, *P. monodon* and *L. calcarifer* were used in histo-pathological studies. Observation from this study revealed that deposition of metals, vacuolization, neural aggregation and tissue damage were observed in the brain tissue of insects but no damage was observed in seafood samples. Box plot analysis and Pearson's correlation matrix analysis were performed to correlate the values of evaluated metals for all the collected samples. Principal Component analysis revealed that these metals were interrelated with each other and might have originated from the similar sources.

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1.56 Aggregation of heavy metals in some insects and fishes of Shitalakhshya river bank area and their efficacy on brain together with overy

T. R. Choudhury, S. Akhter*, M. Begum*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. B. Quraishi

This study was aimed to estimatethe effects of major ecotoxic heavy metals accumulated in the Shitalaksshya River systems on theinsect, fish, water, sediment and to evaluate their environmental impact on the ecosystem as well as the lives and livelihood of the residents in the studied area.Heavy metals like arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), zinc (Zn) were considered to appraise from the different selected organs in insects (tissues of *Periplaneta americana*, *Chrysomyamegacephala*), fish (tissues of *Oreochromis mossambicus*),water and sediment samples from Shitalakshya riverand surrounding area. Atomic Absorption Spectrophotometer was used for detection of heavy metals. The ranges of metals in different samples were As (5-2160 µg/kg), Cd (2.1-390 µg/kg), Cr (140-7408 µg/kg), Cu (31.4-44960 µg/kg), Pb (100-18400 µg/kg), Zn (45.94-125947.6 µg/kg). Concentration of Zn and Cu were generally higher in all samples than As, Cr, Cd and Pb. Average concentrations of different heavy metals in descending order Zn>Cu>Pb>Cr>As>Cd. Almost all of the metals showed high concentration in the sediment. This research shows how pollutants enter the environment together with their fates. The levels of heavy metals were compared with standards of WHO and FAO recommended values. Tissues of *Periplanetaamericana***,** *Chrysomyamegacephala*and *Oreochromis mossambicus*were used for histological study. The results of the histological evidence showed that the congession of heavy metals, aggregation of neurons and vacuolizations in the nerve cells in both insects and vertebrates. Pearson correlation matrix analyses were done to correlate the values of quantified metals for all the samples that shows strong correlationship among different metals. The outcome of the study provides as a reference to plan, controlled, manage heavy metals and protect the water source of the Shitalakshya river.

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1.57 Heavy metal contamination appraisal in roadside perennial trees, soils and dust: A tool for monitoring urban metal pollution level

T. R. Choudhury, M. B. Sultan*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa, M. M. Rahman* and S. B. Quraishi

Increased usage of transportation and industrial activities profoundly threatened Dhaka city with several environmental pollutants including toxic trace metals. This study was aimed to evaluate and compare the level of heavy metal pollution established by the individual and collective indicators to estimate the degree of environmental pollution and ecological risk caused by traffic-related heavy metals in the urbanized area.

In this study, to understand the potential heavy metal contamination, roadside soil, dust and tree leaves from thirteen sites were collected for the analysis of nine heavy metals i.e. As, Cd, Cr, Pb, Fe, Ni, Zn, Cu and Mn using Atomic Absorption Spectrometer from Dhaka North City Corporation (DNCC). It was found that mostly Zn, Cu, Mn, Ni, Cr, and Pb in soil and dusts exceed the maximum permissible limit at different sampling sites. The analysis of metal concentration in soil and dusts through pollution indices like enrichment factor, geo-accumulation factor and contamination factor reveals DNCC is mostly contaminated with Cu, Pb, Ni, Zn, Cd, Mn, and Cr and least contamination is found with As and Fe. The pollution load index and spatial distribution zone suggest the south-western regions of DNCC to be most contaminated with metal concentration compared to northern regions i.e. namely Tejgaon industrial area, Kafrul, Matikata and Pallabi are most contaminated regions. The multivariate statistical analysis identified vehicular emission and industrial emission as its dominant sources. Besides, health risk assessment reveals children are most vulnerable to metal contamination than adults and the most dominant route of exposure is ingestion. Cr was found to be fallen within the maximum carcinogenic risk. And Cd was found to cause the highest potential ecological risk in this study. However, the analysis of metals in tree leaves among five species, *Ficus aurea, Ficus benghalensis, Ficus religiosa, Ficus rubiginosa,* and *Polyalthia longifolia* revealed that*Ficus aurea* is a hyperaccumulator of Cd and good accumulator for other metals, making it a suitable candidate for urban greening. Besides, the metal accumulation index showed, *Polyalthia longifolia* to be a better barrier of toxic element. Therefore, it can be said that, this scientific study provides an effective tool for assessing urban metal pollution level especially for a developing country like Bangladesh.

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1.58 Distribution, potential source and ecological risk assessment of heavy metal contamination with depth in the sediment of Pasur River, near the Sundarbans mangrove forest, Bangladesh

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Globally, the water bodies like rivers, lakes, estuaries, bays, and oceans are the potential reservoirs for diverse contaminants including heavy metals. The pollution associated with heavy metals in water bodies is one of the critical environmental concerns due to their extended toxic effects on soil-water-air-plant ecosystems and public health. The objective of the study was to evaluate the elemental abundances, spatial and layer-wise distributions of trace elements and identify the pollution sources along with ecological risk in the sediment of Pasurriver. Sediment samples were collected by using 1.5m long cylindrical sediment core (diameter: 4 cm) from 6 stations (marked as S1, S2, S3, S4, S5, S6) of the Pasur river for the heavy metals'levels assessment with the depth of sediment and the elemental (Pb, Cd, Cr, Cu, Ni, Fe, As, Hg, Mn, Zn) analysis was done using atomic absorption spectrometer (AAS). The work is in progress.

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1.59 Concentration of heavy metals in street dust, soil, plants: an implication of using different geochemical background data in estimating the level of heavy metal pollution

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Street dust, soil and plants from the road side area are the most important carriers of heavy metal contaminants usually considered as a valuable indicator of the air quality in an urban environment. This study was thus carried out toinvestigate the factors and processes controlling the airborne transferof toxic metals in dust, leaves, soil and their possible link to metal pollution. Pollution characteristics, bioaccumulation capabilities, possible source identification, ecological and human health risk of 9 major elements were explored in the soil, roadside dust and plant leaves collected from 10 different locations in Dhaka South City Corporation (DSCC), Bangladesh. Roadside soil, leaves of plants and dust showed considerable concentration of heavy metals (As, Cd, Cr, Pb, Fe, Ni, Zn, Cu and Mn) in this study. The concentration was highest in soil samples followed by dust and plant leaves (soil > dust > leaf). Many of the metals were of anthropogenic origin according to enrichment factor (EF). Contamination factor (CF) showed that the contamination of Fe and Cu were very high at some locations. Samples from few locations were moderately polluted by Cd, Cr, Pb and Zn according to bioaccumulation factor (BAF) and have the capability to accumulate in plants. In the geo-accumulation index, soil and dust samples were polluted by As, Pb, Zn and Cu in moderate level. Cd showed a strong potential ecological risk in soil and dust samples and all of the samples showed negligible risk in adult and children according to hazard quotient (HQ). Metals having a strong positive correlation can be originated from a common pollution source. It is expected that the study will act as a baseline in heavy metal pollution monitoring of the investigated area.

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Clinical Chemistry

1.60 Serumzinclevelon60pediatricpatientssufferingfromwilson'sdisease

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. Alam*

Wilson‟s Disease (WD) is a rare autosomal recessive genetic disorder of copper (Cu) metabolism resulting to the accumulative deposition of Cu in liver and brain impairing the normal functions of the affected organs. A combination of various parameters is required to establish a diagnosis as no single finding is adequate for diagnosis of WD. In the present study, samples were collected from 55 patients and serum zinc level was determined using atomic absorption spectrometer (AAS). The study has been completed. The work for scientific publication is underway.

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1.61 Evaluation of essential and toxic elements in biological samples of kidney failure patients and healthy referent

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The objective of the study was to compare the essential and toxic elements in biological samples of healthy and patients with kidney failure and unearth the probable correlations.Under this project samples of blood serum from 87 persons including healthy persons and patients with kidney failure were collected. They were analyzed for the presence of Pb, Cd, Mg and Zn with atomic absorption spectroscopy (AAS). The results are being processed now to submit the report and for scientific publication.

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1.62 Association of heavy metals (Pb and Cd) in development of childhood nephropathy

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and M. R. Shahin*

Heavy metals are blamed for various diseases in human body and associated with growth hindrance in children. It is possible that these toxic metals have a role in the development of childhood nephropathy and current project has been aimed to debunk the conjecture.Under this work samples of blood serum from 40 child have been collected. They are being analyzed for the presence of Pb and Cd with atomic absorption spectroscopy (AAS). The work is in progress.

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1.63 Association of environmental toxic metals with renal and cardio-metabolic risk factors in a rural population of Bangladesh

S. B. Quraishi, A. K. M. A. Ullah, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. M. Salauddin*

Rural villagers are often seen to suffer from various diseases including kidney diseases, diabetics, hypertension at premature age. The possibility is that the continuous contamination of environment by various heavy metals have a strong role there. This project will help to find out the possible relations.The currentinvestigation has been based on the analysis of Pb and Cd in human excretion like urine, body fluid e.g. blood serum and the presence of same elements in the components of environment e.g water, in which the target persons reside by. Until now 30 urine samples and 9 water samples has been analyzed for the presence of Pb and Cd with atomic absorption spectroscopy (AAS).In addition, 26 blood serum has been collected and in the process of analysis. The work is in progress.

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1.64 Association of serum copper level with the development of oral submucous fibrosis in patients having betel nut chewing habit

T. R. Choudhury, A. Sultana*, M. N. Alam, M. M. Hosen, M. A. Maksud, S. R. Khan, L. N. Lutfa and S. B. Quraishi

Oral submucous fibrosis (OSF) is a well-recognized potentially malignant condition in oral cavity. It may lead to oral cancer, a potentially fatal disease leading to raise in incidence among younger and older people. Trace elements play an important role in growth and maintaining the integrity of cells and tissues. Altered level of such elements may impair cellular and physiological function. In this study Serum Cu level was examined in OSF patients.The purpose of the study was to measure the level of serum copper in OSF patients as well as in Control groups. Role of Cu level was justified/ observed in OSF patients in comparison with control groups. This case-control study was carried out on patients with clinically diagnosed of OSF and healthy controls, attending to the Department of Oral and Maxillofacial Surgery at Bangabandhu Sheikh Mujib Medical University (BSMMU). OSF patients were categorized by clinical presentation such as burning sensation in the mouth, blanching of oral mucosa, inelastic and leathery in texture and progressive inability to open the mouth and clinical staging. Serum copper was measured by Flame Atomic Absorption Spectrometry. The obtained data was tabulated and analyzed using Statistical Package for Social Science (Version 26; SPSS Inc., Chicago, IL). To compare the mean values of serum copper between the OSF patients and control group, independent

sample t-test was used. Results of the study shows that the mean serum copper concentration was greater in study group compared to control group. The result was statistically significant. The serum copper level increases as the clinical staging of OSF progresses.There was an increase in copper level in study group compared to control group and escalate in copper level with the advancement of clinical staging of OSF.This study suggests that betel nut chewing may be the causative factor for the development of Oral Submucous Fibrosis

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2. Manpower Development and Training Program

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Yeasmin Nahar Jolly	First Coordination Meeting on Enhancing Wetland Management and Sustainable Conservation Planning (RCA)	International Atomic Energy Agency (IAEA)	8-9 Sep. 2020	Virtual Meeting
	Method validation as per ISO/IEC 17025 Guideline	BAEC	9 Aug. 2020	Virtual Training
	Quality Control Practices in analytical measurements as per ISO/IEC 17025 Guideline	BAEC	2 Sep. 2020	Virtual Training
	Control chart preparation and its acceptance crieteria	BAEC	14 Oct. 2020	Virtual Training
	Documentation for meeting ISO repqirements	BAEC	11 Nov. 2020	Virtual Training
	Required documents and preparation of documents according to ISO Part-2	BAEC	31 Jan. 2021	Virtual Training
	Laboratory Accreditation	AECD	28 Mar. 2021	Virtual Meeting
	Documentation for laboratory method	AECD	27 May 2021	Virtual Training
	Launce event for “Pathways to linking Science and Policy in the field of Global Risk”. 4thwoman in Science Forum 2021	Kuala Lumpur, Malaysia	4 Jun. 2021	Universiti Kebangsaan Malaysia
Dr. M. Safiur Rahman	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13 Mar. 2021	Dhaka
Jamiul Kabir	Method validation as per ISO ISO/IEC 17025 Guideline	BAEC	9 Aug. 2020	Virtual Training
	Quality Control Practices in analytical measurements as per ISO/IEC 17025 Guideline	BAEC	2 Sep. 2020	Virtual Training
	Control chart preparation and its acceptance crieteria	BAEC	14 Oct. 2020	Virtual Training
	Documentation for meeting ISO repqirements	BAEC	11 Nov. 2020	Virtual Training
	Required documents and preparation of documents according to ISO Part-2	BAEC	31 Jan. 2021	Virtual Training
	Laboratory Accreditation	BAEC	28 Mar. 2021	Virtual Meeting
Dr. Tasrina Rabia Choudhury	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR, Dhaka	11-13 Mar. 2021	BCSIR, Dhaka
Dr. Shirin Akter	Quality Control Practices in analytical measurements as per ISO/IEC 17025 Guideline	BAEC	2 Sep. 2020	Virtual Training
	Control chart preparation and its acceptance crieteria	BAEC	14 Oct. 2020	Virtual Training
	Documentation for meeting ISO repqirements	BAEC	11 Nov. 2020	Virtual Training
	Required documents and preparation of documents according to ISO Part-2	BAEC	31 Jan. 2021	Virtual Training

Name of the participant	Title of the event	Organizer	Date	Place
	Laboratory Accreditation	BAEC	28 Mar. 2021	Virtual Meeting
	Documentation for laboratory method	BAEC	27 May 2021	Virtual Training
	Launce event for "Pathways to linking Science and Policy in the field of Global Risk". 4thwoman in Science Forum 2021	Kuala Lumpur, Malaysia	4 Jun. 2021	Universiti Kebangsaan Malaysia
A. R. M. Tareq	ICSTB-2021	BCSIR	11-13 Mar. 2021	BCSIR
M. K. Mamum	33rd Understanding Training Course on ISO/IEC 17025:2017	Bangladesh Accreditation Board (BAB), Ministry of Industries	12-14 Oct. 2020	BAB
	Quality Control Practices in analytical measurements as per ISO/IEC 17025 Guideline	BAEC	2 Sep. 2020	Virtual Training
	Control chart preparation and its acceptance crieteria	BAEC	14 Oct. 20	Virtual Training
	Documentation for meeting ISO repqirements	BAEC	11 Nov. 2020	Virtual Training
	Required documents and preparation of documents according to ISO Part-2	BAEC	31 Jan. 2021	Virtual Training
Ronia Sultana	ICSTB-2021	BCSIR	11-13 Mar. 2021	BCSIR
Md. Fahim. Ehsan	ICSTB-2021	BCSIR	11-13 Mar. 2021	BCSIR
Md. Abdul Mottalib Sarkar	First Virtual Workshop of NITUB on the use, maintenance and trouble shooting of High-Performance Liquid Chromatography (HPLC)	Network of Instrument Technical Personnel and User Scientists of Bangladesh (NITUB)	17 Oct. 2020	NITUB
	Sixteenth Training Course on Oceanography: Principles and Applications	National Oceanographic and Maritime Institute (NOAMI)	12 Jun.-14 Sep. 2020	NOAMI
	Follow-up Training Course on Environmental Monitoring Course	TI, AERE, BAEC	10 -14 Jan. 2021	TI, AERE BAEC

3. Collaboration Work(s)

- IAEA/RCA RAS-7037: Enhancing Wetland Management and Sustainable Conservation Planning (RCA).
- TC project: Building capacity in improving food safety using Nuclear and Other Complementary analytical techniques (BGD/5032), TC cycle 2018-2019.
- RAS/7/029 Project: Supporting sustainable air pollution monitoring using Nuclear Analytical Technology.
- Coordinate Research Project (CRP): D52038, Food traceability and Food safety of Dairy Products as an example through the Nuclear Analytical Techniques.
- Special Allocation Grant Project: MoST (ES-377) of Ministry of Science and Technology, Building capacity in determining carcinogenic metals in human scalp hair of arsenicosis patients and it's correlation with cancer, (Jul. 2020 to Jun. 2021).
- Special Allocation Grant Project: MoST (ES-377) of Ministry of Science and Technology, Assessment of Ambient Air Quality in Dhaka City, Bangladesh and source of pollutant identification, (Jul. 2020 to Jun. 2021).

4. Service Rendered and Revenue Income

Name of organization	Type of sample	No. of samples	Revenue income
Patients from different hospitals and clinics	Urine	1214	9,48,800/-
Patients from different hospitals and clinics	Serum	9	13,500/-
NSU-BUET Joint Research Project	Water	98	34,500/-
ACI Agrolink Ltd	Water	2	17,000/-
Alpha Accessories and Agro Export Ltd	Water	1	8,500/-
Bagerhat Seafood Industries Ltd	Water	2	17,000/-
Beximco Pharmaceuticals Ltd	Water	2	17,000/-
Bright Seafood Limited	Water	2	17,000/-
Crimson Rosella Seafood Ltd	Water	2	17,000/-
Farid Nine Stars Agro Foods (BD) Ltd	Water	2	17,000/-
Farook Sea Foods Limited	Water	1	8,500/-
Gemini Sea Food Limited	Water	2	17,000/-
Glacies Food Ltd	Water	2	17,000/-
International Shrimps Export (Pvt) Limited	Water	1	8,500/-
Jahanabad Sea Foods Ltd	Water	1	8,500/-
Jalalabad Frozen Foods Ltd	Water	2	17,000/-
Japan Fast Trade Ltd	Water	3	25,500/-
Khulna Frozen Foods Export Limited	Water	2	17,000/-
Modern Seafood Industries Ltd	Water	2	17,000/-
Mostafa Organic Shrimp Products Ltd	Water	1	8,500/-
National Sea Food Industries Ltd	Water	2	17,000/-
New Foods Limited	Water	1	8,500/-
Organic Shrimps Export Ltd	Water	2	17,000/-
Primus Frozen Foods Ltd	Water	1	8,500/-
Rupali Sea Foods Limited	Water	1	8,500/-
Rupsha Fish and Allied Industries Ltd	Water	2	17,000/-
Salam Seafoods Limited	Water	2	17,000/-
Shampa Ice and Cold Storage Ltd	Water	2	17,000/-
Sobi Fish Processing Industries Ltd	Water	1	8,500/-
Southern Foods Limited	Water	2	17,000/-
Dhaka Water Supply and Sewerage Authority	Water	2	9,000/-
Trust Seafood Industries Ltd	Water	1	8,500/-
Bangladesh Food Safety Authority (BFSA)	Pesticide	54	-
Bangladesh Food Safety Authority (BFSA)	Vegetables	31	-
Bangladesh Food Safety Authority (BFSA)	Soil	10	-
QC Lab, Dept. of Livestock Service, Bangladesh	Food	6	34.500/-
Bangladesh Food Safety Authority (BFSA)	Milk	1	2,000/-
Transcom Distribution Co.Ltd.	-	2	4,000/-
Bangladesh Ordnance Factories	Mercury	2	5,000/-

Name of organization	Type of sample	No. of samples	Revenue income
M/s Uzzal Chemical	Betel Leaf Spices	1	6,000/-
Cabinet Division	Gold	Gold-10	25,000/-
Bangladesh Bank	Gold, Silver	Gold-1, Silver-1	4,500/-
Ministry of Local Government, Rural Development and Co-operatives	Gold	Gold-10	25,000/-
Ministry of Agriculture	Gold, Silver	Gold-5, Silver-9	33,500/-
Ministry of Local Government, Rural Development and Co-operatives	Gold	Gold-11	27,500/-
Ministry of Women and Children Affairs	Gold	Gold-5	12,500/-
Ministry of Women and Children Affairs	Gold	Gold-5	12,500/-
Ministry of Public Administration	Gold	Gold-5	12,500/-
Ministry of Information	Gold	Gold-33	82,500/-
National University	Gold	Gold-30	75,000/-
Ministry of Cultural Affairs	Gold	Gold-21	52,500/-
Ministry of Education	Gold	Gold-4	10,000/-
Bangladesh Election Commission	Gold	Gold-3	7,500/-
Ministry of Cultural Affairs	Gold	Gold-3	7,500/-
Ministry of Industries	Gold	Gold-21	52,500/-
Ministry of Local Government, Rural Development and Co-operatives	Gold	Gold-10	25,000/-
Cabinet Division	Gold	Gold-10	25,000/-
Amin Jewelers	Gold	Gold-1	2500/-
Different Hospitals and Clinics	As	45	45000/-
Custom House Pangaon port, Dhaka	Fe and Zn	02	4,000/-
Bangladesh Army University of Engineering and Technology (BAUET)	K, Ca, Ti, Mn, Fe, Co, Cu, Zn, Rb, Mo, Pb	01	1800/-
Total		1723	2,000,600/-

Electronics Division, AECD

Objective

Electronics Division has been providing services through repair and maintenance of various types of scientific, medical, analytical, nuclear instruments belonging to all divisions and solar energy unit of Atomic Energy Centre, Dhaka (AECD). The division has also been developing embedded system, PC based system and FPGA based system to facilitate nuclear and analytical research at AECD. This division is also engaged in manpower development through training, Research, Collaboration etc.

Activities

1. Design and Development Work(s)

1.1 Development of iot based nuclear radiation monitoring system

M. A. A. Mamun, M. A. Rahman, S. Sattar, M. T. Khatun, A. Begum and M. Begum

Nuclear radiation monitoring system is required to acquire and to store nuclear radiation data from the environment. An Internet of Things (IoT) based radiation monitoring system facilities the system not only to acquire the radiation data, but also distribute it to the cloud server through internet. The distributed radiation

data can be monitored and stored for the utilization of in the nuclear emergency response and preparedness system. The objective of this work is to design an IoT based system for acquiring nuclear radiation data from the environment as well as monitoring and storing it remotely using web-based user interface. In this work, an application of IoT system for radiation monitoring is proposed. A prototype of the proposed system has been developed, which has two major parts: one is radiation detection unit (RDU) and another one is wireless communication unit (WCU). RDU consists of Geiger Muller (GM) detector with high voltage power supply, signal conditioning unit, and Arduino as counter and data processor. Radiation data is acquired by RDU. WCU transmits the acquired radiation data to the database server through NodeMCU which is an open-source firmware and development board specially targeted for IoT based applications. A web-based user interface (ThingSpeak) is used to aggregate, visualize, and analyze radiation data streams in the cloud. It is observed that the proposed system can detect the presence of nuclear radiation level of the environment remotely. Furthermore, the development of an app for Smartphone using Blynk and an application software for PC using LabVIEW to monitor the nuclear radiation level are ongoing.

1.2 Development of a variable dc high voltage power supply for geiger-muller (GM) tube

M. A. A. Mamun, M. A. Rahman, S. Sattar, M. T. Khatun, A. Begum and M. Begum

Geiger-Muller (GM) tube is a widely used radiation detector because of its low-cost, rugged design and simple of operation. However, GM tube requires a certain dc high voltage for operation depending on the tube design and the mixture of gases inside the tube. If the applied voltage across the tube is very low, the electric field in the tube is not sufficient to trigger a discharge. Otherwise, if the voltage is very high, the tube will suffer continuous discharge, and the tube can be damaged. The objective of this work is to develop a variable dc high voltage power supply for GM tube to achieve the appropriate voltage of operation.

Generally, step up transformers are used in converting a low voltage to a high voltage. Sometimes, it becomes troublesome to build step up transformer with a large number of secondary windings. The design of dc high voltage power supply presented in this work is based on the principle of a dc-dc boost converter which is used to step up dc voltage without transformer. The basic components of the boost converter are a power semiconductor switch (MOSFET), an inductor, a diode, capacitors and a pulse width modulator (PWM) controller. The circuit is operated on continuous current mode, because the output has to produce a constant high voltage in both on-state and off-state of power switches. In this case, at the end of on-state of power switch, the current in the inductor never go zero and continuously supply the current to the output. Using this boost converter, a variable dc high voltage power supply has been developed for GM tube and tested in laboratory. It is observed that the power supply can generate a stable output dc high voltage of about 600 volts from an input dc voltage of 5 volts. Moreover, the output high voltage can be adjusted at any suitable value by adjusting the preset potentiometer.

1.3 The use of wearable sensors for the classification of electromyographic signal patterns based on changes in the elbow joint angle

M. A. A. Mamun, S. A. M. M. Rahman* and M. A. Ali**

Upper limb elbow movement in terms of flexion-relaxation is a complex physical phenomenon in human daily life, particularly during synchronized activities, such as exercising, reaching, pointing, and manipulating. Improper elbow movement might cause musculoskeletal injury, fatigue, pain, or disorders in the upper limb muscles. This work is aimed to identify subject-specific electromyographic (EMG) signal patterns based on changes in five elbow joint angles (at 0°, 30°, 60°, 90° and 120°) during maximum (100%) voluntary isometric (static) contraction using wearable sensors. Surface electromyographic (sEMG) signals were recorded from the upper arm biceps brachii muscle using a three-channel wearable sensor. A non-parametric machine learning algorithm called *k*-nearest neighbors (k-NN) was used to build a model that can determine the EMG characteristics and thus discriminate between elbow joint angles. Fifteen time domain features were extracted from the recorded EMG signal and those were used for classification purposes. Two cross validation (CV) methods, namely, leave-one-out (LOO) and k-fold, were used to examine and validate the model. The results showed that k-fold CV showed higher mean classification accuracies (89.68%) than the LOO method (82.49%). Our classification-based results from sEMG signals acquired with five elbow joint angles could aid the development of more advanced rehabilitation assistive devices and further improve the

neuromuscular activities of the upper arms. Additionally, this result showed that wearable technology has potential application for remotely monitoring and controlling motor rehabilitation exercises.

*Department of Software Engineering, Daffodil International University (DIU), Dhaka, Bangladesh
**Department of Computer Science, American International University-Bangladesh (AIUB), Dhaka, Bangladesh

1.4 Design of a prototype unmanned arial vehicle (UAV) for radiation monitoring and data logging

M. A. Rahman, M. A. A. Mamun, S. Sattar and M. Begum

Main objective of present work is to perform remote monitoring and logging of radiation data using UAV.

A design of prototype UAV quad-copter has been proposed for radiation monitoring and data logging around 1000 meters line of sight area. According to the design, the proposed quad-copter is capable of carrying a GM-survey meter along with data acquisition, logging and transmission facilities. To fulfill the design criterion a prototype quad-copter was assembled using radio link AT9-S, S500 quad frame with landing gear, KK 2.1.5 flight controller, Emax BLHelli 30A ESC, Emax XA2212 BLDC 980KV Motor, Gemfun 10x4.5" propeller CW+CCW, Wildscorpion 5500mah 11.1v 30c lipo battery and 5.8 GHz 600 mW first person view (FPV) combo with 7" Display. To check the flight stability of the assembled quad-copter, various parameters of flight controller and radio-link remote controller were optimized. Due to the poor flight stability of KK 2.1.5 flight controller, it was replaced by an upgraded one Pixhawk PX-4 which is more stable and reliable. Mission Planner software is used for setup, configuration and calibration of various flight parameters of Pixhawk PX-4 flight controller. After replacing the flight controller, the quad-copter is providing better flight stability. Future plan is to incorporate a GM-survey meter along with data acquisition, logging and transmission facilities with the designed UAV.

1.5 Design and development of a low-cost pulse oximeter

S. Sattar, M. A. Rahman, M. A. A. Mamun, M. T. Khatun, A. Begum, M. U. Safia, H. Akhter and M. Begum

Pulse oximeter is an electronic medical equipment to measure pulse rate and oxygen saturation (SpO_2) in blood vessels. It is a most common and important device to check arterial blood fundamentals of human body. But in this Covid 19 pandemic situation it has become an essential device in every house in the world as a primary test tool for the corona affected people. As primary indication of COVID-19 positive symptom is reduced oxygen level in blood. Objective of this work is to fabricate an inexpensive pulse oximeter which can be adopted by people for primary self-assessment of early COVID -19 symptoms.

The designing of the pulse oximeter has been done specifically keeping in mind that it needs to be easily operated by people in everyday lives with minimum instruction. And also it should be easily affordable by people of all walk of life. To achieve these two goals, the design has been done by using Arduino and MAX30105 breakout board for sensing the data and processing it. While LCD panel has been used to displaying the result. The system is powered by a 9V DC consumer grade battery. The combination of these robust consumer grade component helps us to achieve the goal of making the system both adequately easy to operate and affordable for personal use by all.

1.6 Study of CNC system for PCB design using proteus

M. T. Khatun, A. B. Siddik, M. A. A. Mamun, M. A. Rahman, S. Sattar, A. Begum, M. U. Safia, H. Akhter and M. Begum

The Printed Circuit Board (PCB) is the core component in almost all electronic appliances that are used for domestic applications and industrial or research purposes. PCB connects electronic or electrical components using conductive tracks and offers mechanical support to the electronic components. PCB can be manufactured by silk-screening (manually) and CNC (Computer Numerical Control) -milling. The main aim of this work is to make the PCB designing process automated and easier by using CNC system in associated with proteus software. In this work a schematic diagram of a high voltage circuit for Geiger - Muller (GM) tube is designed using proteus software. Then the PCB layout of the circuit is converted into Gerber files that are decoded into G- code through Flat CAM software. The G-code is introduced to the CNC system consisting of a computer, a CNC controller and a CNC machine. The code is stored in the memory of the computer and is uploaded to the CNC controller by Mach3 software. The controller operates the CNC machine to perform isolation routing, drilling and milling for PCB as per the instructed design. The developed design is tested in the laboratory and now it is working properly.

1.7 Toxic and non-toxic gas detection system for septic tank

A. Begum, M. A. A. Mamun, M. A. Rahman, S. Sattar, M. T. Khatun, H. Akhter and M. Begum

The main objective is to develop a system which can be used to detect different types of toxic and non-toxic gases in the septic tank and monitoring the data locally and remotely. In septic tanks, various types of toxic and non-toxic gases are found such as Carbon di-Oxide (CO2), Carbon mono-Oxide (CO), Hydrogen Sulfide (H2S), Methane (CH4), and so on. a toxic gas detection system for a septic tank has been developed, where MQ-135, MQ-136, MQ-4, and MQ-7 sensors are employed for combined detection of CO2, H2S, CH4, and CO gases respectively. With the change of concentration of gases, the sensor resistance changes and accordingly an analog voltage is produced across the sensor. The analog voltages from the sensors are fed to a microcontroller, which reads the values and converts the values into gas concentration in PPM (parts per million). The PPM values for all four gases are displayed on an LCD, where two levels are assigned as "Safe" and "Danger" based on the concentration of each gas. "Safe" status means the concentration of gas is not harmful and "Danger" status means the concentration of gas is harmful. A buzzer will give an alarm when the gas concentration status becomes "Danger". Furthermore, a Bluetooth device is interfaced with the microcontroller for transferring the gas concentration data to a smartphone. For the Smartphone, application software has been developed to monitor the concentration of each toxic gas. The prototype system has been developed and tested which gives satisfactory results. It is supposed to be a helpful and cost-effective system for cleaners working in septic tanks.

1.8 Comparison and analysis different types of computer processor generations

H. Akhter, A. Begum, M. T. Khatun, M. U. Safia, S. Sultana and M. Begum

The objective of this topic Compare relative performance of CPU processor. It is the important heart element of the CPU of the processor and system. The development of computer systems is normally discussed as the development over different generations.With the succession of different generations, came the advancement in computer technology.

The Core i3 range is entirely dual core, while Core i5 and i7 processors have four cores. It is difficult for an application to take advantage of the multicore system. Multiple cores mean that the computer can work on more than one task at a time more efficiently.

2. Repair, Maintenance and Renovation Works

The major instruments include repair High voltage power supply of Neutron Diffractometer, Current generator, X-ray control panel, Electronic balance, Oscilloscope, Survey meter(Gamma-Scout), UPS (Uninterruptible Power Supply), Monitor, Computers, (System Unit with software installation), Intercom Systems. The Division has been successfully maintaining the Intercom Systems of AECD. The system contains Digital PBX-Board, Panasonic 16SLC having 96 lines and Panasonic D1232, having 16 lines.

Table: Type and number of instruments are repaired

Type of the instruments	Name of the user	Quantity
Scientific, Nuclear and Analytical	AECD	6
Computer (System Unit with software installation)	AECD	13
LED Monitor	AECD	1
UPS (Uninterruptible Power Supply)	AECD	2
Intercom System (Line and Set)	AECD	8

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
M. T. Khatun	Fire Fighting, Fire Prevention, Rescue and First Aid Training	Bangladesh Fire Service and Civil Defence Directorate	24 - 25 Feb. 2021	AECD
A. Begum	Follow-up Training Course on Reactor Engineering Course at BAEC (RECB-9) - 2021	BAEC and JAEA	07-25 Feb. 2021	IE, AERE

Name of the participant	Title of the event	Organizer	Date	Place
M. U. Safia	Fire Fighting, Fire Prevention, Rescue and First Aid Training	Bangladesh Fire Service and Civil Defence Directorate	24 - 25 Feb. 2021	AECD
M. B. Sarkar	Fire Fighting, Fire Prevention, Rescue and First Aid Training	Bangladesh Fire Service and Civil Defence Directorate	24 - 25 Feb. 2021	AECD
M. H. Ali	Fire Fighting, Fire Prevention, Rescue and First Aid Training	Bangladesh Fire Service and Civil Defence Directorate	24 - 25 Feb. 2021	AECD

4. Collaboration Work(s)

- S and T Project, "Performance evaluation of Cyclotron 18/9 IBA installed at NINMAS", Shahana Sultana, Principal Engineer, Associate Investigator.
- Collaborated with different National and International Universities

5. Stakeholder Meeting

"Importance of Training Courses on Advanced Electronics for the Development of Skilled Manpower", AECD (Online, Zoom), 4 Jul. 2021.

Experimental Physics Division, AECD

Objective/Introduction

The key objective is to develop solar energy materials and advanced materials in thin film form for solar photovoltaic and different optoelectronic applications. These are summed up bellow:

- Development and characterization of elemental, binary, ternary and quaternary semiconducting materials in thin film form.
- Fabrication of photo detectors and characterization.
- Studies of the fundamental properties of solid-state materials in optoelectronic and nuclear science application.

Activities

1. Research and Development Work(s)

1.1 Investigation of the transport properties of vacuum evaporated thin films of copper gallium di-selenide ($CuGaSe_2$)

K. M. A. Hussain, M. S. S. Chowdhury, T. Faruqe, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Analysis of structural, optical and electrical properties of $CuGaSe_2$ thin film.

Current progress: Thin films of copper gallium di-selenide ($CuGaSe_2$) were prepared in vacuum (10^{-6} mbar) by Stacked Elemental Layer (SEL) deposition method. This stack was then thermally annealed insitu to form a compound, copper gallium di-selenide (CuGaSe2) which is dependent on the thermal annealing temperature (A_T) and duration (A_t). These parameters have been optimized by measuring transport properties, like conductivity, charge carrier concentration and mobility, with a view to use this material as an absorber in solar cells. The transport parameter has been studied by measuring dc conductivity and Hall effect. The type of conduction has been measured by hot- probe method. Shallow and deep acceptor levels and grain boundary barrier heights were determined by measuring conductivity and Hall-voltage as a function of temperature in the range of 300-380K. Eleven samples were prepared of which height were studied for transport parameters and three were studied for stoichiometric composition. All the films are found to be p-type.The conductivity of the film at room temperature increases gradually as the annealing temperature and duration increase from 250℃ to 350℃ and from 5 to 20 minutes, respectively. Beyond that annealing temperature (>350℃) and duration (>20 min), the conductivity drops.All film shows good compound formation. Such films can be used as base material for fabrication of solar cells and hence its composition and transport properties need to be known.

1.2 Optical properties of ZnSe thin films using thermal evaporation technique

K. M. A. Hussain, M. S. S. Chowdhury, T. Faruqe, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Analysis of optical properties of ZnSe thin film

Current progress: Thin films of Zinc Selenide (ZnSe) have been deposited onto an ultrasonically cleaned glass substrate by sequential and successive thermal evaporation method. The films thickness was 500 nm having the fixed thermal annealing temperature for duration 1 hour. The optical properties of the films were investigated by UV-Vis NIR spectroscopy analysis the quality of the films has been ascertained by their optical properties in the photon wavelength 300 nm to 2500 nm.

1.3 Synthesis and characterization of zinc selenide and al doped zinc selenide thin films by thermal evaporation technique

K. M. A. Hussain, M. S. S. Chowdhury, T. Faruqe, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Analysis of structural, optical and electrical properties of ZnSe and Al doped ZnSe thin films.

Current progress: ZnSe thin films of thickness 500 nm and substrate temperature ST = 230^0C and annealing temperature A_T =230^0C and 300^0C with annealing time 1 hour is prepared by thermal evaporation method. Optical properties were characterized by UV-VIS-NIR spectroscopy. The most important parameter optical band gap estimated on this research work. Structural parameters such as crystallite size, stress, strain, dislocation density was obtained from the XRD data using different models. ZnSe films thickness were calculated and synthesis and Analysis of the parameters are going on.

1.4 Study of the theoretical analysis of structural, electrical and optical properties of CdSxSe(1-x) (x=0,0.25,0.50,1.0) solid solution by first principal calculation

M. S. S. Chowdhury, K. M. A. Hussain, T. Faruqe, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Theoretical Analysis of structural, optical and electrical properties of CdSxSe(1-x) solution.

Current progress: The structural optical, elemental, and optical information were investigated by X-ray Diffraction (XRD), UV-VIS-NIR spectroscopy, respectively.In this research CdSxSe(1-x) has been studied due to its potential technological applications in field effect transistors, solar cells, photovoltaic, light emitting diodes, photo catalysis, photoluminescence, infrared photo detector, environmental sensors, biological sensors etc.Analysis of the parameters are going on.

1.5 Study of the theoretical analysis of structural, electrical and optical properties $BaTiO_3$ theoretical analysis by first principle calculation

M. S. S. Chowdhury, K. M. A. Hussain, T. Faruqe, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Theoretical analysis of structural, optical and electrical properties of $BaTiO_3$.

Current progress: Lattice dynamics, structural phase transition, and the thermodynamic properties of Barium Titanate (BaTiO3) are investigated by using first-principles calculations within the density functional theory (DFT). It is found that the GGA-WC exchange-correlation functional can produce better results.On the basis of the site-symmetry consideration and group theory, the comparative phonon symmetry analysis in four phases, which is useful to analyze the role of different atomic displacements in the vibrational modes of different symmetry. The calculated optical phonon frequencies at point for the four phases are in good agreement with other theoretical and experimental data. Analysis of the parameters is going on.

1.6 Optical characterization of the radiation effect on CdTeThin film deposited by thermal evaporation method

T. Faruqe, K. M. A Hussain, M. S. S. Chowdhury, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Analysis of structural, optical and electrical properties of CdT**e t**hin film.

Current progress: CdTe thin films of 50 nm (30 nm at 300^0C S_T and 20 nm at 200^0C S_T), 100nm (60 nm at 300^0C S_T and 40 nm at 200^0C S_T) and 200 nm (120 nm at 300^0C S_T and 40 nm at 80^0C S_T) have been deposited on the glass substrate at fixed annealing temperature 100^0C for 60 min by thermal evaporation method and the gamma radiation effect on their optical properties has been investigated. Transmittance and reflectance have been measured in the region from 400 nm to 1300 nm and were used to evaluate the optical parameters (Transmittance, reflectance, absorption coefficient, extinction coefficient, refractive index) and the

band gap energy for CdTe thin films before and after gamma radiation (50 kGy and 100 KGy of Cobalt 60 Source). Optical band gap and the transmittance were found to decrease with the increase of dose of gamma radiation for all the films.

1.7 Preparation and characterization of the structural, optical, morphological characterization of SnS_2 thin films deposited by spin coating method

F. T. Z. Toma, K. M. A Hussain, M. S. S. Chowdhury, T. Faruqe, J. Parvin and S. Ahmed

Objective: To observe the SnS_2 thin film and also measure the parameters.

Current progress: SnS_2 thin films with constant speed and different deposition time were prepared by simple and relatively easy spin coating method. Stanicclоridepentrahydrate, Thioacetamide were used as the precursors whereas Amoniumcloride, Distilled water and Triethyleamine worked as solvent and stabilizer respectively. Solutions of all the samples were prepared using chemical bath deposition method. All the samples prepared at 1000, 1500 and 2000 rpm spin speed with varied deposition time such as 60s, 90s and 120s were annealed at room temperature for 1 hour. The thicknesses of all samples were measured and were found near 114 nm. The optical parameters such as transmittance, absorption coefficient and energy band gap of the films were investigated by UV-VIS-NIR. The optical measurement of transmittance, absorbance and band gap of these films were determined over 310nm to 2500nm using UV-Vis Spectrometry at room temperature. These films can be used as one of the important components for solar cell and electronic applications. Measurement and Analysis of the parameters are going on.

1.8 Synthesis and the structural analysis of cds thin film using chemical bath deposition (CBD) technique

F. T. Z. Toma, K. M. A Hussain, M. S. S. Chowdhury, T. Faruqe, J. Parvin and S. Ahmed

Objective: To observe the CdS thin film and also measure the parameters.

Current progress: The structural and optical properties of CBD deposited CdS thin films have been studied by varying the processing parameters and Cd/S ratio of the starting Precursors in order to better understand the growth conditions. A CdS thin film was prepared on glass substrate by CBD from a bath containing Thiourea and Ammonium hydroxide. The structural analysis was performed by XRD. The deposited CdS thin film was a cubic phase with small nano crystalline grains. The film was deposited at 60° C for 2 hours. After sintering the film at 300°C for 1 hour the color of the film was changed like dark yellowish and the thickness of the film was obtained 100 nm. These studies have allowed us to establish a standard set of conditions for the fabrication of homogeneous and continuous very thin CdS films in laboratory

1.9 Deposition and characterization of sns_2 thin films by chemical bath deposition technique (CBD)

F. T. Z. Toma, K. M. A Hussain, M.S. S. Chowdhury, T. Faruqe, J. Parvin and S. Ahmed

Objective: To observe the SnS_2 thin films and also measure the parameters of the samples.

Current progress: Tin di-sulfide (SnS_2) thin films were synthesized by chemical precipitation method. SnS_2 thin films are deposited on glass substrate. Thin films were prepared at room temperature for 5 hours. andannealing temperature $A_T = 100^0$C for 60 min. Annealing temperature significantly influenced crystallinity and surface roughness of the thin films in CBD method. These films may be a good candidate for suitable application in various optoelectronic devices. Analysis of the parameters is going on.

1.10 First principle calculations of structural, optoelectronic and lattice dynamics of $Ba_xSr_{1-x}TiO_3$(x=1.0, 0.5, 0.0)

M. S. S. Chowdhury, K. M. A. Hussain, T. Faruqe, J. Parvin, F. T. Z. Toma and S. Ahmed

Objective: Study of Structural Optical and Latiice Dynamic Parameters of $Ba_xSr_{1-x}TiO_3$(x=1.0, 0.5,0.0).

Current Progress: First Principle Calculations are performed to explore the structural, electrical and optical properties of $Ba_xSr_{1-x}TiO_3$(x=1.0, 0.5,0.0) using Density functional theory (DFT) within the Tran-Blaha modified Becke-Johnson (mBJ) approximation and generalized gradient approximation (GGA) as implemented in wien2k and Quantum ESPRESSO. The mBJ gives improved band gaps compared to GGA.The calculated band gap of BaTiO3, Ba0.5Sr0.5TiO3 and SrTiO3 within mBJ exchange correlation are 2.6, 2.7 and 2.8 respectively. Density Functional Perturbation Theory (DFT) is employed to calculate the lattice dynamics. Negative frequencies are performed in the phonon dispersion spectra of all three provskites indicating that the phases in questions are dynamically unstable.

2. Seminar/Symposium/Conference/workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. K. M. A. Hussain	International e-Conference on Physics 2021	BPS	5-7 Feb. 2021	Virtual platform
	Webinar on Overview of Approach for Estimating activity in a package Using a Portable High Purity Germanium (HPGe) Detector	IAEA, Viena	14-15 Jun. 2021	Virtual platform
	Webinar on Nuclear Security Detection Measures and Assessment of Alerts and/or Alarms at a Major Pblic Event	IAEA, Viena	27 Apr. 2020	Virtual platform
M. S. S. Chowdhury	International e-Conference on Physics 2021	BPS	5-7 Feb. 2021	Virtual platform
	Workshop on 2D Materials for Spin-Orbitronics	ICTP, Italy	3-5 May 2021	Virtual platform
T. Faruqe	International e-Conference on Physics 2021	BPS	5-7 Feb. 2021	Virtual platform
	Webinar on Covid-19 Vaccine Basic Concepts and Facts	Annesha Science Society, Dhaka, Bangladesh	16 Jan. 2021	Virtual platform
	Webinar on Contemporary update on vaccines, comparisons and contradictions in the current socio-economic context of the world	Annesha Science Society, Dhaka, Bangladesh	19 Dec. 2020	Virtual platform
	Webinar on Covid-19 Attack on lung, perspective of pulmonary physician	Annesha Science Society, Dhaka, Bangladesh	22 Aug. 2020	Virtual platform
J. Parvin	International e-Conference on Physics 2021	BPS	5-7 Feb. 2021	Virtual platform
F. T. Z. Toma	Webinar on Where not to publish your research	National Young Academy of Bangladesh	22 May 2021	Virtual platform
	Webinar on Research paper writing: some points	IEEE	30 Apr. 2021	Virtual platform
	International e-Conference on Physics 2021	BPS	5-7 Feb. 2021	Virtual platform
	Webinar to celebrate 127th Birth Anniversary S.N,BOSE	Bose Centre of Advanced Study and Research in Natural Sciences University of Dhaka, Bangladesh	13 Jan. 2021	Virtual platform
	Webinar on Covid-19 Vaccine Basic Concepts and Facts	Annesha Science Society, Dhaka, Bangladesh	16 Jan. 2021	Virtual platform
	Webinar on Contemporary update on vaccines, comparisons and contradictions in the current socio-economic context of the world	Annesha Science Society, Dhaka, Bangladesh	19 Dec. 2020	Virtual platform

Name of the participant	Title of the event	Organizer	Date	Place
	Webinar on Covid-19 Attack on lung, perspective of pulmonary physician	Annesha Science Society, Dhaka, Bangladesh	22 Aug. 2020	Virtual platform
	International webinar on Material science research and the recent trends	Department of Physics, Balagarah Bijoy Krishna Mahavidyalaya, India	28 Jul. 2020	Virtual platform

3. Collaboration Work(s)

Collaboration with teachers and research student(s) of the following institute(s)

- Department of Physics and Department of Electrical and Electronic Engineering, University of Dhaka (PhD thesis, M. S thesis, B. Sc report).
- Physics Department, Dhaka University of Engineering and Technology (DUET). (M. Phil. thesis).
- Physics Discipline, Khulna University. (B.Sc. report/M.S. thesis).
- Department of Electrical and Electronic Engineering, University of Chittagong (M.S. thesis)
- Department of Glass and Ceramic Engineering (BUET).
- Materials Science of Semiconductor Processing Journal -as a reviewer.
- Physica B: Physics of Condensed Matter Journal as reviewer.
- Every year students carry out their thesis work in the laboratories of the Division. Their works are also supervised in a close co-operation.

Health Physics Division, AECD

Objective(s)

- Population exposure control
- Occupational exposure control
- Medical exposure control
- Radiation protection services

Programe(s)

Environmental Radiation and Radioactivity Monitoring

- Measurement of background radiation levels throughout Bangladesh and assessment of population exposure.
- Analysis of different radionuclides in environmental and biological samples both qualitatively and quantitatively.
- Development and standardization of analytical methods for low level measurement of radioactivity in environmental samples.
- Measurement of environmental gamma dose by Thermo-luminescent Dosimeter.
- Estimation of radioactivity concentration in Naturally Occurring Radioactive Materials (NORM) samples of different gas fields.
- Measurement of environmental gamma doses by In-Situ method.
- Assessment of Gross Alpha and Gross Beta activity in environmental samples.
- Determination of the Radon concentration in environmental samples such as air, water and soil.

Occupational Exposure Control

- Control of occupational exposure by monitoring individual radiation exposure and workplace monitoring throughout the country.

- Measurement of extremity doses of workers in Nuclear Medicine and Interventional Cardiology Department.

Medical Exposure Control

- Control of medical exposure by measuring of patient's surface dose of cardiac patient
- during CAG and PTCA.
- Measurement of patient surface dose during CT examination.

Quality Assurance Programme for Radioactivity Measurement

- Performance test of detecting system.
- Participation in the inter-laboratory inter-comparison exercise (Proficiency Test) in Asia
- Pacific Region organized by International Atomic Energy Agency (IAEA).

Quality Assurance Programme of Individual Monitoring System

- Performance test of TL Dosimeter system through routine test and calibration.
- Participation in the inter comparison program of individual radiation monitoring (regional and international).

Activities

1. Research and Development Work(s)

1.1 Survey of background radiation levels throughout Bangladesh

S. Yeasmin, M. S. Rahman, J. Ferdous, A. K. M. M. Rahman, M. M. M. Siraz, S. Pervin, N. Hassan, S. Banik, N. Sultana, Z. Hossain and A. Joydhar

Objective: To assess the external exposure of population due to natural and artificial radiation.

Current progress: During this reporting period, measurement of background radiation level has been carried out regularly in and around Dhaka city on monthly basis as a part of this work. In this study, Gamma Scout (w/Alert, Digital Survey meter) was used with Global Positioning System (GPS) for pointing the location. The average background radiation level was found from (0.14 to 0.24) μSvh^{-1}. It is observed that there is no change in background radiation level from the data of previous years.

1.2 Workplace monitoring of different radiation facilities of Atomic Energy Centre Dhaka

S. Yeasmin, M. S. Rahman, J. Ferdous, A. K. M. M. Rahman, M. M. M. Siraz, S. Pervin, N. Hassan, S. Banik, N. Sultana, Z. Hossain and A. Joydhar

Objective: The objective of workplace monitoring is to protect occupational workers from ionizing radiation.

Current progress: Five divisions of AECD, viz. Non-Destructive Testing (NDT), Accelerator Facilities Division (AFD), Material Science Division (MSD), Chemistry Division and Health Physics Division (HPD) of AECD have been using radioisotopes and radiation producing equipments for research and development works. Radiation monitoring has been done on monthly basis in and around the above-mentioned divisions by using Gamma Scout (w/Alert, Digital Survey meter). The radiation levels in front of isotope storeroom (corridor) of HPD, Source room (corridor) of HPD, NDT Source storeroom and in front of door of NDT source room were found (0.52 - 2.0) μSvh^{-1}, (0.21 - 0.4) μSvh^{-1}, (0.48 - 4.40) μSvh^{-1} and (0.20-0.40) μSvh^{-1} respectively. The control panel of AFD, XRD room of MSD and EDXRF room of Chemistry division were found around background level. No major change in dose level was observed.

1.3 Measurement of radioactivity in rain water

S. Yeasmin, M. S. Rahman, J. Ferdous, A. K. M. M. Rahman, M. M. M. Siraz, S. Pervin, N. Hassan, S. Banik, N. Sultana, Z. Hossain and A. Joydhar

Objective: To determine the radionuclides and their concentration in rain water.

Current progress: During the reporting period, twenty rain water samples were collected from AECD campus Dhaka, Tongi, Mohammadpur and Mirpur area. The activity concentration of natural radionuclides

^{238}U, ^{232}Th, ^{40}K and artificial radionuclides (if any) were determined by Gamma Spectrometry System consists of High Purity Germanium (HPGe) detector coupled witha digital spectrum analyzer (DSP^{ec}jr 2.0). The radioactivity range of ^{238}U series, ^{232}Th series and ^{40}K was within the acceptable limit. No artificial radionuclide was observed.

1.4 Radioactivity concentration of different food samples imported from SAARC and other countries

S. Yeasmin, M. S. Rahman, J. Ferdous, A. K. M. M. Rahman, M. M. M. Siraz, S. Pervin, N. Hassan, S. Banik, N. Sultana, Z. Hossain and A. Joydhar

Objective: To monitor the level of radioactivity in different food samples imported from SAARC and other countries as a part of radioactivity monitoring surveillance program.

Current progress: Total 35 (Thirty-five) imported food samples were collected from different local markets in Mirpur, Dhaka. DifferentFood samples such as Anchor Beans, Dabli, Ginger, Garlic, Rice, Red Wheat, White Wheat, Lentils, Chhola, Palm Oil and Soybean oil were imported from different countries such as Australia, China, India, Pakistan, Maldives, Malaysia and Nepal. The samples were processed following the standard procedures provided by IAEA and analyzed for gamma emitting radionuclides. The radioactivity range of ^{238}U series, ^{232}Th series and ^{40}K was within the acceptable limit. No artificial radionuclide was observed.

1.5 Assessment of natural radioactivity in coal and soil samples collected from Barapukuria coal mine in Dinajpur district of Bangladesh

M. I. A. Chowdhury*, M. M. M. Siraz, S. Pervin, A. F. M. M. Rahman**, M. J. Dewan* and S. Yeasmin

Objective: To determine the natural radionuclides and their activity concentration in coal and soil samples.

Current progress: Total six coal and eleven soil samples were collected from Barapukuria Coal Mine in Dinajpur District of Bangladesh. The detection and measurement of radionuclides in the samples was carried out by gamma spectrometry system using a high-resolution HPGe coaxial detector coupled with DSPEC jr 2.0 Digital Signal Processing Gamma Ray Spectrometer. The activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K in the soil samples have been found to be varied from 23.67±3.45 Bqkg^{-1} to 62.79±8.15 Bqkg^{-1}, 12.27±3.06 Bqkg^{-1} to 50.28±9.12 Bqkg^{-1} and 68.8±39.5 Bqkg^{-1} to 496.55±51.1 Bqkg^{-1} respectively. The Radium Equivalent activities of soil and coal samples varied from 19.89±4.33 Bqkg^{-1} to 62.79±8.15 Bqkg^{-1} with an average value of 37.83±6.52 Bqkg^{-1}. No artificial radionuclide was detected in any of the samples. The total annual effective dose associated with soil and coal samples in this study ranged from 0.218 mSvy^{-1} to 0.502 mSvy^{-1} with a mean of 0.343 mSvy^{-1}.The results have been compared with national and international safety standards and they were found within recommended safety limits.

*Department of Nuclear Engineering, University of Dhaka

**Nuclear Power and Energy Division, Bangladesh Atomic Energy Commission

1.6 Study of radioactivity and assessment of radiological hazard in soil and water samples collected from various regions in the southern part of Bangladesh

M. M. M. Siraz, A. F. M. M. Rahman*, S. Pervin, S. Banik, Z. Hossain, A. Joydhar and S. Yeasmin

Objective: To measure the radioactivity and assess the radiological hazard associated with soil and water Samples.

Current progress: Under the project, "Survey for the probable site for the Nuclear Power Plant in the Southern area of Bangladesh", total forty-five soil and forty-five water samples were collected from Nishanbaria (West), Nishanbaria (East) and Kumirmara of Borguna district and Moudubi and Char Montaj of Potuakhali district in the southern part of Bangladesh. All the samples were processed following the standard procedures as per International Atomic Energy Agency (IAEA) guidelines. The collected samples have been analyzed by Gamma Spectrometry System consists of a high-purity germanium (HPGe) detector with relative efficiency of 19.6% coupled with a Digital Spectrum Analyzer (DSPec jr 2.0). The work is in progress.

*Nuclear Power and Energy Division, Bangladesh Atomic Energy Commission

1.7 Background radiation survey in the 32 km radial distances of rooppur nuclear power plant

S. Yeasmin, S. Banik, M. M. M. Siraz, S. Pervin, J. Ferdous, N. Hassan, Z. Hossain and A. Joydhar

Objective: To measure the background gamma radiation in the 32 km radial distanceof rooppur nuclear power plant.

Current progress: To prepare baseline data of environmental background radiation around the Rooppur Nuclear Power Plant (RNPP) site, background gamma radiation monitoring was performed in the 32 km radial distances of RNPP. The equipment used for the measurement of radiation dose Level is Radiation Survey Meter (Gamma-Scout). The work is in progress.

1.8 Determination of radioactivity in environmental samples collected from the 32 km radial distances of rooppur nuclear power plant

S. Yeasmin, S. Banik, M. M. M. Siraz, S. Pervin, J. Ferdous, N. Hassan, Z. Hossain and A. Joydhar

Objective: To measure the radioactivity and assess the radiological hazard associated with various environmental samples.

Current progress: To prepare baseline data of environmental background radiation around the Rooppur Nuclear Power Plant (RNPP) site of total 133 samples (soil and vegetation=23, water=49, sediment and aquatic vegetation= 32, and food stuffs=29) were collected from the 32 km radial distance of RNPP. Among these samples 65 samples were processed following the standard procedures as International Atomic Energy Agency (IAEA) guidelines. After preparation samples will be measured by using high-purity germanium (HPGe) detector with relative efficiency of 19.6%. The work is in progress.

1.9 Assessment of occupational exposure using TLD in Bangladesh

S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Hassan and M. S. Rahman

Objective: The objective of this study is to assess and analyze the occupational exposure to ionizing radiation in the fields of nuclear medicine.

Current progress: The TLD system in use is based on TL card containing two elements of LiF:Mg,Ti (TLD-100) for the evaluation of $H_p(10)$ and $H_p(0.07)$ which have been read out by Harshaw TLD reader (Model-4500). All radiation workers are being monitored on a quarterly basis using whole body TLD badges. The average annual effective dose received by the radiation workers in the fields of nuclear medicine in the year 2019 is 0.032 μSv respectively. The cumulative dose of all the radiation workers in the fields of Nuclear Medicine is 11.18 mSv respectively. From this study, it can be concluded that although most of the radiation workers received doses less than the recommended limit by various international organizations, and the workers should pay more attention to radiation protection procedures and practices to keep radiation dose as low as reasonably achievable (ALARA).

1.10 Study on outdoor environmental gamma radiation of Tejgaon thana by in-situ method

M. S. Rahman, M. A. Rahman*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Hassan, Z. Hossain and M. K. U. Sikder*

Objective: Tomeasure real-time environmental gamma radiation from natural and artficial radionuclides.

Current progress: In-Situ Environmental gamma-ray dose rate was measured at 32 locations of Tejgaon Thana under Dhaka district using real-time environmental radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The dose rate varied from 0.085-0.190 μSv/h with an average of 0.145 μSv/h. The annual effective dose of the population due to the environmental gamma radiation was also calculated and it was varied from 0.104 - 0.233 mSv.

*Department of Physics, Jahangirnagar University

1.11 Study on indoor and outdoor gamma radiation of INMAS Mitford hospital campus by in-situ method

M. S. Rahman, L. A. Tonu*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Hassan, N. Sultana, Z. Hossain and P. K. Das*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is

required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current Progress: In-Situ indoor radiation was measured at 32 locations of INMAS, Mitford Hospital Campus using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The indoor radiation dose rate varied from 0.151- 4.31 µSv/h with an average of 0.456 µSv/h. The annual effective dose of the population due to the indoor gamma radiation was also calculated and it was varied from 0.305 - 8.764 mSv.

*Department of Physics, Pabna Science and Technology University

1.12 Study on indoor and outdoor environmental radiation of DMCH by in-situ method

M. S. Rahman, F. S. Mim*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and S. M. Tareq*

Objective: Tomeasure real-time environmental gamma radiation from natural and artficial radionuclides.

Current progress: In-Situ Environmental gamma-ray dose rate was measured at 32 locations of DMCH campus using real-time environmental radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The dose rate varied from 0.095-0.580 µSv/h with an average of 0.147 µSv/h. The annual effective dose of the population due to the environmental gamma radiation was also calculated and it was varied from 0.832 - 1.621 mSv.

*Department of Environmental Sciences, Jahangirnagar University

1.13 Study on outdoor radiation of BSMMU hospital campus by in-situ method

M. S. Rahman, F. Hassan*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and S. M. Tareq*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 32 locations of BSMMU Hospital Campus using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The indoor radiation dose rate varied from 0.181- 3.518 µSv/h with an average of 1.054 µSv/h. The annual effective dose of the population due to the outdoor gamma radiation was also calculated and it was varied from 0.279 - 5.514 mSv.

*Department of Environmental Sciences, Jahangirnagar University

1.14 Radiation monitoring at indoor places of aecd campus by in-situ method

M. S. Rahman, O. Faruque*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and K. N. Sakib*

Objective: Tomeasure the indoor radiation of AECD Campus from natural and artificial radionuclides.

Current progress: Indoor radiation was measured at 20 locations of AECD Campus using thermoluminescent dosimeters. The measurement was performed from Nov 2019-Apr. 2020. The indoor radiation dose rate varied from 352- 482 µSv/month with an average of 354 µSv/month. The annual effective dose of the population due to the indoor gamma radiation was also calculated and it was varied from 1.279 - 3.114 mSv.

*Department of Physics, Mawlana Bhashani Science and Technology University

1.15 Continuous radiation monitoring at indoor places of aecd campus using thermoluminescent dosimeter

M. S. Rahman, M. Ashraf*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and M. K. U. Sikder*

Objective: Tomeasure the indoor radiation of AECD Campus from natural and artificial radionuclides.

Current progress: Indoor radiation was measured at 20 locations of AECD Campus using thermoluminescent dosimeters. The measurement was performed from May 2020-Apr. 2021. The indoor radiation dose rate varied from 352- 482 µSv/month with an average of 354 µSv/month. The annual effective dose of the population due to the indoor gamma radiation was also calculated and it was varied from 1.279 - 3.114 mSv.

*Department of Physics, Jahangirnagar University

1.16 Study on outdoor radiation of BSMMU hospital campus by in-situ method

M. S. Rahman, A. Tareque*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and S. K. Das*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 32 locations of BSMMU Hospital Campus using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.181- 3.123 µSv/h with an average of 1.012 µSv/h. The annual effective dose of the population due to the outdoor gamma radiation was also calculated and it was varied from 0.234 - 4.921 mSv.

*Department of Physics, Jagannath University

1.17 Study on outdoor radiation of evercare and united hospital campuses by in-situ method

M. S. Rahman, S. Akter*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and K. N. Sakib*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ outdoor radiation was measured at 64 locations of Evercare and United Hospitals Campuses using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.120- 1.812 µSv/h with an average of 4.124 µSv/h. The annual effective dose of the population due to the indoor gamma radiation was also calculated and it was varied from 0.131 -1.243 mSv.

*Department of Physics, Mawlana Bhashani Science and Technology University

1.18 Study on outdoor radiation of Square hospital and National Heart Foundation campuses by in-situ method

M. S. Rahman, S. S. Mitu*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and K. N. Sakib*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 64 locations of Square Hospital and National Heart Foundation Campuses using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.102- 0.821 µSv/h with an average of 0.271 µSv/h. The annual effective dose of the population due to the indoor gamma radiation was also calculated and it was varied from 0.431 - 2.514 mSv.

*Department of Physics, Mawlana Bhashani Science and Technology University

1.19 Study on outdoor radiation of LabAid and Suhrawardy medical college hospitals by in-situ method

M. S. Rahman, A. A. Shuhan*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and M. K. U. Sikder*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 64 locations of LabAid and Suhrawardy Hospital Campuses using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.152- 3.232 µSv/h with an average of 0.472 µSv/h. The annual effective dose of the population due to the indoor gamma radiation was also calculated and it was varied from 0.432 - 7.514 mSv.

*Department of Physics, Jahangirnagar University

1.20 Study on Outdoor radiation of three large hospitals in Dhaka by in-situ method

M. S. Rahman, M. Mustafiz*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and M. R. Rahman*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 96 locations of BSMMU and DMCH and Mitford Hospitals Campuses using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.103- 3.145 µSv/h with an average of 0.254 µSv/h. The annual effective dose of the population due to the outdoor gamma radiation was also calculated and it was varied from 0.263 - 7.843 mSv.

*Physics Discipline, Khulna University

1.21 Study on outdoor radiation of cancer hospital in Dhaka by in-situ method

M. S. Rahman, M. Arman*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and M. K. U. Sikder*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 32 locations of BSMMU Hospital Campus using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.123- 2.174 µSv/h with an average of 0.354 µSv/h. The annual effective dose of the population due to the outdoor gamma radiation was also calculated and it was varied from 0.246 - 7.342 mSv.

*Department of Physics, Jahangirnagar University

1.22 Study on outdoor radiation of BIRDEM hospital in Dhaka by in-situ method

M. S. Rahman, M. Shakil*, S. Yeasmin, M. M. M. Siraz, S. Pervin, S. Banik, N. Sultana, Z. Hossain and M. K. U. Sikder*

Objective: Nuclear medicine workers usually handle radioactive sources during preparation and administering. So, there is a possibility to receive higher doses during their daily work. Therefore, it is required to measure real-time gamma radiation dose rate in nuclear medicine departments in order to ensure safe working environment of workers.

Current progress: In-Situ indoor radiation was measured at 32 locations of BIRDEM Hospital Campus using real-time gamma radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). This device meets all European CE standards as well as the American "FCC 15 standard". All the locations were marked out using global positioning system (GPS). The outdoor radiation dose rate varied from 0.104- 2.034 μSv/h with an average of 0.365 μSv/h. The annual effective dose of the population due to the outdoor gamma radiation was also calculated and it was varied from 0.354- 6.702 mSv.

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1.23 Accidental and retrospective dosimetry using glass material as natural dosimeter by TL method

A. K. M. M. Rahman, S. Banik, N. Hassan, Z. Hossain and S. Yeasmin

Objective: Retrospective dosimetry is one of the most important tools of accidental dosimetry for dose estimation when dose measurement was not planned. In the affected area several objects can be considered as natural dosimeters; some of these materials are suitable for retrospective dosimetry using thermoluminescence (TL) analysis.

Current progress: This project uses luminescence techniques to investigate the radiation dose history of materials suspected to have been exposed to man-made (artificial) radiation, from the perspective of retrospective dosimetry measurement. After investigated the glass samples seem promising for retrospective dosimetry purposes, having TL responses, proper glow curve peaks and the intensity of TL peaks vs. Temperature received provided nearly linear response in the dose range of 0.5 Gy to 8.0 Gy. Some of the glasses have been found to be sensitive enough that they can be used as TL dating material in radiological accident situation for gamma dosimetry with lower detection limit 0.5 Gy. At high dose (8.0 Gy), the glass samples show relatively better response. Obtained results showed that collected glass samples have different dosimetric properties but most of them shoed better response (luminescent signal) which can be used to calculate the dose.

1.24 Glow curves analysis of different types of thermoluminescent dosimeters

A. K. M. M. Rahman, S. Banik, N. Hassan, Z. Hossain and S. Yeasmin

Objective: The use of radiation in everyday life is increasing day by day. So, the proper evaluation of the performance of radiation dosimeter is important. Thermoluminescence dosimeter is the widely used radiation dosimeter especially in the fields of environmental, personnel, and clinical radiation applications. The present work is concern with the investigation of glow curves of different types of commercial TLDs.

Current progress: Harshaw TLD 100, TLD 500 and TLD 700 chips were collected from Health Physics Division, Atomic Energy Centre Dhaka and irradiated at low (0.5 Gy) and high (8.0 Gy) dose with Sr-90/Y-90 irradiator and clinical linear accelerator (LINAC) and then read with Harshaw 3500 manual TLD reader. The TLD 100 and TLD 700, due to presence of difference in the concentration of isotopes of Li, are abundantly used to obtain the information of radiation dose such as gamma and beta. Response of TLD-100 and TLD-700 under varying dose from 1.4 to 7.0 mGy was compared. In this work thirty TLDs of two different types was used: TLD 100 and TLD 700. The TLDs were irradiated in an experimental setup using a Sr-90/Y-90 irradiator. The composition of the dose in different types of TLDs was evaluated for dosimetric properties focusing on linearity and reproducibility. It was found that the response of TLD 700 is 1.2 times greater than that of TLD 100 and the reproducibility tests made on two types of chips were found satisfactory. On the other hand, TLD 500 showed two glow peaks.

1.25 Assessment of occupational radiation exposure and associated health risk

S. Banik, M. M. M. Siraz, S. Pervin, A. K. M. M. Rahman, M. S. Rahman, N. Hassan, Z. Hossain and S. Yeasmin

Objective: With the recent advancement in medical science of Bangladesh, radioisotopes are used immensely in medical practices (both diagnostic and therapeutic purposes). The benefits surpass the health hazards due to ionizing radiation. Due to health issues, the necessity for the evaluation of the dose of occupational exposure in medicals comprising nuclear medicine (NM), interventional cardiology (IC), radiotherapy (RT), and Radiology (RD) upholds to maintain proper radiation protection for radiation workers.

Current progress: With the device Harshaw TLD reader 4500 Health Physics Division, Atomic Energy Centre, Dhaka is providing radiation protection of workers using thermoluminescent dosimeter (TLD) all over the country. TLDs are used for the dose measurements. The workers in the mentioned fields received doses

below the recommended limit of 20 mSv per year which was imposed by national and international regulations/guidelines. The annual average effective dose of individuals is lower than worldwide average value. Depending on the average occupational dose, the expected number of radiation induced cancer cases among the monitored workers is less than 1. The trend of dose distribution is to move towards lower levels which reveals that majority of the organizations maintain adequate radiation protection.

1.26 Occupational exposure in radioactive waste management unit in Bangladesh using thermoluminescent dosimeter in between 2009 and 2018

S. Banik, M. M. M. Siraz, S. Pervin, A. K. M. M. Rahman, M. S. Rahman, N. Hassan, Z. Hossain and S. Yeasmin

Objective: With the development of a country, generation of waste is increased. Now, research is crucial to understand the hazardous effect of this waste product and make proper treatment plan. Among several types of wastes, radioactive waste is considerably most hazardous one for human health and also need special processes to store and disposal. The aim is to maintain proper radiation protection in the radioactive waste management unit (WMU) by using Thermoluminescence dosimeter.

Current progress: With the aim of ensuring occupational safety of the workers working in this unit, Health Physics Division, Atomic Energy Centre Dhaka is providing Thermoluminescent Dosimeter (TLD) to the workers to make sure the radiation level below recommended limit as the requirement of the Nuclear Safety and Radiation Control (NSRC) Rules-1997 and BAER Act 2012. A Harshaw TLD reader (Model-4500) is used to read out the TLDs. During the year 2009 to 2018, 251 workers were monitored quarterly basis (four times in a year) and 192 workers were being reported and rest of the TLDs was not returned. The study was done by considering job category such as Scientists and others (Experimental officer, technical officer, and other staffs). The overall cumulative effective dose received by the workers was 16.626 mSv and the annual average effective dose that was found for the workers of WMU is under recommended limit of 20mSv/year by ICRP.

1.27 Environmental gamma dose measurement using thermoluminescent dosimeter (TLD) at AECD campus

S. Pervin, N. Hassan, M. M. M. Siraz, S. Banik, A. K. M. M. Rahman, M. S. Rahman, Z. Hossain and S. Yeasmin

Objective: The aim of this work is to measure the gamma dose component of environmental radiation in AECD campus.

Current progress: Ten locations were selected at AECD campus for the measurement of environmental gamma dose by TLD-100. Ten sets of TLD (100) chips, each set contains five LiF-100 chips, were placed on gonad height at ten locations for three months. The TLD chips were collected and doses were measured by TLD reader, Model no. Harshaw- 3500. The quarterly average dose level was found to be 413.49 ±46 μSv.

1.28 Measurement of gross alpha in tap water in Dhaka city

S. Pervin, S. Banik, M. M. M. Siraz, M. S. Rahman, Z. Hossain, A. Joydhar and S. Yeasmin

Objective: The radioactivity of drinking water is an environmental factor which contributes to the population exposure to ionizing radiations. The activity of monitoring the water radioactive content is the responsibility of the national public health systems by ensuring the maintaining of the effective dose by ingestion in the provided limits.

Current progress: Sixteen tap water samples were collected randomly from different locations of Dhaka city. The gross alpha activity in tap water samples will be measured by using Zinc Sulfide Scintillation (ZnS) detector. All samples were prepared according to EPA 900 method.

1.29 Study on outdoor environmental gamma radiation of Mirpur and Tongi thana by in-situ method

S. Banik, S. Pervin, M. M. M. Siraz, N. Hassan, N. Sultana, Z. Hossain and S. Yeasmin

Objective: Tomeasure real-time environmental gamma radiation from natural and artificial radionuclides.

Current progress: In-Situ environmental gamma-ray dose rate was measured at 10 locations such as mosque, school, residential area, market, and hospital of Mirpur and Tongi Thana under Dhaka district using real-time

environmental radiation measuring device (GAMMA-SCOUT GmbH and Co. KG). All the locations were marked out using global positioning system (GPS). The dose rate varies from 0.14-0.21 µSv/h with an average of 0.165 µSv/h. The annual effective dose of the population due to the environmental gamma radiation varied from 0.245-0.367 mSv.

2. Seminar/Symposium/Conference/Workshop Attended

Name of the person	Title of the event	Organizer	Date	Place
Selina Yeasmin Jannatul Ferdous Dr. A.K.M. Mizanur Rahman M.M. Mahfuz Siraz Shikha Pervin Nazia Hassan and Subrata Banik	International e- Conference on Physics 2021	Bangladesh Physical Society, University of Dhaka, and Frontiers of Physics of US + Bangladesh collaboration	5-7 Feb. 2021	Virtual Online platform
Selina Yeasmin Dr. Mohammad Sohelur Rahman Jannatul Ferdous M.M. Mahfuz Siraz Shikha Pervin Nazia Hassan and Subrata Banik	International conference on Science and Technology for celebrating the Birth centenary of Bangabandhu (ICSTB 2021)	BCSIR	11-13 Mar. 2021	BCSIR Dhaka
Dr. Mohammad Sohelur Rahman	Waste Safe 2021-7th International Conference on Integrated Solid Waste and Faecal Sludge Management: Blue Appropriate Social Oriented Solutions	Khulna University of Engineering and Technology, Bauhaus University of Weimar (Germany), University of Padova (Italy) and IWWG	27-28 Feb. 2021	KUET, Khulna
	International Conference on the Management of Naturally Occurring Radioactive Materials (NORM) in Industry	IAEA	19-30 Oct. 2020	Vienna (Virtual Conference)
	4th International Conference on Bangladesh Environment (ICBEN-4)	Bangladesh Poribesh Andolon (BAPA) and Bangladesh Environment Network (BEN)	26-27 Dec. 2020	Dhaka
	WasteSafe 2021: 7th International conference on Integrated solid waste and faecal sludge management: Blue appropriate social oriented solutions	KUET, Khulna	27-28 Feb. 2021	Khulna (Virtual platform)

3. Training Course Organized and Seminar Arranged

Title	Date	Place	No. of participants
Seminar on "Occupational exposure control (using TLD)"	31 Mar. 2021	Virtual platform	11

4. Collaboration Work(s)

- Collaborated with IAEA, JAEA (Japan)
- Collaboration Project with MOST and MOE
- Special Research Allocation Project: 2020-2021 under MOST, GOB
- Grant of Advanced Research in Education: 2020-2021, 2021-2022, 2022-2023 under MOE, GOB
- To enhance knowledge on radiological science delivering theoretical lectures, preparing and editing question papers in the field of Medical Physics, Health physics and Radiation Protectio, such as, MD in Radiotherapy and Radiology course (NINMAS), Environmental radioactivity course (MIST).

5. Services Rendered

5.1 Services Rendered for Imported and Exportable Food Samples (^{137}Cs radioactivity Testing)

Name of the month	Milk and Milk products (A)	Others (B)	Imported C = A+B	Individual product	Monthly total
Jul. 2020	52	175	227	34	261
Aug. 2020	30	143	173	36	209
Sep. 2020	50	100	150	22	172
Oct. 2020	35	190	225	2	227
Nov. 2020	20	243	263	20	283
Dec. 2020	20	143	163	19	182
Jan. 2021	25	182	207	29	236
Feb. 2021	28	185	213	24	237
Mar. 2021	9	148	157	27	184
Apr. 2021	19	175	194	5	199
May. 2021	9	99	108	4	112
Jun. 2021	47	334	381	6	387
Grand Total					2689

5.2 Gross Alpha and Gross Beta Service Provided (Tested gross alpha activity)

Name of organization	Type of sample	No. of sample	Total parameters
Dhaka Women College	Water	1	1
Square Pharmaceuticals Ltd. (Dhaka unit)	Water	4	4
Beximco Pharmaceuticals Ltd. (Dhaka unit)	Portable water	2	2
SK-F Pharmaceuticals Ltd.(BD)	Water	6	18
Square Pharmaceuticals Ltd. Pabna	Bore hole Water	1	1
Total		14	26

5.3 Service Provided to New Organizations (Issued TLD badges)

Name of the month	No. of new organizations	No. of new workers
Jul. 2020	11	20
Aug. 2020	54	64
Sep. 2020	59	102
Oct. 2020	34	58
Nov. 2020	53	67

Name of the month	No. of new organizations	No. of new workers
Dec. 2020	41	74
Jan. 2021	30	47
Feb. 2021	19	45
Mar. 2021	21	53
Apr. 2021	8	34
May 2021	7	31
Jun. 2021	10	18
Total	347	613

5.4 Dose Measurement and Reporting

Name of the month	Number of organizations	Number of measured TLD badges
Jul. 2020	329	1019
Aug. 2020	357	793
Sep. 2020	409	1158
Oct. 2020	301	1224
Nov. 2020	315	703
Dec. 2020	568	1134
Jan. 2021	334	1563
Feb. 2021	323	752
Mar. 2021	343	783
Apr. 2021	107	329
May 2021	69	189
Jun. 2021	304	1083
Total	3759	10730

5.5 Individual Monitoring Service (IMS)

Practices	Number of organizations	Number of radiation workers
Radiotherapy	14	395
Nuclear Medicine	18	497
Industrial Radiography	44	293
Diagnostic Radiology	4657	8295
Research	20	379
Others (Quality Control, Level Gauge etc)	134	636
Total	4887	10495

Materials Science Division, AECD

Objective

Materials Science Division, Atomic Energy Centre, Dhaka carries out research in bulk and nano structural applications-oriented materials, which have potential use in the different branches of i.e. nanotechnology, telecommunication, information technology and biotechnology. The division is involved with both synthesis and characterization of different kind of materials. Divisional activity is further enriched by an ADP project.

The divisional activity is further enriched by an international collaboration programme of BAN-02, International Science Programme, Uppsala University, Sweden. MSD accomplished exhaustive research in the nanocomposite magnetic alloy systems which have potential applications in the miniaturization of electrical and electronic components. Large numbers of students are involved with this group through different academic programmes from various public and private universities under national and international collaboration. The division also provides supports and services to the industrial and research organizations.

Program(s)

- Development of spinel type soft ferrites using magnetite and commercial grade raw materials and study of their characteristic properties.
- Synthesize, characterization and study of the biomedical application of nanometric scale ferrite / materials and study their applications using MRI and hyperthermia machine.
- Development of ferrite permanent magnets from beach sand mineral magnetite extracted from Cox's Bazar beach sand.
- Study of the magnetic and structural properties of amorphous/nanocrystalline materials.
- Study of the structural and magnetic properties of perovskites.
- Crystallographic characterization and quantitative phase study of inorganic, organic, thin film, and unknown materials by XRD method.
- Study of the magnetic and electrical properties of microwave ferrite materials.
- Mineralogical study of soil, rock, clay, terracotta, and silt materials by XRD method.
- Synthesis and Characterization of Chitosan, ZrO_2, Al_2O_3 coated ceramic materials for biomedical application.
- Preparation of functionalized Carbone nano-tube applications.
- Synthesis of Reduced Graphene Oxide and its application as biomedical coating.

Activities

1. Research and Development Work(s)

1.1 Silica coated iron oxide nanoparticles for environment remediation and nuclear waste management

S. M. Hoque, M. M. Haque, M. N. I. Khan, H. N. Das, R. Rashid, S. I. Liba, M. R. Hasan, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and M. A. Mamun*

The objective of the work is to study of silica coated iron oxide nanoparticles for environment remediation and nuclear waste management. Nanomaterials specially magnetite iron oxide nanoparticles (MNP) are recently gained much interest in biomedical, environmental and nuclear application for its high surface area, adsorption capacity and excellent superparamagnetic properties. To prevent agglomeration, dissolution and leaching of magnetite in aqueous and highly acidic conditions, surface modification of magnetite nanoparticles by silica coated or forming of magnetite-silica core shell structure gained much popularity among the researchers. Silica coating not only protects the magnetite core but also provides easy conjugation with different application specific functional groups and higher absorption capacity. In this work, Silica coated magnetic nanoparticles (SMNP) were prepared by optimized and simplified methods using the available lab facilities. The results confirmed the successful synthesis of uncoated and silica coated iron oxide nanoparticles with average size of 12.19±3.11nm,14.23±2.79 nm and12.22±2.97 nm for uncoated, coated 1 and coated 2 samples respectively with high purity single phase Fe_3O_4 inverse spinel cubic structure. The average coating thickness of coated 1 and coated 2 samples were found approximately 1.76±0.48nm and1.34±0.39nm respectively. The saturation magnetization of SMNP (54.5emu/g) was found lower than MNP (62.9emu/g) due to the coating effect but still retained the superparamagnetic properties. Smaller and Uniform particle size distributions, possibility to be further modified by functional groups (presence of Hydroxyl groups) required for specific heavy metal or radionuclides separation and excellent superparamagnetic properties support the potentiality of these synthesized SMNPs to be used in future environmental remediation and waste management applications.

*Nuclear Power and Energy Division, BAEC

1.2 Evaluation of remineralization potential of nano-hydroxyapatite on tooth enamel surface: An in-vitro study

S. M. Hoque, F. M. Kamal, M. N. I. Khan, H. N. Das, R. Rashid, S. I. Liba, M. R. Hasan, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and R. Naser*

The objective of the work is to to analyse the remineraization potential of synthesized nano-hydroxyapatite on artificial caries lesions using scanning electron microscope (SEM) with energy dispersive X-ray (EDX). Benefits of remineralizing agents in a wide variety of formulation have been proved in caries management and dental protection. Nano-hydroxyapatite is one of the most biocompatible and bioactive material having very good perspective in dentistry. The enamel samples of extracted human teeth were subjected to artificial carious lesions using lactic acid. Then 10% n-HAP solution was applied as remineralization agent for 30 days, daily for 2 hours. The change in mineral contents at baselime, after demineralization and after remineralization were compared by EDX and SEM analysis. SEM and EDX results of the samples showed significant change in Ca and P weight percentage after remineralization. nHAP has the potential to remineralize artificially induced carious lesions.

*Department of Applied Chemistry and Chemical Engineering, University of Dhaka

1.3 Preparation of cobalt ferrite nanoparticles by co-precipitation method and coated with dextran for MRI contrast of brain and cancer treatment by hyperthermia

S. M. Hoque, M. N. I. Khan, A. Mamun, H. N. Das, R. Rashid, S. I. Liba, M. R. Hasan, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and H. B. Kashem*

The objective of the work is to Study of Preparation of Cobalt Ferrite Nanoparticles by Co-Precipitation Method and Coated with Dextran for MRI Contrast of Brain and Cancer Treatment by Hyperthermia. In this study, cobalt ferrite ($CoFe_2O_4$) nanoparticles were prepared by co-precipitation method and were coated with dextran. The average crystallite size of cobalt ferrite ($CoFe_2O_4$) magnetic nanoparticles were found 16.5 nm with lattice parameter 8.30433Å, XRD results also confirm the respective functional groups in the structure for both coated and uncoated nanoparticles. HRTEM image shows the high crystallinity of the coated nanoparticles and SAED pattern shows the lattice fringe spacing of the sample corresponds to the (311) plane of $CoFe_2O_4$. This value was found to match with the corresponding intensity peak (311) of X-ray diffraction. The coated particles also showed superparamagnetic properties with saturation magnetization 0.0654 emu/g and zero coercivity at room temperature. Dynamic light scattering (DLS) was used to determine hydrodynamic diameter and polydispersity index (PDI) of the coated particle which was 182 nm and 0.255 respectively. Zeta Potential measured was -10.08 mV. The synthesized nanoparticles showed moderate antibacterial effect on grain positive (S. aureus) bacteria. The cytotoxicity studies were conducted at different concentrations for both coated and uncoated sample and no cytotoxicity application of cancer treatment. The MRI result was also satisfactory which was carried on a ferrite rat. Here synthesized cobalt nanoparticles showed result to be a strong agent for cancer treatment.

*Department of Applied Chemistry and Chemical Engineering, University of Dhaka

1.4 An in-vitro study on acquired remineralization of enamel by nano-hydroxyapatite, sodium fluoride and polyetheylene oxide

S. M. Hoque, M. M. Haque, M. N. I. Khan, A. Mamun, H. N. Das, R. Rashid, S. I. Liba, M. R. Hasan, A. Nahar, A. Kumar, A. Parveen, K. Hasan, N. Begum and N. Z. Khan*

The objective of the work is to An In-vitro Study on Acquired Remineralization of Enamel by Nano-hydroxyapatite, Sodium fluoride and Polyetheylene oxide. The hardest part of our body is enamel. Enamel is composed of calcium and phosphorus which can be demineralization in contact with food and beverages. The hardest part can be prevented from demineralization and helped to remineralize from a chemical compound named hydroxyapatite. HAP has a ratio of calcium and phosphorous about 1.67. Here we are comparing hydroxyapatite solution with a paste type solution with a paste type solution made from HAP, polyethylene oxide and sodium fluoride. We are comparing which can demineralize the decayed teeth faster, HAP or the paste solution. For this purpose, 10 sound extracted teeth were collected from Dhaka Dental College. The teeth were separated in two groups. Group-A composed of 3 teeth which were treated by 15% rod were separated in two groups. Group-A composed of 3 teeth which were treated by 15 wt% rod shaped nano-hydroxyapatite solution and group-B composed of 7 teeth which were treated by the paste solution prepared

by 15 wt% rod shaped nano-HAP and 1450 ppm sodium fluoride. The specimens were demineralized through different beverages. The enamels were dipped in the beverages for a certain period of time. The demineralization was monitored by SEM and EDAX. Remineralization process was done for 4 weeks by brushing the enamel specimens 2 times/day with an interval of 12 hours for about 2 minites. In between the intervals, the enamel specimens were stored in distilled water and the temperature was maintained at 37°C. The result shows that the paste solution produced a surface morphology which is similar to the baseline enamel morphology. The increase in mineral content such as Ca/P ratio was more significant in the paste solution ($P<0.04$). Whereas in case of nano-hydroxyapatite, the ratio is less significant ($P<0.051$). The use of nano-hydroxypatite with sodium fluoride helps to demineralize the demineralized teeth and therefore it helps to prevent carious lesions. And also, it will help to create surface morphology similar to baseline teeth morphology.

*Department of Applied Chemistry and Chemical Engineering, University of Dhaka

1.5 A histological study on the effects of synthesized hydroxyapatite on the eruption of rat incisors

S. M. Hoque, M. M. Haque, M. N. I. Khan, H. N. Das, R. Rashid, S. I. Liba, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and M. A. A. Kayes*

The objective of the work is to a histological study on the effects of synthesized hydroxyapatite on the Eruption of Rat Incisors. The incisors of 10 Wistar rats were transected, pulp tissue was extirpated from the level of the gingival margin and each canal was prepared with files. Following the surgical procedure, the exposed pulp tissue was treated with hydroxyapatite (HAp) or covered with a calcium hydroxyide preparation. Following an observation period of 1 and 4 weeks, the experimental teeth were extracted and examined using light microscopy for histological changes in rat dental pulp cells. The result showed that incisors treated by HAP and $Ca(OH)_2$ erupted at 7 and 28 days after application into the root canal; both sides of incisors erupted at the same level from the gingival margin. Eruption-not recovered cases were not found in the present study. The histological finding revealed that although at 7 days after Hap application, there was much damage on the enamel organ and hemorrhage and coagulation were found but the histological appearance of Hap treated teeth at 28 days was closely resembled that of normal wound healing including the formation of a moderate inflammatory infiltrate beneath the injury and a local increase in angiogenesis and cell proliferation. On the other hand, calcium hydroxide exhibited distinct liquefaction necrosis of the tissue close to application site at 7 days followed by moderate inflammatory cell infiltrate beneath the injury and a local increase in angiogenesis and cell proliferation was seen. There was an increase in the microcirculation and embolism. Healing also induces by the mesenchymal cells. Therefore, it can be concluded that Hap may be more suitable for pulp healing because it produces minimum detrimental side effects on tooth development.

*Department of Applied Chemistry and Chemical Engineering, University of Dhaka

1.6 Cultivation and identification of rat`s bone marrow cell inside the 3d porous network synthesized hydroxyapatite-chitosen-gelatin basied scaffold

S. M. Hoque, F. M. Kamal, M. M. Haque, M. N. I. Khan, A. Mamun, H. N. Das, R. Rashid, S. I. Liba, M. R. Hasan, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and K. Mohona

The objective of the work is to cultivation and identification of rat`s bone marrow cell inside the 3d porous network synthesized hydroxyapatite-chitosen-gelatin baisied scaffold. The effect of prepared hydroxyapatite ($Ca_{10}(PO_4)_6(OH)_2$) and scaffolds for the adhesion, differentiation and proliferation on extracted rat`s bone marrow cell have studied. Furthermore, wet chemical precipitation method was used for hydroxyapatite preparation. Calcium nitrate-tetrahydrate and di-ammonium hydrogen phosphate were used to prepare hydroxyapatite. The bone like matrix formation of hydroxyapatite-Chitosan-gelatin based composite scaffold was prepared through freeze drying technique. Here, glutaraldehyde was used which acted as a cross-linker during preparation of scaffold. Crystal structure of hydroxyapatite was estimated using peak pattern of X-ray diffraction (XRD). Formation of hydroxyapatite and hydroxyapatite-chitosan-gelatin based scaffold were identified by Forier transform infrared spectroscopy (FTIR). Transmission electron microscopy (TEM) accomplished the shape of hydroxyapatite is needle-like. Thermo Gravimetric Analysis (TGA) also have been carried out to check thermal stability. Scanning Electron Microscopy (SEM) reveals the creation of a good interlinked porous scaffold having a pore size in between 40-500 µm which is ood for tissue growth and

performing osteo-induction and osteo-integration. Cytotoxicity measurement claimed that the prepared hydroxyapatite and scaffolds are nontoxic. Raman spectroscopy of prepared scaffold is mostly similar with femoral mouse bone. Necessary cell cultivation through Raman spectroscopy of prepared scaffolds is mostly similar with femoral mouse bone. Necessary cells were extracted from a rat femur and tibia-fibula. Those cells have attached with scaffolds at the time of incubation. Surface image of scaffold was taken before and after of cell cultivation through Raman spectrometer. Cells growth was observed through hemocytometer. It was revealed that number of cells have become approximately twice after using hydroxyapatite and scaffold. Bone marrow cell cultivation with prepared porous scaffold can be capable to create new dimension for bone regeneration and restoration in bio-medical field.

*Department of Physics, University of Dhaka

1.7 Synthesis, characterization, and performance evaluation of Fe_3O_4 nanoparticle as MRI contrast agent and hyperthermia

S. M. Hoque, F. M. Kamal, M. M. Haque, M. N. I. Khan, A. Mamun, H. N. Das, R. Rashid, S. I. Liba, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and F. A. Reete*

The objective of the work is to synthesis, characterization, and performance evaluation of Fe_3O_4 nanoparticle as MRI contrast agent and hyperthermia. Iron metal nanoparticles and superparamagnetic iron oxide nanoparticles were successfully synthesized by a novel, simple, synthesis method called chemical co-precipitation. The samples are a result of three batches created using co-precipitation method with dextran coating to achieve biocompatibility of Fe_3O_4NPs. X-ray diffraction (XRD) result indicated the presence of single-phase inverse spinel structure of Fe_3O_4 with a grain size of 13.98 nm determined by Scherrer's formula and lattice parameter was 8.394 Å. The actual size of the particle was measured by Transmission electron microscope (TEM) and it was 13 nm. Physical Property Measurement System (PPMS) was used to do Vibrating sample magnetometry (VSM) and the result confirmed the ferromagnetic nature of the prepared magnetite nanoparticles. It also confirmed that the prepared iron oxide nanoparticles are superparamagnetic in nature. The measured saturation magnetization was 60.7 emu/g with a coercivity of 96.14 Oersted. Dynamic light scattering technique (DLS) data at room temperature showed that the average hydrodynamic diameter of the coated particle was between 124.7 nm to 164.6 nm with a PDI range of 0.27 to 0.30 which was suitable for in vivo application. Fourier Transform Infra-Red (FTIR) spectroscopy of bare particle confirmed the presence of pure magnetite (Fe_3O_4) nanoparticles and the result of coated particle confirmed the presence of dextran on coated sample. Differential Scanning Calorimetry (DSC) analysis showed that the iron oxide nanoparticles glass transition temperature is around 240°C, crystallization temperature is almost about 450°C, melting temperature is about 557°C and crosslinking or oxidation is observed at approximate 614°C. Magnetic Resonance Imaging (MRI) data showed that, there is an increase in T_2 relaxivity with the use of Fe_3O_4 nanoparticles than that of without any contrast agent. There is a clear T_2 effect and a distinct increase in signal intensity in T_2- mapped images. Angiography results showed that there is a clear increase of negative image contrast in the images with Fe_3O_4 contrast agent.

*Department of Pharmacy, North South University

1.8 Effect of Ti^{4+} doping on structural, electrical and magnetic properties of $Ni_{0.4}Cu_{0.2}Zn_{0.4}Fe_{2-x}Ti_xO_4$ ferrites

F. M. Kamal, S. M. Hoque, M. N. I. Khan, H. N. Das, R. Rashid, M. R. Hasan, A. A. Begum, K. Hasan, A. Hossain, Z. Begum, N. Begum and U. H. Tanni*

The objective of the work is to effect of Ti^{4+} doping on structural, electrical and magnetic properties of $Ni_{0.4}Cu_{0.2}Zn_{0.4}Fe_{2-x}Ti_xO_4$ ferrites. In this study, Ti is substituted for Fe at the B-site of the lattice. The structural property is studied by X-ray diffraction method. The X-ray diffraction patterns of these compositions confirm the formation of the single-phase spinel structure. The lattice parameter calculated from XRD data is noted with increase in Ti^{4+} content. The values of bulk density, X-ray density and porosity are also calculated. The X-ray density is found to be higher than bulk density. The variation of bulk density and porosity is found in good agreement with each other. The values of porosity for different Ti contents are in the range 15-19%. The microstructural investigation using Scanning Electron Microscope shows that the grain size decreases with increase in Ti content expect for x=0.02. The grain size decreases from 18.9 μm to 10.9 μm. The magnetic properties are obtained from vibrating sample magnetometer (VSM) at room temperature. The coercivity

(H_c), saturation magnetization (M_s) and remanent magnetization (M_r) are calculated for different amount of Ti content. The saturation magnetization is found to be in good agreement with reported values.

*Department of Physics, University of Cumilla

1.9 Synthesis and magnetoelectric characterization of sr-substituted Ni-Zn ferrites

F. M. Kamal, S. M. Hoque, M. N. I. Khan, H. N. Das, R. Rashid, M. R. Hasan, A. A. Begum, K. Hasan, A. Hossain, Z. Begum, N. Begum and A.T. Trina*

The objective of the work is to Synthesis and magnetoelectric characterization of Sr-Substituted Ni-Zn Ferrites. Two secondary phases Sr_2FeO_4 and $SrFe_{12}O_{19}$ are present in the XRD pattern for higher concentration of Sr (0.15 and 0.02). An increase in lattice constant is observed with the increase of Sr^{2+} content in the lattice. The density of the samples is found to decrease whereas porosity increases with the substitution of Sr^{2+} ions. Microstructural investigation by using scanning electron microscope shows that the grain size is increased with the increase of Sr content, but the grain size is undermined for the sample with Sr x=0.05. The saturation magnetization is found to decrease with Sr content which is attributed to Neel`s two sub-lattice model of ferrites. The observed variation in Ms can be explained in terms of cation redistribution between A- and B- sublattices. Magnetic hysteresis is investigated at room temperature. All the samples exhibited lower coercivity values indicating that the materials belong to the class of soft ferrites. The dielectric constant decreases with increasing frequency exhibiting normal dielectric behavior of ferrites. Room temperature AC resistivity of the samples shows the significant dispersion with frequency. The electrical conduction in this ferrite is explained based on the hopping mechanism between the Fe^{2+} and Fe^{3+} ions on octahedral B-sites.

*Department of Physics, University of Cumilla

1.10 Influence of total absorbed dose of Co-60γ-radiation on the properties of h-MoO_3 thin films

M. N. I. Khan, S.M. Hoque, F.M. Kamal, A. Nahar, A. Parveen, A. A. Begum,K. Islam, N. Begum and S. K. Sen*

High energy radiations may alter the physical characteristics of these devices. In this context, studying the effect of gamma (γ-) radiation on relevant semiconductor thin films for devices is of paramount importance to ensure its optimum performances. In this research, the effect of high energy γ-radiation (with doses 50 kGy, 150 kGy and 250 kGy) on the properties of hexagonal molybdenum trioxide (*h*-MoO_3) thin films was thoroughly investigated. The enhanced crystallinity of the as-synthesized thin films was observed due to the reduction of defects and disorders. Interestingly, the identified hexagonal phase of the pristine film remained identical after high dose irradiation. Fourier transforms infrared (FTIR) spectra confirmed the hexagonal structure of MoO_3 films evidently before and after irradiation, although the peak intensities and wave numbers were found to vary slightly. With increasing γ-irradiation the band gap was shown to reduce from 2.92 to 2.84 eV as measured by UV-Vis-NIR diffuse reflectance spectrophotometer. The γ-irradiation has displayed a significant improvement in the degree of crystallinity and reduced the optical band gap without transforming the hexagonal phase of pristine nanocrystalline *h*-MoO_3 film.

*Department of Physics, Chittagong University of Engineering and Technology

1.11 Comparative study of specific loss power and transverse relaxivity of spinel ferrite nanoensembles coated with chitosan and polyethylene glycol

S. M. Hoque, F. M. Kamal, M. N. I. Khan, A. Mamun, H. N. Das, R. Rashid, S. I. Liba, M. R. Hasan, A. Nahar, A. Kumar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and M. K. Islam*

We synthesized spinel ferrite nanoensembles (MnFe2O4, CoFe2O4, and Fe3O4) using the chemical co-precipitation method and characterized their physical, chemical, and magnetic properties by X-ray diffraction (XRD), transmission electron microscopy (TEM), physical properties measurement system (PPMS), Mössbauer spectroscopy, Fourier transform infrared spectroscopy (FTIR), dynamic light scattering (DLS) and Raman spectroscopy. Their relaxation properties and potential for hyperthermia therapy were determined using nuclear magnetic resonance (NMR) and cell viability assay, respectively. XRD and TEM data confirmed that the particle core sizes were 6-9 nm before coating while their sizes increased to 10-14 nm and 14-20 nm after coating with chitosan and polyethylene glycol (PEG), respectively. Mössbauer spectroscopy

showed superparamagnetic behavior for MnFe2O4 nanoparticles and ferrimagnetic behavior for the CoFe2O4 and Fe3O4 nanoparticles. A detailed studies of MH loops of all three ferrites before and after coating showed surface functionalization by a large reduction of coercivity and anisotropy. The successful coating was further confirmed by the peak shifts in the FTIR spectra of the particles whereas Raman spectra of coated ferrites also displayed the characteristic absorption patterns and suppression of the ferrite peaks suggesting successful coating. The induced heating profile of the nanoparticles in stable suspension was tested with a radio frequency magnetic field of 76 mT and a frequency of 400 kHz. High mortality (>98%) of 9 L gliosarcoma cancer cells by hyperthermia suggested that these nanoparticles could be used for cancer therapy. Transverse relaxivities (r2) determined by NMR for chitosan-coated MnFe2O4, CoFe2O4, and Fe3O4 nanoparticles were 297 (±22), 353 (±26), and 345 (±13), mM−1S−1, while for PEG-coated nanoparticles are 165 (±22), 146 (±14), and 159 (±07) mM−1S−1, respectively. Overall, these spinel ferrite nanoensembles show great promise for cancer the theranostics research applications.

*Department of Electrical and Electronic Engineering, Islamic University Kustia

1.12 Effect of annealing temperature on the structural and optical properties of CdS thin films deposited by CBD

M. N. I. Khan, S. M. Hoque, M. M. Haque, A. Nahar, A. Parveen, A. A. Begum, K. Islam, N. Begum and E. M. K. I. Ahamed*

CdS thin films deposited by CBD offers ultrathin films along with the good structural, electrical and optical properties within a very low processing cost. CdS thin films were deposited by CBD technique and the as deposited films were annealed at 200°C and 400°C temperature under vacuum environment. The as deposited and annealed films were characterized by X-ray diffraction and UV-Visible near infrared spectroscopy. A comparative study of crystallographic and optical properties between the as deposited and annealed films were investigated. Analysis on structural and optical properties showed that the annealed CdS thin films offer much better crystallinity and less lattice defects as compared to the as deposited films. Near about 90% transmittance is achieved for the as deposited films and the optical transmittance is quite reduced for the annealed films and at the same time, the transmittance has increased slightly in the blue region at 400o C annealing temperature. Moreover, thinner (near about 100 nm) CdS layer can be fabricated by CBD with high transmittance enhances the possibility of applying this layer as buffer layer for high performance thin-film solar cell fabrication.

*Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology

1.13 Synthesis of cobalt ferrite-reduced graphene oxide nanocomposite as magnetic adsorbent for textile dye removal

M. A. Mamun, S. M. Hoque, M. M. Haque, A. Parveen, Z. Begum and G. C. Mallick*

The objective of the work is to Synthesis of Cobalt Ferrite-reduced Graphene Oxide Nanocomposite as Magnetic Adsorbent for Textile Dye Removal. This paper reports on the synthesis of cobalt ferrite-reduced graphene oxide ($CoFe_2O_4$-RGO) nanocomposite by hydrothermal method. The nanocomposite material has been characterized using various analytical techniques, including X-ray diffraction (XRD), Scanning electron microscopy (SEM), Fourier transform infrared (FTIR) spectroscopy, Raman spectroscopy, Thermogravimetric analysis (TGA) and Vibrating sample magnetometer (VSM) to demonstrate the successful attachment of cobalt ferrite nanoparticles to reduced graphene oxide sheets. The synthesis and characterization process were carried out at Materials Science Division, Atomic Energy Center Dhaka, Bangladesh Atomic Energy Commission. The cubic spinel structure of prepared $CoFe_2O_4$ nanomaterials was confirmed from the diffraction patterns. The distribution of $CoFe_2O_4$ nanoparticles on RGO sheets was confirmed from the SEM micrographs. The reduction of graphene oxide and the composite formation of $CoFe_2O_4$ nanostructures with RGO sheets was explored by using Raman spectroscopy and FTIR spectroscopy. The magnetic behavior of $CoFe_2O_4$-RGO nanocomposite was analyzed through the hysteresis loop. There are many functional groups in RGO which can make the composite suitable for dye removal purpose.

*Department of Physics Science Engineering and Technology School Khulna University

1.14 Effect of sintering treatment on the microstructure of $NiFe_2O_4$ synthesized by the sonochemical and the conventional method

S. M. Hoque, M. N. I. Khan, F. M. Kamal, H. N. Das, S. I. Liba, A. Parveen, A. A. Begum, K. Islam and N. Begum

The objective of the work is to Effect of sintering treatment on the microstructure of $NiFe_2O_4$ synthesized by the sonochemical and the conventional method. The sample was sintered at temperatures ranging from 1273 K to 1673 K for 3 h. XRD peaks of as-synthesized $NiFe_2O_4$, their Transmission Electron Microscopy (TEM), high resolution TEM, and selective area (electron) diffraction pattern demonstrate that the particles are in the completely crystalline state. The purpose was to compare the effect of sintering treatment on the microstructure quality of the $NiFe_2O_4$ prepared by these two techniques. Homogeneous coaxial grains did not form until 1573 K for conventionally prepared samples, while for the sonochemical method, homogeneous grains started to form even as low as 1373 K. Furthermore, other measurements were done only for the sintered samples prepared by the sonochemical method to evaluate the magnetic properties. An abrupt change in B-H loops was found with T_s for a maximum applied field of 1500 A/m. M-H loops with the maximum applied field of 1.6×10^3 KA/m and Mössbauer spectroscopy demonstrate that the samples are all at the ferrimagnetic stage. Curie temperatures T_c, determined from the temperature dependence of the initial permeability μ', for the same samples almost remained unchanged, which confirms that the cation distribution is almost unchanged with the variation of T_s.

1.15 Neutron imaging and tomography with medipix2 and dental microroentagenography: An overview

S. M. Hoque, F. M. Kamal, A. Nahar, A. Parveen, A. A. Begum, K. Islam, N. Begum and M. N. I. Khan

The objective of the work is to the Study of the Neutron Imaging and Tomography with Medipix2 and Dental Microroentagenography: An Overview. This overview confined to semiconductor detector Medipix2, neutron radiography and tomography and dental microroentgenography. Medipix2 is a pixel-based detector technology employed to measure charge particles, photons (visible through gammas) and neutron. Neutron Beam for this technology are LVR-15 Research Reactor (107 n/cm^2 s) and Spallation neutron source ($3\times106 n/cm^2$ s) .This technology has been verified with photograph and neutronogram of a relay and photograph and tomographic 3D reconstruction of a bullet cartidge, tooth and fishing thread. Comparison of spatial resolution among different imagers also has been presented.

1.16 Tailoring the properties of Ni-Zn-Cu ferrites by Gd^{3+}substitution

S. M. Hoque, M. N. I. Khan, S. I. Liba, A. Nahar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and M. D. Hossain

The objective of the work is to Tailor the properties of Ni-Zn-Cu ferrites by Gd^{3+} substitution. $Ni_{0.7}Zn_{0.2}Co_{0.1}Fe_{2-x}Gd_xO_4$ (x = 0.00, 0.02, 0.05, 0.07, 0.1 and 0.12) ferrites, were prepared by the standard solid-state reaction technique have been studied. The single phase of cubic spinel structure was confirmed by X-ray diffraction, lattice constant, bulk density and porosity were calculated. The FE-SEM examined the surface morphology of the prepared samples. Real and imaginary parts of the complex permeability and magnetic properties of the samples were measured using Impedance Analyzer and VSM respectively. Initial permeability decreases with increasing of Gd content up to x = 0.05 and then increases with Gd. The dielectric constant and dielectric loss tangent of the studied samples decreased with the increase of Gd concentration. The eddy current loss of the prepared samples is expected to decrease with the increase of Gd content due to increase in ac resistivity.

1.17 Biocomposites of synthetic polymer modified microcrystalline jute cellulose particles and their hemolytic behavior

S. M. Hoque, S. I. Liba, A. Nahar, A. Parveen, A. A. Begum, K. Hasan, N. Begum and M. A. Rabbi*

We synthesized the $MnFe_2O_4$nanoparticles by chemical co-precipitation method and controlled the particle size with different pH values of 9, 10, 11, and 12. The manganese ferrite at different particle sizes was characterized by X-ray diffraction (XRD), high-resolution transmission electron microscopy (HRTEM), energy dispersive X-ray spectroscopy (EDX), physical properties measurement system (PPMS), and

Mössbauer spectroscopy to determine different properties of nanoparticles which will focus on the preparation technique and it will also provide an overview of the structural and magnetic properties of manganese spinel ferrites. The XRD results obtained for manganese ferrite nanoparticles showed the formation of manganese ferrite nanoparticles with an average particle size are in good agreement with previously reported experiment results and displayed good magnetic properties. The crystalline sizes of XRD results are 5 to 15 nm. The lattice parameters calculated from the d-values clearly demonstrate the spinel structure of the ferrites. Bright field, dark field, selected area diffraction patterns, and high-resolution TEM (HRTEM) images demonstrate a low dimension of the particle size at the nanometer scale and very good crystallinity. From the PPMS results, maximum magnetization was found as 11 to 66 emu/gm at 5 K whereas the maximum magnetizations were 8 to 41 emu/gm at 300 K temperature for all samples of pH 9 to 12 with an applied field of 5 Tesla. The Mössbauer results confirmed the doublet pattern and therefore dominated by the superparamagnetic nature of these samples. However, $CoFe_2O_4$ shows pure ferromagnetic behavior. Both cobalt and manganese ferrite nanoparticles of different particle sizes were coated with a biocompatible and biodegradable polymer namely chitosan (CS) to study the applications of those nanoparticles of different sizes and their effect as MRI contrast agent and magnetic fluid hyperthermia.

*Department of Physics, Islamic University

1.18 Synthesis and analysis of the influence of Eu^{3+} on the structural, ferromagnetic, dielectric and conductive characteristics of $Ni_{0.4}Zn_{0.45}Cu_{0.15}Fe_{(2-x)}Eu_xO_4$ composites using conventional double sintering ceramic method

M. N. I. Khan, S.M. Hoque, F.M. Kamal, S. I. Liba, A. Parveen, A. A. Begum, K. Islam, N. Begum and S. Khatun*

The objective of the work is to the study of the synthesis and analysis of the influence of Eu^{3+} on the structural, ferromagnetic, dielectric and conductive characteristics of $Ni_{0.4}Zn_{0.45}Cu36+0.15Fe_{(2-x)}Eu_xO_4$ composites using conventional double sintering ceramic method. A series of Eu substituted $Ni_{0.4}Zn_{0.45}Cu_{0.15}Fe_{(2-x)}$ Eu_xO_4 (NZCFEO) ferrites with x = 0.00, 0.02, 0.04, 0.07, 0.10, 0.12, 0.15 has been prepared by double sintering ceramic method. X-ray diffraction peaks confirm the single-phase cubic spinel structures of all the samples. The lattice parameter is found to be distorted with the addition of Eu into the samples. X-ray density and bulk density increase with the increase of Eu content. Better crystallization has been obtained with the decreasing porosity as a result of increasing Eu^{3+} concentration. The dielectric constant of the samples shows a decreasing trend while both AC and DC resistivities are observed to increase with the increase of Eu^{3+} concentration. The high resistivity offers greater value of the activation energy.

*Dept of Physics, Jagannath University

1.19 Enhanced dielectric properties of bismuth doped barium titanate ceramics with their structural and compositional studies

M. N. I. Khan, S.M. Hoque, F.M. Kamal, M. M. Hoque, H.N. Das, A. Parveen, A. A. Begum, K. Islam, N. Begum and A. Nahar

The objective of this research work is to study the dielectric properties of Bismuth Doped Barium Titanate Ceramics. Several strategies have been employed to tune the functional properties of environmentally friendly Barium titanate (BaTiO3). In this work, bismuth (Bi) doped BaTiO3 with a general formula Ba1-xBi2x/3TiO_3 (where x = 0.00, 0.01, 0.02, 0.03, 0.04, 0.05 and 0.06) were prepared by the conventional solid-state reaction method. The effect of Bi on the structure of BaTiO3; and their morphological and compositional studies were carried out by X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM), and Energy Dispersive X-ray (EDX) respectively. Furthermore, the effect of Bi on the transport properties of $BaTiO_3$ was investigated. Our studies revealed that for x = 0.01, Bi doping gives rise to the highest tetragonality of the crystal with more homogeneous grains and pores distribution among all the doping concentration. Furthermore, the dielectric constant for x = 0.01 samples has been observed to be the highest, which is consistent with the structural and morphological studies. Also, the tetragonal to cubic phase transition temperature (Curie temperature) of the sample is found to increase with increasing Bi doping concentration. Our studies suggest that the higher value of the dielectric constant with higher Curie temperature can be obtained by a small amount of Bi doping (x = 0.01), which has potential applications in various electronic and energy storage devices.

2. Seminar/Symposium/Conference/Workshop Attended

Name of the person	Title of the event	Organizer	Date	Place
Dr. Engr. Sheikh Manjura Hoque	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Engr. Faizul Mohammad Kamal	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Dr. Md. Mahbubul Haque	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Dr. Mohammad Nazrul Islam Khan	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Dr. Md. Al-Mamun	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Dr. Harinarayan Das	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Dr. Engr. Rimi Rashid	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Samia Islam Liba	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Md. Razibul Hasan	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Arijun Nahar	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, University of Dhaka
Arup Kumar	International e-Conference on Physics, 2021	BPS	5-7 Feb. 2021	BPS FOP, USA, DU

3. Training Courses and Seminars Organized

Speaker	Title of the event	Date	Place	No. of participent
Dr. Engr. Sheikh Manjura Hoque	$Fe_xCo_{1-x}Fe_2O_4$ nanoparticles used as MRI contrast agent and cancer drug delivery	19 Sep. 2019	MSD, AECD	12
Dr. Engr. Sheikh Manjura Hoque	An Expedition for the Grant Application 2020-2022	29 Sep. 2019	MSD, AECD	12
Dr. Engr. Sheikh Manjura Hoque	A visit for the Grand Application, 2020-2022	7 Oct. 2019	MSD, AECD	10

4. Collaboration Work(s)

- To improve the research quality, Materials Science Division is involved with a collaboration work on Magnetic and structural properties of Ferrites, Nanocomposites and Perovskite Materials with International Program for Physical Sciences (IPPS) under International Science Program of Uppsala University, Sweden.
- On the other hand, to help in the development of manpower, this division is involved with the preparation of question paper, evaluation of examination paper, evaluation of thesis paper in the level of M.S./M.Phil. /Ph.D. at different public Universities in the country.
- This division is also involved with the collaboration research work with different public and private Universities in the country.

5. Service Rendered and Revenew Income

Name of service provided	Number of samples	Revenue income
Service Provided by XRD	46	2,76,000/-
Service Provided by SEM and EDAX	35	1,05,000/-
Service Provided by UV	8	1,600/-
Service Provided by DLS	12	18,000/-
Service Provided by ASS	3	6,000/-
Service Provided by FTIR	100	50,000/-
Service Provided by DSC/TGA	21	31,500/-
Service Provided by PPMS	21	84,000/-
Service provided by TEM	4	20,000/-
Service Provided by Zeta Potential	15	22,500/-
Service Provided by Raman Spectroscopy	12	24,000/-
Total	277	6,38,600/-

Medical Physics Division, AECD

Objective/Introduction

- To develop qualified medical physics professionals with instrumental and clinical knowledge.
- To provide medical physics expert services in hospitals over the country to manage cancer patients.

Programe

- To develop well-qualified medical physicists (QMPs) and nuclear medicine technologists.
- To facilitate research work leading to MS/MPhil/PhD degrees and post doctoral research works with the affiliation of different Universities.

Activities

1. Research and Development Work(s)

1.1 Dosimetric verification of radiotherapy treatment planning system using thorax phantom

R. Khatun and S. Akter

Quality Assurance (QA) in radiotherapy treatment planning process is essential to ensure that the dose calculation is performed correctly and to minimize the patient exposure. The study was conducted at radiotherapy department in Delta Hospital, Dhaka using CIRS Thorax 002 LFC (CIRS Inc., Norfolk, Virginia) phantom. IAEA protocol given in TECDOC 1583 was followed to perform the study. The phantom was scanned twice in each hospital using a CT. For the first scan the reference plugs with different known material properties were inserted into the holes in the phantom to check CT numbers to the RED (Relative Electron Density) conversion curve. The second scan was done without reference plugs and was used for the planning of clinical test cases as defined in the TPS audit exercise.The acceptance criterion for the difference between the stored and measured values of CT numbers for the same RED was ± 20HU.

All systems reviewed in this study had generic or TPS manufacturer supplied CT to RED conversion curves. Based on the measurements, we concluded that there were differences of 6-12% in the region of higher electron densities. However, it was estimated that this difference in relative electron density affects dose calculation accuracy less than 2%.

1.2 Absolute dosimetry of medical linear accelerator using water phantom measurement

S. Akter and R. Khatun

Absolute dosimetry for photon energies of a Medical Linear Accelerator was determined using the standard protocol of IAEA Technical Report Series (TRS-398). Beam data were obtained for 1D water phantom with

farmer chamber (FC 65-P) for 6MV and 15MV photon beam generated from Medical Linear Accelerator (Clinac iX, Varian) of Institute of Nuclear Medical Physics (INMP), Bangladesh Atomic Energy Commission. The machine was tuned to deliver 1 cGy/MU at SSD technique at D_{max} for all the available photon energies. The measurements were done using the Source to Surface Distance (SSD) technique at 10 cm depth with 10x10 cm^2 field size. Beam quality index were measured for two photon energies using the Tissue Phantom Ratio $TPR_{20,10}$ and correction factor K_Q values are taken from IAEA TRS-398. The electrometer readings were corrected for temperature-pressure, polarity and recombination effect. The corrected meter readings were multiplied with the calibration factor provided by the secondary standard dosimetry laboratory (SSDL) and also with K_Q values. The beam quality parameters of the available photon beams were within the Varian acceptance tolerance limit.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. R. Khatun	Application of IMRT Thorax Phantom	AECD	28 Jan. 2021	AECD
S. Akter	Absolute Dosimetry Measurement of Photon Beam of Medical Linear Accelerator	AECD	7 Feb. 2021	AECD

3. Collaboration Work/MoU

Medical Physics Division gives up the necessary support of Annual Development Project (ADP) of the Ministry of Science of Technology (MOST), Establishment of PET/CT and Cyclotron facility at INMAS Mymensingh and Chattogram and Cyclotron facility at Institute of Nuclear Medical Physics (INMP), Savar, BAEC.

4. Others

Lecture delivered on FTC training course on "Nuclear and Radiological Emergency Preparedness Course at BAEC (NREPCB-9)-2020.

Non-Destructive Testing Division, AECD

Objective

Non-Destructive Testing (NDT) Division has been working as an excellent centre for R and D, acquisition and dissemination of knowledge and technology on NDT in the country. Since its inception, NDT Division has been working with right earnest to develop and promote the science and practice on NDT and its industrial application in Bangladesh having the objective of reducing foreign dependency and to make Bangladesh self-reliant on NDT technology for facilitating its socio-economic development.

Activities

1 Research and Development Work(s)

1.1 Development of technical working procedures of NDT methods

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam, M. A. Habib, S. C. Dey, A. Rahim, K. Alam, M. A. M. Islam and R. Pritom

To control and maintain the quality of industrial products and to assure reliability to the users, it is required to use NDT applications in all stages of processes for the uninterrupted operation of the industrial components. Considering the demands of the industries and to make these industries benefit and productive, NDT Division is continuing its application based R & D programs. For this purpose the detailed technical working procedures of both conventional and advanced NDT methods like Radiographic, Ultrasonic, Magnetic Particle, Liquid Penetrant and Remote Visual Inspection have been developed to solve various technical problems exists in industries.

Depending on the geometry, dimension, orientation of the components, service condition, anticipated defect nature in the component and applicable codes and standards, the working procedures were developed for the inspection of different equipment used in various industrial sectors viz. Power Plant, Steel Structure etc.

1.2 Corrosion evaluation and wall thickness measurement in insulated pipes by tangential radiography

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam, M. A. Habib, S. C. Dey, A. Rahim, K. Alam, M. A. M. Islam and R. Pritom

The scope of this work is to evaluate the corroded zones and to measure wall thickness of insulated pipes in order to make a correlation directly in assessing the remaining life time of power plants, petroleum and petrochemical industries etc. without removing specially insulations from the metal part so that the cause of accident due to fire and leaks, low production or unpredictable shutdown of plants can be minimized.

An attempt has been taken to develop a standard protocol for method validation to be utilized to determine remaining wall thickness of the pipe creating grooves of different depths on the external surface.

1.3 Development of eddy current testing technique for heat exchanger tube

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam, M. A. Habib, S. C. Dey, A. Rahim, K. Alam, M. A. M. Islam and R. Pritom

Eddy Current Testing Method has been using as a quality control tool for the inspection of numerous engineering components particularly the ferromagnetic and non-ferromagnetic Heat Exchanger Tubes, Feed Water Heater Tubes, Condenser Tubes, Air Conditioner Tubes etc. of Petrochemical Industries. A program on the above topic has been taken whose objective is to interpret the signals arising from different known defects and finding the better response of a defect at a particular frequency by utilizing Multi Frequency Eddy Current Testing Equipment - MS 5800 with Multiview 6.0R software.

Few experiments have been performed with the MultiScan MS 5800 Multi Frequency Eddy Current equipment having options to use 4 frequencies simultaneously. For this investigation, Stainless Steel tube having artificial defects of different volumes was analyzed experimentally.

1.4 Digital industrial radiographic method for industrial practices

M. F. H. Chowdhury, M. S. Alam, M. N. N. Alam, M. A. Habib, S. C. Dey, A. Rahim, K. Alam, M. A. M. Islam and R. Pritom

The scope of this work is to make the digital image of an object onto the imaging plate by the ionizing radiation and processing the image with the aid of appropriate computer facility in order to enhance their contrast and spatial resolution and to sharpen and smoothen their edge definitions for analysis of object structures.

Using X-ray Source Digital image of metal samples were analyzed to assess the integrity by adjusting different parameters available in the I See! Software.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the person	Title of the event	Organizer	Date	Place
Md. Ahasanul Habib Sanjoy Chandra Dey and Rafiuzzaman Pritom	Webinar on "Radiation Protection Optimization in Industrial Radiography"	AFAN and IAEA	14 Apr. 2021	Virtual Platform CISCO
Khorshed Alam	Webinar on "Radiation Protection Optimization in Industrial Radiography"	AFAN and IAEA	14 Apr. 2021	Virtual Platform CISCO
	Training on "Fire Fighting, Fire Prevention, Rescue and First Aid Training"	Bangladesh Fire Service and Civil Defence Directorate and AECD	24- 25 Feb. 2021	AECD
M. A. Mohaiminul Islam	Webinar on "Radiation Protection Optimization in Industrial Radiography"	AFAN and IAEA	14 Apr. 2021	Virtual Platform CISCO
	Training on "Fire Fighting, Fire Prevention, Rescue and First Aid Training"	Bangladesh Fire Service and Civil Defence Directorate and AECD	24- 25 Feb. 2021	AECD

3. Collaboration Work(s)

3.1 IAEA Projects

Strengthening Regional Capacity in Non-Destructive Testing and Examination Using Nuclear and Related Techniques for Safer, Reliable, More Efficient and Sustainable Industries Including Civil Engineering (RCA) (RAS1022).

3.2 Lecture delivered

- Basic NDT Training for BAF Officers, organized by the "Flight Safety Institute", Dhaka of Bangladesh Air Force (BAF). Besides the participants from Bangladesh Air Force and Bangladesh Navy.
- Lectures on different NDT methods to the 10th Aircraft Accident Investigation Course, organized by the Flight Safety Institute, Dhaka of Bangladesh Air Force (BAF). A total of 7 participants from Bangladesh Air Force, Bangladesh Navy, Nigerian Air Force and Sri Lanka Air Force were present in this course.

3.3 Inspection of the Manufacturing of LTME for the construction of Rooppur Nuclear Power Plant

Rooppur Nuclear Power Plant (RNPP), the first nuclear power plant of Bangladesh is being constructed by the Government of the People's Republic of Bangladesh at Rooppur, Pabna in collaboration with Russian Federation. Considering the demands of the RNPP project NDT Division has been involved to ensure safety, reliability and integrity of the power plant. As the requirement of RNPP project the following experts of NDT Division were deployed at various Nuclear Power Plant Equipment Manufacturing Plants located at different region of Russian Federation to attend the inspection of the manufacturing of Rooppur Nuclear Power Plant.

Name of person	Duration	Place
M. F. H. Chowdhury	25 Aug. 2020 -till now	Petrozavodsk and Saint Petersburg, Russia
M. S. Alam	25 Aug. 2020 -till now	Volgadon, Russia
M. N. N. Alam	25 Aug. 2020 - 17 Mar. 2021	Saint Petersburg, Russia
M. A. Habib	20 Feb. - 31 Aug. 2020	Saint Petersburg, Russia
	25 May 2021 - till now	Petrozavodsk, Russia

4. Service Rendered and Revenue Income

Name of service given to the organization	Nature of service	No. of service	Revenue income
Advanced Technique and Inspection Company Ltd	• Calibration of Ultrasonic Flaw Detector • Calibration of Electromagnetic Hand Yoke • Calibration of Ultrasonic Thickness Gauge	2 1 2	12,000/-
Deya Oil Ltd	• Calibration of Ultrasonic Thickness Gauge	1	2,000/-
Rifat Enterprise	• Calibration of Ultrasonic Thickness Gauge	2	4,000/-
Bay-Tech NDT and Engineering Services	• Calibration of Ultrasonic Thickness Gauge • Calibration of Ultrasonic Flaw Detector	1 1	5,000/-
2 Times to Biztech Business Ltd	• Dye Penetrant Testing of Bracket Welding Joints of IPCO Development Ltd	1 (2 Times)	2,000/-
IES - Industrial Engineering Services	• Calibration of Ultrasonic Flaw Detector • Calibration of Electromagnetic Hand Yoke	1 2	7,000/-
Solution NDT and Inspection Services	• Calibration of Ultrasonic Flaw Detector • Calibration of Ultrasonic Thickness Gauge	1 1	5,000/-

Name of service given to the organization	Nature of service	No. of service	Revenue income
PEB Steel Alliance LTD	• Calibration of Ultrasonic Flaw Detector • Calibration of Ultrasonic Thickness Gauge	1 1	5,000/-
Innovative Engineering Services	• Calibration of Ultrasonic Thickness Gauge	1	2,000/-
Bangladesh Industrial X-ray	• Calibration of Ultrasonic Flaw Detector • Calibration of Electromagnetic Hand Yoke • Calibration of Permanent Magnetic Yoke • Calibration of Ultrasonic Thickness Gauge • Calibration of Industrial Radiographic Film Densitometer	3 3 2 2 3	26,000/-
Sonargaon Steel Fabricate Ltd.	• Calibration of Ultrasonic Flaw Detector	1	3,000/-
Basundhara Steel and Engineering Ltd.	• Calibration of Ultrasonic Flaw Detector • Calibration of Ultrasonic Thickness Gauge	1 1	5,000/-
Confidence Steel Limited	• Calibration of Ultrasonic Flaw Detector	1	3,000/-
NDE Steel Structures Limited	• Calibration of Ultrasonic Flaw Detector • Calibration of Ultrasonic Thickness Gauge • Calibration of Electromagnetic Hand Yoke • Calibration of UV Black Light System	1 1 1 1	8,000/-
4 times to Saj Engineering and Trading Company	• Ultrasonic Testing of Shaft • Calibration of Electromagnetic Hand Yoke • Magnetic Particle Testing of Turbines (GT-1 and GT -2 each of Model: 94.2, Siemens) of Meghnaghat Power Ltd • Magnetic Particle Testing of Turbines (Model: SGT 4000F, Siemens) of Ashuganj Power Station Company Ltd (APSCL) [North Part] • Magnetic Particle Testing of Turbines (Model: SGT 4000F, Siemens) of Ashuganj Power Station Company Ltd (APSCL) [South Part]	1 1 22 man day 4 man day 10 man day	7,50,650/-
Universal Marine Consultants	• Calibration of Ultrasonic Thickness Gauge	1	2,000/-
Western Marine Services Ltd.	• Calibration of Ultrasonic Flaw Detector	1	3,000/-
Q and T Industrial Inspection Company	• Calibration of Ultrasonic Flaw Detector • Calibration of Ultrasonic Thickness Gauge • Calibration of Electromagnetic Hand Yoke • Calibration of UV Black Light System • Calibration of White Light Meter	2 1 2 1 1	14,000/-
FBA Marine Ltd.	• Calibration of Ultrasonic Thickness Gauge	1	2,000/-
MARS Engineering Services	• Calibration of Ultrasonic Thickness Gauge	2	4,000/-

Name of service given to the organization	Nature of service	No. of service	Revenue income
Radiant Engineering Training Services and Inspection Ltd	• Calibration of Ultrasonic Flaw Detector	1	3,000/-
Z.S. Gauging House	• Calibration of Ultrasonic Thickness Gauge	1	2,000/-
Total			8,69,650/-

Accelerator Facilities Division, AECD

Objective/Introduction

The objectives of this Division are (a) to operate and maintain the 3 MV Van de Graaff Accelerator and its associated sub-systems (b) to enrich the Ion Beam experimental facilities (c) to utilize the Ion Beam for research and development works in the field of health, environment, agriculture and industry. (d) to enrich and operate the 'Gamma Spectroscopy System', detection and analysis of radionuclides in different specimens.

Activities

Accelerator Facilities Division of the Atomic Energy Centre, Dhaka operates and maintains the 3 MV Van de Graaff Accelerator and its associated sub-systems, which is capable of producing and accelerating proton beam in the range of nano to micro-amperes. The proton beam and associated facilities are being utilized for elemental analysis of environmental, health, biological, agricultural and industrial specimens. This division has also been developed a 'Gamma Spectrometry System' using existing HPGe detector, Lead shielded chamber, spectroscopy amplifier, MCA and with other associated electronic circuitries. The system is being used for the detection and analysis of radiological substances, their activities in various specimens of the earth surface and the products.

Research and Development Work(s)

1. Operation and management of the 3 MV VDG accelerator and gamma spectrometry system

M. J. Abedin, M. M. Rahman, S. Easmin and L. Hossain

Objective: The main objective is to keep the accelerator operational, to produce and accelerate the proton beam for research purpose. Radionuclides detection by Gamma Spectrometry System and analysis the spectrum data using Gene-2000 software.

Current progress: Detection and analysis of radiological substances accumulated in different specimens collected from coalmine and waterfall areas, imported and locally produced powder milk, and vegetable samples from local market using 'Gamma Spectrometry System' of Accelerator Laboratory of AECD. The VDG Accelerator is operational. According to the user's demand, the accelerator is to operate, produce and accelerate the proton beam for irradiation of different specimens. For quantitative measurements of both the essential and toxic elements of foodstuff like vegetables, fruits and milk samples. Specimens collected from Cox's Bazar Sea Beach area, medicinal plants, soil and vegetables have been dried, ground and prepared as pellets and irradiated the pellets by proton beam of 10 to 15nA.

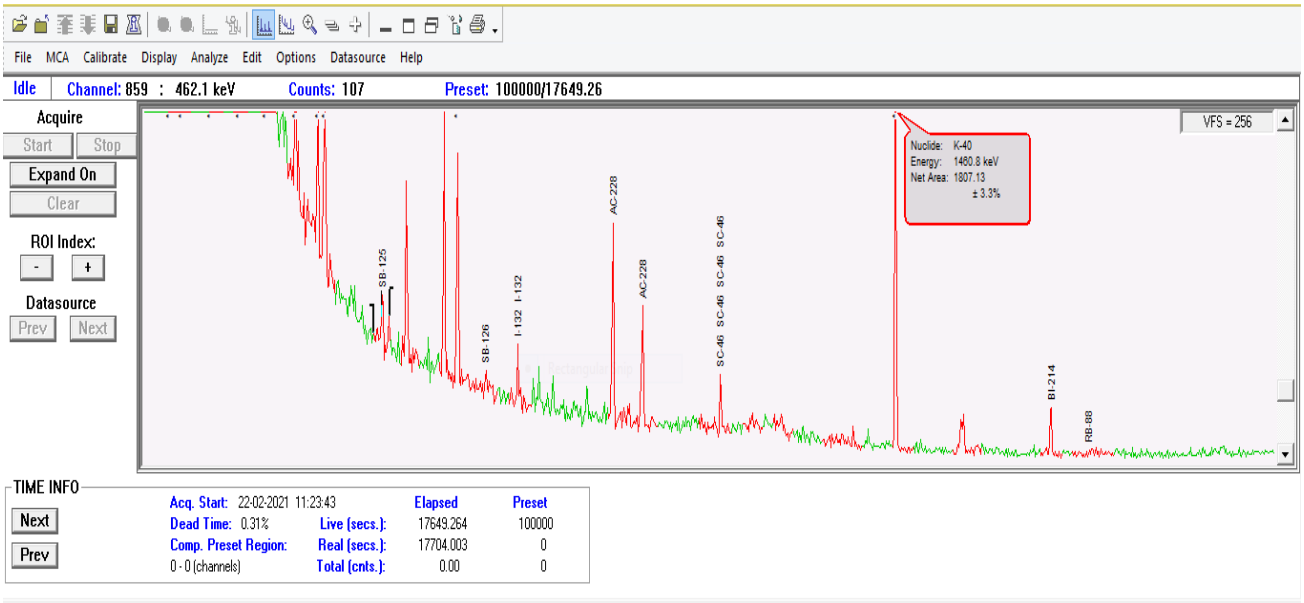
The students of different universities have been done their thesis experiments for MS, MPhil and PhD degrees using 'Gamma Spectrometry' technique with the collaboration of VDG Accelerator laboratory.

2. Radionuclides detection, analysis and pollution level assessment of soil of Cox's Bazar sea beach area

M. J. Abedin, M. Rahman and A. Rahman*

Objective: The goal of the research works is to detect and analysis the radiological substances accumulated in Cox's Bazar Sea Beach area and to assess the pollution level by getting sufficient information for the evaluation of their impacts on the environment as well as on living beings.

Current progress: Twenty different soil specimens were collected, processed and taken under gamma experiments for the detection of radiological substances accumulated somehow. Cox's Bazar Sea Beach is a tourist crowded place, probability of radiological contamination is risky for the visitors. The collected soil samples were 1000gm each. Each of the specimens was taken under gamma experiments about 17000 seconds for data acquisition. The gamma energies emitted from the radionuclides present in samples were detected by the HPGe detector, amplified and processed by MCA unit. Data acquisition and spectrum data analysis were done according to the energy lines of different radionuclides by Genie-2000 software. The detected energy lines of different radionuclides and a part of results of one of the soil samples is projected here:



	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	6-	42	23.29	13.60	0.54	-5.818E+06	12795.0	8.484E+06
M	2	120-	179	137.76	75.02	4.54	2.590E+03	112.64	1.297E+04
m	3	120-	179	158.86	86.35	4.61	1.516E+03	102.19	1.422E+04
	4	321-	355	344.40	185.91	1.14	-5.492E+01	290.58	1.572E+04
	5	434-	466	443.94	239.33	2.26	3.112E+03	220.66	8.850E+03
	6	540-	566	549.23	295.83	2.23	7.698E+02	147.23	4.773E+03
M	7	618-	665	629.61	338.97	2.09	4.420E+02	40.03	1.960E+03
m	8	618-	665	654.77	352.47	2.13	9.106E+02	45.77	1.645E+03
	9	851-	872	861.33	463.32	1.67	1.459E+02	82.97	1.789E+03

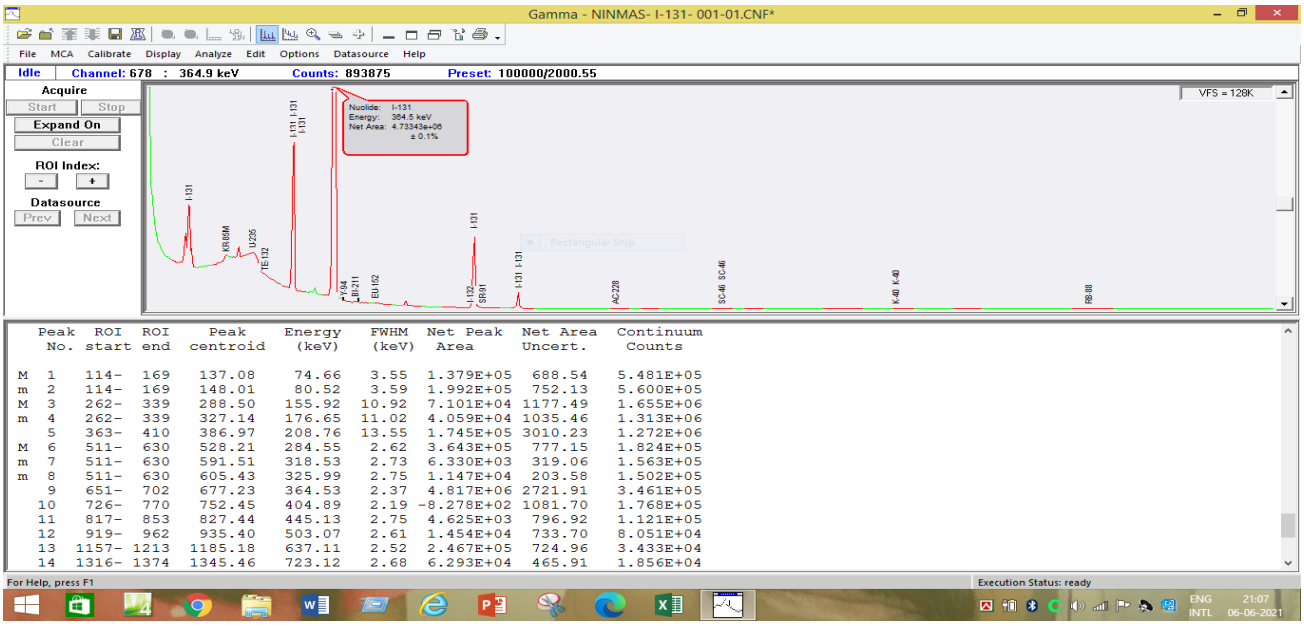
*Department of Soil, Water and Environment, University of Dhaka

3. Assessment of ^{131}I radioisotopes, its energy lines and disintegration process using gamma spectrometry system

M. J. Abedin, M. Rahman and M. S. Islam*

Objective: The objective of this research work is to study the energy lines of ^{131}I radioisotopes, its half-life and decreasing process of activity.

Current progress: ^{131}I radioisotope used injection syringe were collected from NINMAS in a lead shielded box and kept it in another lead shielding of Accelerator laboratory, AECD. Carefully, it was set in the gamma experiment chamber and the data acquisition started. The data acquisition of gamma experiments, spectrum data collection and analysis was controlled by Genie-2000 software. Five different energy lines were detected and projected in spectrum data. The half-life of ^{131}I radioisotope is eight days and upto ten half-lives were taken under consideration for data acquisition. The energy lines and a part of analyzed data is shown below;



A PhD thesis will be submitted to the Department of Physics, Jahangirnagar University under this research program.

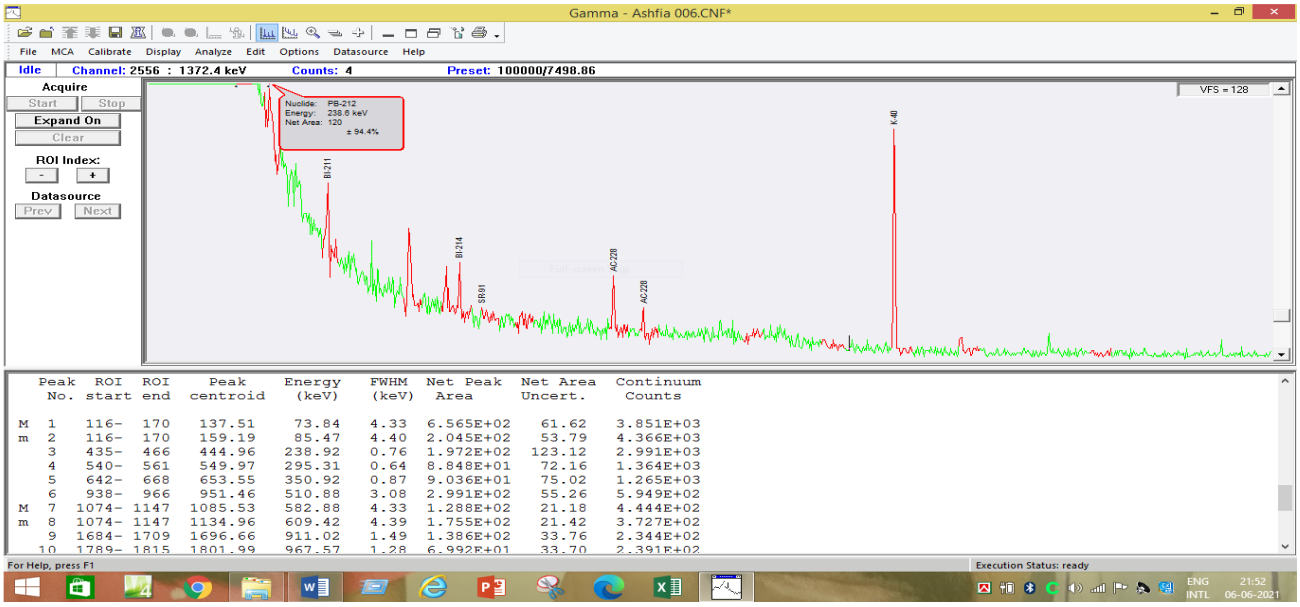
*Department of Physics, Jahangirnagar University, Savar

4. Analysis of radiological contamination of baby food powder milk collected from local market using 'gamma spectrometry technique

M. J. Abedin, M. Rahman and A. Rahman*

Objective: The main objective of this research work is to analyze the radiological substances contain in baby food powder milk available in the local markets and their impacts.

Current progress: Different types (brands) of powder milk were collected from local market and each of the packet was 500gm. Accordingly, the packet is being set in the experiment chamber, started the acquisition, collected gamma spectrums and analyzed the data files using commercial software Genie-2000. One of the analyzed spectrum data has been projected bellow.



M.Sc. Engineering thesis will be submitted under this program to the department of Nuclear Science and Engineering, MIST, Dhaka.

*Department Nuclear Science and Engineering, MIST, Dhaka

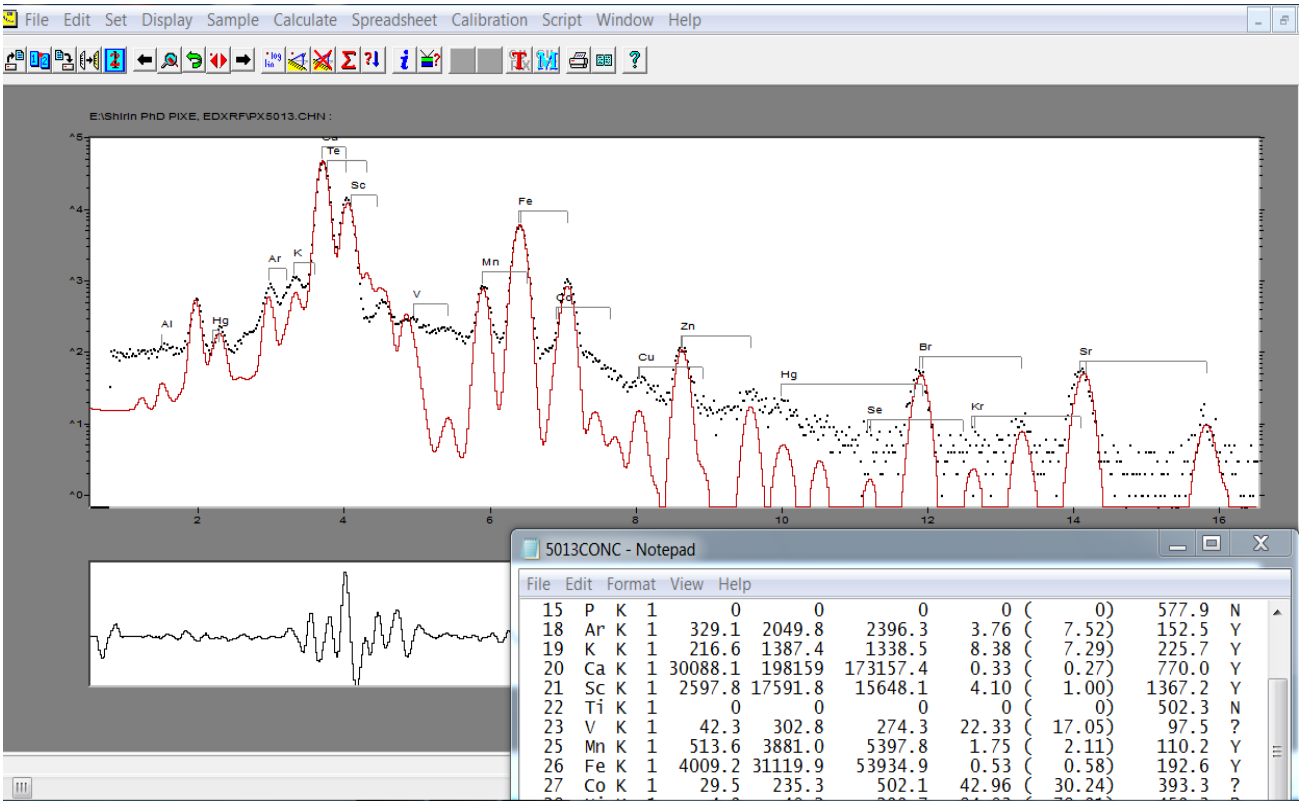
5. Elemental assessment of vegetables grown in Bangladesh using PIXE technique

S. Akter, L. Hossain and M. J. Abedin

Objective: The objective of this research work is to analyze the elemental concentration for the assessment of pollution level due to heavy metal contamination.

Current progress: Different vegetable samples **w**ere collected directly from the field, dried, ground and made as pellets (7mm diameter and 1mm thick). The pellets were being irradiated by 2.4 MeV proton beam and with the beam current of 10 to 15 nA. The data acquisition were done by PIXE technique controlled by MAESTRO-32 software. The spectrum data files were analyzed using GUPIX/DAN-32 software for pollution assessment.

Analyzed spectrum and data table of one of the vegetable samples (Kachu Shak)



Analyzed data table of a vegetable specimen (Kachu shak)

Element	Concentration (µg/gm)	Stati. errors (%)	LOD
Al	160	57.44	167.70
Ar	2396.3	3.76	152.5
K	1338.5	8.38	225.7
Ca	173157	0.33	770.0
Sc	15648	4.10	1367
V	274.3	22.33	97.5
Mn	5397.8	1.75	110.2
Fe	53935	0.53	192.6
Co	502	43	393
Ni	391	47.75	325.90
Cu	189	89.52	307.60

Element	Concentration (µg/gm)	Stati. errors (%)	LOD
Zn	7376	3.71	299.80
As	119	140.28	318.10
Br	29917	2.17	513.60
Kr	519	49.89	447.90
Sr	7158	8.57	774.40
Ag	554	37.10	542.70
Te	27074	6.79	3970.20
I	4055	23.39	1621.40

A manuscript has been written using analyzed spectrum and data of vegetable samples

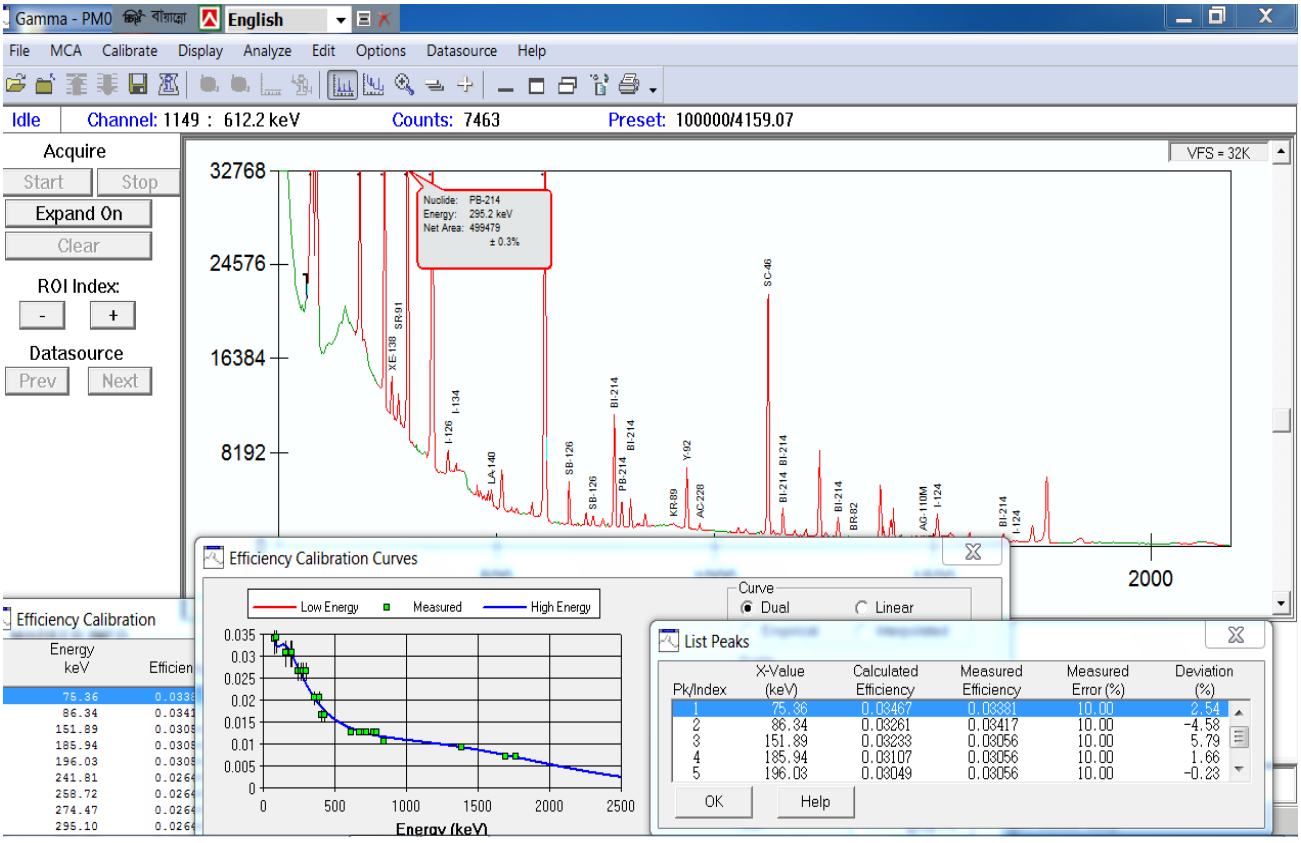
6. Characterization of ^{226}Ra point source and analysis its daughter radionuclides

M. J. Abedin, Y. N. Jolly, S. Akter and M. S. Islam

Objective: The main objective of the research work is to assess the disintegrations and the product of daughter radionuclides.

Current progress: The 'Gamma Spectroscopy' data acquisition setup is being calibrated using ^{137}Cs and ^{60}Co point sources. ^{226}Ra (Initial activity= 370 kBq was taken under gamma experiments about 7200 seconds. The energies emitted from ^{226}Ra is being detected and analyzed by Genie-2000 software. The efficiency calibration of the detector has been also done using emitted gamma energy lines. The efficiency curve, calculated efficiency table, decay process and daughter radionuclides with their half-lives are shown;

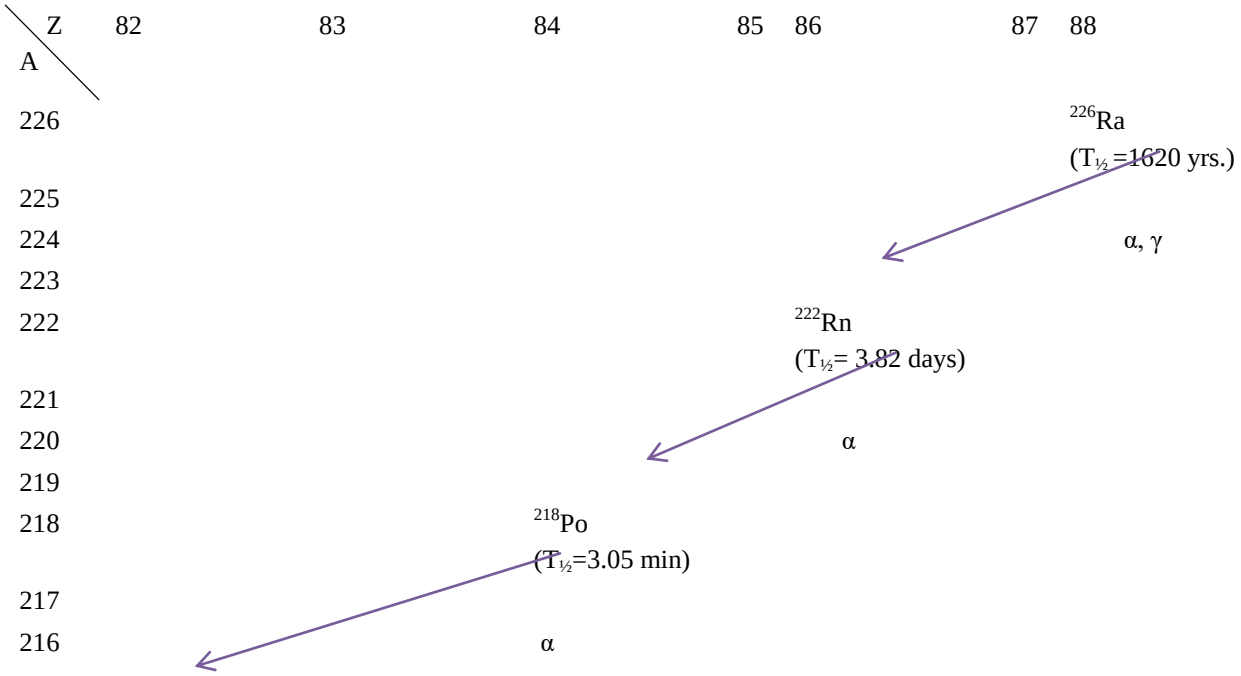
Efficiency curve obtained for ^{226}Ra characterization

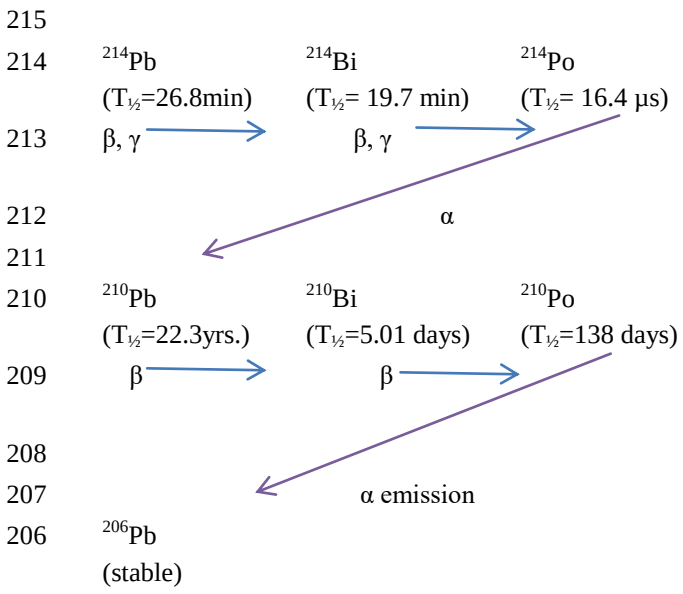


Calculated efficiencies

Gamma energy line (keV)	Calculated efficiency	Measured efficiency (certified)	Measured error (%)	Deviation (%)
75.36	0.03467	0.03381	10.00	2.54
86.34	0.03261	0.03417	10.00	-4.58
151.89	0.03233	0.03056	10.00	5.79
185.94	0.03107	0.03056	10.00	1.66
196.03	0.03049	0.03056	10.00	-0.23
241.81	0.02746	0.02649	8.00	3.65
258.72	0.02628	0.02649	8.00	-0.79
274.47	0.02520	0.02649	8.00	-4.88
295.10	0.02387	0.02649	8.00	-9.90
351.87	0.02065	0.02036	8.00	1.45
388.34	0.01900	0.02036	8.00	-6.69
406.02	0.01829	0.01654	8.00	10.59
422.72	0.01768	0.01654	8.00	6.89
609.63	0.01343	0.01260	6.00	6.58
665.86	0.01275	0.01260	6.00	1.19
703.71	0.01237	0.01260	6.00	-1.85
720.20	0.01222	0.01260	6.00	-3.01
768.99	0.01186	0.01260	6.00	-5.91
786.64	0.01174	0.01260	6.00	-6.82
839.84	0.01142	0.01049	6.00	8.91
1378.80	0.00908	0.00910	4.00	-0.21
1691.79	0.00724	0.00699	4.00	3.52
176076	0.00678	0.00699	4.00	-3.02

Main γ-energies of ^{226}Ra decay chain in radioactive equilibrium with its daughters





Recommended energy lines, half-life and AE/decay, daughter nuclides of ^{226}Ra

Energy lines (keV)	Daughter nuclides	Half-life	Absolute emission/decay
75.36	^{212}Pb	10.64 hrs.	0.1077
185.94	^{222}Rn	3.82 days	0.0328
186.21	^{226}Ra	1600 yrs.	0.0351
241.81	^{214}Pb	26.8 min	0.0900
258.72	^{214}Pb	26.8 min	0.0055
274.47	^{214}Pb	26.8 min	0.0033
295.10	^{214}Pb	26.8 min	0.1970
351.87	^{214}Pb	26.8 min	0.3890
388.34	^{214}Bi	20.0 min	0.0041
406.02	^{214}Bi	20.0 min	0.0017
609.63	^{214}Bi	20.0 min	0.4330
665.86	^{214}Bi	20.0 min	0.0125
703.71	^{214}Bi	20.0 min	0.0047
720.50	^{126}Sb	12.4 days	0.5380
768.99	^{214}Bi	20.0 min	0.0504
786.64	^{214}Bi	20.0 min	0.0032
839.84	^{214}Pb	26.8 min	0.0059
1691.79	^{124}Sb	60.208 days	0.4730
1760.76	^{214}Bi	20.0 min	0.1700

Plasma Physics Division, AECD

Objective/Introduction

The plasma physics division is the newest division of the Atomic Energy Center, Dhaka (AECD) which is started to work in Jan. 2016 to promote fundamental, advanced and applied research works in the related areas of plasma physics. The major objective of the plasma physics division is to build up capacity in the area of plasma research and plasma-based technology development. The major areas of research and development are

as follows: Theoretical, computational and experimental studies on the Space plasma, Industrial plasma and Fusion plasma.

Activities

1. Research and Development Work(s)

1.1 Design and development of an efficient DPF device

N. A. Chowdhury, M. A. Malek, M. R. Haque and M. K. Islam

Current progress: A dense plasma focus (DPF) is a high pulsed co-axial accelerator that produces a high-density, high-temperature plasma along with pulsed x-rays, neutrons, electrons, ions, and electromagnetic waves. Fusion neutron and soft X-ray production from a low energy DPF as a function of pressure and the dimension of electrodes are studied.

Study on the Fusion Neutron Production: From the numerical experiment, a basic understanding has been acquired about the working principle and neutron production of a miniature device with different filling gas pressure. Correlation of neutron yield with plasma focus properties-like pinch current, peak current, maximum induced voltage, axial speed, radial piston speed, shock speed, plasma ion density, pinch duration is understood as a function of pressure. It has been observed that the production of fusion neutron maximizes in the pressure where pinch current maximizes. It is also observed that pinch length is constant with respect to pressure; pinch radius increases with pressure; Plasma temperature, axial and radial speed of plasma sheath increase with the decrease of pressure; plasma ion density and pinch duration increases with pressure.

Study on the Neon Soft X-ray Production: The UNU/ICTP DPF is a 3 kJ DPF machine which is operated at 14 kV, 30 μF. In our present research work, the neon soft X-ray yield is improved from optimized UNU/ICTP DPF device by computing the optimum combination of inductance with anode length, anode radius and cathode radius, keeping their ratio constant at 3.368 through a lot of numerical experiments at four operating pressures. It is found that our computed values of neon soft X-ray yield is improved around six times from previously computed value for optimum anode configuration of the UNU/ICTP DPF machine.

1.2 Study on the excitation and instabilities of dust modes in dusty plasma

M. K. Islam, M. S. Munir and A. Hossain

Objective: To help laboratory experiment of justifying dust modes, especially the dust lower hybrid (DLH) mode, it is important to clarify the conditions for excitation of different electrostatic dust modes in magnetized dusty plasma. In addition, the effect of the photo electron on the dust modes in the irradiated laboratory and natural dusty plasmas including the effects of magnetic field is important to understand the plasma behavior more clearly in those plasma environments.

Current progress: The conditions for excitation of electrostatic dust modes in magnetized dusty plasmas with negatively charged dust grains are investigated theoretically. It is found that the plasma parameters, wave propagation direction with respect to the applied magnetic field direction as well as the parameters related with dust grain impose conditions to excite different dust modes in magnetized dusty plasma. A crucial condition is found to excite dust lower hybrid (DLH) mode. Detailed analysis of the conditions to excite electrostatic dust modes in magnetized dusty plasma is published to help laboratory experiment to justify the different dust modes precisely.

A theoretical investigation of the photoelectric effect on the low frequency dust acoustic (DA), dust ion acoustic (DIA) and ultralow frequency dust lower hybrid (DLH) modes has been done using fluid model considering collisional effects between charged and neutral particles of plasmas, lighter particles streaming along the external electric field including dust charge fluctuation. The growth rate of the instability of the modes increases with respect to photoelectric current, dust surface potential and streaming velocity of the electrons. Due to the slower streaming velocity of the ions, ions have no significant contribution to the instability of the dust modes. It is also observed that the dust modes become unstable significantly due to photoelectric effect compared to the streaming and collisional effects.

1.3 Theoretical studies on fusion plasma physics

N. A. Chowdhury

Objective: Energy is essential for heating, lighting homes, producing food, operating industrial facilities, enabling communication, providing public and private transportations, etc. Standard living is directly proportional to energy consumption. On the other hand, there is a clear discrepancy between the minimum requirement of energy and the production of the energy. Now, fusion plasma is one of the new fundamental branches of physics and is also used to generate the essential energy for living.

Current progress: Kinetic theory of plasma particles is rigorously important for understanding the real picture of the laboratory fusion plasma. Now, I have been working on the application of kinetic theory in fusion plasma under extreme conditions of temperature and density.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the person	Title of the event	Organizer	Date	Place
Dr. Md. Khairul Islam	Introduction to Research Work, Thesis and Publication	Information Centre, Novo Theater, Dhaka	19 Sept. 2020	Virtual platform
Dr. Md. Khairul Islam	Necessity of Lawson Criteria in Fusion Energy Production	Atomic Energy Center	10 Dec. 2020	AECD
Nure Alam Chowdhury	Design and Development of Dense Plasma Focus Fusion Device and its Application	Atomic Energy Center	24 Dec. 2020	AECD
Dr. Md. Khairul Islam	First International Symposium on Space Science: Importance, Challenges and Emerging, Opportunities in the Space Industry and Islamic World; Theme: Building tomorrow's innovators	ICESCO and Space Foundation, USA	10 Jun. 2021	Online platform

3. Collaboration Work(s)

- The division is involved with the collaborative research work on the matters of common interest of the plasma physics group of different national and international universities. The division has close cooperation with teachers and research students (M. Sc., M. Phil. and Ph. D.) of various universities concerning academic works. Areas of collaboration during the period 2020-2021 are given below:
- Providing support to establish Fusion Laboratory in Khulna University under the collaboration work, Establishing Dense Plasma Focus Device in Khulna University.
- For capacity building, the division is collaborating with the Plasma Research Centre, University of Tsukuba, Tsukuba, Japan.

ATOMIC ENERGY RESEARCH ESTABLISHMENT (AERE), SAVAR

CENTRE FOR RESEARCH REACTOR (CRR), AERE

Objectives/Introduction

Center for Research Reactor (CRR) has been operating and supervising the Bangladesh's only nuclear research reactor "BAEC TRIGA Research Reactor (BTRR)". The BTRR is a valuable installation for various research activities in the field of Nuclear Science and Technology and it acts as a neutron source. It has a maximum steady state thermal power of 3 MW. The reactor achieved its first criticality on 14 Sep. 1986. The reactor has so far been used in various fields of research and utilization such as, manpower development for nuclear power program in the country, Neutron Activation Analysis (NAA), Neutron Radiography (NR), Neutron Scattering (NS), experimental reactor safety research, education, training etc. Center for Research reactor (CRR) is responsible for the operation and maintenance of the reactor and its associated equipment and systems with ensuring appropriate level of safety as delineated in the Safety Analysis Report (SAR). CRR is also responsible for the preparation of various Safeguards and Additional Protocol related reports for AERE facilities on routine basis as per the agreement with the IAEA. These reports are sent to Bangladesh Atomic

Energy Regulatory Authority (BAERA) through Chairman of BAEC.Finally, BAERA sends the reports to the IAEA.

Activities

1. Research and Development Work(s)

During the reporting period the reactor was operated at power levels of 50 W to 2400kW for reactor physics experiments conducted by CRR personnel and to provide neutron beam for various reactor users. During this period, the total operating hour was about 62.18 hr and total burn up of the reactor fuel was about35.89 MWh. A total number of 584 samples were irradiated through 54 irradiation requests (IRs). Nuclear safety is the most important issues in the nuclear installations. The important reactor safety parameter such as burn up estimation, control rod worth, core excess reactivity, shutdown margin, loss of reactivity with power increases, reactivity coefficients, thermal hydraulic analysis and thermal power calibration of the reactor were measured during the reporting period by scientist/engineer of CRR. Study on these safety parameters of the nuclear reactor is very important for reactor safety and efficient operation.

Different groups of the Institute of Nuclear Science and Technology (INST) used the neutron beam of the reactor to carry out various Research and Development (R & D) activities. Neutron Activation Analysis technique is used to determine the trace elements present in soil, foodstuff, and vegetable samples. The Neutron Radiography group used the NR technique to detect voids, cracks, internal continuity in materials and determine water absorption behavior of jute plastic composites and various types of building materials e.g. bricks, tiles, etc. The High Performance Powder Diffractometer (HPPD) has been set up at the reactor to enhance the R & D facilities in neutron scattering technique. Structural studies of materials are being done by this technique to characterize materials crystallographically and magnetically. The micro-structural information is obtainable by neuron scattering method which is very essential for determining its technological applications. This technique is unique for understanding the magnetic behavior in magnetic materials. Ceramic, steel, electric and electronic industries can be benefited from this facility to improve their products and fabrication process.

Reactor is operated for training, research, practical experiments related to safety, industrial attachment program for students from different universities as well as for trainee from BAEC training institute.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participants
General Operating Characteristics-2 [for Trainee Reactor Operator of CRR]	7 Jul. 2020	CRR	9
Instruments and Controls-1 [for Trainee Reactor Operator of CRR]	14 Jul. 2020	CRR	9
Core Excess and Shutdown Margin Measurement [for Trainee Reactor Operator of CRR]	21 Jul. 2020	CRR	9
Instruments and Controls-2 [for Trainee Reactor Operator of CRR]	21 Jul. 2020	CRR	9
Safety and Emergency Systems-1 [for Trainee Reactor Operator of CRR]	28 Jul. 2020	CRR	9
Safety and Emergency Systems-2 [for Trainee Reactor Operator of CRR]	5 Aug. 2020	CRR	9
Standard and Emergency Operating Procedures-1 [for Trainee Reactor Operator of CRR]	12 Aug. 2020	CRR	9
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Evacuation	17 Aug. 2020	CRR	22
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Fire Response	17 Aug. 2020	CRR	22
Standard and Emergency Operating Procedures-2 [for Trainee Reactor Operator of CRR]	19 Aug. 2020	CRR	9

Title of the event	Date	Place	No. of participants
Radiation Control and Safety-1 [for Trainee Reactor Operator of CRR]	26 Aug. 2020	CRR	9
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Evacuation	21 Oct. 2020	CRR	22
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Fire Response	21 Oct. 2020	CRR	22
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Evacuation	15 Dec. 2020	CRR	19
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Fire Response	15 Dec. 2020	CRR	19
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Evacuation	25 Feb. 2021	CRR	20
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Fire Response	25 Feb. 2021	CRR	20
Workshop on Stakeholder Demand Confirmation for BAEC Proposed High Power Research Reactor Project	17-21 Jan. 2021	AERE and BAEC HQ	45
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Evacuation	20 Jun. 2021	CRR	25
Lecture on Emergency Response Plan and Practical Demonstration on Emergency Fire Response	20 Jun. 2021	CRR	25
Workshop on Layout Plan and Design Confirmation for Proposed BAEC High Power Research Reactor	7-17 Jun. 2021	AERE and BAEC HQ	25
Workshop on Reviewing of Survey Activities and Feasibility Study Report for Proposed BAEC High Power Multi-purpose Research Reactor (HPMPRR)	20-26 Jun. 2021	AERE and BAEC HQ	25

3. Collaboration Work(s)

- TC Project (Ongoing): Strengthening operational safety, design and development of spent fuel storage facility of the BAEC TRIGA research reactor and capacity building for the design of a thermal hydraulics and reactor safety testing laboratory.
- ADP Project (Ongoing): Balancing, Modernization, Refurbishment and Extension (BMRE) of Safety Systems of the 3 MW TRIGA Mark-II research reactor facility at AERE, Savar, Dhaka. Under this project several systems of the BTRR are being upgraded for the purpose of long term (about 15-20 years) operation of the BTRR.
- ADP Project (Date of Completion: 30/06/2021): Technical Study/Survey Project to Establish High Power Research Reactor in Bangladesh.

4. Repair, Maintenance and Renovation Works

Jul. 2020	• The SCRAM condition of the reactor due to the problem with the NP-1000 has been observed; a disconnection in the input AC supply was found due to the damage in the internal printed circuit board. Therefore, an external connection has been made with a piece of wire. • Routine stack monitor check has been done successfully. • Check list of digital console has been done successfully. • Maintenance work of 650 KVA diesel generator has been performed. • Maintenance of 10 H.P pump: Rubber spacer and lube oil were changed. • Secondary Pipeline Strainer Cleaning: Secondary pipeline water was removed; strainer was cleaned and primed the secondary pump.

Aug. 2020	• The reactor SCRAM condition was appeared for the malfunction of NPP-1000 module. The high voltage trip circuit was not working properly due to a faulty transistor Q2 (2N 2222A). This transistor has been replaced successfully. • Electrical design work and wiring diagram of reactor control room SDB system has been done. • Electrical design work and wiring diagram of reactor control room ESDB system has been done. • Functional check and maintenance of the water based fire protection system: Functional check and churn test (operable condition) of the electric driven fire pump and associated systems were performed to ensure Fire Pump reliability.
Sep. 2020	• Investigation of whole SCRAM loop has been started to check the functionality of relays and other SCRAM loop related equipment. • Calibration of RTD modules of the TPC. • New cable tray at reactor control room for cable guiding has been installed properly. • Cable laying has been completed according to the design. • Fire suppression system has been installed. • Quarterly Surveillance program was performed.
Oct. 2020	• Investigation of whole SCRAM loop was being continued. This investigation of the whole SCRAM loop helped to find out the main cause of some problems which was not properly identified earlier. • A SCRAM message was observed due to the error signal from seismic system. The investigation revealed that the seismic switch in the reactor hall was not working properly due to faulty fuse. The fuse has been replaced and the seismic switch was functioning well. • Check list of digital Console has been done successfully. • Connection of control room SBD and ESDB has been done accordingly. • All the old cable of control room has been replaced by the new one for better performance and safety. • Water Treatment Plant pipe line maintenance: Replacement of Union, Socket and 1-inch Pipe line. • Vibration monitoring: Primary and secondary pumps and motors vibration were measured to check the operating condition of the system.
Nov. 2020	• An investigation inside the NFT1 showed that a connector has been burned. So addition connection has been done in that connector to solve the problem. Now the NFT1 is functioning properly. • New 1250 KVA transformer has been installed at CRR. • New VCB, PFI has been installed at CRR. • 650kVA Diesel Generator Maintenance: Fuel Filter, Lube Oil Filter and Engine Oil (ACEAE15W40) were changed.
Dec. 2020	• Maintenance of CCTV. • Calibration of RTD modules of the TPC. • Routine stack monitor check has been done successfully. • New LT, ACB and DBs are installed at CRR. • Annual maintenance and surveillance activities were performed for the following mechanical systems: Primary pumps, Secondary pumps, 250 kVA and 650 kVA Generators, Water treatment plant, Fire pump, 10 HP pump, Ventilation system etc. • Annual maintenance and surveillance activities were performed for the following mechanical systems: Primary pumps, secondary pumps, 250kVA and 650 kVA Generators, water treatment plant ,fire pump, 10 HP pump, ventilation system etc.
Jan. 2021	• Calibration of RTD modules of the TPC. • Routine stack monitor check has been done successfully.

	• Cabling work of new substation and EM duct room has been performed. • Cooling Tower Cleaning and Maintenance: Cleaning, Greasing of the cooling tower Fan (CT-1 and CT-2) along with priming of Secondary Pump and pipe line.
Feb. 2021	• The outlet temperature in the UIT display was observed abnormal value. This problem arose from the RTD module which is responsible for the outlet temperature. A new RTD module has been installed to resolve the problem of outlet temperature. • Testing and commissioning work of substation equipment has been completed successfully. • 250kVA Diesel Generator Maintenance: Lube Oil Filter, Fuel Filter and Engine Oil (ACEAE15W40) were changed.
Mar. 2021	• Cabling work of DB to SDBs has been completed according to design. • Vibration monitoring: Primary and secondary pumps and motors vibration were measured to check the operating condition of the system.
Apr. 2021	• Electrical renovation work foe RIPD and INST link building supply has been completed. • Secondary Pipeline Strainer Cleaning: Secondary pipeline water was removed; strainer was cleaned and primed the secondary pump.
May 2021	• New electrical connection work has been started for new entry control system of CRR. • 10 H.P pump maintenance: Lube oil and Rubber gasket were changed.
Jun. 2021	• Semi-annual maintenance and surveillance program were performed efficiently. • 650kVA Diesel Generator Maintenance: Auto Battery Charger were changed. • Semi-Annual maintenance and Surveillance program were performed.

INSTITUTE OF NUCLEAR SCIENCE AND TECHNOLOGY (INST), AERE

Radioisotope Production Division, INST

Objective

The objective of Radioisotope Production Division (RIPD) is to substitute the import of medical radioisotopes, ^{99m}Tc cold kit and therapeutic radiopharmaceuticals by indigenous production. To achieve the goal, the production and supply of two medically important radioisotopes ^{99m}Tc and ^{131}I are regularly done. RIPD is now meeting the entire demand of ^{99}Mo/^{99m}Tc generator of 15 Nuclear medicine centers under the umbrella of Bangladesh Atomic Energy Commission and also supplies ^{99}Mo/^{99m}Tc generators to seven private and government run hospitals. The ^{99}Mo/^{99m}Tc generators produced at the cGMP compliant facility are comparable with the best quality generator available in the global market. RIPD also dispense Bulk ^{131}I which is extensively used in the 15 Nuclear medicine centers of BAEC and CMH, Dhaka. Beside this, RIPD also conducts research and development works in the field of medical radioisotopes and radiopharmaceuticals.

Activities

1. Research and Development Work(s)

- Test production of different cold kits like DTPA, DMSA and MDP.
- Gamma Radiation Shielding Efficiency study for locally available beach sand minerals based composite materials.
- Use of Chitosan as potential adsorbent material for ^{99}Mo/^{99m}Tc Generators.
- Effect of Radioactive Concentration of $Na_2{}^{99}MoO_4$ on Chromatographic ^{99}Mo/^{99m}Tc Generator.
- Research on different Tetraazamacrocyclic Ligands as ^{99m}Tc cold kit.

1.1 Assessment of heavy metal contents in commercial foodstuffs and broiler (gallus domesticus) meat and its impact on swiss albino mice as an animal model

M. Z. Amin, K. N. Tumu, M. Munshi, Y. N. Jolly, M. M. Rahman and M. A. Satter

This study was designed to examine the effect of commercially available poultry feedstuff on the broiler, subsequently, its impact on the experimental animal. The proximate composition as well as concentrations of Pb, Ni, Mn, As and Zn in broiler feed and meat were determined using energy dispersive X-ray fluorescence (EDXRF) spectrometry. Higher levels of Cr, Mn, Zn, Cu, Ni were observed in broiler feed, broiler meat and in the liver of the experimental mice Swiss albino treated with BB1 and BB2. The concentration of these (Cr, Pb and As) metal were 0.182, 0.18, 0.163 µg/g and 0.233, 0.08, 0.158 µg/g, respectively.

1.2 Appraisal of metal pollution in the aquatic environment of Shitalakhya river, Bangladesh and ecological risk assessment, journal of nature science and sustainable technology

Y. N. Jolly, S. Rana, S. Akter, J. Kabir, M. S. Rahman, M. M. Rahman and M. S. Sultana

The present study deals with the evaluation of water and sediment quality; and subsequently the assessment of ecological risk due to heavy metal contamination in the aquatic environment of Shitalakhya River, Bangladesh. According to toxicity reference value (TRV), threshold effect level (TEL), probable effect level (PEL) and severe effect level (SEL), moreover, several indices viz., index of geo accumulation (Igeo), contamination factor (Cf), degree of contamination (Cd), modified degree of contamination (mCd) and pollution load index (PLI) of the study area is in low to moderate level of contamination. Potential ecological risk analysis of the sediment samples indicated that most of the sites posed low ecological risk. Pearson's correlation and Hierarchical cluster analysis indicated that the contaminants comprising cluster I (Cu, Pb, Cr, Mn and Cd) might have some common anthropogenic sources.

1.3 Thermo-catalytic conversion of greenhouse gases (CO_2 and CH_4) to CO-rich hydrogen by CeO_2 modified calcium iron oxide supported nickel catalyst

M. A. Hossain, B. V. Ayodele, H. R. Ong, S. I. Mustapa, C. K. Cheng and M. R. Khan

In this study, the thermo-catalytic conversion of two principal greenhouse gases (methane and carbon dioxide) to carbon monoxide (CO)-rich hydrogen (H_2) is investigated over cerium oxide (CeO_2) promoted calcium ferrite supported nickel ($Ni/CaFe_2O_4$) catalyst. The CeO_2 promoted $Ni/CaFe_2O_4$ catalyst was prepared using wet-impregnation technique. To ascertain the physicochemical properties, the as-prepared catalyst was characterized using various instrument techniques. The characterization of the catalysts reveals that CeO_2-$Ni/CaFe_2O_4$ possesses suitable physicochemical properties for the conversion of methane (CH_4) and carbon dioxide (CO_2) to CO-rich H_2.

1.4 Preparation and quality control of ^{99m}Tc-MDP- an ideal tool for bone scintigraphy

M. F. Waheed, R. Akhter, S. Razia, M. M. Rahman, M. A. Hossain, M. R. Ali and M. M. Rahman

^{99m}Tc-MDP bone scanning is the widely performed nuclear medicine procedure in most of the nuclear medicine departments worldwide. 50-60% of ^{99m}Tc-MDP is localized in the bones while rest is cleared by the kidneys. In this study, the production and quality control of MDP at Radioisotope Production Division (RIPD) of Institute of Nuclear Science andamp; Technology in lyophilized form for labelling with high activity of ^{99m}Tc (100-150 mCi) was done to establish a stable production line. The method was validated for routine production at RIPD, the radiochemical purities of ^{99m}Tc- MDP was 95%. The biological distribution in mice showed high uptake in bone tissue. Sterility and apyrogenecity tests showed absence of microorganisms and pyrogen and in the lyophilized formulation.

1.5 Synthesis, characterization and antibacterial activities of nickel (II) and copper(II) complexes of an N-pendent cyanoethyl derivative of a tetraazamacrocycle

R. K. Shil, S. Rabi, S. Barua, R. Amin, M. A. Manchur and T. G. Roy

An octamethyl substituted tetraazacylotetradecadiene ligand salt Me8[14]diene.2$HClO_4$ (L.2$HClO_4$) on reduction produced three isomeric C-chiral ligands LA, LB and LC. Interaction of LB with excess acrylonitrile resulted in LBX. Reaction of LBX with $Ni(CH_3COO)_2.4H_2O$ followed by the addition of $NaClO_4$ afforded the complex, $[NiLB](ClO_4)_2$, which after reflux yielded $[NiLBX](ClO_4)_2$. This complex underwent reactions with KX (X = SCN, Br or I) and $NaNO_2$ to form $[NiLBX(NCS)_2]$; $[NiLBXBr_2]$; [NiLBXI2] and

$[NiLBX(NO_2)(H_2O)](ClO_4)$ respectively. These complexes were characterized on the basis of elemental, spectroscopic, magnetochemical and conductrometric analysis. The antibacterial activities of the ligand and complexes have been investigated against different human pathogenic gram positive and gram-negative bacteria.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Md. Mustafizur Rahman, Dr. Mohammed Anwar Hossain, Dr. Momtaz Fatima Waheed, Dr. Rabeya Akhter, Md. Tariqul Islam and Ruhul Amin	Workshop on Stakeholder Demand Confirmation for BAEC Proposed High Power Research Reactor Project	CRR	17-21 Jan. 2021	AERE, Savar
Dr. Mohammed Anwar Hossain, Dr. Momtaz Fatima Waheed, Dr. Rabeya Akhter, Md. Tariqul Islam and Ruhul Amin	Workshop on Confirmation of Feasibility Study and Strategic Planning for Proposed BAEC High Power Research Reactor Project	CRR	17-21 Jan. 2021	AERE, Savar
Dr. Mohammed Anwar Hossain	Workshop on Reviewing of Survey Activities and Feasibility Study Report for Proposed BAEC High Power Multi-Purpose Research Reactor (HPMPRR)	CRR	17-21 Jan. 2021	AERE, Savar and BAEC HQ
Dr. Momtaz Fatima Waheed	Technical Meeting on State of the Art Research Reactor Based Radioisotope and Radiopharmaceutical Production	IAEA	22-26 Mar. 2021	Virtual
Dr. Rabeya Akhter	Workshop on Online Workshop on Research Reactor Utilization project (B)	MEXT, Japan	17 Dec. 2020	Virtual
Md. Tariqul Islam	Workshop on Webinar on IAEA Nuclear Security Series No. 37-G: Implementing Guide on Developing a National Framework for Managing the Response to Nuclear Security Events -Challenges and Opportunities for States	IAEA	9 Dec. 2020	Virtual
Md. Tariqul Islam	FTC training on Environmental Radioactivity Monitoring Course at BAEC	BAEC and JAEA	12-16 Jan. 2021	TI, AERE
Md. Tariqul Islam and Ruhul Amin	5 hours training on APA for the officers of 10^{th} grade or higher	INST	14 Jun. 2021	Virtual
Md. Tariqul Islam	Training on National Integrity Strategy	INST	22 Jun. 2021	Virtual

3. Manpower Development and Training Program

Conducted full theoretical and practical courses of Radiopharmacy for the MD Residency (Nuclear Medicine) course of BSMMU in 2020 and 2021.

4. Collaboration Work(s)

IAEA TC Project BGD/6/022: Producing Therapeutic Radiopharmaceuticals.

Objective: To produce and supply of Therapeutic Radiopharmaceutical (Lu-177) to meet the local demand of these isotopes is under implementation. The Project is still going on. Three scientific visits and one fellowship had been completed.

5. Repair and Maintenance Work(s)

- Operation and maintenance of the cGMP complaint computer controlled on-line ^{99m}Tc generator production facility at RIPD and ^{131}I Production Plant.
- Maintenance of Non-pyrogenic Water Production Plant, Hot Air Sterilizer, Steam Sterilizer.
- Operation and Maintenance of Evacuation chamber for vacuum vial preparation.
- Operation and Maintenance of HPGe.
- Operation and Maintenance of peristaltic pump.
- Operation and Maintenance of ^{99m}Tc Cold Kit Production.

6. Service Rendered and Revenue Income

Name of organization	Nature of service	No. of quantity	Revenue income
NINMAS, 14 INMAS and 7 Govt. Non Govt. Hospitals including: CMH, Dhaka; LabAid, Dhaka; Everecare Hospital Dhaka; United Hospital Dhaka; NICVD, Dhaka; Ahsania Mission Hospital, Dhaka and Chevron Hospital, Chattogram	Supply of ^{99}Mo/^{99m}Tc generator	846 no. of ^{99}Mo/^{99m}Tc generators	9,00,16,463/-
NINMAS, 14 INMASs and CMH, Dhaka	Supply of I-131 radioisotope	3117.62 GBq of oral I-131 solution	2,85,78,668/-
Total			11,85,95,131/-

7. Lecture Delivered

Scientists of this division conducted full theoretical and practical courses of MD Residency (Nuclear Medicine) course of BSMMU.

Nuclear and Radiation Chemistry Division, INST

Objective/Introduction

The objective of Nuclear and Radiation Chemistry Division (NRCD) is modification of materials to use in the fields of health, agriculture, water treatment and biodegradable packaging material by the application of nuclear technique especially gamma ray. Moreover, this division involved to measure the water quality of research reactor, provides analytical services to different institute of BAEC/other organizations of Bangladesh and study on environmental pollution of different matrix.

Activities

1. Research and Development Work(s)

1.1 Preparation of gamma radiation assisted poly-vinyl alcohol/acrylic acid/poly-4-styrene sulphonic acid based hydrogel

S. M. M. Hasnine, T. Ahmed, M. S. Rahaman, S. Sultana, M. J. Alam, M. M. Rahman, F. Khatun and A. R. Azady

In this study, poly-vinyl alcohol (PVA), acrylic acid (AAc), and poly-4-styrene sulphonic acid (PSSa) were copolymerized in different compositions using gamma irradiation to form the hydrogel at a radiation dose range of 10-30 kGy. Physical properties like gel fraction and swelling ratio were investigated. The gel fraction increased when AAc concentration increased but decreased when PSSa concentration increased. In swelling experiment, the swelling becomes steady at radiation higher than 25 kGy. At 20 kGy the highest swelling was noticed with a swelling value of 1000% at 48 h. Nevertheless, for the concentration of PSSa from 0 to 100% the value of swelling increased from 200 to 1022%.

1.2 Removal of methylene blue dye from aqueous solution by peo/dma/2-hema blend hydrogels at 10 kgy

S. M. M. Hasnine, T. Ahmed, M. S. Rahaman, S. Sultana, M. J. Alam, M. M. Rahman, F. Khatun and S. Mallick

PEO/DMA/2-HEMA blend hydrogels were prepared by applying gamma radiation dose from Co-60 source at 10 kGy. Concentrations of PEO, DMA were kept constant and 2-HEMA concentrations were varied from 0-3 wt. %. Methylene blue dye removal was examined by a hydrogel that contained 1% HEMA for kinetics and isotherm considerations. From the effect of initial dye concentrations study, it was found that the highest dye adsorption capacity was around 3.9 mg/g at 500 minutes.On the basis of correlation factor, it was found that Pseudo first order (R^2=0.951) fitted well than Pseudo second order (R^2=0.944) with the adsorption experiment. From isotherm studies it could be deduced that R^2 values of Freundlich constant was 0.817 which was higher than R^2 value of Langmuir 0.756, this indicated that th was more biased towards the Freundlich adsorption model.

1.3 Removal of methylene blue dye from aqueous solution by PEO/DMA/AAc blend hydrogels at 10 kGy

T. Ahmed, S. M. M. Hasnine, M. S. Rahaman, S. Sultana, M. J. Alam, M. M. Rahman, F. Khatun and C. R. Sarker

In this work, Hydrogels based on polyethylene oxide (PEO)-N,N- dimethylacrylamide (DMA) grafted with acrylic acid (AAc) (PDA hydrogels) was synthesized from aqueous mixture of concentrations of 5 % wt. PEO ,2.5 % wt. DMA and varying concentrations of 1% wt.,3% wt.,5% wt. of acrylic acid (AAc) using Co-60 γ-radiation source at 10 kGy. The segment of PEO / DMA/AAc gel containing 5% AAc may be of better flexibility and more beneficial for the complex formation with dye than that of PEO / DMA/AAc gel with 1% and 3%AAc at 10 kGy radiation dose (optimum dose). Methylene blue dye removal was examined by this hydrogel for kinetics and isotherm considerations. The result showed that dye adsorption capability of PDA hydrogels is 29% after 6hrs. On the basis, of correlation factor, it was found that Pseudo second order (R^2=0.969) fitted well than Pseudo first order (R^2=0.952) with the adsorption experiment. From isotherm studies it could be deduced that R^2 values of Langmuir 0.985 which was higher than R^2 value of Freundlich adsorption model was 0.982, this indicated that the gel was more biased towards the Langmuir adsorption model.

1.4 Preparation of Starch, 4-styrene sulfonic acid (SSS) and 2-hydroxyethylacrylate (HEA) based hydrogel by gamma radiation

T. Ahmed, S. M. M. Hasnine, M. S. Rahaman, S. Sultana, M. J. Alam, M. M. Rahman, F. Khatun and K. Nipa

Hydrogel from Starch, and 4-styrene sulfonic acid(SSS) and 2-hydroxyethylacrylate (HEA) was prepared by gamma radiation at 1 kGy,3 kGy,5 kGy from ^{60}Co gamma source. Concentrations of startch, HEA, and SSS were 5%, 5% and 15% respectively used. HEA and SSS were mixed at a ratio of 1:3 with starch solution. Gel fraction and swelling ratio of the prepared hydrogel was investigated. Gel fraction increased when radiation dose increased from 1 kGy to 5 kGy complete opposite result was achieved in the swelling experiment.Highest gel fraction was found 95.3% and lowest swelling ratio was 2751.0173% at 5 kGy.

1.5 Application of sulfonated GMA grafted non-woven polyethylene fabric for the efficient removal of methylene blue dye from wastewater

N. Rahman, S. Shahnaz, M. N. Sardar, N. C. Dafader, A. R. Miah and M. H. Kabir

An environmental friendly, economically feasible and reusable sulfonated adsorbent were constructed by gamma radiation grafting of glycidyl methacrylate (GMA) on non-woven polyethylene fabric followed by chemical modification. The adsorbent was characterized by FTIR, TGA and SEM technology. The adsorption of methylene blue (MB) from aqueous solution were investigated by the developed sulfonated-GMA-g-PE film. Different conditions such as contact time, pH and initial MB concentration effect on the adsorption capacity was identified. The kinetic adsorption data were analyzed by pseudo-first-order and pseudo-second-order equations. Pseudo-first-order rate kinetic model is more applicable for the adsorption. The adsorption isotherm fitted best with Freundlich model. Futhermore, the adsorbent could be regenerated and reused repeatedly for the adsorption of MB from aqueous solution.

1.6 Development of poly (Acrylic Acid-co-Acrylamide)-starch hydrogel using radiation technique for the removal of Cr(III) from tannery effluent

N. Rahman, S. Shahnaz, M. N. Sardar, N. C. Dafader, A. R. Miah and M. H. Kabir

A superabsorbent hydrogel entitled as poly (acrylic acid-co-acrylamide)-starch was synthesized from Starch, Acrylic Acid and Acrylamide using radiation technique. Three different radiation doses- 5 kGy, 10 kGy, 30 kGy were applied and favourable yields were achieved in each case. The hydrogel was characterized by the FT-IR spectra, SEM, gel fraction, swelling kinetic and equilibrium degree of swelling (EDS). Adsorption of Chromium (III) ion on the hydrogel was investigated through both batch and column methods. Having prompt and significantly high swelling capacity, 10 kGy poly(AAc-co-AAm)-Starch was picked as optimum for metal ion adsorption. The effect of dose, pH, initial concentration of the metal ion, contact time, temperature on Cr(III) adsorption was systematically observed in batch experiment. The maximum empirical adsorption capacity of 10 kGy hydrogel was found 85.13 mg/g for Cr^{3+} at pH 3.2 from 1050 mg/L $Cr_2(SO_4)_3.6H_2O$ solution. In effect, the adsorption fitted better with the Langmuir isotherm. Pseudo first order kinetic model and Intra-particle Diffusion (IPD) model were followed by the adsorption mechanism while the equilibrium adsorption capacity reached by 24 hours. The thermogravimetric properties of the adsorption were defined by the degressive ΔG° with progressive temperature and positive ΔS°, ΔH°. The hydrogel even showed noteworthy desorption of Cr(III) ion in sodium hydroxide (NaOH) solution. The column method adsorption was also found feasible since the experiment depictured the break throw point at 110 ml. While tracing the applicability of the hydrogel in real tannery wastewater, the adsorption capacity was recorded as 49.03 mg/g for Cr(III) at pH 2.5.

1.7 Application of radiation grafted waste polypropylene fabric for the effective removal of Cu (II) and Cr (III)

M. N. Sardar, N. Rahman, S. Shahnaz, N. C. Dafader, A. R. Miah and M. H. Kabir

This study focuses on the adsorption of hazardous Cr (III) and Cu (II) ions from aqueous solution by applying modified waste polypropylene (PP) fabric as an adsorbent. Pre-irradiation technique was performed for grafting of sodium styrene sulfonate (SSS) and acrylic acid (AAc) onto the PP fabric. The monomer containing 8% SSS and 16% AAc in water was used. Graft yield at 30 kGy radiation dose was 390% when 4% NaCl was added as additive. The prepared adsorbent and the PP fabric was characterized by SEM, FTIR, TGA and DMA. The influences of different parameters including pH, contact time, temperature, initial metal ion concentration and adsorbent dose were also investigated. The equilibrium adsorption data were better fitted to the Langmuir isotherm model with maximum monolayer concentration 384.62 mg/g for Cr (III) and 188.68 mg/g for Cu (II) ions. The adsorption capacities of the adsorbent for Cr (III) and for Cu (II) were found to be 242.78 mg/g (pH = 3.50, metal ion concentration = 880 ppm) and 169.75 mg/g (pH = 4.92, metal ion concentration = 640 ppm) respectively. The kinetic data were better explained by the first-order pseudo kinetic model having good matching between the experimental and theoretical adsorption capacity. The adsorption process was spontaneous, endothermic and thermodynamically feasible as known from the thermo-dynamic data. Furthermore, investigation of desorption of metal ions and reuse of the adsorbent suggest that the adsorbent is an efficient and alternative material in the removal of Cr (III) and Cu (II) from aqueous media.

1.8 Health risk assessment of ground water neighboring DEPZA area, Savar, Dhaka

F. T. Ahmed, N. Ahmed, M. T. Islam, M. M. Rahman, N. C. Dafader, S. Sultana and M. A. Ali

Groundwater is used for domestic and industrial water supply and also for irrigation purposes in all over the world. In recent years, the new environmental problems are arising due to industrial hazard wastage, global climate change, ground water contamination and etc. gives an attention to protect environment.one of the major source of contamination of ground water is improper discharge of industrial effluents these effluents contain so many heavy metals which are cause more effects the human life. In the present study, physico-chemical characteristics of groundwater samples collected from around Dhaka Export Processing Zone, Savar, have been assessed. 18 sampling locations were analyzed to assess the groundwater quality and evaluate the human health risk. The trace metals like Cd, Cr, Cu, Pb, Fe, Mn, Ni, and Zn were analyzed in all the samples. The concentrations of Zn, Pb, Ni, Cu within all the water sources investigated were lower while Fe, Cr, Cd were slightly higher than the Bangladesh drinking water standard as well as permissible limits set

out for regulatory purposes by the WHO. From the study of health risk, it has been seen that, the Hazard Index of all studied metal for oral ingestion was found greater than 1.00 which can pose serious non-carcinogenic threat in long run. Overall, it can be concluded that the groundwater quality of the surrounding of DEPZ area was not up to mark due to metal pollution and the population is exposed to potential non-carcinogenic health risk.

1.9 Lessening of transfer of Cd from soil to leafy vegetable by using of kitchen compost and biochar

F. T. Ahmed, R. H. Arif, M. T. Islam, M. M. Rahman, M. F. Alam, S. Sultana, M. T. Miah and M. A. Ali

Contamination of agricultural soil by heavy metals, especially with Cd predominantly resulting from extensive use of inorganic phosphate fertilizers, is a prime environmental concern around the world. Finding effective alternative to inorganic phosphate fertilizers is of paramount importance to reduce Cd contamination and subsequent transfer from soil to crops without hampering the crop production. A pot experiment was conducted to assess the effects of kitchen compost, quick compost and biochar as organic amendments, applied alone and in combination at 1 t/ha, 5 t/ha, 10 t/ha, 40 kg/ha, 60 kg/ha, 80 kg/ha, 0.5 t/ha+40 kg/ha, 2.5 t/ha+60 kg/ha, 5 t/ha+80 kg/ha with or without TSP on the growth and yield of Red amaranth (*Amaranthus cruentus*) as well as on the uptake of Cd from contaminated soil. From the analysis, it has been seen that soil of sandy loam type showed the highest increase in plant height were observed by 75% (T4: Kitchen compost 10 t/ha), fresh weight biomass by 171% (T4: Kitchen compost 10 t/ha), dry weight biomass by 91% (T4: Kitchen compost 10 t/ha) and fresh yield by 172% (T4: Kitchen compost 10 t/ha) and 3%, respectively. The application of Kitchen compost 10 t/ha treatment reduced the highest Cd concentration in plants e.g. 69% while P fertilizers increased 80% cd concentration in plants when TSP 80 kg/ha is applied. The findings of this study revealed that phosphate fertilizers significantly increased Cd transfer from soil to crops, while all organic amendments substantially reduced the transfer of Cd and 10 t/ha of kitchen compost (T4) was found to be highly effective in this regard. This experimental study, therefore, figured out kitchen waste compost (10 t/ha) as an effective alternative to inorganic phosphate fertilizer for safe crop production and reducing Cd risks in agricultural systems.

1.10 Estimation of ecological risks of heavy metals from Dhaleshwari River sediment of tannery vicinity area

F. T. Ahmed, A. Sarker, M. T. Islam, M. M. Rahman, M. M. M. Hoque, M. T. Miah and M. A. Ali

This research was conducted to measure the pollution concentration of heavy metals and their ecological risks in sediments of the Dhaleshwari river near tannery vicinity area. FAAS was used to determine the concentration of lead (Pb), Cadmium (Cd), Copper (Cu), Chromium (Cr), Iron (Fe), Manganese (Mn), Nickel (Ni) and Zinc (Zn) in different sediment samples. The mean concentration of Pb, Cd, Cu, Cr, Fe, Mn, Ni and Zn in sediments was 15.40, 0.73, 6.82, 64.71, 305.16, 19.94, 18.20 and 7.29 mg/kg, respectively. According to Sediment Quality Guideline (USEPA, 1999), mean concentration of sediments were not polluted for Pb, Cu, Mn and Zn; moderately polluted for Cd and Ni and heavily polluted for Cr and Fe. The sediment contamination factor (CF), pollution load index (PLI) and geo-accumulation index (I_{geo}) demonstrated that most of the sediment samples were heavily contaminated by Cd and Cr. In view of the potential ecological risk (PLI), sediments of Dhaleshwari river showed high potential ecological risk for Cd and Cr and for I_{geo}, Cd showed moderate to strong contamination in some points. So continuous monitoring and assessment will keep checking the pollution status of the Dhaleshwari river sediment and authority can also take immediate actions in this matter to prevent such pollutions by heavy metals.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
RAS 1024-Fisrt Project Coordination Meeting (PCM) , " Reutilizing and Recycling Polymeric Waste through Radiation Modification for the Production of Industrial Goods"	21-22 Jun. 2020	Virtual Meeting	1

Title of the event	Date	Place	No. of participant
2020 FNCA Workshop on "Radiation Processing and Polymer Modification for Agricultural, Environmental and Medical Applications"	26 -27 Oct. 2020	Virtual Meeting	1
'MEXT The Nuclear Researchers Exchange Program 2020'FNCA Research Course. Training on"Development of biocompatible hydrogel from natural polymers using electron beam technique"	5 Dec. 2020- 19 Mar. 2021	National Institute for Quantum and Radiological Science and Technology(QST), Takasaki, Japan (Organized by MEXT, NSRA)	1
Roundtable for the Asia and the Pacific Region "Atoms Contributing to the Search for Solutions to Plastic pollution"	18 May 2021	Virtual Meeting	1
RAS 1024-Second Project Coordination Meeting (PCM) , " Reutilizing and Recycling Polymeric Waste through Radiation Modification for the Production of Industrial Goods"	27 May 2021	Virtual Meeting	1

3. Seminar/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Farah Tasneem Ahmed	Nagorik Sheba Udhvaboner Sokkhomota Briddhi	Bangladesh Atomic Energy Commission	11- 12 Mar. 2021	Dhaka
Mohammad Mahfujur Rahman	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	Bangladesh Council of Science and Industrial Research (BCSIR)	11-13 Mar. 2021	Dhaka

4. Service Rendered and Revenew Income

Name of service	No./quantity of sample	Revenue income
Ground water samples analysis to measure Na, K, Ca, Mg, Cu, Zn, Fe, Mn, Ni, Cd, Pb, Cr, Co, Cl^-, F^-, HCO_3^-, NO_3^- SO_4^{2-} and PO_4^{3-}	Water Samples - 26	---
Milk Sample Analysis to measure Pb	Milk Samples - 05	7,500/-

Health Physics and Radioactive Waste Management Unit, INST

Objective/Introduction

The objective of Health Physics and Radioactive Waste Management Unit (HPRWMU) is to ensure protection of man and the environment, at present and in future, from the hazards of ionizing radiations associated with Radioactive Wastes (RW) and Radiation Sources (RS). In order to achieve the above mentioned objective, the unit is conducting its activities in the following areas:

- Radiation Protection Service (RPS): Providing routine and emergency radiation protection service throughout the country for the assessment and control of radiation exposure to he occupational workers and the public.
- Environmental Radioactivity Monitoring (ERM): Radioactivity monitoring in the environmental samples and dose assessment of natural radioactivity in staple foodstuff.

- Secondary Standard Dosimetry Laboratory (SSDL): Performing standardization of radiation monitoring equipments.
- Radioactive Waste (RW) Management: Working for safe management of RW and radiation sources including their ultimate disposal.

Activities

1. Research and Development Work(s)

1.1 Immobilization of contaminated zinc oxide ash

M. M. Islam, M. A. Haydar, K. Asaduzzaman and M. H. Rahman

Immobilization of the contaminated Zinc Oxides (ZnO) which were stored in two different shipping containers HJCU2154420 22Gl and DFSU 678215 45G1 at the scrap yard of BSRM Steel Mills Limited. Zorargonj, Mirsarai, Chittagong was performed. The Dose rate measurement and surface activity of the contaminated ZnO were also conducted prior to immobilization and safe storage of the ZnO. From the measurement the radiation dose rate and surface activity on outside of the container HJCU2154420 22Gl were found to be varied as 0.21- l5.80 μSv/h and 0.48-12.40 Bq/cm^2, respectively. For the container No. DFSU 678215 45G1, the measured values were found as 0.2-1.44 μSv/h and 0.24-1.10 Bq/cm^2.

Presence of ^{137}Cs radionuclide in both the containers containing ZnO was detected by using Radio Isotope Identifier. Furthermore, from the gamma spectral analysis by using a HPGe detector a distinct photo peak at the energy of 661.7 keV indicating the presence of ^{137}Cs in the analyzed sample. On the basis of the activity concentration of ^{137}Cs containing contaminated ZnO were carefully segregated and converted to a stable solid form through the cementation process in order to prevent the dispersion of the ZnO ashes in the surroundings environment by maintaining an appropriate water cement ratio. The Portland composite cement, sand and water were used to immobilize the ZnO ashes inside a 250L Galvanized Iron (GI) cylindrical drum of height 36 inch and diameter of 24 inch. The entire matrix mixed thoroughly and allowed to set uniformly.

Radiation dose rate and surface activity level was also performed for each cemented drum. Results show the reduction in the radiation dose rate and surface activity level of the immobilized ZnO. The dose rate reduction of the contaminated ZnO are approximately 68 to 84 % and at lm distance 88 to 90%. Whilst, the reduction in the surface activity are ranging from 71 to 89% and at lm distance which was found 83 to 88%.

Decay pattern of the contaminated ZnO ashes was also evaluated in the study. Results obtained from the decay pattern will be useful for selection of the possible disposal route of the immobilized ZnO.

1.2 Assessment of radioactivity in wheat flour and ingestion doses to the public from ingested radionuclides

K. Asaduzzaman, M. Begum and M. M. Islam

Addressing the public concern, measurement of radioactivity in various brands of wheat flour sample collected from several local market of Dhaka city and associated radiation risk to the general public due to their consumption have been performed. Gamma-ray spectroscopy system using HPGe detector having a relative efficiency of 20% was employed to detect radionuclides in wheat flour sample. The results were reported on a dry weight basis and in the unit of Bq kg^{-1} together with uncertainty. The analysis showed the presence of three natural radionuclides ^{226}Ra, ^{228}Ra and ^{40}K in all studied wheat flour sample, but varying degrees. No fallout ^{137}Cs was detected in any sample. The radioactivity levels in the investigated wheat flour samples were ranged 2.23±0.32 to 7.82±0.27 Bq kg^{-1} (Average: 4.82±1.51 Bq kg^{-1}), 0.21±0.28 to 7.40±0.89 Bq kg^{-1} (Average: 3.87±1.69 Bq kg^{-1}) and 69.47±1.59 to 244.99±1.60 Bq kg^{-1} (average: 136.78±57.37 Bq kg^{-1}) for ^{226}Ra, ^{228}Ra and ^{40}K, respectively. On an average, the total dose received from the consumption of a kilogram of wheat flour was 35.22±10.22 μSv y^{-1} with a dose contribution of 9.77±3.06 μSv y^{-1} from ^{226}Ra, 19.30±8.46 μSv y^{-1} from ^{228}Ra and 6.14±2.57 μSv y^{-1} from ^{40}K which is far below the worldwide average yearly ingestion dose. Conversely, the mortality risk of cancer via the consumption of wheat flour was found to be lower than the tolerable limit of 0.29×10^{-3} for radiological risk. Results obtained from this work did not show any significant radiological risk for the general public of Bangladesh due to the daily consumption of different brands of wheat flour. It is expected that the present results will help to set up a baseline data and

reference information to assess any radiological loadings of various wheat flours in the future in Bangladesh, particularly following the latest (11 Mar. 2011) Fukushima Daiichi, Japan nuclear reactor accident and ongoing nuclear power plant at Rooppur, Pabna, Bangladesh.

1.3 Background gamma radiation mapping in the vicinity of rooppur nuclear power plant (RNPP)

K. Asaduzzaman, M. A. Haydar, M. A. Rahman, M. I. Ali and M. M. Islam

Radioactive substances occurring after the operation of Nuclear power plant (NPP) or a nuclear accident may spread across the environment, causing great damage to the mankind and the environment and long-term permanent effects. Determining the distribution of radiation doses that are present in the environment is necessary for assessing the effects of radiation exposure for public health. Before and after the construction of a NPP, it is very important to monitor the environmental radiation in its vicinity to determine any changes in dose level with time as a result of radioactive release from NPP. Such monitoring is very useful in assessing the possible radiological risks to public health in the area where the nuclear power plant is installed and for the guarantee of normality during commercial operation. In this context, background gamma radiation doses were measured in the surface (ground) level and 1 meter above the ground level at 108 selected points in the 32 km radial areas of RNPP. In the surface level, the measured gamma radiation dose rate was varied from 0.01 to 0.21 µSv/h, while its range was 0.01 to 0.21 µSv/h in 1 meter above the ground level, same as surface level dose. The highest dose 0.21 µSv/h were measured Near Philipnagar, Daulatpur (latitude: 24°05'88.2"N, longitude: 88°48'34.0"E) and Koldiar, Daulatpur (latitude: 24°04'56.7"N, longitude: 88°52'57.5"E). Somewhat relatively higher doses were noticed towards the upstream of Padma river. This is the first survey report of background gamma radiation dose level and its distribution at the RNPP site.

1.4 Evaluation of radioactivity and associate radiological risk to public from ingested radionuclides due to consumption of pulses

K. Asaduzzaman and M. Begum

Various types of pulses are grown in Bangladesh. Some pulses are imported. The samples were collected (17 samples) from the local market of Dhaka city in basket method. Radioactivity in pulse sample were measured and radiation dose to the general public due to their consumption has been estimated. Gamma-ray spectroscopy system using HPGe detector (relative efficiency of 20%) was employed to detect radionuclides in pulse samples. The results of radioactivity concentration in pulse samples were reported on a dry weight basis and in the unit of Bq kg^{-1} together with uncertainty. The analysis showed the presence of three natural radionuclides ^{226}Ra, ^{228}Ra and ^{40}K in all investigated sample, but varying degrees. No signature of ^{137}Cs was present in any sample. The radioactivity concentration of ^{226}Ra, ^{228}Ra and ^{40}K in the pulse samples were varied from 2.81±0.43 to 8.30±0.38 Bq kg^{-1} with an average of 5.09±1.52 Bq kg^{-1}, 0.56±0.37 to 3.99±0.26 Bq kg^{-1} with an average of 1.59±0.98 Bq kg^{-1} and 341.04±2.25 to 510.46±2.31 Bq kg^{-1} with an average of 419.63±61.79 Bq kg^{-1}, respectively. These values are far below than the world average ingestion doses values of 120 µSv y^{-1} for uranium and thorium series radionuclides and 170 µSv y^{-1} for non-series ^{40}K reported by UNSCEAR-2000. On the other hand, the mortality risk of cancer via the consumption of pulse sample was found to be lower than the tolerable limit of 0.29×10^{-3} for radiological risk. This research could serve as a prototype on the current level of radioactivity in pulses and could serve as a baseline data and reference information to evaluate any radiological loadings of various types of pulses in the future in Bangladesh, particularly following the nuclear power plant at Rooppur, Pabna, Bangladesh.

1.5 ^{137}Cs and ^{60}Co based high energy gamma radiation attenuation efficacy of several clay built composites in relation with ordinary concrete

M. M. Rahman, M. M. H. Bhuiyan, R. Khan, R. A. Ramon, T. Siddiqua, S. Sultana, N. Arobi, M. Rajib and S. H. Firoz

In the study, emphasize was given to analyze the radiation attenuation efficacy of high energy gamma-rays (^{137}Cs; 661.5 keV- ^{60}Co; 1173.2 keV and 1332.5 keV) for the determination of shielding design of high energy gamma ray's facilities. Some composites were prepared by indigenous low-cost materials such as raw beach sand (RBS) of Cox's bazar, Magnetite-Ilmenite (M-I), Island Sand (IS) as filter and sticky type clay as binder. The gamma -ray attenuation efficacies of the prepared samples and ordinary concretes (OC) were measured using broad beam transmission geometry, GM detector, and stated in terms of linear attenuation co-

efficients (LAC) and Half Value Layers (HVL). The attenuation efficacy was explained with the help of morphology of the composites measured by neutron radiography technique. The investigation shows that the clay-based MI and RBS composites have very significant attenuation properties which can be used as gamma-ray shielding materials in comparison to ordinary concrete.

1.6 Measurement of absorbed dose to water calibration factor ($N_{D,W}$) of some ionization chambers with ^{60}Co Beam

T. Siddiqua, M. S. Rahman and M. M. H. Bhuiyan

In the study, the absorbed-dose-to-water calibration factors ($N_{D,W}$) of 11 chambers (0.125-0.6 cc, diode) were calibrated with ^{60}Co which are used for routine dosimetry and Quality Assurance (QA) of radiotherapy beams at Radiation Oncology Centers in Bangladesh against the reference standard of Secondary Standard Dosimetry Laboratory of Bangladesh Atomic Energy Commission. The measured calibration factors were compared with the manufacturer values except the diode chambers. The deviation between the manufacturer's and measured values of $N_{D,W}$ were found in between -0.15% to 2% with an uncertainty of ±1.3% (k=1). The result shows an excellent agreement of calibration coefficient of ionization chamber provided by SSDL with previous values given by manufacturers except two semi-flex chambers.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
In-house training course on "Obligatory health rules to prevent corona virus (COVID-19)"	16 Aug. 2020	HPRWMU, INST, AERE, Savar, Dhaka	21
In-house training course on "Promotion bio-data submission concept"	25 Aug. 2020	HPRWMU, INST, AERE, Savar, Dhaka	18
In-house training course on "Evaluation of uncertainty in gamma spectrometry"	8 Sep. 2020	HPRWMU, INST, AERE, Savar, Dhaka	22
In-house training course on "Inventory and record keeping of radioactive waste and disused sealed radioactive sources using radioactive waste management registry (RWMR) Code"	21 Sep. 2020	HPRWMU, INST, AERE, Savar, Dhaka	17
In-house training course on "Radiation detection equipment overview"	19 Nov. 2020	HPRWMU, INST, AERE, Savar, Dhaka	23
In-house training course on "Radiation dosimetry for clinical photon beam"	24 Nov. 2020	HPRWMU, INST, AERE, Savar, Dhaka	20
In-house training course on "Nuclear non-proliferation and IAEA safeguards	9 Dec. 2020	HPRWMU, INST, AERE, Savar, Dhaka	23
In-house training course on "^{60}Co machine and medical linear accelerator competing technologies of external beam radiotherapy"	27 Dec. 2020	HPRWMU, INST, AERE, Savar, Dhaka	20
In-house training course on "Radiation Physics and Dosimetry"	11 Jan. 2021	HPRWMU, INST, AERE, Savar, Dhaka	22
In-house training course on "Medical LINAC radiation survey system"	27 Jan. 2021	HPRWMU, INST, AERE, Savar, Dhaka	21
In-house training course on "A brief theoretical basic discussion on ionizing radiation and radioactivity"	11 Feb. 2021	HPRWMU, INST, AERE, Savar, Dhaka	14
In-house training course on "Artifact in positron emission tomography image"	15 Feb. 2021	HPRWMU, INST, AERE, Savar, Dhaka	14
In-house training course on "Dosimetry of gamma calibration GC-60"	23 Feb. 2021	HPRWMU, INST, AERE, Savar, Dhaka	19

Title of the event	Date	Place	No. of participant
In-house training course on "Co-60 external beam radiotherapy"	9 Mar. 2021	HPRWMU, INST, AERE, Savar, Dhaka	21
In-house training course on "Contamination monitoring and decontamination techniques"	24 Mar. 2021	HPRWMU, INST, AERE, Savar, Dhaka	21
Training Course on "Basic Radiation Knowledge For School Education Course" organized and run by Nuclear Human Resource Development Center, JAEA	1-4 Feb. 2021	Virtually (Online)	20
Training Course on "Nuclear/Radiological Emergency Preparedness", organized and run by Nuclear Human Resource Development Center, JAEA	14-17 Dec. 2020	Virtually (Online)	-
Training Course (OTC) JFY2020 on Environmental Radioactivity Monitoring (ERM)	25 Nov. - 3 Dec. 2020	JAEA	-

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. M. Moinul Islam	TM on Lesson Learned from Disposal of Low Level Waste Under the International LLW Disposal Network (DISPONET) Project	IAEA	7-18 Jun. 2021	RCT (Microsoft Team)
Dr. M. Moinul Islam	FY 2020 FNCA On line Workshop on Radiation Safety and Radioactive Waste Management	NSRA, FNCA	14-15 Dec. 2020	RCT Virtual platform
Dr. Khandoker Asaduzzaman	IAEA Technical Meeting on Self-Assessment of Nuclear Security of Materials and Facilities under Regulatory Control	IAEA	27 - 30 Oct. 2020.	Virtual Online platform
Dr. Khandoker Asaduzzaman	Integrated Digital Service Delivery Platform workshop (Testing, Consultancy and Reporting Service)	Ministry of Science and Technology	2 - 4 Mar. 2021.	Novo theater, Dhaka
Tanjim Siddiqua	Webinar on "Indigenous and Interdisciplinary Approaches for Sustainable Development".	bdSTEM (University of Barishal)	5 Sep. 2020	Virtual platform
Tanjim Siddiqua and Nourin Arobi	Webinar on "Advances in Proton and Heavy Ion Treatment for Cancer"	Bangladesh Medical Physics Association (BMPA)	2 Oct. 2020	Virtual platform
Tanjim Siddiqua and Nourin Arobi	Seminar on "Basics of Radiation Protection in Medicine"	Medical Physics Division, Khwaja Yunus Ali Medical College and Hospital	6 Oct. 2020	KYAMCH, Enayetpur Sirajganj
Tanjim Siddiqua	Webinar on "Treatment Plan Evaluation and Optimization Based on Radiobiologic Parameters"	Bangladesh Medical Physics Association (BMPA)	23 Oct. 2020	Virtual platform

Name of the participant	Title of the event	Organizer	Date	Place
Tanjim Siddiqua, M. A. Rahman and Nourin Arobi	Seminar on "Radiation Protection in Medical Practices"	Establishment of Calibration and Quality Control Facilities for Radiotherapy, Diagnostic Radiology and Neutron" Project of BAEC	28 Oct. 2020	INST, AERE
Nourin Arobi	Plan Class Specific Reference QA of LINAC for Volumetric Modulated Arc Therapy	Bangladesh Medical Physics Association (BMPA)	8 Dec. 2020	Virtual platform
Tanjim Siddiqua and Nourin Arobi	Training Seminar Program on "Uses of Radiation in Medicine and Involvement of Stakeholders"	Establishment of Calibration and Quality Control Facilities for Radiotherapy, Diagnostic Radiology and Neutron" Project of BAEC	7 Feb. 2021	North East Medical College and Hospital, Sylhet

4. Collaboration Work(s)

- INT9186 - IAEA Sustaining Cradle-to-Grave Control of Radioactive Sources.
- FNCA project on Radiation Safety and Radioactive Waste Management.
- Asian Nuclear Safety Network (ANSN) 'Radioactive Waste Management Topical Group (RWMTG).
- Special allocation project of Ministry of Science and Technology, 2020-2021, "Radiological risk assessment of commercially available baby food caused by ionizing contaminants".

5. Repair, Maintenance and Renovation Works

- Renovation work of a part of the HPRWMU building (ongoing).
- Photo eye sensor replacement of Gamma Calibrator System GC-60 and G10 was accomplished with the help of engineers from IE, AERE.

6. Others

- M. Moinul Islam, Review of the article, Nuclear Science and application, Dec. 2021.
- M. Moinul Islam, Review of the internal report 'Source term and Radiological Consequence Analysis of VVER-1200 Type Reactor under Postulated Severe Accident Conditions, 7 Mar. 2021.
- M. Moinul Islam, Thesis evaluation, University of Dhaka, Apr. 2021.
- M. Moinul Islam, project monitoring of special allocation project for the year 2020-2021 under the Ministry of Science and Technology.
- Number of environmental sample analysis: 10
- Number of calibrated radiation measuring devices: 100
- Number of radiation survey: 50
- Management of RW: 04

7. Service Rendered and Revenue Income

No. of service given to the organization	Name of service	No. of sample	Revenue income
10	Radiation survey	17	1,02,000/
2	Interim storage	4	-
~ 40	Radiation measuring devices calibration, dosimetry	100	4,49,000/-
Total			5,51,000/-

Reactor Physics and Engineering Division, INST

Objective/Introduction

The program of the division is to conduct R & D activities using modern methods for the computational analysis of nuclear reactors, with particular emphasis on reactor physics, design and safety. Here we procure and implement computer codes related to reactor engineering and nuclear data processing with international collaboration. The ultimate objective of the division is to support the development of infrastructure for nuclear power program to meet the ever increasing demand of electricity.

Activities

1. Research and Development Work(s)

Neutronics and Thermal Hydraulics calculations are needed for efficient utilization and safe operation of nuclear reactor. In this regard MCNP modeling of TRIGA and VVER type reactor is going on. The following on-going research projects are highlighted to reflect the activities of the division are as follows.

- Nuclear engineering and nuclear data processing.
- Radiation shielding technology.
- Neutronics analysis of nuclear reactors.
- Thermal hydraulics and Safety studies of nuclear reactors.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
MEXT The Nuclear Researchers Exchange Program FY-2020	3 Dec. 2020 19 Mar. 2021	Tokyo Institute, Japan	1
Four Lectures delivered for Reactor Engineering Course at BAEC (RECB-9)-2021	7-25 Feb. 2021	TI, AERE	-
In-house Training Course	Jul. 2020- Jun. 2021	RPED, INST	8

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Muhammed Sohel Rana	Inspection of the Manufacturing of LTME for the construction of Rooppur Nuclear Power Plant	Russian Federation	25 Aug. 2020 - 30 Jun. 2021	Volgodonsk, Rostov, Russia
Dr. Md. Jahirul Haque Khan, Mohammad Sayem Mahmood, Dr. Mohammad Abdul Motalab and Md. Altaf Hossen	Workshop on Stakeholder Demand Confirmation for BAEC Proposed High Power Reseacrh Reactor Project	CRR, AERE	17-21 Jan. 2021	CRR, AERE
Dr. Md. Jahirul Haque Khan	Overview of Research Activities of RPED	RPED	4 Feb. 2021	RPED, INST
Dr. Md. Jahirul Haque Khan and Md. Altaf Hossen	Workshop on Confirmation of Feasibility Study and Strategic Planning for Proposed BAEC High Power Reseacrh Reactor Project	CRR, AERE	10-18 Feb. 2021	CRR, AERE
Dr. Md. Jahirul Haque Khan	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13 Mar. 2021	BCSIR, Dhaka

Tandem Accelerator Facilities Division, INST

Objective/Introduction

A 3 MV Tandem Accelerator was installed at the campus of Atomic Energy Research Establishment (AERE) of Bangladesh Atomic Energy Commission in Savar in 2010. The use of low-energy charged particle accelerator in nuclear research is of high significance, both with regard to fundamental nuclear investigations and to provide valuable data/information for various fields of applied sciences, to study various environmental pollution studies. Among the latter category, analytical techniques like PIXE (Particle Induced X-Ray Emission) and Rutherford Backscattering (RBS) are well established. With regard to fundamental studies, investigation of nuclear reactions using modern high quality detectors and electronics system is gaining new interests.

The main objective of this division is to keep the complex accelerator system operational and provide ion beam for doing research. The other objectives are the following:

- To train manpower in advanced nuclear technology.
- To study basic nuclear phenomena.
- To provide valuable data/information for various fields of applied sciences.
- To study various environmental pollution in the country.
- To help students to obtain academic degrees.

Activities

1. Research and Development Work(s)

1.1 Elemental analysis using PIXE technique

The main objective of establishing the Tandem Accelerator Facility is to provide analytical service: qualitative and quantitative analysis of elements in environmental samples, i.e. soil, water, air, food, blood, industrial materials, etc. In this division the following researches are carried out using PIXE technique.

- Investigation of elemental and radiological contamination of soils in shipyards.
- Study of soil samples and tree bark in ship breaking area to environmental pollution due to ship breaking activities.
- Determination of lead contamination in human body by analyzing blood samples.
- Analysis of elemental profile of available medicinal plants at Savar, Dhaka.
- Studies of essential and trace elements in some fruits and vegetables of southwestern Bangladesh.

1.2 Radionuclide research and development studies under Bangladesh-USA-German cooperation

Bangladesh-USA-German Cooperation has been established for Radionuclide Research and Development Studies, in particularly to develop ^{86}Y radioisotope. The radionuclide ^{86}Y ($T_{1/2}$=14.7 h; $I_{\beta+}$=33%; $E_{\beta+}$=1.2 MeV) is a well-developed positron emitter, forming a theranostic pair with the therapeutic radionuclide ^{90}Y ($T_{1/2}$=2.7 d; I_{β^-}=100 %; E_{β^-}=2290 keV). The radionuclide ^{90}Y is commercially available. The production of ^{86}Y via ^{86}Sr(p,n)-reaction is also fairly well established. The nuclear reaction cross section database, however, is weak. It is therefore planned to measure the cross section data with a higher accuracy, partly to improve the database, but also from mechanistic point of view. Six irradiations of the^{86}Sr-containing stacks were carried out with protons. Two irradiations were performed with protons of primary incident energy of 45±0.2 *MeV* at JULIC cyclotron at FZJ, Germany. One irradiation with 27±0.3 *MeV* primary energy protons was carried out at the 88-inch Cyclotron, Lawrence Berkeley National Laboratory (LBNL), USA. The other three stacks were irradiated with 16.7±0.2 *MeV* primary energy protons at the BC 1710 cyclotron at FZJ, Germany. After gamma-ray counting, spectra were transferred in the laboratory of Tandem Accelerator, AERE, Savar and analyzed here. During proton irradiations of a ^{86}Sr target, besides ^{86}Y, several other short-lived isomeric states of neutron deficient isotopes of yttrium are also formed. It is intended to measure the isomeric cross section ratios in those cases. The results should shed some light on the effect of nuclear spins and angular momentum distribution on the formation of the isomeric states.

2. Repair, Maintenance and Renovation Works

- Regular maintenance of 40 KVA main UPS, 2KVA control room UPS and 15 KVA water cooling system UPS.
- Installation and commission of six newly bought dehumidifiers in control room and hall room.
- Power Supply unit of industrial computer in control room is replaced by a new one.
- PLC PS4 unit of DILO system is replaced by a new one procured through IAEA TC project. Gas removal, filling and filling with compressor tests are also done.
- Maintenance of water flow pressure switch used in water cooling and central AC system.
- Problems in electrical connection of motor used in central AC and water cooling system are fixed.
- Problem in water flow sensor in switching magnet by adjusting potentiometer F2 is fixed.
- Work is going on to fix the regulation error problems between power supply unit and power supply control unit of 358 Duoplasmatron ion sourceand 860 negative sputtering ion sources.
- MPI CANNODE missing problems are fixed by re-placing optical T/R card by new one.

3. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
In-house training course on PIGE Technique, Particle Accelerator Application and PIXE Technique	4 - 6 Aug. 2020	TAFD seminar room	13
In-house training course on Motion Controller for Sample Positioning, 3D Linear Stage and Torque Wrench	6 -8 Sep. 2020	TAFD seminar room	8
In-house training course on Ion Beam Mutation, Uses of Different Types of Gases at 3 MV Tandem Accelerator and UPS for Cooling System	4 - 6 Oct. 2020	TAFD seminar room	11
In-house training course on Construction of New Beamline, Temperature and Humidity Monitoring and RBS Technique	2 - 4 Nov. 2020	TAFD seminar room	9
In-house training course on Medical Application of Low Energy Accelerator, PIXE and RBS Detector Status Test Using Pulser and Oscilloscope and 358 Duplasmatron Ion Source	1 - 3 Dec. 2020	TAFD seminar room	12
In-house training course on Importance of Cleanliness in Accelerator Facility, Different types Cooling System at 3 MV Tandem Accelerator and Neutron Production Beam Line	10 - 12 Jan. 2021	TAFD seminar room	13
In-house training course on Ion Beam Alignment, Stripping of Charged Ion beam and 860 Negative Sputtering Ion Source	2-4 Feb. 2021	TAFD seminar room	13
In-house training course on He Leak Detection System, Data Communication at 3 MV Tandem Accelerator and Mass Spectrometry Using Injection Magnet	2 - 4 Mar. 2021	TAFD seminar room	6

4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Md. Mehedi Hasan	IAEA Training Workshop on "Ion Beam Driven Materials Engineering: New Roles for Accelerators for Quantum Technologies"	Department of Nuclear Science and Applications, International Atomic Energy Agency(IAEA)	4 -7 May 2021	Online Platform
	IAEA Training Workshop on "Ion Beam Driven Materials Engineering: New Roles for Accelerators for Quantum Technologies"	Department of Nuclear Science and Applications, International Atomic Energy Agency (IAEA)	4 -7 May 2021	Online Platform

5. Collaboration Work/MoU

IAEA-TC Project (Code: BGD 0010), Strengthening Capacity in the Maintenance and Utilization of the Tandem Accelerator Facility, Period: 1 Jan. 2018 to 31 Dec. 2020.

Isotope Hydrology Division, INST

Objectives/Introduction

- Investigations of surface-water and groundwater resources: their origin, dynamics, interrelations and residence time.
- Studying water resources contamination issues like pollution, source, and transport of contaminants.
- Studying the recharge mechanism of groundwater, flow dynamics and hydraulics and possible interconnection between different aquifer systems using environmental tracers (stable isotopes δ^2H and $\delta^{18}O$ and radioactive ^3H and ^{14}C).
- Determination of groundwater parameters such as direction of groundwater flow, filtration velocity, vertical flow velocity, permeability, effective porosity and dispersion coefficient by single-well dilution technique.

Activities

1. Research and Development Work(s)

1.1 Isotope signatures and hydrochemistry as tools in assessing sources and groundwater aquifers in Chapainawbganj Sadar and Nachole upazila, Chapainawbganj

R. K. Majumder, M. Moniruzzaman, M. A. Q. Bhuiyan, M. A. Ahsan, A. H. A. N. Khan and F. Islam

Most of the part of Chapainawabganj district is lying in Barind areas, which is highly vulnerable in terms of declining groundwater trends due to the increased population, expansion of farming works and decreased surface water flow in Bangladesh. Several reports claimed that, the groundwater table is going down by 1 to 2 feet every year in some parts of this area. The main objective of this research is investigation of groundwater recharge mechanism and aquifer connectivity by isotopic and hydrochemical techniques. The key outputs will be as follows- knowing the recharge mechanism will help in better aquifer management and groundwater abstraction planning for irrigation and drinking, identification of safe drinking aquifers will be possible, hazard maps will facilitate knowledge for taking preventive measures and validation of ongoing managed recharged aquifer projects.

1.2 Stable isotope and hydrogeochemical evaluation of groundwater in Tangail district, Bangladesh

R. K. Majumder, M. Moniruzzaman, M. A. Q. Bhuiyan, M. A. Ahsan, A. H. A. N. Khan and F. Islam

The groundwater system of Tangail district is little bit complex in terms of its geology. It is bounded by flood plains of the Jamuna River in it's western part and uplifted Pleistocene terrace in eastern part. These two distinct subsurface geological conditions influence the groundwater quality. Total 80 groundwater and river water samples have been collected from Tangail district. However, the main objectives of this study has been set to analyze the evolution, origin and mixing of water using stable isotope technique to assess hydrogeochemical characteristics. The isotopic compositions (**δ**2H and **δ**18O) of groundwater of Tangail district range from -43.5 and -9.6‰; with an average of -26.43 ‰ and -6.84 and -2.07‰ with an average of e -4.57 ‰ respectively. The $\boldsymbol{\delta}^2H$ and $\boldsymbol{\delta}^{18}O$ values of floodplain portion of Tangail district fall close to the global meteoric and local meteoric water lines, that suggest that most of the groundwater sample are mixing through the aquifer, where rainwater is infiltrated though the sediment with slowly mixing into the groundwater. Oppositely, groundwater samples of Madhupur Tract are more enriched which indicates that comparatively old recharge. The enrichment of Mg^{2+}, Na^+, K^+, and HCO_3^- indicates the high water-rock interaction. Excessive use of fertilizer in agricultural field results in high concentration of SO_4^{2-} and NO_3^- in the shallow aquifer. The deep groundwater is comparatively fresh. Careful management of aquifers is highly recommended for sustainable development of groundwater resources.

2 Repair, Maintenance and Renovation Works

2.1 Maintenance of the Ion Chromatograph

An Ion Chromatograph (model: DIONEX ICS-3000, SP) has been used since 2008 for measuring seven major anions and six major anions in liquid samples. During analyzing samples, there were some problems, i.e., in matching calibration curve, high background conductivity and non-alignment of needle of the auto-sampler.

However, total system has been then checked by a service engineer. The anion and cation suppressor and tubes were found blocked, those have been washed properly. Fortunately, anion suppressor is working but cation suppressor is not functioning. Alignment of needle of the auto sampler has also been fixed. The instrument is now functioning properly with the anion suppressor.

2.2 Maintenance of the Atomic Absorption Spectrophotometer

The Atomic Absorption Spectrophotometer (AAS) has been installed in 2009 and used to analyze several cations and heavy metals like Na, K, Ca, Mg, Fe, Mn, Cu, Zn, Pb, Cd, Cr, Ni etc. in different types of samples (i.e., rainfall water, surface water, groundwater, fog, soil, wastewater etc.). However, the analytical results of some elements were not satisfactory due to low lamp energy for most of the elements. A servicing has been then done by a service engineer to identify the drawbacks. Some recommendations have been given- (i) a 30 KVA online UPS system is required for controlling and stabilization of the temperature, (ii) new lamps are required to analyze the following elements: Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Manganese (Mn), Arsenic (As), Iron (Fe), Lead (Pb), Chromium (Cr), Nickel (Ni), Cadmium (Cd), Copper (Cu), Zinc (Zn), Aluminum (Al) and Barium (Ba), (iii) a new auto sampler belt of Graphite Furnace system is required to resume the auto sampler system, (iv) a new exhaust fan is needed to install.

2.3 Maintenance of the Liquid Water Isotope Analyzer (LWIA)

The Liquid Water Isotope Analyzer (LWIA) has been installed in 2014 for measuring $\boldsymbol{\delta}^{2}H$ and $\boldsymbol{\delta}^{18}O$ stable isotopes of water samples and functioning well till now. Recently the stable isotopes standard has been finished and we need to buy bulk volume of standards for future uninterrupted stable isotopes analysis. Also there are some shortage of instrument syringes.

2.4 Maintenance of the Water Purification System

The Water Purification System (Ultra-Pure) of IHD has been installed in 2008. But this system was not in working condition for last few years. A servicing has been then done to repair the system. Now, the system is functioning properly.

3. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
Follow-up Training Course (FTC) "Nuclear and Radiological Emergency Preparedness-2020"	22 Nov.- 3 Dec. 2020	TI, AERE	1
MEXT Nuclear Researchers Exchange Program - Individual Research course on "Techniques for Synthesizing Functional Bio-related Gels by Utilizing Gamma Ray"	5 Dec. 2020- 19 Mar. 2021	Kyushu University, Fukuoka, Japan	1
Joint ICTP-IAEA Workshop on the Use of Cosmic Ray Neutron Sensor for Soil Moisture Management and Validation of Remote Sensing Soil Moisture Maps	10 - 19 May 2021	Virtual Online platform	3

4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participants	Title of the event	Organizer	Date	Place
Dr. Md. Moniruzzaman	8th International Conference on Water and Flood Management (ICWFM 2021)	Institute of Water and Flood Management, BUET	29-31 Mar. 2021	BUET, Dhaka
	Bangladesh International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	Bangladesh Council of Scientific and Industrial Research (BCSIR)	11-13 Mar. 2021	BCSIR, Dhaka

5. Collaboration Work

5.1 IAEA, RCA project RAS7035: Enhancing Regional Capability for the Effective Management of Groundwater Resources Using Isotopic Technique, Period: 2020/2021.

5.2 SandT project

Environmental Isotopes and Hydrochemistry to Assess Seawater Intrusion in Groundwater Aquifers of Bhola District, Principal Investigator: Ratan Kumar Majumder and Associate Investigator: Dr. Md. Moniruzzaman, Period: 2020/2021.

5.3 IAEA-TC Program (BGD5033)

Using Nuclear Techniques in Assessing River Bank Erosion, Period: Jun. 2019- Dec. 2022.

5.4 Memorandum of Understanding (MoU) between INST, BAEC and ITP, CAS

MoU Signing Events: Revised and extension of MoU had been signed on 27 Mar., 2018 between INST (Director: Dr. Nirmal Chandra Dafadar), BAEC and ITP (Director: Prof. YAO Tandong), CAS at gamma-conference room, BAEC Headquarter, Dhaka, Bangladesh, **Period:** 5 years (2018-2023).

6. Service Rendered and Revenew Income

Name of service provided	No./Quantity of sample	Revenue income
Water samples (RO-1, RO-2, PTP-1, PTP-2 and Raw water) have been collected from Square Hospitals Ltd. (18/F Bir Uttam Qazi Nuruzzaman Sarak, West Panthapath, Dhaka-1205) and analyzed for nine major ions, eleven heavy metals and three physicochemical parameters (pH, EC, TDS) by using Atomic Absorption Spectrophotometer (AAS), Ion Chromatograph (IC) and portable multimeter	5	1,36,000/-
Total		1,36,000/-

Reactor and Neutron Physics Division, INST

Objective/Introduction

Reactor and Neutron Physics Division (RNPD) is entrusted with the responsibility of utilization of the research reactor in the country for research and applications in nuclear techniques. RNPD has three major facilities namely, (i) Neutron Scattering, (ii) Neutron Activation Analysis and (iii) Neutron Radiography. All these facilities utilize neutrons generated in the TRIGA Mark II Research Reactor for specific research and discharging services in the nuclear techniques. These research groups mainly focus on characterization of essential materials, analysis of toxic and heavy elements in different sample matrices and studies of structural and building materials for defects and flaws.

Activities

1. Research and Development Work(s)

Neutron Activation Analysis

1.1 Comparison of epithermal and instrumental neutron activation analysis for the determination of uranium and other elements in soil samples using BAEC TRIGA Reactor

M. A. Islam, M. S. Rahman, K. Naher, R. Khan, U. Tamim, S. M. Hossain, M. A. Azam, M. A. A. Talukder, I. Khalil, M. S. Islam and M. S. Uddin

In this research, epithermal neutron activation analysis (ENAA) was implemented for the first time at 3 MW TRIGA research reactor of Bangladesh Atomic Energy Commission (BAEC) to determine Arsenic (As), Antimony (Sb), Samarium (Sm) and Uranium (U) in soil/sand samples and characteristically compared with instrumental neutron activation analysis (INAA) to find out advantageous features of ENAA over INAA. The ENAA detection limits (DL) were determined for the studied four elements (As, Sb, Sm and U) using standard reference materials (IAEA-Soil-7 and IAEA-SL-1) and compared with those of INAA. It is observed that DLs of As, Sb, Sm and U obtained by ENAA for SL-1 and Soil-7 are 17%, 42%, 28%, 25% and 29%, 25%, 31%, 35%, respectively lower than those obtained by INAA. The analytical sensitivities of those elements for SL-1 and Soil-7 are 31%, 9.0%, 75%, 28% and 25%, 11%, 15%, 48%, respectively higher than those obtained by INAA. Moreover, ENAA is the most effective if the Q_0 values of the interested nuclides are greater than 10. The calculated Q_0 values of As, Sb, Sm and U are 13.7, 20.3, 15.2 and 102, respectively. The findings from this research indicate that ENAA technique is better than INAA for the determination of trace

amounts of As, Sb, Sm and U in soil samples using BAEC TRIGA Mark II research reactor. ENAA technique will be used for the determination of these elements, especially, U in soil/sand samples to find out potential U-mining areas in Bangladesh.

1.2 Spatial distribution and contamination of trace elements in surface sediments of the Kaptai Lake, Bangladesh using neutron activation analysis

M. A. Islam, B. Das, M. B. Hossen, K. Naher, R. Khan, U. Tamim, S. M. Hossain, M. A. Azam, M. A. A. Talukder, I. Khalil, M. S. Islam and M. S. Uddin

In this study, total concentrations of 25 major, minor, and trace elements (Na, Al, K, Sc, Ti, V, Cr, Mn, Fe, Co, Zn, As, Cs, La, Ce, Sm, Eu, Tb, Dy, Yb, Lu, Hf, Ta, Th, and U) in surface sediments of the Kaptai lake, Bangladesh were determined by using research reactor-based neutron activation analysis (NAA) technique. To identify concentration variations and pathways of elements, sediment samples were collected from 32 different locations of the lake. Samples were neutron- irradiated using a pneumatic transfer system of the 3 MW TRIGA research reactor at Bangladesh Atomic Energy Commission, and gamma-ray activities of the product radionuclides were measured using a high-resolution HPGe detector system. For the quality control analysis of the relative standardization approach of NAA, reference materials (RMs): IAEA-Soil-7, IAEA-SL-1 (lake sediment), and NIST-1633b were used in this study. When compared with upper continental crustal (UCC) average values, it is observed that the mean concentration of Ti, Zn, As, Cs, La, Ce, Sm, Eu, Dy, Yb, Lu, Hf, Ta, Th and U show elevated values with respect to UCC. Assessment of elemental contamination, using different pollution indicators, suggests that sediments of the Kaptai lake are minorly enriched by Zn, As, Cs, REEs, Hf, Ta, Th and U. The calculated pollution load index (PLI) values also suggest deterioration of sediment quality in 3 sampling stations. Pearson's correlation matrix of the elements was calculated to establish relationships among elements and their origins which indicates that Fe, Co, As and Cs are of similar origins. These results are necessary for future monitoring related to elemental contamination of the lake ecosystem.

1.3 Natural radioactivity measurements and evaluation of radiological hazards in sediment of Tista River, Bangladesh

R. Khan, H. M. T. Islam, A. R. M. Islam, K. Naher, M. A. Islam, U. Tamim, M. A. Azam, M. A. A. Talukder, I. Khalil, M. S. Islam and M. S. Uddin

To assess the radiological health hazards and associated excess lifetime cancer risks of naturally occurring radionuclides 226Ra, 232Th and 40K in sediments of Tista river, Bangladesh, sediment samples from 10 different sampling sites were studied using Gamma ray spectrometry (GRS). The mean activity concentrations of 226Ra, 232Th and 40K were found to be 67.4 ± 21 Bqkg-1, 104 ± 1.8 Bqkg-1 and 983 ± 27 Bqkg-1, respectively. The results of the radiological indices and dose rates obtained in this study were all below than their recommended values except for Absorbed dose rate (D), Gamma representative level index (Iγ) and Excess lifetime cancer risk (ELCR)but lower than their maximum recommended limits indicating that the use of the sediments as building materials do not constitute any excessive radiological hazards. Excess lifetime cancer risk (ELCR) is 2 times higher than the recommendation value of 2.90×10-4 indicating that the area is known to be subjected to environmental degradations due to small scale industrial activities. Therefore, the results of this study could serve as an important radiometric baseline data upon which future epidemiological studies and environmental monitoring initiatives could be based.

1.4 Natural radioactivity concentration and assessment of radiological hazards in sediment of Brahmaputra River, Bangladesh

R. Khan, M. A. S. Apon, A. R. M. Islam, K. Naher, M. A. Islam, U. Tamim, M. A. Azam, M. A. A. Talukder, I. Khalil, M. S. Islam and M. S. Uddin

The concentrations and distribution of natural and anthropogenic radioactive materials 226Ra, 232Th and 40K in sediments from Brahmaputra river, Bangladesh were investigated based on the environmental radioactivity and radiation hazard. The results show that the concentration of 232Th was found to be higher than that of the 226Ra and the activities of 226Ra, 232Th and 40K in this area are higher than the world average. The radiological parameters of natural radioactivity were assessed by calculating the radium equivalent activity, radiation hazard index (internal and external), absorbed dose rate, annual effective dose rate, Gamma representative level index and Excess lifetime cancer risk. The average activity concentrations

of 226Ra (238U), 232Th, and 40Kin sand and sediment were found to be 42.7± 18.6, 82± 31.6 and 871± 104Bq/kgand the ranges of their activity concentrations were 13.6-106.5, 47.3-211 and 702.3-1202.In the Present study, the fractional contributions of radionuclides to the total absorbed dose rate are calculated which are varied from site to site. Average contributions of the 226Ra, 232Th and 40K fraction to the total absorbed dose rate are 19.71, 49.55, and 36.57 % respectively. Multivariate statistical analysis Pearson's correlation examines the correlations between radiological parameters are significantly positively related with $P<0.01$ level, and Cluster analysis is identifying and classifying the radiological parameters. Overall the result of this study suggests a potential radiological threat to the environment as well as to the human health.

Neutron Radiography

1.5 Neutron shielding properties of kappa carrageenan-pva based hydrogels as user-safety material

R. A. Ramon, T. Ahmed, R. Barman, M. S. Rahaman, K. Naher and S. Sultana

The decades of advancements in nuclear power and nuclear therapies have opened doors to neutron-based science and technologies such as neutron radiography, neutron activation analysis, neutron diffractometry and neutron capture therapies. The operating conditions of these applications, therefore, are requiring increased protections for both the operators and surroundings from any unwanted escape of neutron particles and activating surrounding atoms into radionuclides causing radioactive decay. The widely used and most effective neutron shielding materials are water, hydrocarbons, and paraffin wax. These hydrogen-based materials are suitable for neutron shielding because hydrogen has a large neutron cross-section. Among them, Water, being the most abundant, lacks geometrical stability and flexibility. Hydrogels, being a three-dimensional hydrophilic crosslinked polymeric network, can absorb and retain large amounts of water and offer considerable structural integrity, geometrical flexibility while being eco-friendly, lightweight and cost-effective. In this work, neutron shielding efficacy of Kappa carrageenan-PVA based hydrogel sheets have been investigated from their linear neutron attenuation coefficients determined from optical density measurements of the radiographic films. The dependence of neutron shielding on the variation of hydrogel-sheet-thickness and neutron flux densities have been studied. The neutron shielding properties of the hydrogels increased with the increase in the neutron flux density and the maximum neutron shielding efficacy was found to be comparable to that of cadmium sheet (reference). The ultimate goal for this material is to be used as a user safety material in an eco-friendly manner.

Neutron Scattering

1.6 Structural and thermal properties of zirconium doped strontium neodymium oxide

J. Maudood, S. Hossain, I. B. Elius, M. S. Islam, A. Hye and F. Ahmed

In this study, the structural, microstructural, chemical and mechanical properties of zirconium doped strontium neodymium oxide were observed by scanning electron microscopy (SEM) and differential thermal analysis (DTA). The microstructures of the material showed that the effect of zirconium doping reduced the grain size and the samples become very dense at 1300℃. The DTA is used to analyze changes in physical, mechanical and chemical stabilities of materials measured as a function of increasing temperature and of time. To understand the temperature dependent behaviour DTA scan of the precursor was recorded and the dilatometer measurement of $SrNd_{0.65}Zr_{0.35}O_{3-\delta}$ (SNZ) exhibits a good agreement with the literature results made of YSZ as a commercial material used for the SOFC electrolyte component. All the results demonstrate that SNZ perovskite may be a promising candidate of proton conducting electrolyte for the intermediate temperature solid oxide fuel cells (IT-SOFCs).

1.7 Synthesis and characterization of $Ca_{1-X}sr_xce_{0.6}Zr_{0.2}Y_{0.2}O_{3-\Lambda}$ perovskite for solid oxide fuel cell

M. S. Islam, S. Hossain, J. Maudood, I. B. Elius, M. S. Akter, A. Hye and F. Ahmed

The purpose of this research is to synthesis and structural studies of advanced materials for applications in solid oxide fuel cell. In this research, three samples of $Ca_{1-x}Sr_xCe_{0.6}Zr_{0.2}Y_{0.2}O_{3-\delta}$, where x = 0.4, 0.5, 0.6 (CSCZY1, CSCZY2 and CSCZY3 respectively) were synthesized by the conventional solid state reaction method. All the samples were sintered at 1200℃ for 12 hours in an air atmosphere. Structural and morphological studies have been performed by X-ray diffraction (XRD) and scanning electron microscopy (SEM) respectively. The XRD data has been analyzed by using the Chekcell software and it confirmed the single phase orthorhombic crystal symmetry with the pmmm space group. The SEM images of the pellets

surfaces show that the samples sintered at 1200℃ are uniform. All the properties reported here show that the synthesized materials can be a suitable candidate for application in solid oxide fuel cell (SOFC).

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Kamrun Naher	FY2020 FNCA workshop on Research Reactor utilization project	NSRA, MEXT	17 Dec. 2020	Virtual workshop
Dr. Mohammad Amirul Islam	FNCA Project Meeting on Climate Change Research using Nuclear and Isotopic Techniques	ANSTO, Australia	5-6 Nov. 2020	Virtual workshop
Dr. Kamrun Naher and Dr. Mohammad Amirul Islam	JAEA-BAEC Steering Committee Meeting	JAEA	14-15 Dec. 2020	Online meeting
Dr. Mohammad Amirul Islam	FNCA Senior Official Meeting	Cabinet Office, Gov. of Japan	3-4 Mar. 2021	Online meeting
Dr. Mohammad Amirul Islam	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)		11-13 Mar. 2021	BCSIR, Dhaka
Robin Barman	Follow-up Training Course on Nuclear and Radiological Emergency Preparedness	BAEC and JAEA	22-3 Dec. 2020	TI, Savar, Dhaka
Ragib Absar Ramon	Follow-up Training Course on Environmental Radioactivity Monitoring	BAEC and JAEA	10-16 Jan. 2021	TI, Savar, Dhaka
Dr. Shahzad Hossain, Jobair Maudood and Md. Saiful Islam	International e-Conference on Physics 2021	Bangladesh Physical Society	5-7 Feb. 2021	Virtual Online platform
Dr. Kamrun Naher, Dr. Rahat Khan, Umma Tamim, Robin Barman, Md. Saiful Islam and Ragib Absar Ramon	Workshop for Confirmation of Feasibility Study and Strategic Planning for Proposed BAEC High Power Research Reactor Project	CRR, AERE, Savar.	10-18 Feb. 2021	AERE, Savar and BAEC HQ
Dr. Kamrun Naher and Dr. Rahat Khan	Workshop on Confirmation of Layout Plan, Design and Cost Estimation for Proposed BAEC High Power Multi-purpose Research Reactor Based on Stakeholder Demand	CRR, AERE, Savar.	7-17 Jun. 2021	AERE, Savar and BAEC HQ
Dr. Kamrun Naher and Dr. Rahat Khan	Workshop on Reviewing of Survey Activities and Feasibility Study Report for Proposed BAEC High Power Multi-purpose Research Reactor (HPMPRR)	CRR, AERE, Savar.	20-26 Jun. 2021	AERE, Savar and BAEC HQ

3. Collaboration Work/MoU

Collaboration with

- Sunway University, Malaysia
- Indian Institute of Technology, Kharagpur, India
- Prince of Songkla University, Thailand
- Suez Canal University, Egypt
- University of Brunei Darussalam, Brunei Darussalam

- University of St. Andrews, UK
- University of Dhaka, Bangladesh
- Military Institute of Science and Technology, Bangladesh
- Atomic Energy Centre, Dhaka (AECD)

4. Repair, Maintenance and Renovation Works

- Amplifier of the diffractometer at SAND laboratory has been repaired.
- Repair and maintenance work has been done for Multi-Channel Analyzer of the diffractometer at SAND laboratory of NS group.

5. Others

Actively participated in two FNCA projects.

INSTITUTE OF ELECTRONICS (IE), AERE

General Electronics Division, IE

Objective

This division deals with the design, development, and fabrication of electronic and nuclear instruments which are mainly used for testing and measuring purposes. Several Nuclear Instruments have been designed in the General Electronics Division. These are Portable Radiation Dose Rate Meter (MDGE), Hand and Foot Radiation Monitor (HFRM), and Scintillation Survey Meter (SSM). These Instruments have been supplied to different Institutes and Industries across the country.

Activities

1. Research and Development Work(s)

- Microcontroller based portable radiation dose rate meter (MDGE).
- Microcontroller-based hand foot and cloth contamination monitor.
- Design and development of microcontroller based chiller controller for VLSI Laboratory.
- Design and development of a microcontroller based temperature control system.
- Design and development of a microcontroller based light control system.
- Design and development of laboratory power supply.
- Design and development oflight intensity control system for microscopic measurement and photography system.

2. Software Development

Development of Microcontroller Based Instruments: The software development of Microcontroller Based Instruments is going on.

3. Production Work(s)

- Light Intensity Control System for Microscopic Measurement and Photography System.
- Model- LICS03, Serial No.: 032101Beneficiary: IFRB. This Instrument has been designed and fabricated as per the requirement of the MIID division IFRB in Mar. 2021.
- Light Control System, Model: LCS01, Serial No: 111901.This Instrument has been designed and fabricated.

4. Repair and Maintenance Work

- Portable Radiation Dose Rate Meter, Model: DRGE-31, Serial No:070402, Beneficiary: MAF Newsprint Mill Ltd. Chattogram, repair date: Jul. 2020.
- Radiation Alert Inspector (Dose Rate Meter), Model: Inspector, Serial No: 12911, Beneficiary: HIS Inspection Services (BD) Ltd., repair date: 18 Aug. 2020.

- Portable Radiation Dose Rate Meter, Model: MDGE-11, Serial No: 101201, Beneficiary: BSMEC, Cox's Bazar, Repair Date: 10 Sep. 2020.
- Portable Radiation Dose Rate Meter, Model: DRGE-31, Serial No: 070401, Beneficiary: Nuclear Mineral Unit, INM, AERE, Savar, repair date: Nov. 2020.
- Portable Radiation Dose Rate Meter, Model: MDGE-11, Serial No: 121401, Beneficiary: Bangladesh Institute of Nuclear Agriculture (BINA), repair date: Dec. 2020.
- Gamma Source Controller of Co-60 Gamma Irradiator, Model: GSCIE-11, Beneficiary: GSD, IFRB, Mar. 2021.

5. Electronic Re-Calibration of Radiation Instruments

- Portable Radiation Dose Rate Meter, Model: DRGE-31, Serial No: 030701, Beneficiary: Abdul Monem Ltd.(Beverage Unit), Cumilla, re-calibration date: Jan. 2021.
- Portable Radiation Dose Rate Meter, Model: MDGE-11, Serial No: 071301, Beneficiary: RNPD, Institute of Nuclear Science and Technology, AERE, Savar, re-calibration date: Jun. 2021.

6. Manpower Development/Training Program(s)

Name of the participant	Title of the event	Organizer	Date	Place
Md. Ziaul Hasan Majumder	Nuclear and Radiological Emergency preparedness Course-2020	TI	22 Nov. - 3 Dec. 2020	TI, AERE

7. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Md. Ziaul Hasan Majumder	5th International Conference on Inventive Systems and Conrotl (ICISC 2021)	JCT College of Engineering and Technology	7-8 Jan. 2021	Coimbatore, India (Online)
	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13 Mar. 2021	BCSIR

Nuclear Electronics Division, IE

Program(s)

- Design, development and fabrication of nuclear instruments for laboratory use.
- Refurbishment of nuclear instruments.
- Repair, maintenance and installation of nuclear and non-nuclear equipment.
- Academic program: Supervise/Guide thesis work.
- Human resource development and training program.

Activities

1. Research and Development (R & D) Activities

1.1 Design, development and fabrication of the area radiation monitor (ARM)

Area Radiation Monitors are used in nuclear installations to ensure the radiation safety of the personnel. Design and Development of microcontroller-based digital ARM has been completed in cooperation with General Electronics Division. Development work for the inclusion of more channels is going on.

1.2 Design, development of a gamma source control console (GSC)

Gamma Source control Console (GSC) is a customized controller for 90kCi Co-60 Gamma irradiator for its research and industrial application. The failure of BRIT supplied control console it stopped Research and industrial application related to the Irradiator. An emergency system has been setup to continue the research and industrial application. A step has been taken to develop a control console that will control and displays the Irradiation time of the Co-60 source along with Compressor ON time. Development work is going on.

1.3 Design and development of ultrasonic humidity controller

It is a customized instrument for Insect Biotechnology Division of IFRB which is control the humidity of laboratory. One ultrasonic humidity controller has been designed and supplied to IBD, IFRB. The development work of humidity controller is going on.

1.4 Design and development of microcontroller based multichannel radiation detection system

Multichannel radiation detection system is an instrument used in laboratory and field applications to analyze an input with low-level radioactivity. Development of this system is going on.

1.5 Design and development of microcontroller based switchover relay

Changeover relay system is an important part of sophisticated system where a system should run only a few hours and switching to another system which serves the same purpose is very crucial. In many industries, Laboratories certain environment like temperature, humidity is desired and to attain such environment cooler or heater or humidifier is required but such system should not run for a long time as it adversely affects its longevity. Scientist and Engineers of this division has completed the design of microcontroller-based changeover system which will automatically switches to another system after a predefined time.

1.6 Design and development of high voltage power supply system for radiation detection and monitoring system

High voltage power supply (HVPS) is an elementary part in radiation detection and monitoring system and its importance has increased after entering into the era of Nuclear Power. A HVPS has been designed to power up NaI based scintillation detector and the system can be used to drive GM tube or Si based radiation detector after little adjustment that gives it scalability in the field of radiation detection.

1.7 LDR based light sensor development for measuring ambient light intensity

Indoor light intensity monitoring is very essential to maintain an optimum light level according to the specific requirements. Human comfort and wellbeing largely depend on the light level in an indoor environment which may vary from person to person and also according to their time of activities. In this project a light depended resistor (LDR) based light intensity sensor is developed which provides a low cost and dynamic solution to measure the intensity of light in lux(lx) unit. We are anticipating, this cost-effective lux sensor will be helpful to monitor light intensity more efficiently compared to other lx sensors available in market.

1.8 Design and development of artificial environment and monitoring system using microcontroller

Artificial environment is a very important part of research in the field of biology, micro-biology and medical science. It is being used to have a closer look on the instinctive habit and nature of specific animals, plants and insects. In this experiment Arduino Uno based intelligence system with other related sensors has been developed that monitors surrounding environment's temperature, humidity, light intensity and recreates these variables inside an enclosed area with the help of humidifier-dehumidifier, heater-cooler and lighting system. This artificial environment will make the animals and insects to express their instinctive habits and the observation on their habits will help us to achieve realistic results of laboratory experiments.

1.9 Design and development of an IoT-based smart system to monitor, control, and record of laboratory environment

This work represents a microcontroller-based automated system employed to monitor and control the laboratory environment from the cloud. A standard LDR (Light Dependent Resistor) based light sensor was developed and a DHT (Digital Humidity and Temperature) sensor was used to acquire surrounding humidity, temperature and light intensity data. Those data were displayed on a Liquid Crystal Display (LCD) and can be accessed from the cloud.

1.10 Development of PIC-based frequency counter

Frequency is the fundamental property of any signal that conveys important information in signal processing like radiation dose rate measurement. In these work a PIC16f876 based frequency counter is developed that counts the incoming signal frequency and displays it on an LCD. These system measures frequency up-to 56 kHz and consumes 25 mW of power.

1.11 Development of cloud monitoring system

Cloud monitoring system is very essential in modern life. A proto type of cloud monitoring system id developed based on A Tmega328p microcontroller. The microcontroller is the main controlling unit of this system that employs an esp8266 module to connect with the nearest Wi-Fi and sends humidity and temperature data to ThingSpeak platform. Data sent from the system can be monitored or processed from anywhere in the world accessing ThingSpeak platform.

2. Repair and Maintenance Work

- One Ultrasonic Humidity Controller, Model No.-UHCIE-II, Serial No.-051801 has been repaired to IBD, IFRB, AERE, Savar, Dhaka.
- One Ultrasonic Humidity Controller, Model No.-UHCIE-II, Serial No.- 032001 has been repaired to IBD, IFRB, AERE, Savar, Dhaka.
- One Ultrasonic Humidity Controller, Model No.-UHCIE-II, Serial No.-061701 has repaired to IBD, IFRB, AERE, Savar, Dhaka.

3. Manpower Development/Training Program(s)

Name of the participant	Title of the event	Organizer	Date	Place
Md. Motinur Rahman	PPR 2008 and Public Procurement Management	BAEC	11-22 Oct. 2020	AERE

4. Others

Fahmida Akter, CE of this division, working as a project Director of the ADP Project titled “Improvement and modernization of the laboratory facilities of Institute of Electronics”.

Production Division, IE

Objective

The Production Division is mainly engaged with fabrication, assembling and repair of the electronic instruments in order to meet the requirement of different institutes of BAEC and other organizations of the country.

Activities

1. Production Work(s)

Name of the equipment	Specification	Quantity
Production of Digital pH Meter	Measuring range: 0-14 pH, Resolution: 0.01 pH, Input impedance: 10^{12} Ohms, Accuracy: ± 0.01 pH, Type of pH electrode: combination type, temperature compensation: Mannual, input base current: 10Pico Amp. (Approx.), Power requirement: 220 V AC, 50Hz, Readout: 3.5 digit display, Weight: 1.5 Kg (Approx.)	1
Production of A.C. Voltage Stabilizer	Upper cut-off voltage: 270V, Lower cut-off voltage: 120V, Time delay: Direct (No delay), 30 sec. (For TV/Comp), 3 min (For Fridge), Stabilizer output: 205-235V, Input voltage: 220VAC, 50Hz, Weight: 8 Kg (Approx.)	1
Production of Drop-Out Relay	Upper cut-off voltage: 250V, Lower cut-off voltage: 180V, Time delay: 3 min (adjustable), Input voltage: 220VAC, 50Hz, Output (safe range): 180-250V, Weight: 1.8 Kg (Approx.)	2

2. Repair, Maintenance and Renovation Works, etc.

Name of the equipment	Quantity
Drop-out relay	9
A. C. voltage stabilizer	3

Repair and Maintenance Division, IE

Objective/Introduction

The division has been providing services through repair, maintenance and installation of scientific, nuclear, non-nuclear and medical instruments of different institutions of Bangladesh Atomic Energy Commission (BAEC) and outside of this organization. In addition, with design, development, fabrication and refurbishment activities, expert of this division are also taking part in the new instrument installation in BAEC.

Activities

1. Repair and Maintenance Work(s)

Name and description of the instruments	Intender
Canon Laser Jet Printer, Model: LBP6230dh, Serial No: NPJA133475, Manufacturer: Canon, Country of Origin: Vietnam, Approximate Price of the Instrument: 25,000/- (Twenty Five Thousand Taka Only)	IES, AERE
Circuit of AC, Model: WP-008-05, Serial No: 130109, Malaysia, Manufacturer: Toshiba, Approximate Price of the Instrument: 10,000/- (Ten Thousand Taka Only)	ITBBR, AERE
UPS, Model: UVS-1500, Serial No: 394100, Manufacturer: Micro, Country of Origin: Bangladesh, Approximate Price of the Instrument: 10,000/- (Ten Thousand Taka Only)	NRCD, INST, AERE
Tesla Gun, Serial No: C3112/83, Manufacturer: Brings, Country of Origin: Germany, Approximate Price of the Instrument: 10,00,000/- (Ten Lac Taka Only)	RIPD, INST, AERE
Dose Calibrator, Model: VDC-404, Serial No: 20308-5810-04, Manufacturer: Veenstra, Country of Origin: Netherland, Approximate Price of the Instrument: 6,00,000/- (Six Lac Taka Only)	RIPD, INST, AERE
Canon Laser Jet Printer, Model: LBP3300, Serial No: LQHA328290, Manufacturer: Canon, Country of Origin: China, Approximate Price of the Instrument: 30,000/-(Thirty Thousand Taka Only)	ITBBR, AERE
Gamma Calibrator System, Model: GC-60, G10, GI-AM241, SC2323G, Serial No: 0411-2828, Manufacturer: Hopewell Designs, Country of Origin: USA , Approximate Price of the Instrument: 90,00,000/-(Ninety Lac Taka Only)	SSDL, HPRWMU, INST, AERE
NIM Power Supply, Model: 0722, Serial No: 13000128, Manufacturer: Canberra 3102D, Country of Origin: USA, Approximate Price of the Instrument: 20,000/-(Twenty Thousand Taka Only)	RNPD, INST, AERE
Sound System (Amplifier), Model: DM368, Manufacturer: Philips, Country of Origin: UK, Approximate Price of the Instrument: 2,00,000/-(Two Lac Taka Only)	IFRB, AERE
HP Laser Jet Printer, Model: P1102, Serial No: VNF3R577883, Manufacturer: HP, Country of Origin: Vietnam, Approximate Price of the Instrument: 12,000/-(Twelve Thousand Taka Only)	CAD, AERE
Mega Digital Scale, Model: AS-C6, Serial No: 128005, Manufacturer: Mega Digital, Country of Origin: China, Approximate Price of the Instrument: 5,000/-(Five Thousand Taka Only)	IBD, IFRB, AERE
Circuit of Photo Copier, Model: MPW3067, Serial No: CA3200178D, Manufacturer: Toshiba, Country of Origin: China, Approximate Price of the Instrument: 80,000/-(Eighty Thousand Taka Only)	ITBBR, AERE

Name and description of the instruments	Intender
UPS, Model: 2200VA, Serial No: E1305012887, Manufacturer: Power Pac, Country of Origin: Bangladesh, Approximate Price of the Instrument: 3,500/-(Three Thousand and Five Hundred Taka Only)	NRCD, INST, AERE
Electric Kettle, Manufacturer: Kiam, Country of Origin: India, Approximate Price of the Instrument: 2,000/-(Two Thousand Taka Only)	IES, AERE

Robotics Instrumentation and Control Division, IE

Objective

- Robotics
- Instrumentation using Metamaterials
- Design and Development of Control Systems

Activities

1. Research and Development Activities

1.1 Study about shape conversion for resonant tunneling method for subwavelength imaging

M. A. U. Zaman, K. Song, M. H. Shaim and S. Hur

Resonant tunneling method for subwavelength imaging has prospective application in near field cases. But due to diameter modulation factor the fabrication of such kind of lens is more complex than Fabry-Pérot (FP) resonance-based lens. As primarily the theory of resonant tunneling lens is based on cylindrical hole, we extended it for square shaped parallelepiped hole. Therefore, at this work we have mainly proposed a way for shape conversion which might be used as a handy tool regarding fabrication perspective.

2. Manpower Development/Training Program(s)

Name of the participant	Title of the event	Organizer	Date	Place
M. Anzan-Uz-Zaman	Training Course on PPR-2008 and Public Procurement Management	TI	11-22 Oct. 2020	AERE

3. Collaboration Work/MoU

KIMM Ambassador Network

Collaboration with Korea Institute of Machinery and Materials (KIMM); Period: Jun.-Dec., 2020.

4. Other

Design and Maintenance of Electrical line for AC change over switch at IFRB.

Solar Cell Febrication and Research Division, IE

Objective

- To develop a good research team to conduct research in the field of renewable energy.
- To adopt the solar cell fabrication technology.
- To train and develop skilled manpower in the field of renewable energy.
- To fabricate high efficiency single crystalline silicon solar cell.
- To provide environment for conduction research in the field of solar cell fabrication technology.
- To test solar cell that are imported, as a standard testing laboratory for solar cell and solar panel.
- To provide research facilities to the university's student on renewable energy.
- To initiate research collaboration with home and foreign universities.
- To help the government to achieve the millennium Development goal in the field of renewable energy.

Activities

1. Research and Development Activities

1.1 Study of waveform sampling front-end ASIC development for GSO/APD with doi information

M. N. Islam, M. S. Alam and M. A. S. Haque

Study of waveform sampling front-end (WSFE) application specific integrated circuit (ASIC) development for GSO/APD with DOI Information has been presented in this research. This study confined to a detector module multi-array avalanche photodiodes(APD) with GSO crystal for high resolution animal PET, depth-of-interaction (DOI) information by pulse shape discrimination and multi-channel waveform sampling front-end ASIC. Study reveals that APD has shown better performance compared with PMTs for a given geometry and radiopharmaceuticals while individual readout of detector have better resolution and counting rate over light sharing or charge division schemes. Each channel of the WSFE ASIC which has been fabricated on a 4.9mm x 4.9mm wafer using Rohm 0.35µ CMOS ASIC development technology comprises of a preamplifier, a variable gain amplifier(VGA) and a fast analog to digital converter(ADC) to digitize signals from the APD. Micrograph, design specifications, performance and results of the WSFE chip for individual components have been presented as well.

1.2 Development of multi-layer printed circuit board using eagle with CAD and CAM

M. N. Islam, M. S. Alam and M. A. S. Haque

Development of Printed Circuit Board (PCB) by using Eagle has been presented in this project. The Eagle is a CAD tool comprises of Schematic Module, Layout Editor Module, Autorouter Module and CAM Job. The schematic module is for development schematic. After designing the schematic, Electrical Rule Check (ERC) would be performed for electrical errors and consistency check between schematic and board. Thereafter, with the help of this schematic, it needs to create a board in the Layout Editor Module. Then the Digital Rule Check (DRC) has to be operated for reporting any errors in the Board like clearance errors under the set of design rules. Thereafter, 100% finished multi-layer (1 - 16) board would be created by Autorouter with desired track size and layer. Afterwards, adding ground and mounting holes manufacturing data have to be generated by CAM Job and send the board house for fabrication. Finally, the board house provides multi-layer finished Printed Circuit Boards (PCBs). After fabrication, the board should be assembled and tested successfully. The testing data would be presented for functionality characteristics.

1.3 Extraction, optical properties, and aging studies of natural pigments of various flower plants

S. M. A. Zumahi, N. Arobi, H. Taha, M. K. Hossain, H. Kabir, R. Matin, M. S. Bashar, F. Ahmed, M. A. Hossain and M. M. Rahman

Extraction process of five different flowering plants utilizing different dye extraction methods and solvents (ethanol and water) to choose the best dye removal process. The FTIR spectra revealed the presence of several clear functional groups for all five natural dyes. The analytical studies such as UV spectroscopy, column chromatography, and vacuum evaporation were performed to isolate the dyes from their solutions. The UV-Vis studies on the pigments of flower extracts indicated broad absorption peaks in the visible region including clear bandgaps. Among the studied pigments, Alternantheraficoidea showed the lowest direct bandgap of 1.69 eV and an Urbach energy value of 6.33 meV.

The dye extraction yield rate improvement was extended from 11.7 to 24.7% (water solvent) and 11.3-32.4% (ethanol solvent). Throughout the studies, it was observed that ethanol produced a better extraction for organic dyes than water as a solvent. Aging studies revealed that all the dyes at the room temperature showed better stability with minor changes in the observed optical parameters in oxygen-rich conditions; however, these parameters have shown significant variations at a 60 °C temperature.

1.4 A holistic framework towards understanding the optical and dielectric behaviors of perovskites/graphene oxide hybrid films for light absorbing active layer

N. Arobi, S. M. A. Zumahi, K. Ibrahim, M. M. Rahman, M. K. Hossain, M. M. R. Bhuiyan, H. Kabir, A. Amri, M. A. Hossain and F. Ahmed

Methylammonium trichloride $CH_3NH_3Cl_3$ (MACl), methylammonium lead trichloride $CH_3NH_3PbCl_3$ (MAPbCl), and graphene oxide (GO) doped methylammonium lead trichloride GO-$CH_3NH_3PbCl_3$

(MAPbCl:GO) perovskite based thin film coatings deposited onto glass substrates using wet-chemical based spin coating technique at varying GO concentrations (0.025, 0.050, 0.075 g/ml), were investigated for their structural, compositional, optical, and dielectric characteristics. Characterizations of the coatings were carried out using XRD, SEM, FTIR, and UV-Vis spectroscopic methods. The XRD patterns and scanning electron microscope images revealed the cubic and regular constructions of MAPbCl and MAPbCl:GO with higher degree of crystallinity. FTIR studies demonstrated different vibrational modes mainly dominated by the organic salt (MACl) in both structures and a few new bonds such as C═C stretching, C-H (methyl) bending, CH_3-NH_3 rocking were observed. Effective changes in the band-gap values were observed due to GO incorporation. A good correlation among different optical parameter such as absorption coefficient, refractive index, extinction coefficient, and dielectric function was also pragmatic. A very high value of the optical conductivity of 2.02×10^{14} Ω/nm was shown by MAPbCl:GO (0.05 g/ml) perovskite composite. Hence, MAPbCl:GO coatings could be successfully used as a good light absorbing layer in perovskite solar cell (PSC) in an open-air environment and may be explored for further development to achieve a stable structure.

Very Large Scale Integration Technology Division, IE

Objective

Very Large Scale Integration (VLSI) Technology Division has started its journey since 2012 in Bangladesh Atomic Energy Commission, Savar, Dhaka. This division has two clean-rooms (white room of 10,000 grade and yellow room of 1,000 grade) with several microelectronic device fabrication and characterization instruments. This Laboratory opens a new horizon in microelectronics and semiconductor research field for the first time in Bangladesh.

Activities

1. Research and Development Work(s)

- Research on thin film electronic, optoelectronic materials, and condensed matter for high performance electronic device.
- Effect of radiation on semiconductor material used in electronic device.
- Compound semiconductor research for microelectronics/optoelectronics devices.
- Structural and optical property investigation of Gamma (γ) irradiated MoO_3 nanoparticle and thin films.

2. Manpower Development/Training Program(s)

Name of the participant	Title of the event	Organizer	Date	Place
A. A. Mortuza	Enhencing innovative capacity in public service	BAEC	11-12 Mar. 2021	BAEC HQ

INSTITUTE OF COMPUTER SCIENCE (ICS), AERE

Nuclear Cyber Security Division, ICS

Objective/Introduction

The main activities of Nuclear Cyber Security Division (NCSD) are to conduct basic and applied research on nuclear cyber security, computer network and information security, cyber physical infrastructure with new 4^{th} industrial technologies. NCSD also provides training in the field of relevant security issues, cyber security building awareness and ICT for the development of human resources at BAEC. NCSD publishes several articles in the peer reviewed journal, conference proceedings, and participates in the relevant international/national seminars and workshops. This division provides IT enabled services to BAEC as well, such as BAEC domain based official email services, Management Information System, E-Nothi services, software and web application development, maintenance and up gradation of inter-network infrastructure of BAEC through ensuring security at core level network system, manpower development etc. Establishing a data center is going on under the supervision of NCSD Lab for the data security and digitalization of different activities for the Commission. NCSD has developed moodle based e-learning management software as a part of human recourses development and nuclear cyber security awareness to the public. The NCSD is working for the implementation of secure nothi system at BAEC as administration of E-Nothi system.

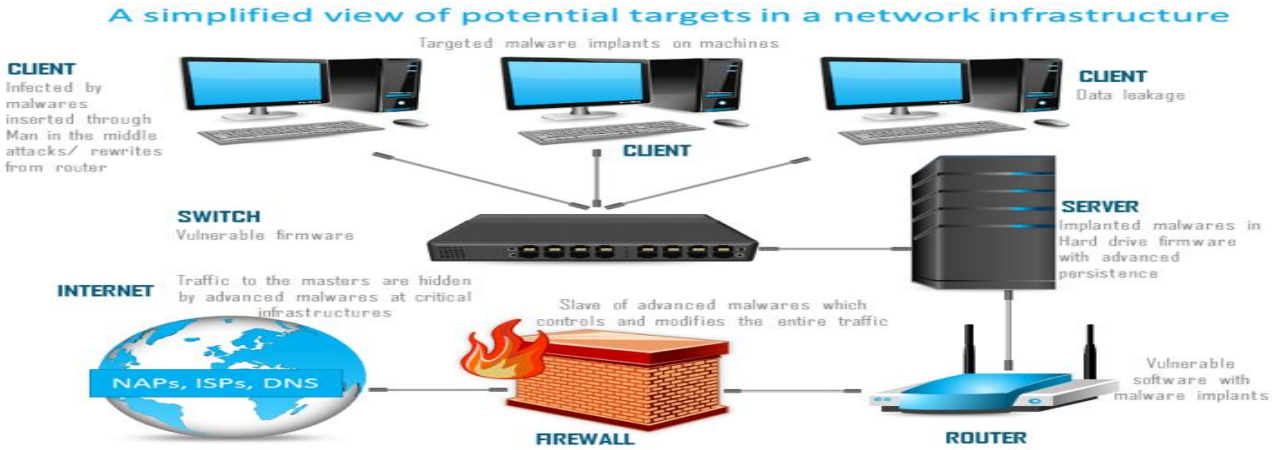
Activities

1. Research and Development Work(s)

1.1 Research on nuclear cyber security and network security at BAEC perspective

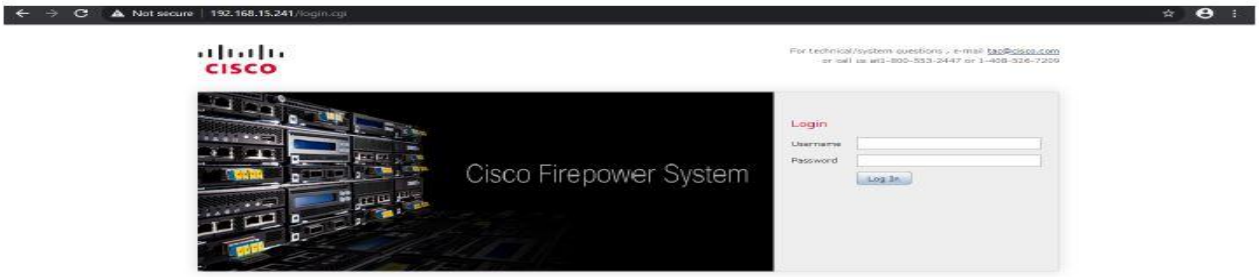
M. S. Islam, K. N. S. Mitu, M. H. Ali and M. D. Hossain

ICS has designed, developed and implemented Network System like LAN and Wi-Fi at BAEC HQ, AERE and AECD. A large number of computers and digital control systems are connected with these networks publicly or privately. So it's a challenging issue to ensure network security for these networks and nuclear cyber security which is concerned with the nuclear related digital control system. Nuclear Cyber Security lab is continuing its research activities and expanding services activities to prevent, detect and respond malicious or unauthorized acts directed at nuclear and radioactive material and its digital control system and providing high assurance security that digital computer, communications system and networks are adequately protected against cyber attacks.



A Simplified AERE Inter network Architecture

Currently, CISCO next generation hardware firewall has been implemented at ICS network server room, AERE as a part of ensuring core network security under the supervision of NCSD lab.

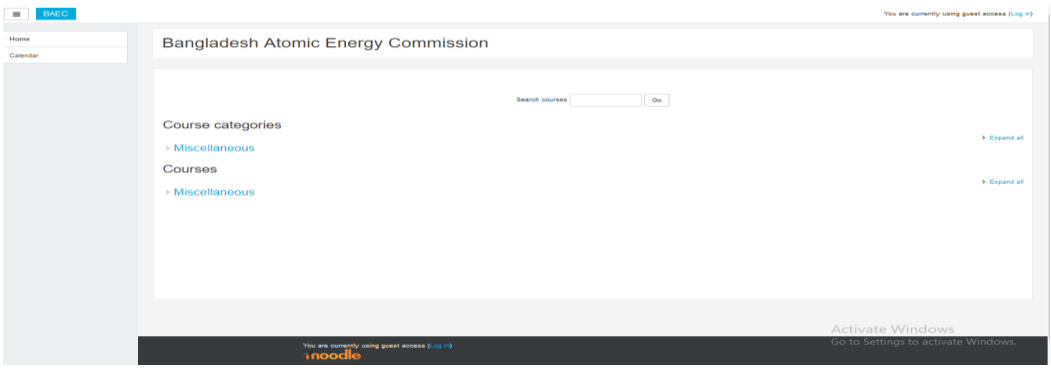


CISCO Firepower system at ICS server room

1.2 Continuation of moodle based e-learning management system for implementing online based nuclear and related education at BAEC

M. S. Islam, K. N. S. Mitu, M. A. Uddin and M. D. Hossain

Bangladesh Atomic Energy commission (BAEC) is a research organization where different academic curriculum with research is going on. For this purpose, different institutes of BAEC offers specialized training courses, Industrial attachment training, different nuclear activity short term or long term courses etc. So to make easier this kind of training course, Moodle based E-learning Management System has been developed at NCSD division of ICS Network Local server**.** Moodle is used to administration, documentation, tracking, reporting and delivery of educational courses or training programs.



Moodle Based E-Learning Management System at BAEC

1.3 Research on nuclear knowledge management system

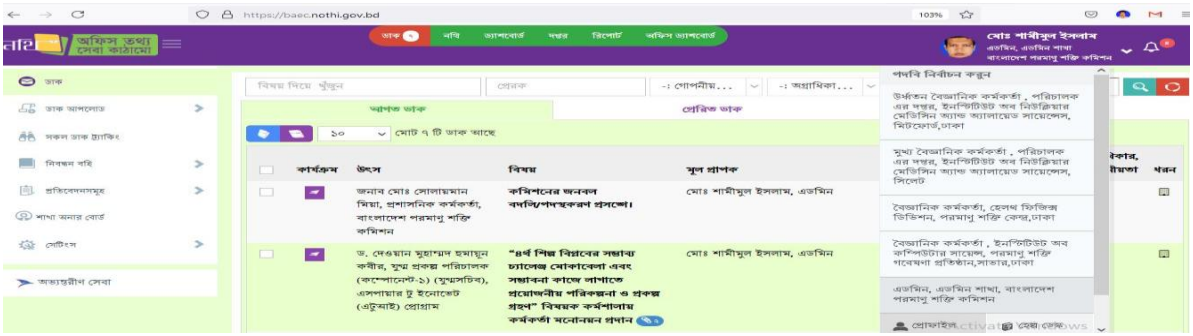
M. S. Islam, K. N. S. Mitu and M. D. Hossain

Bangladesh Atomic Energy commission (BAEC) is a research organization where multidisciplinary researches are going on. Nuclear Knowledge Management (KNM) is one of the paramount research area of NCSD lab according to the BAEC current demand and it is conducting the research for acquiring, transforming, developing, disseminating, cloud based and centralized preserving and sharing knowledge, relevant to achieving specified nuclear knowledge. Automation and nuclear data simulation are needed as a part of nuclear knowledge development for the BAEC.

1.4 Implementation and administration of E-Nothi system at BAEC and its regional offices

M. S. Islam, M. A. Uddin, M. D. Hossain and M. S. Ahmed

BAEC and its regional offices surrounds with many official administrative activities. Now in modern days, its very difficult to accomplish research and managerial administrative task by applying traditional manual nothi system. Its also consumes time, cost and visit. So, to reduce this hassle of manual nothi system, BAEC and its regional offices has implemented e-Nothi System under the supervision of Institute of Computer Science. The admin of E-Nothi system who is from the NCSD division of ICS at BAEC plays a vital role for implementing and administrating the system. The admin is responsible to join an employee to the system, can make resign the employee by taken order from higher authority, Nothi headings edit, any mistaken correction, training to employees etc related activities.



Administration Panel of BAEC E-Nothi System

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Md. Shamimul Islam and Dr. Shakil Ahmed	e-Nothi Training for Focal Point and Office Admin by A2I	a2i and ICT Division	22 Apr. 2021	Virtual platform
Md. Shamimul Islam	Adoption of necessary plans and projects to address the potential challenges of the 4th Industrial Revolution	a2i and ICT Division	26-29 Jun. 2021	Virtual platform
Kh. Nuba Shittain Mitu	Seminar on knowledge Discovery and Data mining	British Computer Society	12 May 2021	Virtual platform
	International Conference on Machine learning and Artificial Intelligence- AI 2021	British Computer Society	15-17 Dec. 2020	Virtual platform
Md. Shamimul Islam, Mohammed Asraf Uddin and Md. Haidar Ali	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13 Mar. 2021	BCSIR, Dhaka

3. Service Rendered

Name of service	Number/quantity of service provided
BAEC Domain based Official Email Services	250
Management Information System Administration Services	1800
E-Nothi Administration Services	400
Wi-Fi Internet Security Services	500

Computer System and Network Division, ICS

Objective/Introduction

Computer System and Network Division is mainly responsible for designing, implementation of computer networks and use of software for using manageable the network. CSND is to provide services of Computer hardware/software installation/ maintenance and troubleshooting and development/up-gradation of network infrastructure of BAEC, Broadband and Wi-Fi internet service, ID card prepared for BAEC employees/students/visitors Manpower development, IT training and consulting services to BAEC. The division conducts policy and ICT relevant national and international collaboration work with the ministry of Science and Technology.

Activities

1. Research and Development Work(s)

1.1 Up-grade design and deployment of local area network of 200mbps bandwidth implement of BAEC head quarter, Dhaka

M. A. Shameem, M. M. Alam, M. O. Goni and J. Ferdose

BD COM Online limited provides high speed internet communication. To fulfill the current requirements of BAEC considering its smooth operation of high speed internet service, optical fiber based network is the state-of-the-art network solution. An optical fiber network design refers to the specialized processes leading to a successful installation and operation of a fiber optic network which includes determining the type of communication system(s) which will be carried over the network. We consider actual component selection, placement, installation practices, testing, troubleshooting and network equipment installation and startup.

Finally, we consider documentation, maintenance and planning for restoration in event of an outage. Existing local area network (LAN) consists of computer network that interconnects computers situated in different buildings at BAEC using network media. Inside LAN, our employees are offered a computer network design applying metallic structured cabling CAT-6. This cabling enables data transfer up to 200Mbps. The network backbone is then customized using optical links. We perform dimensioning of active elements, such as switches and routers, to ensure their margin was sufficient to meet our data throughput 500Mbps rate requirements. We provide 200Mbps internet bandwidth from BD COM Online Limited for high speed broadband internet services. Planning the route of optical fiber from BD COM Online Limited to BAEC to determine exactly where the cable plant and hardware will be located having decided to use fiber optics and chosen equipment appropriate for the application. As every installation is unique, the actual placement of the cable plant is determined by the physical locations from BD COM Online Limited to BAEC campus along the route. Finally planning for the deployment is a critical phase of any work as it involves coordinating activates of many people. We develop a checklist based on the design path for smooth installation.

1.2 LAN design and network devices mikrotik router, manageable switch separately installation at institute of food radiation and biology (IFRB), atomic energy research establishment (AERE) Savar, Dhaka

M. A. Shameem, M. M. Alam, M. H. Ali, M. O. Goni and J. Ferdose

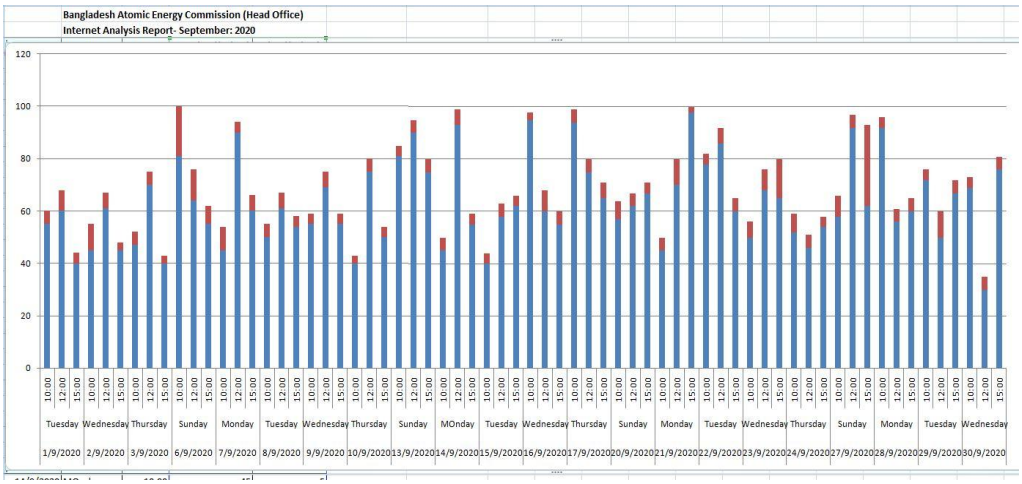
The internet is a structured, organized system. Each network requires a structured planning and designing before deployment it that requires internet access, Internet connectivity factors should be included into the plan, Includes a practical design of network internet connectivity backbone. Procedures of selecting equipments are added and planning designs their networks. The LAN of AERE interconnects more than 550 computers/ Wi-Fi user using various network media. The previous LAN was not properly working; as a result the internet service was interrupted. Hence, Separately LAN was designed and dedicated 20Mbps internate bandwidth supplied using network devices MikroTik Router, Manageable Switch installation currently, internet service is smoothly running at VDG Lab. LAN Networking at IFRB smoothly installed. Every network requires a regular maintenance such as storage maintenance, remote resource access, user management, log management and some other management. Monitoring is a regular task for all network system. It is mandatory when the system is dedicated to public service to make a user friendly and dependable monitoring system. As a result of this LAN network VDG Lab, IFRB, AERE of Savar, Dhaka is getting a high speed internet service.

1.3 An analysis of bandwidth and traffic pattern for network security of Bangladesh Atomic Energy Commission (BAEC, Head Office)

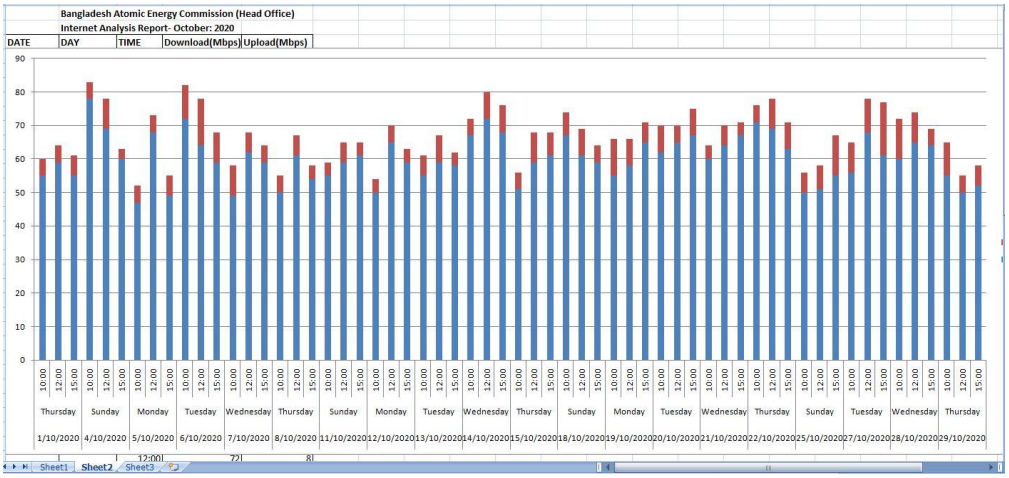
M. M. Alam, M. A. Shameem, M. O. Goni and J. Ferdose

Internet usage has changed, and the demands on the broadband access networks have increased. Characterizing the traffic, as seen by a broadband access network, can help understanding both the demands of today and the demands of tomorrow. In this paper we analyze traffic measurements from Bangladesh Atomic Energy Commission (BAEC, Head Office) broadband access network and derive corresponding user behavior models. The paper focuses on Internet usage in terms of traffic patterns, volumes and applications.

The data presented in this paper was collected from Bangladesh Atomic Energy Commission (BAEC, Head Office) IP access network. The network offers broadband Internet access as well as other services. The network is fiber based, and users can freely choose among the services offered by the different providers connected to the network. The network uses dynamic IP-address allocation with DHCP. The lease time for the IP-addresses varies with the service provider with the shortest lease time. All data was anonymized, where each IP address was coded with a unique identification number, using a hash function. The figures of below will show some patterns of bandwidth usage in a particular time-frame.

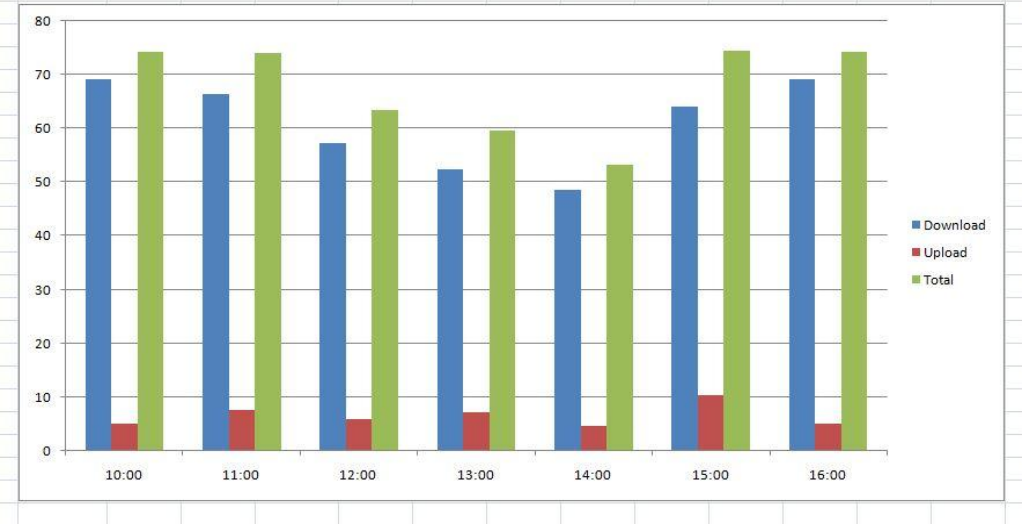


Bandwidth Usage of BAEC (Sep. 2020)



Bandwidth Usage of BAEC (Oct. 2020)

	AVERAGES(September 27- October 1)						
	10:00	11:00	12:00	13:00	14:00	15:00	16:00
Download	69.2	66.40	57.4	52.4	48.6	64	69.2
Upload	5	7.60	6	7.2	4.6	10.4	5
Total	74.2	74	63.4	59.6	53.2	74.4	74.2



Bandwidth Usage of BAEC (Analyzing Time-wise Bandwidth of One Week)

1.4 LAN design and network device cisco wi-fi router installation rest house (AERE) at Atomic Energy Research Establishment (AERE) Savar, Dhaka

M. A. Shameem, M. M. Alam, M. H. Ali, M. O. Goni and J. Ferdose

The internet is a structured, organized system. Each network requires a structured planning and designing before deployment it that requires internet access, Internet connectivity factors should be included into the plan, Includes a practical design of network internet connectivity backbone. Procedures of selecting equipments are added and planning designs their networks. LAN was designed and up-gradated using network devices Wi-Fi Router installed, internet service is smoothly running at AERE Rest House. Network requires a regular maintenance and monitoring is a regular task for all network system. It is mandatory when the system is dedicated to public service to make a user friendly and dependable monitoring system.

2. Manpower Development/Training Program(s)

Name of the participant	Title of the event	Organizer	Place
Md. Mahbub Alam	Nuclear and radiological emergency preparedness training	BAEC and JAEA	Dhaka
	Increasing innovation to implement on citizen services	a2i and MoST	Dhaka
	Planning and preparation to address the challenges of 4IR	a2i andMoST	Dhaka

3. Assemble, Troubleshooting, Repair and Maintenance of PC

Following number of new computers have been assembled for ICS as well as other Institute of BAEC and 50 computers have been repaired and upgraded.

Name of the institute	No. of PC
Institute of Nuclear Science and Technology (INST), Savar	3
Institute of Food and Radiation Biology (IFRB), Savar	5
Institute of Computer Science (ICS), Savar	8
Central Engineering Facility (CEF), Savar	7
Institute of Nuclear Mineral (INM), Savar	4
Central Administrative Division (CAD), Savar	6
Central Finance and Accounts Division (CF and AD), Savar	7
Scientific Information Unit (SIU), Savar	4
Institute of Radiation and Polymer Technology (IRPT), Savar	2
Training Institute (TI), Savar	4

4. Preparation of ID card

The Official ID card for each employee working in BAEC is prepared by Computer System and Networking Division, Institute of Computer Science. In Jul.-2020 to Jun.-2021 more than 166 ID Cards have been prepared by Computer System and Networking Division from different Institutes/Divisions in BAEC.

Name of the institute	Quantity
Institute of Nuclear Science and Technology (INST), Savar	29
Institute of Food and Radiation Biology (IFRB), Savar	27
Institute of Electronics (IE), Savar	9
Institute of Computer Science (ICS), Savar	9
Central Engineering Facility (CEF), Savar	3

Name of the institute	Quantity
Institute of Nuclear Mineral (INM), Savar	2
Central Administrative Division (CAD), Savar	13
Central Finance and Accounts Division (CF and AD), Savar	2
Daily Basis Employe, AERE, Savar	15
Student, AERE, Savar	10
Energy Institute (EI), AERE, Savar	4
Institute of Tissue Banking and Biomaterial Research (ITBBR), Savar	1
Center for Research Reactor (CRR), Savar	4
Scientific Information Unit (SIU), Savar	1
Institute of Radiation and Polymer Technology (IRPT), Savar	2
Contorctors Employec AERE, Savar	2
Atomic Energy Centre, Dhaka	12
BAEC Head Quarter, Dhaka	10
Institute of Nuclear Medicine and Applied Science (NINMAS), Rajshahi	5
Institute of Nuclear Medicine and Applied Science (ININMAS), Shahbag, Dhaka	2
Training Institute (TI), Savar	1
Nuclear Medical Physics Institute (NMPI), Savar	2

5. Assemble, Installation, New Connection, Fiber Splicing, Troubleshooting, Repair and Maintenance of Network devices

Name of the institute	Quantity
Institute of Nuclear Science and Technology (INST), Savar	80
Institute of Food and Radiation Biology (IFRB), Savar	131
Institute of Electronics (IE), Savar	22
Institute of Computer Science (ICS), Savar	15
Central Engineering Facility (CEF), Savar	14
Institute of Nuclear Mineral (INM), Savar	12
Central Administrative Division (CAD), Savar	39
Atomic Energy Center, Dhaka	120
BAEC Head Quarter, Dhaka	135
Energy Institute (EI), AERE, Savar	27
Tissue Banking and Biomaterial Research Unit (TBBRU), Savar	21
Center for Research Reactor (CRR), Savar	3
Scientific Information Unit (SIU), Savar	12
Training Institute (TI), Savar	30
Institute of Radiation and Polymer Technology (IRPT), Savar	31
Hostel Block, DG Banglo and Quarter, Savar	28

Software Engineering Division, ICS

Objective/Introduction

The Software Engineering Division (SED) is mainly responsible for all aspects of nuclear software system from the early stages of system specification through to analysis, design, development and maintaining the system after it has gone into use. In addition, this division is continuing research and development in the field of building knowledge-based expert system to full-fill the goal of Digital Bangladesh, nuclear knowledge management system, e-learning, computer security, mining nuclear knowledge, software development meeting scientific and computation need, data acquisition and analysis, computer simulation and modeling, artificial intelligence and internet of things (IOT), developing database system for storing and processing nuclear data, facilitating paperless administrative work in BAEC, developing ICT based applications/tools to provide hassle-free scientific and other services to the mass people and doing research work in the upcoming technologies.

Activities

1. Research and Development Work(s)

1.1 the necessity of encryption to maintain database security

N. K. Datta, M. I. H. Showrov, A. A. Mamun, M. M. Alam and M. S. Ahmed

For an organization, databases are sensitive information containing employees' personal details and confidential information. Many organizations have started to look at data encryption seriously because of recent security breach cases. In maximum cases, database servers are a common mark for intruder because it contains the most valuable information for most organizations. Once a attackers has gained entrance to valuable data from server, chances are they will steal the data from it. As a result, database security is a top priority for today's IT based world.

Through the network, data being viewed as inherently insecure, encrypting the data itself can be the best option. In terms of database security, encryption can protects the actual data within the database. Therefore we have to build an encrypted database for the software that is running in our organization.

If we have an encrypted database, an attacker may try to find ways to decrypt the encrypted data. How far they could go depends on the cyphers' complexity and algorithms applied to generate the encrypted data. Also, attackers will try their best to access encryption keys, leading them to open the vault or decrypt the encrypted data, similar to gold mining; after all, data is the new gold these days. To avoid these kinds of data breach attempts, it is important to secure the infrastructure in all ways, including limiting access to servers where possible.

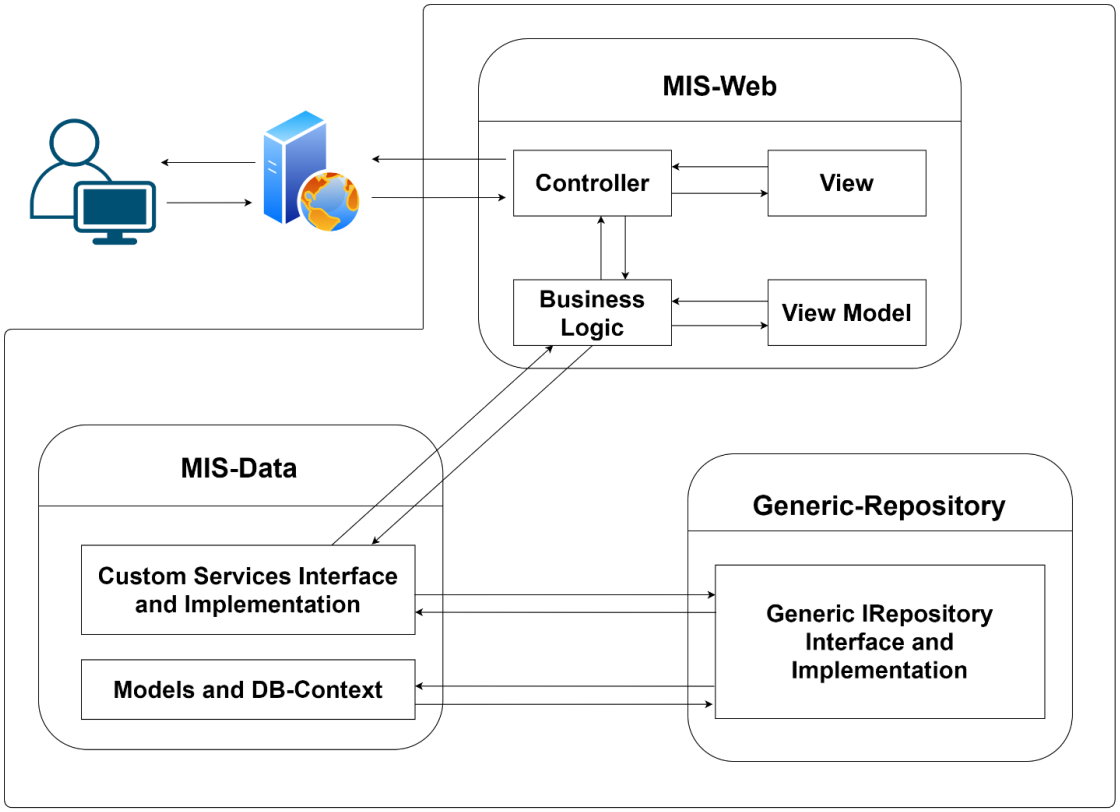
Data encryption is a process of encoding the data. It is mainly a two-way function, which means encrypted data has to be decrypted with a valid encryption key. Encryption is one such technique of Cryptography. Encryption is a way to conceal information by altering it so that it seems to be random data that is not understandable by an unauthorized person. The combination of PKI (Public Key Infrastructure) technology to manage security through encryption and SHA256 one way hash function can perform as a robust encryption technique.

Sensitive data always exists in an organization. It is important to understand not all data requires encryption. Definitely, some data have to be globally shared or frequently repurposed; this type of data does not need to be encrypted.

1.2 Back-End coding flow architecture of BAEC MIS (Management Information System)

A. A. Mamun, N. K. Datta, M. I. H. Showrov, M. M. Alam and M. S. Ahmed

The important goal of a software architecture is to provide developers with a way to organize programming code in such a way that it encapsulates the business or organizational logic but keeps it separate from the delivery mechanism.



Coding Flow Architecture

The round-edged boxes represent separated projects and the sharp-edged boxes in side every project represent different blocks into it.

The main rule of here is that code dependencies can only move from the outer levels inward. Code on the inner layers can have no knowledge of functions on the outer layers. The variables, functions and classes (any entities) that exist in the outer layers cannot be mentioned in the more inward levels. It is recommended that data formats also stay separate between levels, which facilitate development, deployment, operation and maintenance.

When a user sends request to view or manipulate data, the controller in MIS-Web project catches the request first, then communicates with the Business logic. While requested data is fetched, controller makes an action result with Views that can be rendered at client side and the controller doesn't know about what is outside of its boundary. The business-logic layer gains data access through dependency injection from Custom services written in the project named MIS-Data and maps requested data with the view model and sends it back to the controller. View modes are custom designed models used to filter model attributes which provides clean data to the next level through mapping. For every entity there are custom services written in MIS-Data, passes class parameter and ask for data to the Generic repository layer which only have the access to the DB-Context (The data access layer with the database).

Every process works independently and communicates through interface that provides better testability for any of these levels. If the development team decides to change the framework later, it will also help to do so by changing less code. In addition, if the team wants to integrate several frameworks together, it can also be achieved at the bottom layer. So, none of codes at the above layers don't need to change.

The architecture mentioned above provides lots to facilities, some of them are:

- Centralization of the data access logic makes code easier to maintain.
- Business and data access logic can be tested separately.
- Reduces duplication of code.
- A lower chance for making programming errors.

1.3 Importance of social media data in the research of data science

M. I. H. Showrov, N. K. Datta, A. A. Mamun, M. M. Alam and M. S. Ahmed

The usage of social media (e.g. Facebook, Twitter etc.) has increased rapidly in recent years. But it faced a rapid surge because of the COVID-19 outbreak. Peoples' behavior shifted towards social media due to continuous lockdown. It changed the user behavior and habits and made them dependent on digital media [1]. Comparing to the previous year, there was approximately 10.40% increase in the usage of social media. Moreover, TikTok also gained 12 million individual U.S. visitors in Mar. 2020 [2]. Furthermore, a research shows that about 42% male and 46% female claim that claim that their time on social media has increased as a result of the pandemic [3]. With the current trends of technologies, especially the role of computer science, computer technologies have fairly shown their contribution to medical decisions, such as infectious diseases and outbreaks [4, 5]. Historical data are utilized in the process, and an increase in the availability of data enables researchers to generate better decisions and conclusions. Recently, the social media data obtaining from reasonable sources including social media platforms is easier than before. Data science is a multi-disciplinary field that uses scientific methods, processes, algorithms and systems to extract knowledge and insights from structured and unstructured data. It helps to identify and analyze the real-time trend and is currently acts as the focal point for modern business marketing strategies. Moreover, opinion mining of people especially in the pandemic situation helps to identify the remarkable increase of the use of social media has ushered in a growing volume of both structured and unstructured data in different formats, such as text, pictures, videos, sounds, etc. Moreover, it has progressed to become a critical driver for collecting data and spreading information across various sectors like business, science, entertainment and media, journalism, and politics. This volume opens up new opportunity for analysis and discovery of the pattern that provide insights into key challenges, trends, social challenges, and market. For instance, a marketing firm looking for identifying the patterns in customer behavior to forecast future purchasing habits would need to utilize predictive analytics and modeling that needs customer review on the products and services.

The Correlation between Data Science and Social Media Data: The correlation between data science and social media has been repeatedly demonstrated across numerous use cases, shaping business strategies, scientific and medical research, product development, and marketing optimization. Some of correlations are as follows:

- **Monitoring the impact of COVID-19 Pandemic:** Data science techniques are currently used to monitor the worldwide impact of the pandemic by analyzing social media data, and to help inform the public about facts and risks of COVID-19 pandemic.
- **Enhancing Decision Making of the Organization**: Organizations analyze big data to find out the trends in real-time and use these insights in order to inform their decision making by minimizing the business risks.
- **Medical and Scientific Research:** Social media data is a vital resource for healthcare research that offer real-time updates to the public, and raise awareness about different health issues. Scientists, healthcare organizations, and researchers use this social media data and apply data science to take the advantages of the availability and accessibility of data for educational, collaboration and research purposes.

1.4 Air transport industry challenges: The case of the coronavirus

M. I. H. Showrov, N. K. Datta, M. M. Alam and M. S. Ahmed

Due to coronavirus pandemic, the global air transport is facing extreme challenges. In general, aviation creates opportunities for businesses and individuals, and in return can create dangers and threats to society. In particular, the spread of infectious diseases or pandemics -such that aviation can act as a channel of disease transmission- or the effect of aviation on global warming are two clear examples of the negative external effects of the aviation industry on society that need to be addressed. In this regard, the economic performance of the industry is very important. In analyzing the transportation industry, one should pay special attention to possible, reasonable, and desirable scenarios. Hence, protectionist policies, government assistance, and other industrial strategies can be reviewed. The policy review of government actions in the face of the challenges of the aviation industry emphasizes the importance of designing reasonable scenarios for sustainable development and greater welfare of communities.

1.5 Contents management, up-gradation and uploading of the official web portal of BAEC

N. K. Datta, M. I. H. Showrov, A. A. Mamun, M. M. Alam and M. S. Ahmed

A content management system (CMS) is a software application or set of related programs that are used to create and manage digital content. The website of BAEC is to reflect the activities of different institutes in Bangla as well as in English. All types of up-gradation like notice board, NOC. All types of notices of BAEC on the notice board are updated on the web portal. As a result, everybody can know about notices very easily and able to simplifies official activities and accelerates the activities stated in the notice. These service providing activities are routine work as well as continuous activities of this division. NOC of Officers and staffs for passport that is approved by the BAEC are updated in the web portal. As a result, getting and processing passport from passport office have become easier and faster. Besides those, Recruitment Result, Ex Bangladesh earn leave, different "Service box" are updated on the due time. Transfer order, Tender, Annual Performance Agreement (APA), National Integrity Strategy Action Plan etc. are done according to the request of the higher authority. Several requests notes have been sent to SID, HQ to get updated information/photo of different institutes/divisions of BAEC.

1.6 Management and maintenance "Directory of Personnel" of BAEC

N. K. Datta, M. I. H. Showrov, A. A. Mamun, M. M. Alam and M. S. Ahmed

BAEC maintain an employee database where all scientists, Engineers, Doctors and Geologists are on recorded according to institute. Newly appointed employees are added on the database and any up-gradation process is done in the nick of time. To track the employee faster, add new employees in simple steps, Update or Modify details easily, filter and track the employee faster. According to official order of BAEC any posting/newly recruitment/deletion of scientist are done at the due time on the "Directory of Personnel" of BAEC.

1.7 Management and maintenance of foreign visit records web-based software of BAEC

N. K. Datta, M. I. H. Showrov, A. A. Mamun, M. M. Alam and M. S. Ahmed

Scientists of BAEC travel to abroad to attend in seminars, symposium and training for different official purposes. Foreign visit database aims to store overall information of each and every visit of the scientists. BAEC maintain a Foreign Visit database where all international Seminar/ Symposium/ Conference/ Workshop/ Meeting attended by the employee of BAEC are recorded. We provide technical support on any problem to enhance this activity.

There are features available to search list of event participation of any specific scientist or all the participants of any specific event. It is also possible to search participants or events of any specific month of any year. In any specific visiting history, it shows the name of the event, duration, participant's details including designation and institute. If any problem occurred during maintain the normal activities of this software we provide technical support.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Nayan Kumar Datta	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13th Mar. 2021	BCSIR, Dhaka
Md. Imran Hossain Showrov	Environmental Radioactivity Monitoring-2021	BAEC	10-14 Jan. 2021	TI, AERE, Savar

3. Service Renderd

Name of the services	Nature of service	No. of services
Management and Maintenance Official Web-portal of BAEC	ICT Based Expert Servicers	As per required
Contents Uploading at the Official Web-portal	ICT Based Expert Servicers	~ 420
Management and Maintenance Directory of Personnel of BAEC	ICT Based Expert Servicers	~ 140
Management and Maintenance Foreign Visit Records Web-based software of BAEC	ICT Based Expert Servicers	~ 10

INSTITUTE OF ENERGY SCIENCE (IES), AERE

Objective/Introduction

Bangladesh Atomic Energy Commission is struggling on reinforcing its culture of innovation with un-relented commitment to face the energy challenges of Bangladesh in the new millennium. Energy is the strategic input for sustainable development and the issue of energy security is considered like the individual security, social security and territorial security. Institute of Energy Science has been started functioning in 3 Apr. 2008 at the Atomic Energy Research Establishment campus to build a favorable infrastructure for sustainable energy research and to promote the technological know-how in both renewable and non-renewable energy fields. The main research and development activities are as follows:

- Build trained and skilled manpower in different areas related to energy production.
- Undertake and promote R & D activities in the respective fields.
- Develop new technology for efficient and cost-effective energy production.
- Perform R & D in renewable sources, including hydrogen energy.
- Support academic activities, such as M. Sc., M. Phil., Ph. D. thesis work and and carry out collaborative research programs.

Activities

1. Research and Development Work(s)

1.1 Assessment of dose distribution of radioxenon due to a postulated accident of TRIGA research reactor in Bangladesh

M. A. Khaer, M. A. Hoq, M. T. Chowdhury and M. M. Rahman

Assessment of radiological dose due to the deposition of ^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, ^{135}Xe, and ^{138}Xe on ground and immersion considering a hypothetical accident of TRIGA Mark-II research reactor at AERE, Bangladesh has been made. Radiological doses have been investigated in different directions using the Gaussian Diffusion Model (GDM). Meteorological parameters like average wind speed, frequency, etc. in different directions around the TRIGA reactor site have also been evaluated. The maximum dose due to ^{131m}Xe, ^{133m}Xe, ^{133}Xe, ^{135m}Xe, ^{135}Xe, ^{138}Xe and the total (^{131m}Xe + ^{133m}Xe + ^{133}Xe + ^{135m}Xe + ^{135}Xe + ^{138}Xe) were found within the range 3.03E-7-1.23E-4 µSv/hr, 1.01E-5-4.09E-3 µSv/hr, 0.0003- 0.14 µSv/hr, 2.29E-5-9.26E-3 µSv/hr, 0.002 -1.111 µSv/hr, 1.11E-5-4.55E-3 µSv/hr, and 0.003-1.269 µSv/hr, respectively for all the dominant directions. The contribution of dose from immersion due to ^{135}Xe is dominant (87.55%). The extracted result can be used to establish the radiological protective measures in and around the reactor site.

1.2 Radiological concentration distribution of ^{134}Cs and ^{137}Cs due to a hypothetical accident of TRIGA research reactor

M. A. Khaer, M. A. Hoq, M. T. Chowdhury and M. M. Rahman

The assessment of the radiological concentration of ^{134}Cs and ^{137}Cs owing to hypothetical accident of TRIGA Mark-II research Reactor at AERE, Savar, Bangladesh is presented here in this work. The concentration of ^{134}Cs and ^{137}Cs were estimated in different pathways consisting of the ingestion of plants, milk, and meat. The most air concentration has been determined at 65 m distance from the core of the reactor. The maximum concentration passed off without delay simply after the accident in various directions. Site-unique meteorological information such as average wind velocity and wind frequency were analyzed. Considering all directions, the maximum concentration has been observed in the “S” direction. The concentrations of ^{134}Cs and ^{137}Cs were determined to be actual in-ground, vegetation, milk and meat. However, the concentration of ^{137}Cs turned into investigated to be higher than the ^{134}Cs. The concentration of ^{134}Cs and ^{137}Cs were found to be lower in vegetation, milk, and meat than that of ground concentration. Overall, in this study, the concentration in meat has really been investigated to be lower. In case of a reactor accident, the effects of concentration assessment will be a valuable guide for measuring radiological protection in case of radiation protection towards the ingestion of vegetables, milk, and meat across the research reactor at AERE, Savar, Bangladesh.

1.3 Implementation of meteorological data and atmospheric dispersion model for radiological consequence analysis

M. A. Khaer, M. A. Hoq, M. T. Chowdhury and M. M. Rahman

For radiological safety evaluation and emergency response, appropriate selection of dispersion model and trustable meteorological data is crucial for their efficient implementation. Until now the Gaussian Plume Model (GPM) and Lagrangian Gaussian Puff Model (LPGM) have been used for radiological consequence assessment and emergency management. The raw meteorological data have been collected from the Bangladesh Meteorological Department (BMD), Dhaka and analyzed. We studied the radiological safety and emergency response of the VVER-1200 type nuclear power plant using the RASCAL 4.3 and HOTSPOT 3.1.2 codes for INES levels 5, 6, and 7 reactor accidents due to SBO concomitant with LOCA for both dry and rainy seasons. The simulation was performed using Gaussian Plume Model and Lagrangian Gaussian Plume Model for short and long-range, respectively.

1.4 Source-term evaluation and simulation of hypothetical accidents of INES levels 5, 6 and 7 for VVER-1200 type reactor

M. A. Khaer, M. A. Hoq, M. T. Chowdhury and M. M. Rahman

The source-term (inventory) was evaluated by RASCAL 4.3 code using the reactor technical data, reactor location and accidental condition. The LOCA concomitant to SBO was assumed to occur at the RNPP site which led the reactor core to be uncovered. In this accident, a rupture was assumed to occur in the reactor coolant system and this initiated the LOCA to happen more rapidly. The nuclear accident was assumed to occur on 9th Jan. 2020 (dry season) and 17th Jul. 2020 (rainy season), while the shutdown, core uncovered, and core recovered time were considered at 10:00, 12:00, and 14:00 respectively. Due to the decay-heat, the fuel rods meltdown during two hours when the reactor core was uncovered. As a result, the radioactive materials were released from the core of the reactor to the containment through rupture of the reactor containment structure which ultimately increases containment temperature and pressure. Finally, due to the failure of the containment, the radioactive materials were released into the environment immediately just after uncovering the core. This supposition was considered to study the effect of the release of radio nuclide on accidental consequence analysis. In these accidents, the containment is supposed to be failed and subsequently, the huge release of radioactivity to the environment was assumed to occur at the rate of 0.3%, 2%, 10% per day corresponding to INES level 5, 6, and 7, reactor accident respectively (Nguyen et al., 2015). The technical data of the RNPP site used as input data of RASCAL and HOTSPOT code.

1.5 Assessment f radiological dose and emergency response due to INES level 5, 6 and 7 accidents of a VVER-type 1200

M. Khaer, M. A. Hoq, M. T. Chowdhury and M. M. Rahman

In this work, off-site radiological consequences for the three most severe accidents defined by INES (INES User's Manual, 2008), such as INES levels 5, 6, and 7 nuclear reactor accidents, respectively due to SBO concomitant with LOCA of the RNPP, Bangladesh were evaluated. Radiological consequence analyses were performed by the radiological consequence analysis codes to assess the radiological safety and preparing the utility for emergency response of the RNPP site. RASCAL and HOTSPOT codes were applied to evaluate radiological dose values such as Total Effective Dose Equivalent (TEDE), Total Effective Dose (TED), Thyroid CDE, Inhalation CEDE, Ground shine, etc. for INES levels 5, 6, and 7 nuclear reactor accidents, respectively for both dry and rainy seasons.

2. Seminar/Symposium/Conference/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Mohammad Mizanur Rahman, Dr. Mohammed Tareque Chowdhury, Dr. Ajijul Hoq and Md. Abu Khaer	Virtual Training on fundamental of boiling two phase flow and its measurement - IAEA TN-BGD1013-2005250	IAEA	8-9 Dec. 2020	IES, AERE
Dr.Mohammad Mizanur Rahman and Md. Abu Khaer	CRP J15002-2nd Research Coordination Meeting	IAEA	28 Jun.- 2 Jul. 2021	Virtual
Md. Abu Khaer	International Conference on Science and Technology for Celebrating the birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13 Mar. 2021	Dhaka

3. Collaboration Work/MoU

3.1 Special Allocation Project

Radiological Safety Analysis due to Accidental Release of Radiocesium from TRIGA Research Reactor

Period: Jul. 2020 - Jun. 2021, Status: Completed.

3.2 IAEA CRP Project

Application of Dose Assessment Codes for Nuclear and Radiological Emergency Preparedness and Response of Nuclear Installations of Bangladesh, Chief Scientific Investigator: Dr. Mohammad Mizanur Rahman, Director, IES, Period: Jan. 2020, Dec. 2022, Status: On-going.

3.3 TC project

Strengthening operational safety, design and development of spent fuel storage facility of the BAEC TRIGA research reactor and capacity building for the design of a thermal hydraulics and reactor safety testing laboratory, Role of this institute: Capacity building for the design of a thermal hydraulics and reactor safety testing laboratory Counterpart (Thermal hydraulics part): Dr. Mohammad Mizanur Rahman, Period: 2018-2020, Statue: On-going.

3.4 MoU

A draft of MoU (Memorandum of Understanding) between the Institute of Energy Science, Bangladesh Atomic Energy Commission, Bangladesh and the Institute for Integrated Radiation and Nuclear Science, Kyoto University, Japan is approved by BAEC and Kyoto University.

INSTITUTE OF RADIATION AND POLYMER TECHNOLOGY (IRPT), AERE

Objective/Introduction

- Application of radiation processing technologies for the socio-economic development of the country.
- Providing commercial gamma irradiation services for quality improvement of food items and sterilization of medical products, pharmaceutical raw and packaging materials etc.
- To provide irradiation service to research organizations for R and D purpose.
- To expand cooperation with other scientific organizations, universities, private and public sectors through mutual exchange of educational programs, training, technical cooperation and expert services.
- To develop human resources in the field of nuclear science and technology.
- Transferring the technology to the entrepreneurs for industrial applications.

Activities

1. Research and Development Work(s)

1.1 Development of different polymeric composite materials for structural applications and radiation shielding

Mechanical properties of various composite polymeric materials are improved by the direct exposure to different doses of Radiation. Various natural fiber and synthetic matrix materials have been utilized for the property improvement of the polymer composites. In continuation, research has been led for development of the radiation shielding materials. Manufacture and characterization of Jute Fabrics Reinforced Polymer based composites were carried out and comparative study between hand Lay-up and Compression Molding Technique were conducted. Impact of sand on mechanical properties of Jute Fabrics Reinforced Polypropylene based composite has been determined. Fabrication and characterization of Carbon Kevlar Reinforced Polypropylene based composites were done. Physico-mechanical property of unidirectional Jute Fiber Reinforced Polypropylene and Linear Low-Density Polyethylene based composite were determined and impact of dye observed.

1.2 Development of advanced materials for biomedical, environment application

Different types of hydrogel were prepared for biomedical application and heavy metal removal.

1.3 Use of radiation, chemical and microbiological tools for water treatment for different uses

Physico-chemical and microbiological quality assessment of surface water of Turag river, Buriganga river and different aquaculture pond in Savar, Dhaka were conducted. Gamma irradiation was used for the treatment of polluted river water. Research was conducted to investigate naturally occurring bacterial strategy in degrading or detoxifying heavy metals of the Buriganga River. Study was conducted in a view to removal of chromium and lead from paint industry effluent by naturally occurring bacteria. Biodegradation capability of pesticide resistant naturally occurring bacteria to breakdown the hazardous residual pesticide was also observed.

1.4 Dye sensitized Solar Cells (DSSCs) were constructed with TiO2 and ZnO nanoparticles and the effect of gamma (γ) radiation on them was determined.

2. Manpower Development and Training Program

Title of the event and speaker	Date	Place	No. of participant
Development of Biodegradable Films, Speaker: Md. Razzak, SSO, IRPT	17 Aug. 2020	IRPT, AERE, Dhaka	13
Jute-Based Composite Materials, Speaker: Dr. A.K.M. Moshiul Alam, PSO, IRPT	24 Aug. 2020	IRPT, AERE, Dhaka.	13
Kenaf Fiber Reinforced Polymer Composites, Speaker: Md. Serajum Manir, SSO, IRPT	14 Sep., 2020	IRPT, AERE, Dhaka	13
Co-60 Gamma Irradiator Pool Water Quality Monitoring, Speaker: Md. Marjanul Haque, SO, IRPT	21 Sep. 2020	IRPT, AERE, Dhaka	13
Co-60 Gamma Source Pool Water Corrosion and its Prevention, Speaker: Mohammad Zahirul Islam Mollah, PSO, IRPT	12 Oct. 2020	IRPT, AERE, Dhaka.	12
Fabrication of Hydrogel Based Mattress Used For treating Burn Patient, Speaker: Dr. A.K.M. Moshiul Alam, PSO, IRPT	22 Oct. 2020	IRPT, AERE, Dhaka	12
Measurement of EC and pH of Co-60 Pool Water, Speaker: Md. Razzak, SSO, IRPT	17 Nov. 2020	IRPT, AERE, Dhaka	12
Fabrication of Ag- Nanoparticle Based Composites, Speaker: Md. Serajum Manir, SSO, IRPT	24 Nov. 2020	IRPT, AERE, Dhaka	12
Fabrication and Characterization of PLA Based Silk Biocomposites, Speaker: Md. Rabiul Islam, SO, IRPT	6 Dec. 2020	IRPT, AERE, Dhaka	14
Method Validation of Co-60 Gamma Irradiator, Speaker: Md. Marjanul Haque, SO, IRPT	22 Dec. 2020	IRPT, AERE, Dhaka	11
Co-60 Gamma Irradiator Pool Water Quality Control SOP, speaker: Md. Rabiul Islam, SO, IRPT	18 Jan. 2021	IRPT, AERE, Dhaka	15
অফিস আচরণ বিধি ও নিয়ম শৃঙ্খলা সংক্রান্ত, speaker: G.M. Amanat Ali, AO, IRPT	27 Jan. 2021	IRPT, AERE, Dhaka	15
Synthesis of Cellulose Nano Crystals, speaker: Md. Razzak, PSO, IRPT	15 Feb. 2021	IRPT, AERE, Dhaka	16
Synthesis of Ag- Nanoparticles, speaker: Md. Serajum Manir, SSO, IRPT	22 Feb. 2021	IRPT, AERE, Dhaka	14

Title of the event and speaker	Date	Place	No. of participant
Calibration Curve and Dose Mapping of Co-60 Gamma Irradiator, speaker: Md. Razzak, PSO, IRPT	11 Mar. 2021	IRPT, AERE, Dhaka	15
Documentation For Accreditation by Bangladesh Accreditation Board, speaker: Md. Marjanul Haque, SO, IRPT	16 Mar. 2021	IRPT, AERE, Dhaka	15
Biodegradable Shopping Bags, speaker: Dr. Ruhul Amin Khan, Director, IRPT	5 Apr. 2021	IRPT, AERE, Dhaka	8
Plant Growth Promoter, speaker: Md. Razzak, PSO, IRPT	25 Apr. 2021	IRPT, AERE, Dhaka	8
Validation of Analytical Methods, speaker: Md. Razzak, PSO, IRPT	5 Mar. 2021	IRPT, AERE, Dhaka	14
Preparation of Control Charts, speaker: Md. Marjanul Haque, SO, IRPT	19 Mar. 2021	IRPT, AERE, Dhaka	14

3. Seminar/Symposium/Conference/Meeting Attended

Name of participant	Title of the event	Organizer	Date	Place
Dr. Ruhul Amin Khan	UV- Radiation	IRPT, AERE	16 Aug. 2021	IRPT, AERE, Dhaka
Md. Razzak	Sharing Experience on "Protection of Radioactive Sources" in India	IRPT, AERE	13 Sep. 2021	IRPT, AERE, Dhaka
Md. Serajum Manir	Nuclear Safety Culture Analysis	IRPT, AERE	14 Dec. 2021	IRPT, AERE, Dhaka
Dr. Ruhul Amin Khan	Gamma Radiation	IRPT, AERE	8 Mar. 2021	IRPT, AERE, Dhaka
Md. Marjanul Haque	Virtual Workshop on Radiation Technology for Industry and Environment	IAEA	19-22 Apr. 2021	Vienna (Virtual)

4. Repair, Maintenance and Renovation Works

- Mechanical problem of IRPT Co-60 Gamma plant was resolved and plant started working properly.
- Source up-down cable was repaired.
- Shuffling circuit was repaired.
- The capacity of the demineralized water treatment plant is 1000L/hr which was checked properly.
- Repair and maintenance work were done for Heat Press Molding Machine of Composite Lab of IRPT.

5. Stakeholder Seminar/Meeting Arranged

Title	Place	Date
Experience Sharing Meeting with Stakeholders	Seminar Room, IRPT, AERE, Savar, Dhaka	29 Dec. 2020
Experience Sharing Meeting with Stakeholders	Seminar Room, IRPT, AERE, Savar, Dhaka	25 Feb. 2021

6. Service Rendered and Revenue Income

The 350 kCi Co-60 gamma irradiator of IRPT is used to irradiate food items, medical and pharmaceutical products. Generally, 25 kGy is used for sterilization purposes and up to 10 kGy is applied for food items. In this institute, different private companies take food irradiation services for export. The irradiated foods are

mainly spices such as chili, turmeric, coriander, zinger, nut, spirulina, pet food, mushroom etc. Different medical items and pharmaceutical raw materials are irradiated e.g. syringe, surgical gauze, bandage, aluminum tube, specimen container, Eye drape, empty infusion set, petri dish, filter, family planning kits, eye ointment, mannitol, PEG-600, bacitracin Zn etc.

Number of organization	Nature of sample/service	Total number/quantity of sample	Revenue income
4 companies (34 consignment)	Food irradiation	218.479 Ton	74,26,185/-
6 companies (23 consignment)	Medical products	3683.5 cft	19,35,000/-
9 companies (38 consignment)	Pet Food	50.829 Ton	18,27,184/-
Total			1,11,88,369/-

INSTITUTE OF NUCLEAR MINERALS (INM), AERE

Introduction

Institute of Nuclear Minerals is mainly engaged in nuclear mineral exploration program in the potential area of Bangladesh. INM is responsible to explore atomic minerals containing uranium, thorium and other associated valuable metals in different prospective zones of Bangladesh together with nuclear technology transfer to different national, international mining companies, Government organizations for mineral resource exploration and development. Besides INM is now working on geochemical and mineralogical characterization of radioactive rock and sediment, radon survey in potential radioactive anomalous zone of Bangladesh and geo-environmental studies. In addition, this institute provided geophysical borehole logging services as per demands of different organizations/companies.

Activities

1. Research and Development Work(s)

1.1 Installation, calibration and application of ras 24 exploration seismograph (seistronix) for subsurface geological study at AERE campus

M. G. Rasul, S. C. Das, M. Z. Kabir, F. Deeba, M. Rajib, M. S. Islam, M. Asaduzzaman and M. J. Uddin

The current study deals with the installation, calibration and then applied for delineation of subsurface geology of AERE campus using the new RAS 24 Exploration Seismograph (Seistronix) received by the INM. The RAS-24 exploration seismograph is a modular 24-channel, high resolution, signal enhancement seismograph designed for shallow refraction and reflection surveys where shear wave velocity of the near surface materials is estimated. The instrument is widely used in geotechnical, geo-environmental, groundwater and mineral exploration surveys. This is based on a "distributed" approach, like larger seismic systems used for oil and gas surveys. 24 channel geophones were used along a 120 m long line with geophones spaced 5 m apart. Impact energy is generated by hitting on the acrylic board using a sledgehammer and the generated seismic waves were recorded by the geophones. Results are graphically displayed and processed using SeisImager software. The share wave velocities (Vs) of the subsurface materials of the studied area vary from 235 m/s to 278 m/s.

1.2 Levels of radon activity concentration and gamma exposure in air of Barapukuria Coal Mine, Dinajpur

M. Z. Kabir, F. Deeba, N. T. Dina and M. S. Islam

Mining activity results in the release of radon gas and its daughter products. This is particularly important in underground mines. Naturally occurring radon-222 was evaluated using AlphaGUARD PQ2000 PRO (Saphymo, Germany) radon monitor for estimating radon concentration in surface air and groundwater of Barapukuria coal mine area, Bangladesh. By coal mining and exploitation, radioactive radon gas, which is captured in natural geological structures, is reallocated from the deep coal layers. Hence in coal mines may occurs increased accumulation of radon due to its supply through network of fissures and soil fractures, especially through a system of groundwater. The radon concentration for underground water in the mine area

varies from minimal value 108 ± 21 Bq/l to maximal value 459 Bq/l. In air, radon concentration was found from 16± 3 to 80± 12 Bq/m3. Gamma radiation dose rate in air varies from 27.24 to 67.24 nSv/h.

1.3 Measurement of radon activity concentration in river water and floodplain sands of the Jadukata and Chalti river, Sunamganj, Bangladesh

M. Z. Kabir, M. G. Rasul, M. Rajib, S. C. Das, M. S. Islam, M. Asaduzzaman and M. J. Uddin

The Jadukata and the Chalti river are situated in Tahirpur and Bishwamvarpur Upazilla respectively in Sunamgonj district which flows from the Meghalaya ranges. It is reported that numbers of anomalous radioactive areas have been detected in Jadukata river valley of Sunamgonj which is close to the Mahadek uranium belt of India. In the Mahadek basin of Meghalaya, sandstone type uranium deposits are reported. Hence, there is a possibility to leach uranium and this uranium bearing solution may have transported through river water coming from the source area. Keeping this view in mind, a radon survey was conducted at the Jadukata river valley and adjoining area which was a part of exploration activity of the institute of Nuclear Minerals. In-situ radon concentration was measured in river water as well as flood plain sands from randomly selected suitable locations using AlphaGUARD PQ2000 PRO (Saphymo, Germany) radon monitor. Radon concentration in river water of the survey area varies from 3.61± 0.42 Bq/l to 10.23±1.29 kBq/l whereas in floodplain sand it ranges 24±03 Bq/m3 to1270±108 kBq/m3.

1.4 Assessment of water quality around Maddhapara Granite Mining Area, Dinajpur, Bangladesh

F. Deeba, M. Z. Kabir, F. T. Ahmed, S. Sultana, N. T. Dina and S. C. Das

The Maddhapara Granite Mine area lies within latitudes 25° 33′ 15″ N to 25° 34′ 13″ N and longitude 89°3′ 30″ E to 89° 4′ 53″ E. The study area is located in Parbottipur upazila of Dinajpur district of the northern part of Bangladesh. The aim of this study was to analysis the quality of water resources in order to investigate the influences of mining activities on water quality around the study area. Physical properties like pH, Electrical Conductivity (EC) and Total Dissolved Solid (TDS) has been measured by HANNA-HI 9813-5 and HANNA-H 8733 respectively. 20 samples from surface and groundwater were collected from this selected area and have been analyzed for Cl^- $HCO3^-$ $CO3^{2-}$ $NO3^-$, $SO4^{2+}$, $PO4^{3+}$, Na, K, Ca, Mg, Fe, Mn, Cu, Zn, Pb, Cr, Ni, Co and Al using Atomic Absorption Spectroscopy (AAS) to assess their hydrochemistry, drinking suitability and their possible sources of contamination. The average concentration of Na, K, Ca, Mg, Fe, Mn, Cu, Zn, Pb, Cr, Ni, Co and Al are 6.7, 7.33, 1.29, 1.25, 0.19, 0.01, 0.04, 0.12, 0.06, 0.06, 0.03, 0.14, 0.03 ppm respectively. The mean concentration of Cr and Pb exceeded the Bangladesh drinking water standards (2009) and WHO (2017).

1.5 Identification of naturally occurring radioactive materials (NORMs) in the geological formations of jaintiapur and adjoining areas, Sylhet Using HPGe Detector

M. Rajib, M. S. I. Bhuiyan, S. C. Das, M. G. Rasul, M. Z. Kabir, F. Deeba and S. Hossain

Activity of the Naturally Occurring Radioactive Materials (NORMs) was measured in the Tertiary sediments collected from geological formations exposed in the Jaintiapur and its adjoining areas, North-east Bangladesh. High Purity Germanium (HPGe) detector was utilized to determine natural concentration of ^{40}K, ^{226}Ra and ^{232}Th in the soils. The study was a part of the continuing exploration program to identify the potential areas of uranium deposition. A total of 12 sq. km area was surveyed where the average values of NORMs were found as 611±10, 45±13 and 83±12 Bq/Kg, respectively for ^{40}K, ^{226}Ra, ^{232}Th. The highest value of ^{40}K was 1040 Bq/Kg, whereas that of ^{226}Ra and ^{232}Th was measured as 86 and 179 Bq/Kg, respectively. However, no particular spatial distribution was observed at the surveyed area. Therefore, although being slightly anomalous than background radioactivity of the region, the values are not indicative to any rich uranium mineralization zone.

1.6 Exploration for NORMs and REEs in the transported sediments at Jadukata river flood plain, Sunamganj

M. Rajib, M. G. Rasul, M. Z. Kabir, S. C. Das, M. Asaduzzaman and M. J. Uddin

River transported materials from the uranium rich area are potential source of naturally occurring radioactive materials (NORMs) and few associated rare earth element (REE) containing minerals and rock fragments. In

north-east region of Bangladesh, there are several rivers which carry huge amount of transported gravel, pebble and sand size particles of Indian origin and deposit in the flood plain of Bangladesh. Due to abrupt change of elevation and therefore the energy of river water, various sizes of particles are found immediately into Bangladesh territory. As part of exploration activity of the institute, a geological field survey was conducted at the Sunamganj area where several rivers were found to deposit large volume of transported materials. In search of NORMs and REEs in those environments of deposition, the field exploration was conducted using portable gamma-ray spectrometer and radon monitor. Uranium (U-238), thorium (Th-232) and potassium (K-40) was determined in-situ in as many as 50 pre-located sampling points. Soil radon was determined in location at specific interval, whereas radon in water was measured at multiple locations. Two drill holes of appx. 30 feet deep and 4 ditches of 10X5 ft area with about 10 ft deep were made to obtain samples from various depth. In-situ radioactivity and radon in soil and water was tabulated whereas the samples were taken to measure the mineralogical composition, elemental concentration and radioactivity. After obtaining results from each analysis, quantification of radioactive materials will be assumed and the total reserve will be estimated.

1.7 Effect of external radiation on mineral grains from placer depositions of Bangladesh

M. Rajib, M. J. Mollah, M. Hossain, M. F. Hossain and T. Saha

Major beach placers of Bangladesh, such as ilmenite, magnetite, rutile, zircon, garnet along with potential monazite concentrated and silica were undergone irradiation. Individual minerals were separated from beach and river sands and upgraded to best possible physical grade by density, magnetic and electric separators. Gamma dose of 0.01, 0.1 million Grey (mGy) was provided by the Co-60 source with 100% source efficiency. The samples were again irradiated at 1.0 mGy with similar source of approximate present activity of 90 KCi (from initial source activity of 350 KCi). Microscopic observation, X-ray diffraction analysis and elemental composition was attempted before and after irradiation, and radiation induced effects was analyzed. The study would provide the characterization of those minerals for various application. Besides, it would also contribute to the study of the minerals' property in the case of any radiation effect of geological materials in any potential host rock of geological repository for radioactive waste.

1.8 Application of nuclear technology on archeological conservation in Bangladesh

M. Rajib and A. Z. Showly

Scientific studies of art and archaeology present a necessary complement for cultural heritage conservation, preservation and investigation. As cultural heritage objects are frequently unique and non-replaceable, non-destructive techniques are mandatory and, hence, nuclear techniques have a high potential to be applied to study these valuable objects. Nuclear techniques, such as neutron activation analysis (NAA), X ray fluorescence (XRF) analysis or ion beam analysis (IBA), have a potential for non-destructive and reliable investigation of precious materials. Besides these, radiocarbon dating of archeological materials is another important technology applied in this aspect. Conservation of paintings, provenance of pottery, dating of artifacts, authenticity verification of jewellery and artifacts, etc are some of the application of nuclear technology in heritage research. To introduce such research in Bangladesh, a field survey was conducted at Panamnagar, the historical city at Sonargaon of Narayonganj district. Weathering materials from bricks such as salts and lichen, along with surface and ground water samples were collected to analyze the environmental effect on deterioration of building materials. The solid and water samples will be analyzed by various nuclear analytical techniques present in BAEC.

1.9 Calibration of auxiliary seismic station of CTBTO (AS-007, BRDH)

M. Rajib and M. G. Rasul

The Auxiliary Seismic Station (AS007) at Bariadhala (BRDH), Chattogram is the only station under CTBTO in Bangladesh that receives the seismic data at the country. AS007 is equipped with the Guralp computer system that is connected with National Data Center (NDC) located in Atomic Energy Center, Dhaka of Bangladesh Atomic Energy Commission through the VSAT communication system. The station has been accredited as an internationally certified station on 8th Dec., 2011. The station was later upgraded in Sep. 2017. The seismic station AS007 was established to monitor the activities of nuclear testing through earthquake occurrence in the region. At the same time, it can be utilized for natural earthquake monitoring and subsurface geological information. To obtain the related data for those application, AS-007 needs to be

regularly calibrated, usually twice a year. This calibration is also necessary for the International Data Centre (IDC) to effectively use the captured data from AS-007. As part of scheduled calibration activity of 2021, calibration process was run during 23-25 Jun. with the help of support team of CTBTO. The calibration results were obtained according to the site of BRDH as BHE-0.3059351, BHN-0.4444493 and BHZ-0.3075589. Among them, the channel BHN was found not in spec and therefore, reported to CTBTO for correction.

1.10 Geochemical characterization of tertiary sediments from jaintiapur and its adjacent areas, Sylhet, Bangladesh

S. C. Das, M. G Rasul, R. K Majumder, M. I. Khalil, R. Khan, M. Z. Kabir, F. Deeba and M. Rajib

Geochemical characterization of Tertiary sediments in terms of elemental abundances (Al, Na, K, Mg, Ti, Sc, V, Cr, Mn, Co, Fe, Zn, Ga, As, Rb, Ba, Cs, La, Sm, Ce, Eu, Yb, Dy, Ta, Hf, Th and U) obtained from neutron activation analysis are presented by investigating twenty-seven soil and rock samples from the geological formations exposed in Jaintiapur and its adjacent areas, Sylhet, Bangladesh. Ranges of major elements abundances were 0.16-14.46, 0.29-1.27, 0.26-156.53, 0.29-2.99, 0.21-4.00 and 0.01-0.85% for Al, Ti, Fe, Mg, K and Na respectively. Ranges of trace elements abundances were 1.14-29.94, 18.13-568.97, 36.96-702.26, 10.92-776.58, 9.68-274.40, 0.71-135.64, 83.50-2536.45, 3.55-81.03, 0.98-99.83 and 0.81-12.43µg/g for Cs, Rb, Zn, Cr, V, Sc, Ba, Hf, Th and U respectively. The results show that the mean elemental abundances of the studied samples are above the average upper continental crust (UCC) values. It can be inferred that the elemental distributions in studied geological formation are mostly controlled by heavy mineral distribution such as enrichment of ilmenite, zircon and monazite. Major and trace elemental ratios and enrichment of light-rare-earth elements and Th relative to crustal values indicate the sedimentary processes originated from Himalayan felsic source-rock with the accumulation of heavy minerals.

1.11 Lithological profiling of madhupur clay formation exposed at the INMP project site at AERE Campus, Ganakbari, Savar

S. C. Das, M. G. Rasul, M. Rajib, M. Z. Kabir, F. Deeba and M. J. Uddin

The present study is on the vertical lithological profiling of exposed Madhupur Clay Formation at the INMP project site at AERE, Ganakbari, Savar. The study shows that a thickness of 8m Madhupur Clay Formation is underlined by about 2m thick Alluvial Clay and overlined by about 2m Mottled Clay (base not seen). The Madhupur Clay is brownish to brick red to yellowish red in colour, massive, sandy silt to silty clay in lithology, medium dense to stiff, colitic, contains ferruginous and calcareous nodules, and surficial deposits. Mottled clay is grey in colour with patches of red, yellow and brown, massive and also contains calcareous and ferruginous nodules. Alluvium clay is grey to greyish white in colour, massive, contains ferruginous and calcareous nodules.

1.12 Delineation of subsurface lithology from the drilled boreholes samples of the proposed HPRR site at the AERE campus, Ganakbari, Savar

S. C. Das, R. K. Majumder, M. Rajib, M. Z. Kabir, F. Deeba, M. Moniruzzaman and F. Islam

The present study implies to the delineation of lithology of subsurface geological formations and unit boundaries using the borehole drilling down to a depth 40m with sample collection at each 3 m interval from the four boreholes at the proposed HPRR site at the AERE campus, Ganakbari, Savar. The drilling has been performed using wash boring technique to construct 3-inch (3.62 cm) diameter borehole. The collected samples from the boreholes demonstrate the subsurface lithological distribution of sand, silt, and clays in the area. The uppermost layer (up to the depth of 10 to 12 m) of the area shows reddish-brown, medium dense to stiff silty clay and sandy silt deposits of the Pleistocene Madhupur Clay Formation. The Madhupur Clay Formation is underlain by the sand deposit of various grades along with silts and occasional clay layer, which is the Plio-Pleistocene Dupi Tila Sandstone Formation (base not found) up to the depth of 40 m.

1.13 Determination of fineness modulus (FM) of river sands

M. Rajib

Fineness Modulus (FM) indicates the average size of particle in an aggregate. This is mainly used for the measurement of sand size for civil engineering application, such as construction and earth filling purpose. The FM can be determined by the standard sieve analysis in the laboratory. The thumb rule is the lower the FM, finer the particles and higher FM means larger particles. As standard measurement, FM 2.2-2.6 indicates fine

sand, 2.6-2.9 is medium sand and 2.9-3.2 is coarse sand. To determine the FM of sand, three (3) samples were analyzed using the standard sieve mesh #16, 30, 50 and 100, correspond to 1.18, 0.6, 0.3 and 0.15 mm, respectively. After drying the sample in oven for about 30 min under 80^0C, the sieve shaker was run for about 15 min to obtain fractions at individual mesh. Weighing the sand particles at each mesh, the values were utilized to calculate the FM of the sand particles. The results were found as 2.34, 2.51 and 1.61, which indicates first two samples as fine sand, whereas the 3rd samples is below fine sand size. This analysis can be utilized to provide services as per demand, as well as for research purpose on the size fractionation of sand for various engineering application.

2. Manpower Development and Training program

Name of the speaker	Title	Place	Date	No. of participant
Dr. Md. Golam Rasul Chief Geologist and Director	INM- It's Mission, Vision and Activities	INM	29 Dec. 2020	22
	Leadership/Mindset in Scientific Arena	INM	27 Jan. 2021	20
	CTBTO- It's Activities and Role in Bangladesh	INM	15 Feb. 2021	20
	ADP/SandT Project- Role in Future Plan and Activities of INM	INM	12 Apr. 2021	19
Mohammad Zafrul Kabir Chief Geologist	Geophysical Logging-An Overview	INM	29 Dec. 2020	22
	Geophysical Methods for Uranium Exploration	INM	27 Jan. 2021	20
	Laboratory Safety and Fire Safety	INM	15 Feb. 2021	20
	Citizen Charter	INM	12 Apr. 2021	19
Mrs. Farah Deeba Principal Geologist	Perspective Plan of Institute of Nuclear Minerals (INM)	INM	29 Dec. 2020	22
	এপিএ কর্ম সম্পাদনের সার্বিক চিত্র	INM	27 Jan. 2021	20
	Elemental Analysis Using PXRF	INM	15 Feb. 2021	20
	Annual Activities/ Programs of Institute of Nuclear Minerals (INM)	INM	25 Mar. 2021	19
Dr. Mohammad Rajib Principal Geologist	Geological Exploration	INM	29 Dec. 2020	22
	Nuclear Knowledge Management	INM	27 Jan. 2021	20
	Scientific report/abstract/research proposal/ referencing	INM	25 Mar. 2021	19
	Fire and Laboratory Safety	INM	12 Apr. 2021	19
Engr. Shafiqul Islam Principal Engineer	Power Savings and Preventive Maintenance Works of Electronic Instruments	INM	29 Dec. 2020	22
	Trouble Shooting of Electronic Instruments and Repair and Maintenance Works of Electronic and Nuclear Instruments	INM	27 Jan. 2021	20
	Prerequisite Requirements of Geophysical Logging System. and Head Re-heading of Geophysical Logging System	INM	25 Mar. 2021	19

Sudeb Chandra Das Scientific Office	Use of Software and Data processing in Geological Research	INM	29 Dec. 2020	22
	Methods and Materials of Scientific Research/Petrological and Geochemical Approaches- Sampling to paper publication	INM	25 Mar. 2021	19
	National Integrity Strategy (NIS)	INM	12 Apr. 2021	19

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Md Golam Rasul	Online Training Course on on Access and Analysis of Radionuclide IMS Data and IDC Products training	CTBTO	30 Nov-11 Dec. 2020	WebEx video-conferencing.
	Online Training Course on NDC Capacity Building: Access and Analysis of waveform IMS Data and IDC Products	CTBTO	8-12 Feb. 2021	WebEx video-conferencing.
Dr. Mohammad Rajib	Online Training Course on NDC Capacity Building: Access and Analysis of Waveform IMS Data and IDC Products.	CTBTO	8 to 12 Feb. 2021	Virtual
	RNToolkit v.0.1.1- Radionuclide Analysis Software training on NDC Capacity Building: Radionuclide processing and RN software products.	CTBTO	28 Sep. 2020	Virtual

4. Collaboration Work/MoU

4.1 Special Allocation Project

- Measurement of Radon Activity Concentration and Gamma Radiation Dose in Air of Barapukuria Coal Mine Area, Bangladesh, Principal Investigator: Mohammad Zafrul Kabir, Chief Geologist, Co-Investigator: Farah Deeba, Principal Geologist,Year: 2020-21.
- Application of seismic data from CTBT-NDC (National Data Center) for geological investigation, Principal Investigator: Dr. Mohammad Rajib, Principal Geologist, Co-Investigator: Dr. Md. Golam Rasul, Chief Geologist, Year: 2020-21.

4.2 Research Collaboration with Universities

Salt weathering on archaeological monuments due to environmental factors: A study for the conservation of archaeological heritage of Panamnagar, Bangladesh, Principal Investigator: Dr. Syed Mohammad Kamrul Ahsan, Professor, Department of Archaeology, Jahangirnagar University, Research Associate: Dr. Mohammad Rajib, Principal Geologist; Started on Dec. 2020.

4.3 Lectures Provided

- Subject Based Practical Training organized by Technical Teachers Training College (TTTC), Dhaka on "Hydraulics in Geoscience Research, 2 hours, 12 Jun. 2021.
- 17th Training Course on Oceanography (a) Exploration and processing of heavy minerals from beach places of Bangladesh; 1 hour., (b) Radioactivity in the coastal environment of Bangladesh; 1 hour., Organized by National Oceanographic and Maritime Institute (NOAMI), Dhaka, 9 Jun. 2021.

NUCLEAR MEDICAL PHYSICS INSTITUTE (NMPI), AERE

Objective/Introduction

Institute of Nuclear Medical Physics (INMP) is the pioneer institute which introduced the radiotherapy treatment by LINAC to the cancer patients under Bangladesh Atomic Energy Commission (BAEC) which was started in 2018 and is located at Ganakbari, Savar, Dhaka. In Bangladesh, cancer is the leading cause of mortality due to insufficient of treatment service and also highly expensive. This institute provides the

diagnostic service by using PET-CT, the radiotherapy treatment service by using LINAC and follow up regularly for the cancer patients. INMP consists of a team of professionals oncologists, dynamic medical physicists and well-trained technologists who are promised to ensure the better treatment with the minimum cost all over Bangladesh.

Objective

- To provide patient's services for cancer detection and radiotherapy through medical physics techniques.
- To build up skilled radiation oncologists, medical physicists and technologists through academic and specialized training.

Activities

1. Manpower Development and Training Program

Title	Date	Duration	Participants
Special Course on Medical Physics	19 Mar. 2021 (continuing)	Online platform	24
In-house training	13 Sep. 2020 - 15 Dec. 2020	INMP, AERE	27

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Masud Parvej, Abul Hasnat, Sarmin Suntana, Nazneen Sultana and Samiul Alim	15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH) virtually, 2020	ICRT	7 Dec. 2020	Online platform
Samiul Alim	South Asia Medical Physics and Cancer Research E-Learning Program (ELP-01)	SCMPCER	27 Jun. and 15, 25 Jul. 2020	Online platform
	South Asia Medical Physics and Cancer Research E-Learning Program (ELP-03) (Seven hours lecture ,two-hours practi- cal demonstration, moderated group discussion one hour, one our examina- tion) Awarded 22 CDP credit point.	SCMPCER and IOMP	Feb. 2021	
	Breast Cancer conference	Oncology Club BD	13-15 Nov. 2020	Online platform
	Breast Cancer conference	Tata Memorial Hospital and Nag Foundation (India)	11-16 Jan. 2021	Online platform
	Radiation planning Technique in Carcinoma Breast: In view of upcoming challenges	BMPS	30 Oct. 2020	Online platform
	SAARC Radiation Oncology Symposium Educational Event and Planning challenge.	Radiation Knowledge, USA and Oncology Club BD	6,13, 20 and 27 Mar. 2021	Online platform

3. Scientific Routine Activities (Quality Control (QC))

QC	Times	By using
Geometrical QC	4	-
Absolute Dosimetry	1	Solid phantom
	3	Water phantom

QC	Times	By using
Relative Dosimetry	2	3D water phantom
Air Calibration of CT	45	-
Image Quality of CT	42	CAT phantom
PET QC	178	^{22}Na source

4. Repair, Maintenance and Renovation Works

- Main Thyratron and Thyratron socket of LINAC have been purchased and replaced.
- 17 MLC motors (Half = 12, Full =5) have been replaced.

5. Service Rendered and Revenue Income

Name of service provided		Number/quantity of sample/patient/service	Revenue income
PET Scan		576	1,71,60,000/-
CT-Simulation		133	93,100/-
Manual Plan		4	800/-
3D CRT	Plan	121	6,39,800/-
	Fraction	2473	
IMRT	Plan	8	1,06,200/-
	Fraction	228	
Patient Review		134	26,800/-
USG		4	1,100/-
Total			1,80,27,800/-

BEACH SAND MINERALS EXPLOITATION CENTRE (BSMEC), COX'S BAZAR

Objective/Introduction

- Geological exploration for economic placer minerals in the coastal and fluvial depositional environments of Bangladesh.
- Routine laboratory and plant processing of placer sands; processing and separation of economic minerals like magnetite, ilmenite, zircon, garnet, rutile, silica from bulk sand.
- Comparative study on the occurrence, distribution, mineral composition and characteristics of heavy and radioactive minerals from coastal and fluvial environments of Bangladesh.
- Effect of heavy mineral deposits on ground water quality along the southeastern coast of Bangladesh.
- Determining radionuclides and trace elements in the sediments and seawater of southeast coast.
- Study on marine and coastal environmental radioactivity.
- Laboratory enrichment of radioactive minerals (viz. Monazite and Zircon) and quantification of radioactivity.
- Providing research support and industrial training to academic and professional organizations..

Activities

1. Research and Development Work(s)

1.1 Beneficiation of monazite based on density contrast from IRMS middling of pilot plant at BSMEC, Cox's Bazar

M. M. Karim, M. F. Hossain and T. Saha

Monazite, a rare earth mineral has been beneficiated using gravity separation technique with a laboratory shaking table based on density contrast between different minerals from undifferentiated mineral assemblages of IRMS Middling of pilot Plant at BSMEC, Cox' Bazar. During production of different heavy minerals at

pilot plant major portion of rare monazite (0.90% of raw sand) concentrated at the middling of IRMS. Total 03 (three) different samples are processed for beneficiation at Quality Control Laboratory (QCL) of BSMEC. This concentrate contains near about 12% monazite which can be beneficiated up to 94% enrichment applying three to four cycles of separation using a laboratory shaking table (i.e., Gravity separator) and lab scale IRMS (i.e. Magnetic separator). From washout to 3rd cycle of separation, beneficiation of monazite gradually stepped up as 39%, 61%, 87% and 94% at final stage. The beneficiated samples are sent to Material Science Division, Atomic Energy Centre, Dhaka for detailed mineralogical characterization and elemental analyses with ED-XRD system. The technique is though iterative but easy, convenient, eco-friendly and techno-economically feasible.

1.2 Assessment of heavy mineral deposition from recent deposits of Nijhum Dwip, Noakhali and Their Feasibility

M. M. Karim, M. F. Hossain and T. Saha

Collaboration research is going on with department of Oceanography, Noakhali Science and Technology University on the prospect of heavy minerals present in the recent depositions at the coastal area of Nijhum dwip. As many as 12 (Twelve) samples were received from various locations containing surface and subsurface sample. Heavy Liquid Separation Analysis was conducted to identify heavy mineral percentage of these samples. Size sieve>500µm is to remove unwanted shell and rock fragments, mica chunks and other biological materials. Heavy liquid separation technique by bromoform was applied. Among them sample ID: Station 2; DS-2, Station 3; DS-3 and Station 4; DS-4 are mainly clay. So, these three samples were out from Heavy Mineral Separation due to shortage of sand in samples. In this study, maximum concentration of heavy mineral was 28.1% and minimum concentration was 3.23%.

1.3 Ground water quality monitoring at the coastal area (Kolatoli), Cox's Bazar

M. M. Karim, M. F. Hossain and T. Saha

Long term ground water quality monitoring is being continued to analysis the quality of water at BSMEC and its adjoining area. For this purpose, 12 samples are collected every month from shallow tube wells including 2 sea water samples of this region. As case study, physical parameters such as pH, EC, TDS, salinity and temperature are measured of these samples. Water in the observation wells of Bangladesh Water Development Board, located in BSMEC campus is also included. Further chemical analyses of the water samples are continuing with collaboration with DPHE, Cox's Bazar. Objective of this study is to observe the effect of heavy mineral and radioactive minerals to the physical and chemical quality of ground water of this area.

1.4 Assessment of the physiological condition of heavy mineral deposits located at Shilkhali and Lombori Area of Teknaf Upazila, Cox's Bazar

M. M. Karim, M. F. Hossain, T. Saha and M. M. Islam

A baseline geological survey has conducted at the existing heavy mineral deposit of Shilkhali and Lombori area of Teknaf Upazila. Sampling point selected as random pattern because most of the area covered by human settlement, anthropogenic activities and development project. Uncover and open area got priority for sampling. Total 36 samples collected from Shilkhali area and 40 samples collected from Lombori area and all the samples collected from deposits surface and 5 (Five) feet sub surface. Within this reporting year total 38 (Thirty Eight) samples of surficial deposit are analyzed for heavy mineral concentration using Heavy Liquid Separation Technique. The average abundance of heavy minerals is 18.98% at Shilkhali area and 20.94% at Lombori area. Presence of heavy minerals relatively low in surface condition compares to previously investigated data, because anthropogenic activity destroys natural environment. Most of the deposit area has been deteriorated due to human sattlement, construction of road, schools and other anthropogenic activities and also natural erosion. However, subsurface condition of heavy minerals remains unchanged compare to previously identified heavy minerals deposits along backdune area. But foredune area, i.e. near shore line is changeable because it experienced successive erosion and deposition and this area directly attach with coastal dynamics of the Bay of Bengal.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participants
In-house Training on Annual Performance Agreement for BSMEC Employees	17 Nov. 2020	BSMEC, Cox's Bazar	6

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Md. Masud Karim	Training Course on PPR-2008 and Public Procurement Management	TI, AERE	11-22 oct. 2020	AERE
Tumpa Saha	BAEC-JAEA joint Follow-up Training Course (FTC)-2020 on Nuclear and Radiological Emergency Preparedness Course	TI, AERE	22 Nov.-3 Dec. 2020	AERE
	সরকারি অফিস ব্যবস্থাপনা ও দক্ষতা উন্নয়ন	BIM	18-20 Aug. 2020	Online
Md. Masud Karim and Tumpa Saha	সুনীল অর্থনীতির উন্নয়নে সমুদ্র সম্পদের সুষ্ঠু ব্যবহার ও চ্যালেঞ্জ এবং বিওআরআই এর ২০১৯-২০২০ অর্থবছরে সমাপ্ত R and D প্রকল্পসমূহের ফলাফল উপস্থাপনা সংক্রান্ত সেমিনার	BORI	28 Mar. 2021	BORI, Cox's Bazar
Md. Yousup Ali	Electrical (House Wiring)	MAWTS	8 Nov.-6 Dec. 2020	MAWTS, Dhaka

4. Collaboration Work/MoU

- Joint research with Bangladesh Space Research and Remote Sensing Organization (SPARRSO) on Investigation of heavy minerals using multispectral satellite imagery in the coastal part (Teknaf Upazilla) of Bangladesh.
- Research collaboration with Department of Oceanography, Noakhali Science and Technology University on Prospect of heavy and light mineral depositions of Nijhum dwip, Noakhali.

ATOMIC ENERGY CENTRE (AEC), CHATTOGRAM

Objective/Introduction

- Ensure safety of food and environment from radioactive contamination.
- Monitoring and assessing of pollution level in marine and coastal environment due to nuclear activities or radioactive waste disposal.
- Promote research and development activities on environmental issues.
- Expand cooperation with other scientific organizations, universities, private and public sectors through mutual exchange of educational programs, training, technical cooperation and expert services.
- Develop human resources in the field of nuclear science and technology.

Activities

1. Research and Development Work(s)

1.1 The presence of terrestrial radionuclides in the Karnaphuli and Halda river sediments and concomitant hazards to the dwellers

S. Hossain, A. K. M. S. I. Bhuian, S. Khatun, M. Ahmed and N. S. Resma

Description: The present study measures the concentrations of terrestrial radionuclides in the sediment samples collected from these two rivers by using high-purity germanium (HPGe) γ-ray spectrometry. The concentrations ($Bq.kg^{-1}$) of ^{226}Ra, ^{232}Th and ^{40}K show in the range of 17.63 ± 1.47-38.90 ± 2.50, 27.86 ± 1.76-

48.80 ± 2.70 and 324.28 ± 26.83-640.70 ± 42.70, respectively, which is similar to the literature data and world mean value except for four sampling locations (Kalamiabazar, Natun bridge, Rajakhali and Chaktai khal) that shows higher concentrations of primordial radionuclides. These four sampling points are located adjacent to the industrial wastes discharge channels into the Karnaphuli river. In fact, among the thousands of industries located on the bank of the Karnaphuli river, about 200 units were identified as the sources of environmental pollution. To assess human health hazards due to natural radiation, several indicators such as radium equivalent activity (Ra_{eq}), external hazard index (H_{ex}) and outdoor annual effective dose equivalent were calculated and compared with the recommended limits. The present results serve as an input to prepare the baseline radioactivity in commercially important river sediments prior to the operation of the first nuclear power plant in the country.

1.2 Radiation dose rate evaluation from natural and anthropogenic radioactivity in soil and industrial wastes of nasirabad industrial area, Chattogram, Bangladesh

S. Hossain, A. K. M. S. I. Bhuian, S. R. Talukdar and M. Ahmed

Description:Under this study, a total of 37 (31 soils and 6 solid waste) samples near from different types of industries along four-kilometer range were collected. The presence and activity concentrations of naturally occurring radioactive materials (NORM) and anthropogenic radionuclides in the samples were estimated using HPGe detector of 40% relative efficiency. The activity concentration of ^{226}Ra, ^{232}Th and ^{40}K were found to be ranging from 8 ± 2 to 131 ± 18.33 with an average of 21 Bq.kg^{-1}, 10 ± 2.69 to 133 ± 15.96 with an average of 40 Bq.kg^{-1} and 81 ± 22.68 to 930 ± 260.40 with an average of 449 Bq.kg^{-1} respectively. Besides this, some hazard indices like, the radium equivalent activity (Ra_{eq}), external hazard index (H_{ex}), internal hazard index (H_{in}), and the activity concentration index (I_{γ}) were calculated to assess the radiation hazard in this region. The averages of calculated hazard indices were within the normal limits, except the activity concentration index, which shows elevated values. The outcomes of this study could serve as important baseline radiological data for future epidemiological studies and environmental monitoring initiatives in the study area.

1.3 Study of the background gamma radiation and natural radioactivity of Cox's Bazar district, Bangladesh

S. Hossain, A. K. M. S. I. Bhuian, S. Khatun, S. R. Talukdar, N. S. Resma and M. Debnath

Description: This is an ongoing research work which aims to determine the natural radioactivity level of ^{226}Ra, ^{232}Th and ^{40}K etc. as well as artificial ^{137}Cs in soil, water, sediment and plants from various areas of Cox's Bazar in order to develop a baseline database before RNPP installation. Various parameters like radium equivalent activity, absorbed dose rate, external and internal radiation hazard index will also be calculated to monitor the activity level and to assess the radiological health risks of the inhabitants of this region. Samples have already been collected from various locations of Cox's Bazar district and data collection is going on in our gamma spectrometry laboratory.

1.4 Radioactivity analysis of soil samples taken from the northern shore of the Karnaphuli river in the Chattogram city area

S. Hossain, A. K. M. S. I. Bhuian, S. Khatun, M. Ahmed, N. S. Resma and M. Debnath

Description: This is an ongoing research activity which aims to perform the analysis of natural radioactivity level in soil samples taken from specific locations on the northern shore of the Karnaphuli River in the Chattogram city area. In order to look for any correlation between the radiation dose rate and the environmental parameters, the environmental parameters will be measured in the specific locations. Additionally, hazard indices will also be assessed to see if there are any health risk to the population of the city. Seasonal variation of the radionuclides will also be taken into account in this study. Samples have already been collected from various locations of study area and data collection procedure in going on in the gamma spectrometry laboratory (GSL).

1.5 Qualitative assessment of jar and bottled water available for drinking purpose in the Chattogram city corporation area of Chattogram, Bangladesh

S. Hossain, N. Deb, C. K. Mahmud and N. Khatun

Description:Bottled water and jar water is safe for consumption but sometimes portable bottled water and jar water does not meet the satisfactoriness standards. Here, the concentrations of seven heavy metals were

determined by using Atomic Absorption Spectrophotometry (AAS). To evaluate TBC and TCC, standard plate count (SPC) and membrane filtration technique was exploited respectively. The Physico-chemical property of each sample was determined by the multi-parameter waterproof meter (HANNA, HI 98194). Moreover, concentrations of seven trace metals were determined by Atomic Absorption Spectroscopy (Flame method) and results showed that Bottled water samples and Jar water samples contain Copper concentration in the range of 0.012 to 0.027 mgL/1 and 0.016 to 0.033 mgL/1 respectively. The analysis also revealed that the concentration of Cd, Cr, Pb, and Zn in bottled water samples and jar water samples were nil or below the detection limit of the instrument while Iron was detected in only one jar water sample and Manganese in three jar water samples. In the context of microbiological contamination, 40% jar water samples, as well as 33.33% portable bottled water samples, are contaminated by pathogenic micro-organisms.

1.6 Elementary contaminants and radioactivity levels in the effluent discharged from different industries to murari khal, Patiya, Chattogram, Bangladesh

S. Hossain, A. K. M. S. I. Bhuian, N. Deb, S. R. Talukdar, C. K. Mahmud, N. Khatun, N. S. Resma and M. Debnath

Description: The specific aims of the present work are- to measure the level of natural radioactivity and toxic elements in the investigated samples. Two types of samples (40 of each)- sediment and water have been collected from some selected sites of Murari Khal, Patiya of Chattogram with necessary precautions. The geographical location of sampling points has been recorded by using GPS. The activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K (in Bq.kg^{-1}) of the collected samples have been measured using HPGe γ-ray spectrometry and the data processing and analysis is being carried on. In addition, all the forty samples of sediment have been digested and prepared for the quantitative analysis of heavy metals. The concentrations of heavy metals of 80 samples have been determined by Atomic Absorption Spectrophotometer (AAS).

1.7 Distribution of radionuclides and heavy metals in sediments and mangroves of the coastal zone of Sandwip, Chattogram

S. Hossain, A. K. M. S. I. Bhuian, N. Deb, S. R. Talukdar and C. K. Mahmud

Description: The present study aims to assess the current environmental condition by determining the mass concentration of radionuclides and distribution of various heavy metals in mangrove sediments, plants and to estimate a possible anthropogenic input. Following some precautions, the samples (sediment and mangroves) were collected from some coastal areas of Sandwip Island of Chattogram district. For measuring the activity concentration due to natural radionuclides, the powdered sample were weighed and then taken into individual cylindrical plastic container. Water samples were prepared according to the instruction of IAEA. The containers were sealed tightly and wrapped with thick vinyl tapes around their screw necks. For heavy metal analysis, the samples were prepared according to international guidelines and analysis will be done as per schedule**.**

2. Manpower Development and Training program

Title of the event	Date	Place	No. of participants
In-house training course on office and laboratory management	05 Jan.-25 May 2021	AECC, BAEC	38

3. Training program/Workshop/Seminar/Symposium/Conference/Meeting Attended

Name of the participants	Title of the event	Organizer	Date	Place
Nipa Deb and Nazma Khatun	Chemistry Today-Virtual Educational and Research Lecture Series in Science, Technology and Engineering.	Chemistry Alumni Association (CAAB), BUET	1-11 Sep. 2020	Dhaka
Chowdhury Kaiser Mahmud	Enhencing innovative capacity in public service	BAEC	11-12 Mar. 2021	BAEC HQ

Name of the participants	Title of the event	Organizer	Date	Place
Mohiuddin Ahmed	Follow-up Training Course on "Nuclear and radiological Emergency Preparedness"	Training Institute, AERE	22 Nov.-03 Dec. 2020	TI, AERE
Nazma Khatun	Online training course on National portal	Divisional Commissioner's Office, Chattogram	11 Nov. 2020	Chattogram
Nazma Khatun and Rashmi Roy	Online training course on "Implementation of APA 2020-2021''	SID, BAEC	17 Nov. 2020	Dhaka
Nighat Sultana Resma	33rd Understanding Training Course on ISO/IEC 17025:2017	Bangladesh Accreditation Board (BAB)	12-14 Oct. 2020	Ministry of Industry
	Basic Radiation Knowledge for School Education Course	Japan Atomic Energy Agency (JAEA).	1-4 Feb. 2021	Online
Manish Debnath	32nd Understanding Training Course on ISO/IEC 17025:2017	Bangladesh Accreditation Board (BAB)	5-7 Oct. 2020	Ministry of Industry
	27th Assessor Training Course on ISO/IEC 17025:2017	Bangladesh Accreditation Board (BAB)	7-11 Mar. 2021	Ministry of Industry
Rashmi Roy	Online training course on National portal	Divisional Commissioner's Office, Chattogram	12 Nov. 2020	Chattogram

4. Stakeholder Meeting

Two Stakeholder meetings were arranged at the Atomic Energy Centre, Chattogram on 28 Sep. 2020 and 30 Nov. 2020.

5. Collaboration Work

5.1 IAEA/CRP Project-JO2005: Improvement of the Assessment of Initial Alarms of Radiation Detection Instruments.

To developed technical documents and tools that can be used by FLOs and expert organizations to enhance Member States' ability to make high confidence assessments on whether or not nuclear and other radioactive material out of regulatory control is present when an initial alarm occurs.

5.2 IAEA/RCA Project - RAS/7/028: Enhancing Regional Capabilities for Marine Radioactivity Monitoring and Assessment of the Potential Impact of Radioactive Releases from Nuclear Facilities in Asia-Pacific Marine Ecosystems.

To improve the integrated regional quality-assured capabilities for marine radioactivity monitoring and for impact assessment of routine and accidental releases of radioactivity into the marine environment.

6. Others

- Tertiary inspection of detained container no.: PCIU0118478×**20′** at Chattogram Sea Port.
- Inspection of the level of radioactivity in the vicinity **of** ship-breaking yard of Janata Steel Corporation, Shitakunda, Chattogram.
- Radioactivity testing and monitoring of Zinc Oxide/ Zinc Concentrate at GPH Factory Yard, Chattogram.

7. Service Rendered and Revenue Income

Name of service provided	No. of sample	Revenue income
Radioactivity testing of imported food and allied materials	19686	24,50,10,752/-
Radioactivity testing of miscellaneous food-stuffs	121	4,29,239/-
Total		24,54,39,991/-

RADIOACTIVITY TESTING AND MONITORING LABORATORY (RTML), MONGLA, BAGERHAT

Objective/Introduction

- Radioactivity testing of foods and other allied materials imported & exported through Mongla sea-port at Mongla, Bagerhat, Bhomra land-port in Satkhira, Benapole land-port and Jashore airport.
- Radioactive materials safety service to the port authority and customs department while inspection of special consignments that contain suspected radioactive materials in it. Activities like nuclear security, safeguard and controlling illegal traffic of radioactive materials in the region.
- Radioactivity analysis of environmental samples, harmful contaminated objects, radioactive material or any other sample requested for nuclear forensic investigation.
- Radiation protection and safety service during transport of radioactive materials imported or exported through Mongla port to assure safe handling of radioactive materials to and from the region.
- Radiation protection and safety service to the public, hospitals, local industries, universities or research institutes and exploration companies etc.
- Combine work in emergency service during nuclear and radiological incidents, accident in the region or in nationwide under joint operation by BAEC.
- Cooperation to implement the "Bangladesh Atomic Energy Regulatory Authority Act 2012" and "Nuclear Safety and Radiation Control Rule 1997": Law number 19, 2012.

Activities

1. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
Local Training on Lab Safety	12-14 Feb. 2021	RTML	17
Local In house Training on Radioactivity Measurement in Food	20-21 Mar. 2021	RTML	8
Local Training on General Emergency and Calamity Management	9-11 Apr. 2021	RTML	25

2. Stakeholder Meeting

Two (2) stakeholder meeting arranged with Mongla Custom Authority, Mongla Port Authority, Clearing and Forwarding Agents, Mongla, Bagerhat, 14 February, 2021 and 22 March, 2021.

3. Project Work(s)

Under ADP Project of Development of HR and Establishment of Residential Accommodation Facilities for RTML

- Two residential buildings are completed.
- Electric connection and water supply are established and now in operational condition.
- Connective road, walkway, guard house, gardening works are accomplished.

4. Service Rendered and Revenue Income

Name of service	No. of sample	Income
Measurement of radioactivity in food	65	12,41,773/-

II. BIO-SCIENCES

INSTITUTE OF FOOD AND RADIATION BIOLOGY (IFRB), AERE, SAVAR

Agrochemical and Environmental Research Unit, IFRB

Objective/Introduction

Agrochemical and Environmental Research Division (AERD) is involved in research relating to residues fate, distribution, degradation, translocation and impact of pesticides in environment and also engaged in elemental analysis and their impact on food and environment and in rendering services. The objectives are as follows.

- To know the present status of residues of pesticides, heavy metals and trace elements in food and environment.
- To generate and provide pesticide residue data for fixing National Acceptable Daily Intake (ADI) and Maximum Residue Limit (MRL) of Bangladesh.
- To promote safe and effective use of pesticides for safe guarding human health and environment.

Activities

1. Research and Development Work(s)

1.1 Determination the presence and quantity of soil pesticides in coastal Lakhsmipur district of Bangladesh

M. A. Uddin. M. A. Rahman, Z. Fardous and M. A. Z. Chowdhury

Determine the presence and quantity of some selected pesticides from soil sediments collected from some ponds and canals located in the Lakshmipur district of Bangladesh. The high performance liquid chromatography (HPLC) technique was used to determine the concentration of pesticide residues. Some soil samples were found to be contaminated with carbamate (carbofuran and carbaryl) and organophosphorus (diazinon) pesticides. The concentration of carbofuran pesticide ranged from 0.303 μg/kg to 1.851 μg/kg. The highest concentration of carbofuran pesticide was found in SSP6 (1.851 μg/kg) and the lowest concentration was found in SSP9 (0.303 μg/kg). Carbaryl pesticide was found to be present in the sediment of only one pond, the concentration being 1.047 μg/kg. Organophosphorus (diazinon) pesticide was found in soil samples and the concentrations ranged from 0.147 μg/kg to 0.759 μg/kg, which were higher than the EEC-recommended limit of 0.1 μg/kg.

1.2 Assessment of trace elements in serum in Bangladeshi patients with rheumatoid arthritis

M. A. Z. Chowdhury, Z. Fardous, M. A. Rahman and M. Nesha

Rheumatoid arthritis (RA) is an autoimmune disorder that is a painful health crisis. This study aimed to assess trace elements in serum (Zn, Cu, Mn, and Fe) in Rheumatoid Arthritis patients, and thereby correlate these parameters with the association of Rheumatoid Arthritis. This study included 20 Bangladeshi RA patients and 20 normal healthy volunteers as control subjects. Trace elements were determined by atomic absorption spectroscopy (AAS). The mean values of Zn, Cu, Mn, and Fe were 6.62 ± 0.34, 1.42 ± 0.17, 7.51 ± 0.23, and 29.25 ± 0.41 ppm for the RA patients respectively and 13.57 ± 9.13, 1.15 ± 0.17, 1.59 ± 0.18, and 62.47 ± 5.25 ppm for the control subjects, consequently. There was a significant difference ($p<0.05$) in the trace element levels between the RA patients and control subjects**.**

1.3 Translocation and accumulation of chromium (Cr) and lead (Pb) in chilli plants (capsicum annuum l.) grown on artificially contaminated soil

Z. Fardous, M. A. Z. Chowdhury, M. A. Rahman, M. A. Uddin and M. Nesha

The concentrations of heavy metals were estimated by Atomic Absorption Spectroscopy (AAS) technique. The current study is an endeavour to measure the bioaccumulation potentials of heavy metals in different parts of chilli plants (Capsicum annuum L.) grown in artificially contaminated soil with various concentrations of Cr and Pb. The mean concentration of Cr and Pb accumulated in different parts of plants in high, medium, and low levels of contamination was in the following order: roots>leaves>shoots>fruits. Cr concentration in fruits was lower than that of the WHO standard. However, fruits grown on medium

contaminated soil contained 0.695 mg/kg Cr which did not follow the safe guideline by SEPA. A significant amount of Pb was traced in fruits grown in highly contaminated soil that exceeded the standard limit set by FAO/WHO. Accumulation of Pb was higher than Cr at different levels of contamination in every part of the chilli plants. The transfer factor for Cr and Pd was found in the following order, leaves>shoots>fruits>roots and leaves>shoots>roots>fruits, correspondingly at every level of contamination. The bioconcentration factors were higher in Pb than Cr. The daily intake of metals in combination with health and carcinogenic risk indexes indicated that the edible parts of chilli plants are safe to consume as recommended by SEPA/WHO/FAO. The present study can be considered a reference for assessment and monitoring of heavy metals associated with human health risks in chilli plants at different industrially contaminated sites.

2. Manpower Development and Training Program

Title	Date	Place	No. of participant
In house Training course on Criteria of ISO 17025 in Laboratory Practice	14-Jan. and 15 Feb. 2021	AERD, AERE	7
In house Training course on Use of Radiation Techniques for Cultural Heritage Preservation and Consolidations	16 Mar. and 12 Apr. 2021	AERD, AERE	7

3. Seminar/Symposium/Conference/workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. M. Alamgir Zaman Chowdhury	Workshop on Selection of CRG Generated Technologies of validation	PIU-BARC, NATP-2	8 Jun. 2021	BARC auditorium

Food Technology Division, IFRB

Objective/Introduction

Food Technology Division is basically involved in carrying out research on improvement of food safety (food fraud, adulteration, origin authentication, species identification etc.) and quality (nutritional, functional and microbiological quality) through conventional and nuclear technology. Research works of FTD also focus on development of convenience food and food additives from different kinds of food and food derivatives.

Activities

1. Research and Development Work(s)

1.1 Evaluation of changes in proximate compositions sugar profile and anti-oxidants markers of tomato (*Lycopersiconesculentum* l.) during unripe and ripe stages

M. A. Rahman, M. P. Hasan and R. Hasan

A comparative study was carried out to investigate the changes of nutritional value, sugar content and antioxidant marker of unripe and ripe tomato in Bangladesh. The study was showed that moister content and protein content of ripe tomato significantly (p<0.05). higher compare to unripe tomato. On other hand, fat content and ash content of unripe tomato significantly (p<0.05). higher compare to ripe tomato. The highest amount (46.62mg/100g) of calcium was found in ripe tomato. Unripe tomato was contained the highest values (36.74mg/100g) and (1.86 mg/100g) of phosphorus and iron respectively. The highest amount (3.4 ±0.07%), (1.72 ± 0.02%) and (1.59 ±0.08%) of total sugar, reducing sugar and non-reducing sugar were found in unripe tomato compare to ripe tomato. The study was observed that ripe tomato contained highest values (27.5± 0.01 mg GAE/100g), (26.51 ±0.03 mg/ml) and (4.83 ±0.01 mg QUER/g) of total phenol. DPPH scavenging activity and total flavonoid respectively compare to unripe tomato. The study revealed that unripe tomato is not health beneficial to diabetic subject's due to high amount of sugar level compare to ripe tomato. On the other hand, ripe tomato is an excellent source of antioxidant that improve immune system of the human. The study was found that ripe tomato is the best for human consumption compare to unripe tomato.

1.2 Gamma radiation application to rice: Reduced glycemic index in relation to modified carbohydrate observed in FTIR spectra

M. A. Khatun, M. Razzak, M. A. Hossain, M. A. Rahman, R. A. Khan and R. Huque

This study was conducted with a popular, low price Bangladesh rice variety BRRI Dhan 29 with a view to possible carbohydrate modification targeting lower glycemic index using gamma radiation application. Irradiation process (5 and 10 kGy at a dose rate of 9.74kGy/h) altered amylose content, amylose/amylopectin ratio, swelling power, and solubility index. FTIR spectroscopy confirmed the changed molecular structures due to radiation application. Treatment with a dose of 5 and 10kGy caused increased amylose and amylose/amylopectin ratio significantly ($p < 0.02$). The highest amylose content was found in 10 kGy irradiated rice (30.20%) compared to unirradiated one (17.27%). Gamma radiation caused decreased swelling and increased water solubility in rice powder. These features of carbohydrate amendment in irradiated rice lead to reduced glycemic index as investigated with the in vivo experiments. Therefore, this study suggests gamma-irradiated rice (10kGy) is beneficial for diabetic subjects keeping lower blood glucose levels.

1.3 Detection of species adulteration in meat products and Mozzarella-type cheeses using duplex PCR of mitochondrial cyt b gene: A food safety concern in Bangladesh

A. Khatun, A. Hossain, M. S. Hossain, M. K. Munshi and R. Huque

Description:Food origin authentication is imperative for consumer protection. This study explored meat and milk species identification as a pioneering country-specific report on mislabeling prevalence among processed meat and milk products in Bangladesh. Meat products (64; sausages, burger patty, meatball, kabab) labeled as chicken or beef and Mozzarella-type cheeses (25), made in Bangladesh and of overseas origins, were analyzed for species detection. Two duplex PCRs (cattle-buffalo and chicken-pig) were applied with species-specific mitochondrial Cyt b gene primers and found to be accurate for species identification in meat and milk products. Bangladeshi origin beef-labeled products were found to be mixed with buffalo ($n = 2$) and chicken ($n = 5$) suggesting up to one third of products might be mislabeled. Such mislabeling would allow these 'beef' products to charge a higher price compared with chicken products that command a lower price. Imported meat products were also found mislabeled with buffalo and chicken. Cheese samples, declared as bovine, were found to contain buffalo DNA, and no cattle or buffalo DNA was found in six imported cheese samples. All the meat and cheese products were Halal, as none contained pig DNA. This pilot study shows the majority of products were labelled correctly, but large proportions were not and strict monitoring is recommended to ensure food safety and address consumer preferences, especially religious concerns.

1.4 Novel practice to produce safe and healthy dry fish using irradiated chitosan coating

M. L. Rahman, R. Barua, A. A. Jubayer, J. M. M. Islam, A. H. M. Kamal, M. Ali, M. S. Hossain, M. S. Rahaman, M. S. Rahaman, M. A. Hossain, R. Haque and M. A. Khan

In Bangladesh, dry fishes are mostly produced by drying in an open environment under sunlight, and so the producers are forced to use insecticides and fungicides to prevent microbial and blowfly infestation. That is why dry fishes are often contaminated with residual insecticides and fungicides, which cause a severe threat to human health. In this experiment, gamma radiation treated chitosan solution was used while drying the fishes, and the effect was evaluated. Experimental results suggested that chitosan coating did not hinder the drying process but improved the quality of the produces. Chitosan coating was found as a repellant of blowflies as well. Besides, it also prevented microbial contamination. The nutritional value of the produced dry fishes was examined and found very satisfactory. Overall results suggested that the application of irradiated chitosan can be a very suitable and cost-effective way to produce safe and healthy dry fishes.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
IAEA/RCA Regional training course in data analysis for food authentication using Chemometric Add-ins for Excel (CAFE) software	14 - 18 Dec. 2020	Virtual Training	2
TC project (BGD 5032): Virtual Training Course on the Chemometrics Add-in For Excel (CAFE) software for food authentication	8-12 Feb. 2021	Virtual Training	6

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Roksana Huque	Virtual Stakeholder Consultation Workshop on the Draft National Food Safety Strategic Plan 2022-2026	FAO	16 Jun. 2021	Dhaka, Bangladesh

4. Collaboration Work(s)

4.1 IAEA RCA project, Code: RAS 5081

Enhancing food safety and supporting regional authentication of food staff through implementation of nuclear techniques

4.2 IAEA TC project, Code: BGD 5032

Building capacity in improving food safety using nuclear and other complementary analytical techniques.

5. Service Rendered

No. of service given organization	Nature of sample	Number of sample	Revenue income
Zap International product Ltd.	Spirulina powder	1	1,000/-
Plant Biotechnology and Genetic Engineering Division, IFRB, AERE	Sugarcane	10	Inter laboratory service
	Ripe tomatoes	10	Inter laboratory service

Gamma Source Division, IFRB

Objective/Introduction

Gamma Source Division (GSD) of Institute of Food and Radiation Biology (IFRB) has been rendering irradiation services since 1980 to different institutes/ organizations and private companies using Co^{60} panoramic gamma irradiator. GSD is the pioneer irradiation service provider in Bangladesh. Its main objective is to develop and utilize gamma irradiation techniques in research and commercial sectors for better quality products. GSD has provided irradiation services for research purpose to different government (including institutes of BAEC) and private organizations at free of cost during this time period. GSD has served irradiation to commercial products of 7 food industries and 33medical and pharmaceutical companies of Bangladesh and earned 19, 63, 740/-revenue from Jul. 2020 to Jun. 2021. During this reporting period, the activities of the source were 42.21kCion 1 Jul. 2020 and 37.35kCion 30 Jun. 2021. At the same time, the dose rates were 1.69kGy/hr on 1st Jul. 2020 and 1.47kGy/hr on 30 Jun. 2021.

Activities

1. Research and Development Work(s)

GSD has provided irradiation services for research purpose to various Divisions/Institutes of Bangladesh Atomic Energy Commission (BAEC), Lab Aid Pharma Ltd., Bangladesh Agriculture Research Institute (BARI), Bangladesh Jute Research Institute (BJRI), Rajshahi University, Bangladesh University of Science and Technology (BUET) at free of cost during this time period. GSD provides irradiation service for research purpose to 386 food samples (Sugarcane, capsicum seed, wheat seed, rice callus, chilli, bean, coconut water, oat seed, mangoetc.) and 2901 medical and pharmaceutical samples (Bone graft, bone chips, amnion graft, skull bone, scaffold, amniotic membrane, hydrogel, fexofenadine hydrochloride usp, chitosan, gelatin film etc.).

2. Manpower Development and Training Program

Title	Date	Place	No. of participant
Wipe test of Co-60 Gamma Irradiator	9 Aug. 2020	GSD office room	8
Application of radiation technology for Agriculture	18 Aug. 2020	GSD office room	8
Radiation Biotechnology	25 Aug. 2020	GSD office room	7

Title	Date	Place	No. of participant
Countermeasures in radiological accident	8 Sep. 2020	GSD office room	8
Contamination monitoring and decontamination technique	15 Sep. 2020	GSD office room	8
Biological effects of radiation	20 Sep. 2020	GSD office room	8
Environmental monitoring in the nuclear/radiological emergency case	6 Oct. 2020	GSD office room	8
Radiation survey, protective gear and safe handling of radioactive materials	12 Oct. 2020	GSD office room	8
Radiation measuring instruments	20 Oct. 2020	GSD office room	8

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. M. Khan	Meeting and roundtable discussions on 'Fruit Fly Chemical Ecology' (on-line)	ARC Centre for Fruit Fly Biosecurity Innovation	27 Jul. 2020	Canberra, Melbourne, Sydney
	The Fourth International Symposium of TEAM (Tephritid Workers of Europe, Africa and the Middle East) (on-line)	TEAM	5-9 Oct. 2020	La Grande Motte, South of France
	Meeting on "Open Discussion on Tephritidae Ecology and Physiology" (on-line)	Thessely University, Greece and The Hellenic Foundation for Research and Innovation (H.F.R.I.)	28 Jul. 2020	Thessely University, Greece
	Coordination meeting for 'International Health Regulation (lHR-2005) focusing on Radiation Hazard'	CDC (Communicable Disease Control Division), DGHS	10 Nov. 2020	DG Health, Dhaka
Dr. M. Khan, Dr. M. F. Mortuza, Ms. A. Nahar and T. I. Tanim	Evaluation of Wetland TanguarHaor at the Rauar Station with Special Reference to its Physico-Chemical, Biological, and Radiological Components and Conservation	Institute of Food and Radiation Biology (IFRB)	24 Jun. 2021	IFRB, AERE Virtual Online platform

4. Others

- Dr. M. Khan. 2020. Reviewed manuscript no. Ms_CJAST_63262: Genetic Characterization of Leaf Tip Necrosis and its Effect on Quantitative traits in Wheat (Triticumaestivum L.) of Current Journal of Applied Science and Technology, 23 Nov. 2020.
- Dr. M. Khan. 2021. Reviewed manuscript- No. BER-D-21-00074, Article: Host plants range of fruit flies (Diptera: Tephritidae) in Madagascar, Bulletin of Entomological Research (Cambridge University Press), 19 Apr. 2021.
- Dr. M. Khan. 2021. Reviewed manuscript no. EEA-2021-0084, Pupal mortality of the oriental fruit fly Bactrocera dorsalis varies depending on the abundance and composition of natural antagonists in the soil of EntomologiaExperimentalis et Applicata (Wileyonline), 5 May 2021.

5. Service Rendered and Revenue Income

No. of organization	Nature of sample/service	Quantity of sample	Revenue income
7	Food Irradiation	3.687 Ton	1,22,020/-
33	Medical and Pharmaceutical Products Irradiation	3,243 cft	17,58,000/-
		16,744 pcs shell dressing	83,720/-

Insect Biotechnology Division, IFRB

Objective/Introduction

Developing the methods of management of insect pests and Phytosanitary treatment using nuclear, microbial and biotechnological approaches.

Activities

1. Research and Development Work(s)

1.1 Survey of dacine fruit flies (diptera: tephritidae: dacini) in two forest areas

M. A. Hossain, K. Seheli, M. Momen, M. F. Hossain and A. Ghosh

To study the species diversity of dacine fruit flies in two selected forest areas a snapshot survey was conducted in 2020. Hawaii plastic traps (150 ml) were obtained from Entomology, Plant Protection and Nematology Department, University of Idaho, USA and deployed along walking trails for 6-7 days to survey fruit flies in Chandra forest of Gazipur district (20 sites) and BaroChaona forest of Tangail district (20 sites). At each site, we maintained three traps, separately baited with the fruit fly lures *i.e.* methyl eugenol, cue-lure and zingerone. We used a 1×1 cm strip of dichlorvos insecticide to kill the flies entering traps. To protect decomposition of the fruit flies 5 ml of 25% propylene glycol was used inside each trap. Plastic rooftops were used to protect the traps from rainfall. Collected specimens were preserved in 95% ethanol and carried to insect Biotechnology Division, IFRB, AERE for identification. Identification of fruit flies was performed by using the keys of Drew and Romig (2013).It was observed that four species, *viz*., *Bactrocera dorsalis, B. rubigina*, *Zeugodacus tau* and *Z. cucurbitae* are comparatively abundant in these forested areas. Among 2,573 collected flies, 851 specimens in cue-lure, 1,688 in methyl eugenol, 34 in zingerone. In both the forests, the oriental fruit fly, *B. dorsalis* is the most abundant species and *B. rubigina* is the second most abundant species. The total number of fruit fly species in Chandra forest and BaroChaona were 10 and 11 respectively. *B. syzygii*was trapped only from BaroChaona forest of Tangail district. Comparatively higher number of fruit flies were trapped in BaroChaona forest than that of Chandra forest. The above results revealed that the fruit fly species are not distributed evenly. Leblanc *et al.* (2019) reported that the highest species diversity of fruit fly was found in protected forest areas of Bangladesh which is similar to that of our present findings.

1.2 Bio-Efficiency of indigenous bacillus thuringiensis JSd1 against melon fly, zeugodacuscucurbitae (Coq.) (Diptera: Tephritidae: Dacinae)

M. A. Bari, K. Seheli, M. Momen, M. F. Hossain and A. Ghosh

This experiment was conducted to estimate the efficiency of indigenous *B. thuringiensis* strains against the 3rd instar larvae of *Z. cucurbitae*and production of efficient *Bt*strains in larger volume for sustainable development and delivery to the farmers.44 indigenous *Bt* strains harboring different *cry* genes were assayed *in vivo* against the 3rd instar larvae of *Z. cucurbitae*following enhanced expression of *Cry* proteins in T_3 broth.Of the tested isolates, 9 causing more than 70% larval mortality were *Bt* JSd1 (95%), SaS_6 (87%), JDc1 (86%), $TaSa_4$ (82%), $NaSc_3$ (80%), $RaSa_2$ (79%), $FhSb_3$ (77%), KSa_2 (75%) and $MuSc_2$ (72%) respectively. Lethal concentration (LC_{50}) (Logarithmic value of spore count) estimated by Probit analysis, the efficiency of the potential isolates was compared. 3rd instar larvae of *Z. cucurbitae* were very susceptible to *Bt*JSd1 (0.429) ml/gm was lowest LC_{50} value with 95% mortality and highest for MuSc2 (0.752) ml/gm with 72% mortality.

1.3 Efficiency of boric acid as lethal bait on laboratory reared aedesaegypti (linnaeus) (diptera: culicidae)

M. F. Hossain, A. Ghosh, M. Momen, M. A. Bari, M. A. Hossain and K. Seheli

Bringing the *Aedesaegypti* mosquito to knees is the basic public health concern to prevent some deadly diseases transmission such as dengue, chikungunya and zika. Attractive toxic sugar baits are being successfully used to suppress this mosquito population. In this preliminary study, the effect of 1% boric acid was evaluated on the mortality and gender of *Aedesaegypti*. After 48h and 96h of engorging the bait the general mortality rate of the male was 71.67 % and 86.67% respectively. In the case of females, the mortality was 61.67% and 76.67 % respectively. To know the effect of age, the experiment was performed with three different aged mosquitoes i.e. newly emerged or one day aged, one week aged and two weeks aged mosquitoes. Lethal efficacy of boric acid was less in the one week aged mosquito than the newly emerged and

old one. The boric acid was found effective to kill the mosquitoes (P<0.01). However, further studies should be focused to enhance the effectiveness and attractiveness of this bait.

1.4 Identification of two economically important Bactrocera species using PCR-RFLP analysis (Diptera:Tephritidae)

A. Ghosh, K. Seheli, N. Sultana, M. A. Hossain, M. A. Bari, M. Momen and M. F. Hossain

Molecular diagnostic techniques can be a necessary step in the development and implementation of fruit fly biological control strategies. In this context, PCR-RFLP is a rapid tool for identification of tephritids insect pests. In the present study, an initiative was taken to identify two economically important tephritid pests *Bactrocera dorsalis* and *Bactrocerarubigina* using PCR-RFLP targeting ITS1 region. Total genomic DNA was extracted from adult fruit flies by using DNeasy Tissue QIAGEN kit. This DNA was then used as template in PCR reaction for ITS1 region. As the ITS1 can be variable in length, for some species the size of the PCR fragment digested with specific enzyme is an additional diagnostic character. Both the species displayed an indistinguishable length of ITS1 region (~850 base pair) in 2% gel electrophoresis. Due to the ambiguity in size, they were then subjected to RFLP digestion with two restriction enzymes. The restriction enzymes SAu_3Ai and HhaI produced similar banding patterns for them. Sau3aI has no cutting site in amplified PCR product, while HhaI generates fragments of 650 bp and 190 bp.This result matches with the reference work for *B. dorsalis*. No previous data is available for *B. rubigina*. By far, no molecular approach has been explored to identify fruit flies in Bangladesh. The result of this experiment will enhance early detection and easy monitoring of these pest species and implementation of appropriate management programmes.

2. Manpower Development and Training Program

Title	Date	Place	No. of participant
Follow-up Training Course (FTC) on Nuclear and Radiological Emergency Preparedness	17 Jan. 2021	IBD, IFRB	12
Environmental Radioactivity Monitoring	24 Jan. 2021	IBD, IFRB	12
Promotion Criteria and Biodata Evaluation Process	8 Feb. 2021	IBD, IFRB	12
Guidelines for Annual Performance Agreement (APA)	14 Feb.2021	IBD, IFRB	12
Effect of Exogenous Factors on Survivability of Sterile Male *Aedesaegypti*	23 Jun. 2021	IBD, IFRB	12

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. K. Seheli	Coordination meeting for International Health Regulation (lHR-2005) focusing on Radiation Hazard'	Communicable Disease Control Division, DGHS	10th Nov. 2020	DGHS, Mohakhali, Dhaka
M. F. Hossain	Training Course on "PPR-2008 and Public Procurement Management"	BAEC	11-22 Oct. 2020	TI, AERE
A. Ghosh	Follow-up Training Course on "Nuclear and Radiological Emergency Preparedness"	BAEC	22 Oct. -3 Dec. 2020	TI, AERE
M. A. Bari	34th BSM Annual Conference (International e-Conference) on "Microbiology for Health and Wellbeing: Today and Tomorrow" (virtual)	Bangladesh Society of Microbiologists	19 Dec. 2020	Dhaka, Bangladesh
M. F. Hossain and A. Ghosh	Follow-up Training Course on "Environmental Radioactivity Monitoring"	BAEC	10-14 Jan. 2021	TI, AERE

Name of the participant	Title of the event	Organizer	Date	Place
Dr. K. Seheli	RAS5082 -1st Virtual Meeting - 'Managing and Controlling Aedes Vector Populations Using the Sterile Insect Technique'	IAEA	18 Mar. 2021	Seibersdorf, Austria
Dr. K. Seheli	CRP D44004-First FAO/IAEA Research Co-ordination Meeting (Virtual)-"Mosquito Irradiation, Sterilization and Quality Control"	IAEA	31 May-4 Jun. 2021	Vienna, Austria
Dr. M. Khan	Meeting on 'National Dengue program', WHO HQ/RO (virtual)	CDC, DGHS and WHO (HQ-RO-CO)	15 Feb. 2021	Dhaka and Geneva
Dr. M. Khan	CRP D41027-Second FAO/IAEA Research Co-ordination Meeting/RCM (Virtual)- "Assessment of Simultaneous Application of SIT and MAT to Enhance Management of the Melon Fly, *Zeugodacuscucurbitae* (Coq.) and the Oriental Fruit Fly, *Bactrocera dorsalis* (Hendel) in Bangladesh"	FAO/IAEA	28 Jun.-2 Jul. 2021	Vienna, Austria

4. Collaboration Work

- IAEA Coordinated Research Programme (CRP No. 23909/R0, 2020-2025), Optimization of ɤ-Irradiation Process for Mass Sterilization and the Quality Assurance of Sterile Aedesaegypti for Field Release Programme.
- FAO/IAEA Coordinated Research Programme (CRP No. 23135/R1, 2019-2024), Assessment of Simultaneous Application of SIT and MAT to Enhance Management of the Melon Fly, *Zeugodacuscucurbitae* (Coq.) and the Oriental Fruit Fly, *Bactrocera dorsalis* (Hendel) in Bangladesh'.
- IAEA RCA Project (No. RAS/5082, 2017-2021), Managing and Controlling *Aedes* Vector Populations Using the Sterile Insect Technique.
- Collaborative research (Apr. 2013 to date) work between IBD, IFRB and Idaho University and Hawaii University at Manoa, USA on Species diversity of tephritid fruit flies in Bangladesh.

Microbiology and Industrial Irradiation Division, IFRB

Objective/Introduction

MII division deals with microorganisms those are closely associated with the health and welfare of human being. MIID is basically involved in doing research and development work on different aspects of Radiation Microbiology.

Activities

1. Research and Development Work(s)

1.1 Preparation of chitosan-silver nanocomposites (Ch-Si NCs) and their assessment of antibacterial activities against different bacterial strains

M. A. K. Sarker, M. S. A. Sarker and M. K. Pramanik

Chitin is the second most abundant polysaccharide found in the shells of crustaceans such as lobsters, crabs and shrimps. Chitosan which has many applications in the fields of food, biomedical, and cosmetics is prepared from chitin. It has been reported that chitosan has antibacterial activity against different types of bacterial strains. Depending on concentrations chitosan shows mild to moderate antibacterial activity against some bacterial strains. Silver compounds also have antibacterial activities but they show a significant levels of toxicity to the host. To potentiate the antibacterial activity of chitosan and reduce the toxicity of silver we prepared chitosan-silver nanocomposites (Ch-Si NCs) and evaluated their antibacterial activity against two

different Gram-positive and two different Gram-negative bacterial strains.*Bacillus subtilis* ATCC 6633 and *Staphylococcus aureus* ATCC 6538 were used as Gram-positive bacterial strains, whereas,*Escherichia coli* ATCC 35150 and *Salmonella enteritidis*ATCC 13076 were used as Gram-negative bacterial strains to assess the antibacterial activity of this nanocomposites. In all bacterial strains Ch-Si NCs produced larger zone of inhibition compared to the chitosan diluted in 0.5% of acetic acid.

1.2 Optimization of direct production and recovery of second generation ethanol from water hyacinth

A. A. Mahin, M. M. Uddin, M. R. Khan and M. M. Hossain

In recent years, the globe is considering biofuel as a potential alternative to fossil fuel because of rapid depletion, instability in supply chain and environmental concerns associated with fossil fuels. Among different generations of biofuels, lignocellulose based second generation biofuels have received significant attention due to the availability and cost prospective substrates. In this study, we assessed the suitability of water hyacinth as lignocellulosic substrate by three potential cellulytic strains such as *Bacillus aryabhattai*, *Bacillus subtilis*and*Streptomyces filamentosus.* The suitability of water hyacinth was evaluated in terms of its composition, releasing of reducing sugars and ethanol production. The amount of cellulose, hemicellulose and lignin was determined by calculating acid detergent fibre(ADF), neutral detergent fibre(NDF) and acid detergent lignin(ADL) and the quantity of reducing sugars and ethanol was determined by DNS and TBP method respectively. The content of cellulose, hemicellulose and lignin was 23.9%, 35.6%, 4.7% respectively. The release of reducing sugars was found to vary with pretreatment processes. The combined pretreatment with H_2SO_4 and gamma irradiation showed highest hydrolysis rate which was 40.83% and freed maximum 18.1 g/L of reducing sugars among all applied pretreatment processes. The highest estimated yield of ethanol from water hyacinth was 11.09 g/L which was achieved by fermenting it with *Bacillus aryabhattai* at 37°C and pH 7 for 48 hrs. Simple distillation process was used for ethanol recovery and the obtained ethanol was 96.79% pure. Therefore, water hyacinth can be considered as a promising source of lignocellulosic biomasses for the production of second generation biofuel in Bangladesh and further study is required to explore and develop a most potential fermenting organism for this purpose.

1.3 Green synthesis of silver nanoparticles using leaf extracts of Glinusoppositifolius and evaluation of its antimicrobial activity

Z. Mahal and T. Mumtaz

Phytopathogenic microorganisms cause devastating damage to crops on various plant parts and cause significant economic loss every year. In winter, they attack ornamental plants severely and cause death. As the pathogenic organisms are getting evolved day by day due to mutation and gaining resistance to chemical pesticides, there is a growing interest of nanoparticles use. Due to the unique properties, metal nanoparticles, such as Ag, Au, Pt and Pd, are extensively used in different sectors over the past few years. Therefore, the aim of our study is to synthesize and characterize the plant mediated silver nanoparticles (AgNPs) using *Glinusoppositifolius* leaves and toobserve its antimicrobial activity. For this purpose both bacteria and fungus were isolated from three different infected plants, viz. hibiscus, marigold and salvia and infected plant parts were cultured on nutrient agar and potato dextrose agar. For the biosynthesis of AgNPs, 5 ml of liquid extract of plant leaves was appended to 45 ml of 1 mM liquid AgNO3 solution in an erlenmeyer flask and incubated at room temperature. The reduction of AgNPs was observed by a change in the color of the solution from colourless to brown and its formation was confirmed by analysis of the spectroscopy profile of UV-visible spectrophotometer. The antimicrobial activity of AgNPs was observed using disc diffusion and agar well diffusion study. Analyzing the diffusion study we found that plant derived nanoprticles has greater antimicrobial effect than only nanoparticles and plant extract itself. Further study is ongoing to characterize the synthesized nanoparticles.

1.4 Sensitivity of bacteria against commercially available some antibiotics

S. Razia and M. A. A. Mahin

Antibiotics are natural or artificial compounds that can inhibit the growth of microorganisms. They have been used for several decades to treat many diseases. All antibiotics cannot be used for all infections because bacteria may have resistance to some antibiotics. Thus, the susceptibility of the organisms to the antibiotics needs to be checked at regular basis. Antibiotic sensitivity or antibiotic susceptibility testing is the

measurement of the susceptibility of bacteria to antibiotics. For the present study, four bacterial strains (*E. coli*, *S. enteritidis*, *B. subtilis* and *S. aureus*) and twelve commercially available antibiotics (methicillin, aztreonam, amoxycillin, azithromycin, cefotaxime/cephotaxime, vancomycin, piperacillin/tazobactam, Streptomycin, co-Trimoxazole/sulpha/trimethoprim, nalidixic acid, chloramphenicaol and ciprofloxacin) were used. To check the sensitivity or resistance of four bacterial strains, disc diffusion technique was applied in which antibiotics disks are placed on the plates which are previously inoculated with the test organism. After 24hours of incubation period at 35±2^{o}C, it was observed that all four bacterial strains were completely resistant to Methicillin. In addition to methicillin, *E. coli* also showed resistance against Amoxycillin; *B. subtilis* and *S. aureus* were showed resistance against aztreonam. Nonetheless, all four bacterial strains were susceptible to most of the tested antibiotics and showed better zone of inhibition against ciprofloxacin (35-45 mm), chloramphenicol (30-40 mm), nalidixic acid (22-40 mm), co-trimoxazole (28-35 mm), streptomycin (25-29 mm) and piperacillin/tazobactam (24-26 mm). Among all antibiotics, ciprofloxacin showed highest zone of inhibition against three bacteria. Although each bacterial strain showed resistance against few antibiotics, they are still susceptible to almost all tested antibiotics. However, since bacteria have the capability to gain resistance with time, this situation will be changed in future.

2. Collaboration Work(s)

- Collaboration with Dhaka University, Jahangirnagar University, Jessore University of Science and Technology, Kushtia Islamic University etc. for academic and research purposes.
- RP project on Radiation based technologies for treatment of emerging organic pollutants (F23034), FY 2019-2022.

3. Service Rendered and Revenue Income

No. of organization	Name of sample	No. of sample	Revenue income
6	Microbiological analysis of Food/Feed	14	34,800/-
4	Microbiological analysis of Pharmaceutical	12	37,800/-
Total		26	72,600/-

Radiation Entomology and Acarology Division, IFRB

Objective

The R&D activities of Radiation Entomology and Acarology Division focuses on development of environmentally safe integrated pest management techniques against agricultural insect pests of economic importance by using gamma radiation, sterile insect technique (SIT), insect pest management by genetic manipulation, biodegradable botanicals, hormones, pheromones, biological control agents and insecticides.

Activities

1. Research and Development Work(s)

1.1 Determination of sterilization dose of blowfly (luciliacuprina for effective sterile insect technique (SIT) practices

M. Yasmin, M. S. Islam, M. Hossain and A. F. Islam

The optimal radiation dose selection is the most important because adult emergence, adult flight ability and mating competitiveness can be hampered with reproductive sterility of male and female flies after exposure to radiation. In this study, we observed the effects of various doses of gamma radiation using OB-SERVO SANGUIS gamma irradiator on pupae of L. cuprina with the aim of determination a sterility dose. Blowfly pupae (3rd old) were irradiated with 40Gy, 45Gy, 50Gy and 55Gy radiation doses. The adult flies emerged from those treated pupae were allowed to mate with untreated male and treated male.The adult emergence and the flight ability of flies that emerged from those treated pupae were not significantly affected ($p>0.05$). In the reproductive sterility, when irradiated females were mated with control (unirradiated) male and irradiated male, both cases the female flies failed to lay eggs. A very insignificant ($p>0.05$) amount of eggs was hatched only from a combination of irradiated (40Gy) male with unirradiated female flies. The longevity of adult males showed a little reduction for sterilization

dose of 50Gy and 55Gy. But the longevity was not affected by 45Gy radiation dose. Result indicates that 45Gy radiation dose should be suitable for sterile of blowfly which will be anessential pre-requisite regarding blowfly SIT program in sun drying marine fish areas of Bangladesh.

1.2 Insect (Blowfly) - an alternative protein source to soymeal, fishmeal and tannery waste for sustainable, safe and cost-effective poultry and fish feed production

A. T. M. F Islam, M. Yasmin, M. S. Islam and M. Hossain

In our country, poultry and fish industries are among the fastest growing agri-businesses. However, the use of expansive imputes (soymeal and fishmeal) and highly toxic impute (tannery waste) as feed ingredients is threatening the survival of producers and consumers. Present initiative proposes to demonstrate that whether larvae or pupae of the blowfly, *Luciliacuprina* contained sufficient nutrient value to use as feed for growing chickens and fishes. Our results demonstrated that raw maggot contains 51.41% crude protein, 20.96% fat, 6.33% ash at dry matter level of 29.54% and dry maggot contains 48,.40% crude protein, 28.28% fat, 5.26% ash, 36.34% GE at dry matter level of 91.73% and dry pupae contains 50.60% crude protein, 26.23% fat, 7.62% ash and 21.78% GE at dry matter level of 98.43% compare to 49.87% crude protein, 09.00% fat for soymeal and 65.3% crude protein and 10.22% fat for fishmeal (Hossain et al. 2017). Results revealed that raw larvae, dry larvae and dry pupae of *L. cuprina* contained a sufficient quantity of protein and other nutrients to be a suitable substitute for soymeal, fish meal and tannery waste in the diet of chicken and fish.

1.3 Population abundance pattern of immature and adults of hog pulm beetle (HPB), Podontiaquatuordecimpunctata

M. S. Islam, M. Yasmin, M. Hossain and A. T. M. F. Islam

We observed the population abundance pattern of immature and adults of hog pulm beetle (HPB), *Podontiaquatuordecimpunctata* on hongpulm tree under field condition in AERE campus. HPBare often abundant where host plants have persisted for several years. They were active throughout the year except during the dry winter months (Dec. to Mar.). The adult beetles appeared at the end of Apr. and remain active until early Dec.. Similarly, the larvae appeared at the middle of May and remain active until Dec.. The eggs were found on leaves or branches of the hog pulm tree at the beginning of May. Population (adults and larvae) gradually increased from May and showed a pick in Aug. and Sep. when the trees are in full foliage there after population gradually decreased and totally disappeared from middle of the Dec. and cease activity was found until Mar.. That time beetles may undergo diapause and remain hidden under soil, dead stems, barks or branches and this possibility needs further study. The adult population reappeared in Apr. and started the reproductive season again. Results of the population abundance of HPB indicating that the higher temperature, humidity and long day length provided advantageous situations for the appearance of this pest and this condition found to be onset of spring (Apr.-May) followed by rainy season (Jun.-Sep.). The study of the host plant phenology showed that young and mature leaves are present all year except Dec. to Mar. (cold and dry season) that time HPB do not get enough leaves because of the complete defoliation. For this reason, population abundance patterns of the HPB seem to be conditioned by the climate and availability of host plants or leaves.

2. Manpower Development and Training Program

Title	Place	No. of participants
In- house training session	REA division	4

3. Seminar/Symposium/Conference/Workshop Attended

Name of the participant	Title of the event	Organizer	Date	Place
Muhsina Yasmin and Mosharraf Hossain	1st International Conference on Science and Technology for celebrating the birth centenary of Bangabandhu (ICSTB- 2021)	BCSIR	11-13 Mar. 2021	BCSIR

4. Collaboration Work(s)

Agreement for academic co-operation between faculty of Science (5 years from Jun. 2020), Yamaguchi University, Japan and Institute of Food and Radiation Biology (No. IFRB- PCM5, REA-8) entitled

"Ecological approach to the Lepidopteran insects in relation with environmental adaptation and population management".

Veterinary Drug Residue Analysis Division, IFRB

Veterinary drug residue analysis division (VDRAD) deals with the development and application of several nuclear and analytical techniques for screening and confirmatory analysis of different veterinary drug residues and related contaminants in foods of animal origin. Specifically, the aim of this division is to monitor and control of those residues in foods to protect public health and to promote international trade of Bangladeshi food products.

Activities

1. Research and Development Work(s)

- Screening of the presence of antibiotics and mycotoxins in animal origin food samples (fish, meat, milk, eggs, shrimp, etc.) collected from different markets and farms of the country using ELISA, Radio Immunoassay (RIA) and Microbial Inhibition Test (MIT) methods.
- Qualitative and quantitative analysis of antibiotics and mycotoxins residues present in animal originated foods (fish, meat, milk, eggs, shrimp, etc.) using chromatographic techniques such as HPLC and state-of-the-art LC-MS/MS System.
- Research on the deposition and depletion of antibiotics applied to food-producing animals to facilitate capability of Bangladesh for participating in the Codex standard setting process/program.
- Conducting joint research with various regional and international research institutes and/ororganizations for achieving international acceptance on analytical capability.
- Routinely participated in the proficiency test (PT) provided by Progetto Trieste, Italyfor reliability of our developed methods validation.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
In house training carried out on method development and validation procedures to determine antibiotic and mycotoxin residues in animal and plant originated foods (fish, meat, milk, eggs, shrimp, rice, wheat, cereals, pulses, etc.) using CHARM II, ELISA, HPLC and LC-MS/MS systemsprovided by Chironjit Kumar Shaha, Md. MarufBillah Prince, DarminChakma, Dr. Shahabe Uddin Talukder, Md. Hedayetul Islam, Dr. Md. Nazrul Islam, Dr. M. Jahurul Islam and Dr. ASM Saifullah	Jul. 2020- Jun. 2021 (8 hrs/month)	VDRAD, IFRB, AERE	10-14

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. A. S. M. Saifullah	First research co-ordination meeting on Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices (Online)	International Atomic Energy Agency (IAEA)	17-21 May 2021	Bangladesh
Dr. M. Jahurul Islam, Dr. Md. Nazrul Islam, Md. Hedayetul Islam and Chironjit Kumar Shaha	Seminar on Food Safety Risks and How to Control Them - Part Iand II (Online)	University of Peradeniya, Peradeniya, Sri Lanka	1 and 22 Jun. 2021	Bangladesh

4. Collaboration Work/MoU

- Non RCA Project (Code: RAS5078), Enhancing Food Safety Laboratory Capabilities and Establishing a Network in Asia to Control Veterinary Drug Residues and Related Chemical Contaminants, Project counterpart: Dr. A S M Saifullah.

- IAEA Coordinated Research Project (Code: D52043), Depletion of veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices. Chief Scientific Investigator (CSI): Dr. A S M Saifullah, Duration: 3 Mar. 2020 to 1 Jun. 2025.
- S and T Project: Determination of Agrochemical Residue in Animal Originated Food using Nuclear Technique (ES-373), Principal investigator: Dr. Md. Nazrul Islam, Associate investigator: Md Maruf Billah Prince.
- and T Project: Determination of Sulfonamides Residues in Egg by LC-MS/MS (ID-473), Principal investigator: Dr. M. Jahurul Islam, Associate investigator: Dr. A S M Saifullah.

5. Service Rendered and Revenue Income

Name of service provided	No. of sample	Revenue income
Sample analysis	9	22,000/-

Plant Biotechnology and Genetic Engineering Division, IFRB

Introduction

Plant Biotechnology and Genetic Engineering Division is a leading research oriented laboratory in the country. It initiated research on plant tissue culture in the early eighties with micropropagation of forest trees. Later on the other crop plants like cereals, fruit, medicinal, ornamental, vegetable, spices etc. have been included in the program. In the mid-nineties research on *Agrobacterium*-mediated genetic transformation has been initiated with the fiber crop jute and this technique is expanded gradually to other plants of economic importance viz. rice, tomato and Papaya. Now the scientists of this division are doing their research on mutation breeding to improve crop plants besides the previous program.

Objectives

- To develop suitable protocol for disease free and high yielding plantlets production through *in vitro* culture.
- To establish *in vitro* protocol for commercial production of forest, fruit, medicinal and ornamental plants.
- To identify the desired tissue culture derived lines from seed, embryo and anther culture through observational trials and primary yield trials.
- To develop *Agrobacterium*- mediated genetic transformation technique to improve crop plants.
- To improve crop plants through mutation breeding using Carbon Ion beam and Gamma irradiations.
- To molecular characterization of mutant lines.

Activities

1. Research and Development Work(s)

1.1 A protocol for rapid in vitro propagation of dragon fruit (hylecereusundatus)

M. H. Kabir, A. N. K. Mamun, M. R. Islam, M. T. Jahan, M. M. Islam, M. M. Islam, P. Das and A. S. M. S. Islam.

Dragon fruit is a climbing vine cactus species belongs to the the family of cactaceae and grown tropical and subtropical region in the world. It is an exotic crop in Bangladesh and has started for cultivation commercially due to its high value. It is mainly propagated by seeds or cuttings. This traditional method of propagation damaged mother plant, slow release of propagules, create seasonal barrier and seeds produced are not true to type due to cross pollination and also propagules carries insect-pest-diseases. Therefore, *in vitro* mass propagation would be a viable and alternative technique to generate disease free propagules from elite clone. Young stem explants of about 2 to 2.5 cm long and 1.0 cm diameter were collected from the experimental field of plant Biotechnology and Genetic Engineering Division, Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Savar, Dhaka. The explants were surface sterilized with 0.1% $HgCl_2$for 10 minutes under laminar air flow cabinet. The explants were then washed with sterile distilled

water for 3 times and finally, explants were excised and inoculated onto MS media containing different concentrations of BA, Kin, and also different combinations of BA + Kin and BA + NAA for multiple shoot induction. An efficient *in vitro* plant regeneration protocol was established in dragon fruit using MS + 2.0 mg/l BA + 2.0 mg/l Kin. through stem segments as explants. Eighty percent explants responded to form multiple shoot within the inoculation of 30 days. The average of maximum number of shoot per explant was recorded to 8.20± 0.46 and the average maximum shoot length of 4.50±0.32 cm was found in this inoculation medium of MS + 2.0 mg/l BA + 2.0 mg/l Kin inoculation after 90 days. Ninety percent of the *in vitro* raised shoots were rooted within the inoculation of 30 days in rooting medium of MS + 2.5 mg/l IBA (Table 2). The average highest number of root per shoot was 6.8±0.87 and the average root length of 6.7 ±0.45 cm were observed in this root induction medium. About 8 months were needed from culture initiation to plantlets establishment in natural environment and 80% plantlets were found to be acclimatized and resumed a new growth at natural environment. The protocol for *in vitro* mass propagation method was developed in this study is useful for commercial cultivation and further study for genetic improvement of this nutritive and valuable exotic fruit plant of dragon.

1.2 Response of nitrogen-fixing water fern *azolla*as biofertilizer to enhance crop yield in a rice cropping system

M. M. Islam, P. Das, M. H. Kabir, M. M. Islam, S. A. M. S. Islam, M. R. Islam, M. T. Jahan and A. N. K. Mamun

The water fern Azolla harbors nitrogen-fixing cyanobacterium Anabaena azollae as symbiont in its dorsal leaves and is known as potent N_2 fixer. Present investigation was carried out to study the influence of fresh Azolla when used as basal incorporation in soil and as cropped with rice variety BINA Dhan-14 and together with and without chemical nitrogen fertilizer in field conditions. Incorporation of 250 kg/ha of fresh Azolla before planting + 250 kg N/ha through fertilizer as basal proved to be the best and recorded maximum land productivity in rice cropping system. There was marked increase in plant height, number of effective tillers, dry mass and nitrogen content of rice plants with the use of Azolla and N-fertilizers alone and other combinations. About 250 kg N could be supplemented through preplanting incorporation of 250kg fresh Azolla. The result indicated that Azolla could be utilized as an alternative source of N-fertilizer for higher production of crops in rice cropping system. Therefore, utilization of Azolla as a green manure benefits rice crop, obtaining the highest response when combining incorporation and association of this fern.

1.3 Effect of gamma irradiation in M1 tomato plants (lycopersiconesculentum l)

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Mutation breeding is an important technique for creating novel mutants. Physical mutagens create a vast amount of genetic variation and have an important role in the studies of plants. Gamma rays and fast neutron are extensively used in the mutagenesis of tomato. Tomato (*Lycopersiconesculantum* L.) is a major solanaceous crops worldwide including Bangladesh. The demand for tomato is increasing tremendously worldwide due to its diverse usage in the kitchen. But shelf life of tomato is a major concern both for the producer and consumers. In this study, seeds of tomato were irradiated with several doses of gamma irradiation and grown in the experimental field to see the effect on the morphological traits. The variation observed in all of the agronomical traits among the treatments. Most of the morphological traits were found better at 250 Gy in comparison with the control and the value decreased sharply at higher doses followed. The highest weight of single fruit was 145.33g recorded in the treatments 250 Gy while the lowest was 70.67g noted in 500 Gy. The highest fruit yield per plant was 1270 gm obtained with 250 Gy and the lowest was 840 gm found in 500Gy. The most important criterion i.e. shelf life was found better (34 days) with the 250 Gy dose level and the lowest was 6 days got in the control treatments. The consequence of gamma irradiation on the morphological characteristics of M1 plantlets was found significant. From the investigation of M1 population of tomato, 250 Gy showed the increased value in most of the traits while 500 Gy showed decreasing trends. The variations found in the M1 plants which could be used in the breeding program.

1.4. Mutagenesis of landrace rice genotype lombur using gamma (γ) irradiation under *in vitro* condition

M. M. Islam*, M. H. Kabir, P. Das, M. M. Islam, M. R. Islam, M. T. Jahan, S. A. M. S. Islam and A. N. K. Mamun

Rice is the most widely consumed staple food for a large part of the world's population, especially in Asia. It ranks third in worldwide production (rice, 741.5 million tonnes in 2014), after sugarcane (1.9 billion tonnes) and maize (1.0 billion tonnes) for its own qualities. This is a main challenge to mitigate demand of increasing world's population. The poor potential for future expansion of cultivable lands and environmental stresses are others constrains to sustainable agriculture. Due to salt sensitive rice production is decreased drastically in seashore area where Bangladesh is facing this problem because of changing climate. Different protocol steps, such as efficient callus induction and plant regeneration, have to be validated. *In vitro* mutagenesis is one of the most effective technique for obtaining rice genotypes with desire agronomic traits. On the other hand, plants derived from somatic embryo contain uniformity and genetic stability which is a very important trait and effective step in *in vitro* mutagenesis. By applying appropriate doses on embryonic calli to gamma irradiation, a desirable mutant could be found which would have significant importance to mankind providing sustainable agriculture. This study was undertaken to observe the effect of irradiation on mature embryos.

Thus, callus induction was done from explants. This mature embryo derived embryogenic callus of indigenous rice genotype lombur were irradiated with different doses of gamma irradiation i. e. 10, 20, 30, 40 and 50 Gy with control. The calluses were observed for the greening percentage and average number of regenerated plantlets from different irradiation doses. For greening of callus, five treatments with control was given in which we found that radiation level of 10 Gy resulted in highest greening percentage of 46.53 % followed by 20 Gy (41.15), 30 Gy (11.44), 40 Gy (20.94) and 50 Gy (05.47). Among the treatments, 10 Gy and 20 Gy were equally good to initiate greening. But the greening percentage decreased sharply followed then with the increase in dose level. It was found very low percentage (5.47 %) of greening in case of 50 Gy gamma irradiation dose compared to other dose levels. This data indicated that gamma irradiation had detrimental effect on callus to initiate greening. The irradiated callus was transferred to regenerative media. Plant regeneration was observed in different doses of gamma rays. The highest plant regeneration found to be 10 Gy followed by 20, 30, 40 and 50 Gy. The survived plantlets were sown in small plastic pots containing soil and organic manure and acclimatized for 7 days in growth room. Then they were transplanted in large clay pot. Seeds were collected and preserved for cultivating M2 population from where mutant selection for positive traits will be done.

1.5 *In* vitro mass propagation of flowering plant torenia (toreniafournieri) through nodal segment

S. A. M. S. Islam*, M. H. Kabir, P. Das, M. M. Islam, M. M. Islam, M. R. Islam, M. T. Jahan and A. N. K. Mamun

Toreniafournieri is known as white moon whilst it bloomed white colour flowers. It is an important ornamental plant in Bangladesh belongs to linderniaceae family. It is usually seen to the homestead, offices and along the highways for beautifying the area and for fencing as well. It is propagated by seeds and planted at the start of rainy season. But seed germination is limited due to seed dormancy and other agronomic factors. Therefore, *in vitro* culture technique is an alternative and appropriate means to produce propagules without seasonal barrier. It has been reported that stem segment can regenerate adventitious buds and axillary shoots *in vitro* (Ishioka and Tanimoto, 1992). Few reports are available using tissue culture techniques for micro propagation of this plant (Tanimoto and Harada, 1986). Thus, this study is conducted to produce mass propagules using *in vitro* culture technique and nodal segments as explants.

A high frequency *in vitro* regeneration protocol was established using stem segments as explant. Stem segments were sterilized by treating with 70% ethanol for 30s followed by washing with distilled water and then treated with 30% chlorox for 30s. The sterilized stems were washed with sterile distilled water 6 times and placed on MS basal medium with different concentrations and combinations of plant growth regulators (BA, IBA, NAA).

The effect of various concentrations and combinations of plant growth regulators were observed to optimize the media components for maximum shoot bud proliferation. Five types of media viz., MSO, MS+1.0 mg/l BA, MS+2.0 mg/l BA, MS+4.0 mg/l BA, MS+0.5 mg/l BA+ 0.01 mg/l NAA were used in this study. Among

the media components studied, MS+1.0 mg/l BA was found to be the best for maximum number (8) of shoot bud proliferation and highest percentage (90%) of explants responded to produce shoot bud. Shoot elongation was observed upon transferred to MS medium devoid of plant growth regulators. Maximum number (10) of shoot was found in this medium of MSO. Maximum shoot length (5 cm) was also observed in this medium of MSO. Strong and healthy shoots were transferred to different concentrations of IBA, IAA, and NAA for root induction. Root was induced only IBA with MS supplemented media. Maximum number (6) of root was found on MS+1.0 mg/l IBA and maximum root length (3 cm) was also observed in this medium. Eighty percent (80%) plantlets were survived at the outdoor condition.

The aim of the present investigation was to develop an efficient *in vitro* regeneration protocol for large scale production of propagules using stem segments as explant of *Toreniafournieri.* For shoot initiation, MSO and for shoot multiplication 1.0 mg/l BA with MS supplement medium was found effective. It is obvious from the study that for shoot initiation do not need hormones but for shoot multiplication, less concentration of BA was needed. For root induction also needed less concentration of IBA.

In vitro plant regeneration system was successfully developed for *Toreniafournieri* using stem segments as explants. Therefore, the protocol established in this study is useful for providing disease free quality planting materials round the year.

1.6 Improvement of capsicum (capsicum annuum l.) using cobalt^{60} gamma source via *in vitro* plant regeneration techniques

M. T. Jahan, S. A. M. S. Islam, M. M. Islam, M. M. Islam, P. Das, M. A. Islam, M. A. Taher, M. H. Kabir, M. R. Islam and A. N. K. Mamun

Capsicum (*Capsicum annuum* L.) is one of the most important vegetable crops in the world and commonly known as pepper, sweet pepper or bell pepper, belongs to the family Solanaceae. It is an excellent source of vitamins A, B-complex, C, E and is rich in minerals like molybdenum, manganese, folate and potassium. The genus consists of about 25 wild and 5 domesticated species. However, *Capsicum annuum* L. is considered as the economically most important species of the genus. In the present study capsicum seeds as well as shoot tip and nodal segment of *in vitro* grown seedlings were irradiated with five level of dose from 10 to 50 Gy of a cobalt^{60} gamma source at a dose rate of 20 Gy/min. Radiation sensitivity and post irradiation recovery were assessed by measuring survival rate, propagation rate, shoot height, and fresh weight. The time at which the cells are irradiated is very critical. The optimal timing for irradiation is considered to be 4-6 days after subculture because at this time the majority of cells are in the G1 phase. One of the most important steps in mutagenesis experiments is to determine the appropriate dose. Theoretically, LD-50 would cause the highest frequency of mutations. In the present investigation LD-50 were determined for three different experimental materials 40 Gy were effective for seeds, on the other hand 30 Gy were effective for both in vitro derived explants viz. shoot tip and nodal segment.

For the induction of multiple shoots, shoot tip as well as nodal segment of *in vitro* grown capsicum seedlings were cultured onto MS fortified with different concentrations of BAP, Kin (1.0- 4.0mg/l) singly or in combination with NAA (1.0- 2.5mg/l). For *in vitro* rooting, individual shoot from the cluster of multiple shoots were separated and cultured on to MS supplemented with different concentrations (0.5-2.5 mg/l) of IBA. Best root development was noticed on the medium containing 2.0 mg/l IBA. In this combination it was observed that 100% shoots rooted well within 20 days of culture and each micro-cutting produced an average of 12 roots.

It has been reported that IBA, is a suitable auxin for adventitious root induction and it was also found superior to IAA or NAA for its more stable nature. Fully developed plantlets were then transferred to small pots containing soil and compost (2:1) for their growth and development. Humidity was maintained by covering the pots with polythene bags. Finally, these plants gradually shifted to outdoor condition. 80 to 85%tissue culture derived plants survived under natural environment.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
All the Scientist of this Division	Annual Plant Tissue Culture and Biotechnology Conference 2020	Bangladesh Association for Plant Tissue Culture and Biotechnology	6 Mar. 2021	Virtual platform
All the Scientist of this Division	Evaluation of Wetland Tanguar Haor at the Rauar Station with Special Reference to its Physico-Chemical, Biological, and radiological Components and Conservation	IFRB	24 Jun. 2021	Virtual platform
All the Scientist of this Division	Effects of the Prdx2 Depletion on Blood Pressure and Life Span in Spontaneously Hypertensive Rats	IFRB	22 Jun. 2021	Virtual platform
All the Scientist of this Division	Molecular Mechanism, Characterization and Control of Bacillus cereus Biofilm formation in Food Safety Perspective	IFRB	10 Feb. 2021	Virtual platform
All the Scientist of this Division	Genetical and Physiological Characterization of Nodule-Derived Bacteria for Practical Application as biofertilizer in Leguminous Crop Cultivation	IFRB	6 Dec. 2020	Virtual platform

3. Collaboration Work(s)

Plant Biotechnology and Genetic Engineering Division (PBGED) has collaboration with International Atomic Energy Agency (IAEA), Regional Cooperative Agreement (RCA) Austria and Forum for Nuclear Cooperation in Agreement (FNCA), Japan. At present Scientists of this division engaged in several projects, these are as follows:

- IAEA/RCA Project (RAS5088), Enhancing crop productivity and quality through mutation by speed breeding.
- IAEA/RCA Project (RAS5070), Developing Bioenergy crops to optimize Marginal Land Productivity through Mutation Breeding and related Techniques.
- IAEA/RCA Project (RAS5077), Promoting the Application of Mutation Technique and Related Biotechnologies for the Development of Green Crop Variety.
- IAEA/TC-Project, Strengthening capacity in the maintenance and utilization of the Tandem Accelerator Facility" IAEA/TC-BGD0010.
- Forum for Nuclear Cooperation in Asia (FNCA) project, Induced mutation for higher protein, amylase and yield in salt tolerant rice landraces by gamma irradiation.

Cytology and Biocontrol Research Group, IFRB

Objective/Introduction

A new research wing has been formed namely "Cytology and Biocontrol Research (CBR)" group at the Institute of Food and Radiation Biology (IFRB), Atomic Energy Research Establishment (AERE), Bangladesh Atomic Energy Commission (BAEC) last Nov. 2020. Research and Development (R & D) activities of this wing has focused on Cytology and Biocontrol, particularly in the field of Dipteran insects. Members of the CBR are Dr. FarzanaYesmin (CSO), Dr. Md. Hasanuzzaman (PSO), Mrs. Tahera Hossain (SSO) and Mrs. ShammeAkter (SA-1). Presently, Dr. Yesmin has been assigned to Group Leader of CBR.

Activities

1. Research and Development Work

1.1 Cytogenetic studies of chironomus spp. (diptera: Chironomidae)

Among Dipteran insects, the genus *Chironomus*is a very much valuable insect because of the large polytene chromosomes in their salivary glands andthis insect is distributed in a broad range ofecologicalconditions.The

objectives of this study are to investigatecytogenetic variation and genetic differentiation of different *Chironomus* species in Bangladesh. Larvae were collected randomly from the Bongshi River, Nayarhat, Savar and examinedcytologicallyat the Cytology and Biocontrol Research (CBR) group of the Institute of Food and Radiation Biology (IFRB), AERE, Savar, Dhaka. Salivary glands of forth instar larvae were used for polytene chromosome preparation following the aceto-orcein squash method. Salivary gland cells contained four pairs (2n=8) of polytene chromosomes with long precious banded structures, puffs, Balbiani rings (BR) and nucleolar organizers (NOR). Four polytene chromosomes are numbered with AB (1^{st}), CD (2^{nd}), EF (3^{rd}) and G (4^{th}). Initially, seven types of polytene chromosome banding structures (Type 1-7) were identified that most likely refers to seven different *Chironomus* species. Polytene complements of Type 1 has a sequence of banding in arms A-F and arm G contained one BR in the middle and one NOR of its both ends. Banding inversion also observed in this arm. Specific and regular banding structure located in all arms A-G of Type 2. Short arm G has special flattened fused banding structure at one terminal end. Polytene chromosomes of Type 3 are comparatively shorter in length and its arm G is very short adorn with BR, NOR and banding inversion. Banding inversion in arm D is found in Type 4 where arm G has two BR and one NOR. Type 5 comprise of long polytene arm (A-F) and G has BR, NOR and banding inversion in the middle. Arm G of Type 6 belong to the specific fused banding pattern with BR in each terminal region and NOR with inversion in the middle. Polytene chromosome of arm G of Type 7 composed of two BR and two NOR of its one terminal end. These cryptic polytene chromosome banding sequences and their arrangements provide significant cytotaxonomic information for identifying the Chironomid species. Further cytogenetic study of natural populations based on long-term sampling strategy from different ecological conditions are in progress. The cytogenetic data could be very useful for testing thehypothesis of the role of chromosome inversion on localadaptation.

1.2 Chromosomal characterization in mitotic metaphase spreads of the bactroceradorsalis x bactrocerazonatahybrid (Diptera: Tephritidae)

The patterns of chromosomal characterization in mitotic metaphase spreads of the *Bactroceradorsalis*x *Bactrocerazonata* hybrid were investigated and analyzed. Both the species are destructive pests (Family-Tephritidae) in agriculture sectors of tropical and sub-tropical countries including Bangladesh. This hybridization could allow the explanation of genes of the possible reproductive isolation by cytogenetical means into *B. dorsalis* speciation. Mitotic metaphase chromosomes were examined from neural ganglia of third instar larvae based on their karyotype morphology and C-banding procedure.Carl Zeiss AXIO Lab A1 microscope and ZEN 3.1 (blue edition) software were used for photographic analysis.The hybrid offspring show five pairs of autosomes and one pair of heteromorphic sex chromosomes (XX/XY) as their parental strains. Chromosome pair 2 and 4 are metacentric and pair 3, 5 and 6 are submetacentric.Chromosome 2 contains minimal amount of pericentric heterochromatin (8.75% in female and 9.23% in male); chromosome 3 and 4 have almost same and 5 and 6 contains comparatively largercentromeric heterochromatin blocks. The X chromosome in both sex apprehend with 30% pericentric heterochromatin block holding a large telomeric band (18% in female and 20% in male). The dot shaped Y chromosome is almost heterochromatic. The ability of *B. zonata* to mate, produce viable and fertile progeny in lab condition, then produce hybrids carrying intermediate chromosome characteristics with the parental strains indicates to the sign of possible prezygotic isolation between *B. zonata* and the other members of the *B. dorsalis* species complex.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Tahera Hossain	Follow-up Training Course on Environmental Radioactivity Monitoring	TI, AERE, BAEC	10-14 Jan. 2021	TI, AERE

Molecular Radiobiology and Biodosimetry Division, IFRB

Objective/Introduction

Molecular Radiobiology and Biodosimetry Division (MRBD) plays a vital role in preparedness for and response to radiation emergencies and to research in the field of radiation biology at the molecular level for the well-being of mankind. The major objectives are as follows.

- To evaluate the radiation absorbed dose of the accidental radiation-exposed individual by analyzing the extent of chromosomal DNA damage.
- To investigate the DNA damage repair mechanism in extremely radiation-resistant bacteria (e.g. *Deinococcusradiodurans*), whose findings could play important role in biomedical research like cancer and aging.
- To find out the local variety or to develop the mutant variety of microbial strain that could be used for economic, health, and environmental benefits.
- Tostudy metagenomics, epigenetics, gene expression profiling, microbial typing, protein purification, and characterization, etc.

Activities

1. Research and Development Work(s)

1.1 Knockout of ppra gene results in loss of survival of radiation resistance bacterium deinococcusradiodurans

A. Y. K. M. M. Rana, S. Islam, A. H. M. Kamal, M. Z. Rahman and P. K. Roy

D. radiodurans is one of the most radiation-resistant organisms, and resistance to UV light, gamma radiation, and desiccation. It is also known as extremophile and listed as the world's toughest known bacterium.It can mend over 100 double-stranded DNA breaks where few DBs are lethal to *E. coli* andhumans. It was found that special DNA repair mechanisms and the structural quality of their genome were responsible for their radiation resistance. We have studied the effect of the *pprA* gene on the survival of this bacterium upon radiation exposure. A survival study under radiation exposure was conducted by comparing the growth of a *pprA* gene disrupted strain, the *pprA* complemented strain and the wild type strain of *D. radiodurans* following gamma- irradiation (Co60) at different dosages at 2, 4, 6, and 8 KGy. The *pprA* gene (*DRA_0346*) is a *Deinococcus*-specific gene that preferentially binds to double-stranded DNA carrying strand breaks and stimulates the DNA end-joining reaction catalyzed by DNA ligases. The*pprA* disrupted strain grew slowly with very few colonies with the increase in the radiation dose. The *pprA*-complemented strain grew at the same rate as the wild-type strain. The*pprA*is not only the gene responsible for radiation resistance. Besides, some other genes, proteins and factors are also found to be responsible for the higher radiation tolerance capability of these bacteria. Understanding the DNA repair mechanism of *D. radiodurans* will play an important role in the research of cancer, aging and the mitigation of radioactive wastes.

1.2 Development of cytogenetic dosimetry laboratory in MRBD for strengthening nuclear and radiological safety of Bangladesh

A. H. M. Kamal, M. Z. Rahman, A.Y. K. M. M. Rana, S. Islam and P. K. Roy

Cytogenetic dosimetry is used to measure the radiation absorbed dose of over-exposed persons by assessing chromosomal damages of lymphocytes. It is an important tool for radiation emergency response and medical surveillance. Ionizing radiation can induce DNA strand breaks on the chromosomes and wrongly repaired breaks can result in abnormal chromosomal structures. The number of abnormal structure is related to the dose, usually in a linear-quadratic dose-effect relationship and cytogenetic dosimetry calculate dose from this relationship. Molecular Radiobiology and Biodosimetry Division (MRBD) has developed the country’s first cytogenetic dosimetry capability by constructing a modern laboratory, installing state-of-the-art facilities, and by train manpower in globally renowned biodosimetry laboratories. The whole work is completed under the auspices of the Bangladesh government ADP project "Modernization of Food and Radiation Biology Facilities of Bangladesh Atomic Energy Commission". Optimization work is going in MRBD to establish the dose-response calibration curve for four different techniques that are used for cytogenetic dosimetry: Dicentric assay (DA), Fluorescent In Situ Hybridization (FISH), micronuclei assay (MN), Premature Chromosome Condensation assay (PCC). MRBD has also joined the WHO BioDoseNet network, an informal network of the World Health Organization, as global networking and collaboration are important for radiation emergency management. Overall, biodosimetry capability will strengthen the nuclear and radiological safety of Bangladesh.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participants
Hands-on training course of carl-Zeiss fluorescence microscope	1-5 Mar. 2020	MRBD, IFRB	8
Hands-on training course of MiSeq DNA Sequencing Data Analysis	30-31 Dec. 2020	MRBD, IFRB	10

3. Collaboration Work

- S and T Project, Generation Of Dose-Response Curve Of Chromosome Aberrations In Human Lymphocytes Induced By X-Rays, Principal investigator: Dr. Md. ZiaurRahman, Associate investigator: D. P. K. Roy (Group ID: MS - 520, financial year: 2020-2021).
- S and T Project, Development of Radiation Resistant Probiotic Bacteria for Preventing Radiation Induced Diarrhea in Cancer Patient, Principal investigator: Abu HenaMostofa Kamal, Associate investigator: D. A. Y. K. M. M. Rana (Group ID: BS - 303, financial year: 2020-2021).
- IAEA Project (Code RAS5085), Using nuclear derived techniques in the early and rapid detection of priority animal and zoonotic diseases with focus on Avian Influenza, Project Counterpart: D. P. K. Roy (Cycle: 2020 - 2023).
- IAEA ZODIAC, Zoonotic disease Integrated Action Project, ZODIAC National Coordinator: Dr. A.Y.K. M. M. Rana (Cycle: 2020 - 2025).

INSTITUTE OF TISSUE BANKING AND BIOMATERIAL RESEARCH (ITBBR), AERE

Introduction

Institute of Tissue Banking and Biomaterial Research (ITBBR) is the only Tissue Bank in Bangladesh that stands for the people who are suffering from massive burns, surgical wounds and traumatic complications. ITBBR has undertaken the service program on theprocessing, preservation and clinical applications of amnion membrane and bone graft for rehabilitative surgery.Most importantly, in recent years, this institute has started cranial bone autograft processing and transplantation.

Besides, tissue banking professionals work on the development of new biomaterial and allograft substitutes to mitigate the huge demand for graft material and arrange public and professional awareness programme to increase tissue donation as well.

Activities

1. Research and Development Work(s)

1.1 Procurement, processing and preservation of gamm irradiated human amniotic membrane for repair and regeneration of damaged tissues

T. A. Arafat, M. L. Hossain, M. H. Adnan, P. C. Karmakar, A. Siddika, M. S. Rahman, M. Arifuzzaman, N. Akhtar and S. M. Asaduzzaman

The amniotic membrane is the innermost lining of the placenta that is normally discarded after parturition. The membrane has numerous growth factors, proteins and stem cell reserves that help in accelerating wound healing with the regeneration of the lost tissues. It is an ideal biological membrane or dressing due to its biological and biomechanical properties. It is readily available, inexpensive to procure and process. It can be procured from the placenta in normal vaginal deliveries as well as Caesarean Sections. Processing is by freeze-drying or by air-drying process with sterilization using gamma irradiation. The product has low antigenicity, anti-microbial properties with the ability to enhance epithelization with marked relief of pain. It is useful as a dressing for flap wounds, burn wounds, injury wounds, diabetic ulcers, leprous ulcers and post-surgery wounds and post-radiation wounds. It is also used as a biological scaffold for cells in tissue engineering.For HAM allograft preparation, amniotic sacs were retrieved from seronegative donors after normal vaginal deliveries. Amnion was separated aseptically from the chorion, washed several times (6-8 times) with sterile physiological saline, spread on sterile surgical gauge and oven-dried at the temperature

40±1ºC for overnight. The dried membranes were cut into different standard sizes e.g., (20×10 cm, 10×10cm, 5×5 cm), triple packed in polythene envelopes, vacuum-sealed and labeled properly under laminar flow cabinetand sterilized by gamma irradiation at the dose of 25 kGy. According to the demand of medical professionals, from Jul. 2020 to Jun. 2021, 5,060pieces of radiation sterilized amnion membrane allografts (including eye grafts) were supplied to hospitals/clinics. Patients were successfully treated using these allografts suffering from various types of skin loss due to burn (acid, fire and electric burn), ophthalmologic defects, vaginal defects, abdominal wall reconstruction and some other complications.

1.2 Microbiological quality control and safety assurance of radiation sterilized tissue allografts

M. H. Adnan, M. L. Hossain, T. A. Arafat, P. C. Karmakar, A. Siddika, M. S. Rahman, M. Arifuzzaman, N. Akhtar and S. M. Asaduzzaman

Tissues like bone, skin, amniotic membrane and soft tissues obtained from the human donor can be used for repair or reconstruction of the injured part of the body. The risk of infectious disease transmission with human tissue grafts is a major concern in tissue banking practice. Non-sterilized, fresh or frozen bone allografts collected under aseptic conditions have been associated with transmission of viral infections such as HIV, hepatitis viruses (especially HCV and HBV) and bacterial infections. To minimize the hazard of infectious disease transmission, several steps are considered: careful donor screening and selection, proper tissue procurement, processing, preservation, storage and distribution. Therefore, the success of transplantation largely depends on the microbiological and immunological quality of the allografts. Contaminated allografts may lead to a serious disease or even the death of the recipient. To guarantee a consistent level of quality and good scientific practice, tissue banks must provide quality management systems that ensure correct performance. A tissue bank must provide optimized technical solutions for the acquisition, storage, documentation, and transfer of graft materials. Despite the safeguards, aseptically processed tissues should not be considered sterile. In response to well-publicized infections associated with the implantation of allograft tissue, terminal sterilization of allografts has been considered an integral part of tissue processing. Tissue banks historically have used one of two methods of sterilization, ethylene oxide or gamma radiation. Among these, the application of gamma irradiation for the terminal sterilization of tissue allografts is well accepted because the process control is precise and the method leaves no residue in the treated product. Based on the initial bioburden level and radiation response of the contaminants, 25 kGy gamma radiation was found suitable for the sterilization of tissue allografts processed in ITBBR. During the reporting period, 569 amnion samples from 24 batches,804 bone samples from 30 batches, 221 pieces of cranial bones and 4 pieaces of massive bones were tested. The samples were supplied to the patients only after passing the sterility test.

1.3 Procurement, processing and preservation of cranial bone autograft and their clinical application in the skull defect's reconstruction

M. L. Hossain, A. Siddika, T. A. Arafat, M. H. Adnan, P. C. Karmakar, M. Arifuzzaman, M. S. Rahman, N. Akhtar and S. M. Asaduzzaman

Reconstruction of cranial bone defects is one of the most challenging problems in reconstructive surgery.Pathological defects or alterations in the shape of the calvarium may be caused by several processes, including traumatic defects, resection of benign or malignant tumors, congenital lesions, and iatrogenic injuries. The most common causes of skull defects include trauma, neurosurgical procedures and infections. It is a difficult task to re-implant autologous skull flaps due to its propensity for resorption. From Jul. 2020 to Jun. 2021, 108frozen cranial bone autografts were supplied to the hospitals for cranial bone reconstruction. Using these autografts, patients suffering from the traumatic head injury, brain tumor and stroke were treated successfully. Most of the patients underwent craniotomy because of traumatic head injury (THI) due to roadtraffic accident (RTA).Thus ITBBR is a unique place for the processing and preservation of human skull bone.

1.4 Procurement, processing, preservation and clinical application of frozen irradiated massive bone allografts for reconstruction of long bone defects

A. Siddika, A. Siddika, M. L. Hossain, T. A. Arafat, M. H. Adnan, P. C. Karmakar, M. Arifuzzaman, M. S. Rahman, N. Akhtar and S. M. Asaduzzaman

The reconstruction of large bone defects caused by trauma, disease or tumor resection is a fundamental challenge for orthopedic and plastic surgeons. Their critical size exceeds the intrinsic capacity of self-

regeneration and consequently, the bone repair is delayed and impaired. In the management of malignant or locally aggressive bone tumors, limb-sparing surgery may be considered in most cases as an appropriate surgical treatment to achieve local tumor control. To restore skeletal continuity in large defects, different methods of reconstruction are currently used. Bone lengthening under continuous distraction is also possible in segmental defects. However, for young patients with a near-normal life expectancy, the implanted material is prone to loosening in the long term. Preserved bone allograft, although it may initially be considered a biological non-living prosthesis, has the advantage of becoming progressively anchored by the host bone. It can be stored deep-frozen for a long time and retains its original biomechanical properties after preservation. Bone allografting has attracted additional interest since it offers the possibility to restore an articular function by preserving the articular cartilage or serves as structural support in failed prosthetic replacement.From Jul. 2020 to Jun. 2021, 2 deep frozen massive bone allografts have been supplied to the different hospitals/clinics throughout the country based on demand.Massive bone allografts are very slowly revascularized and are intimately anchored by the host bone. In reconstructive surgery with massive bone allografts represent a successful alternative to prosthetic implants inyoung adults with a long life expectancy.

1.5 Processing and preservation of gamma irradiated demineralized bone Matrix (DBM) for the reconstruction of maxillofacial bone defects using

P. C. Karmakar, M. L. Hossain, T. A. Arafat, M. H. Adnan, A. Siddika, M. S. Rahman, M. Arifuzzaman, N. Akhtar and S. M. Asaduzzaman

Demineralized bone matrix(DBM) is a bone allograft that has been decalcified to produce a product of collagen and noncollagenous proteins.It isconsidered as a gift in the regeneration of human periodontal defects. It has osteoconductive and osteoinductive properties that prompt bone regeneration. Consequently, about 20% (or about 108,000 procedures per year) of the $1 billion per year bone grafting market focuses on using DBM products in bone repair and regenerative strategies.The DBM provides not only osteoinductive proteins and but also growth factors. Demineralization of bone is the first step during matrix breakdown, which improves the accessibility of the growth factors that retain all or most of its osteoinductive potential. DBM is widely used in the repair of pathologies associated with skeletal defects and periodontal diseases. DBM powder is used primarily in periodontal applications. The property which sets DBM grafts apart from other types of bone graft is its capacity to actively induce the formation of new bone. From Jul. 2020 to Jun. 2021, 79 vial demineralized bone granules have been supplied to the different hospitals/clinics throughout the country based on demand. The use of demineralized bone granules in oral and dental surgical procedures gave satisfactory clinical results. The processing of demineralized bone granules should be continued along with the processing of non-demineralized allogeneic bone grafts.

1.6 Procurement, processing, preservation and clinical application of cancellous bone chips allografts for the treatment of osseous defects and augmentation of spinal fusion

M. L. Hossain, A. Siddika, T. A. Arafat, M. H. Adnan, P. C. Karmakar, M. Arifuzzaman, M. S. Rahman, N. Akhtar and S. M. Asaduzzaman

Cancellous bone is the most commonly used form of autologous bone grafts. Its high concentrations of osteoblasts and osteocytes give it superior osteogenic potential. Additionally, its large trabecular surface area encourages revascularization and incorporation at the recipient site.Incorporation of cancellous bone grafts is a well-studied phenomenon, characterized by the formation of new bone over a necrotic graft bed through the dual processes of resorption and substitution. The human skeleton has a remarkable ability to regenerate itself after injury. This unique restorative capacity allows bones to heal at shapes, sizes and strengths essentially equal to their pre-injured forms. At its core, orthopedic fracture care is an attempt to harness this amazing regenerative capacity and let the body do its work.Modern bone grafts, bone substitutes and bioactive factors attempt to facilitate and enhance the healing process when suboptimal conditions exist. Depending on their properties, preparation and application, bone grafts augment natural healing via osteoinductive, osteoconductive and/or osteogenic mechanisms.Cancellous bone allograft (CBA) alone or in combination with autologous bone precursor cells offers an appealing strategy for skeletal regeneration. In many cases, cancellous bones are preferable to cortical bone due to its higher surface area and open porous structure that allows for easy cellular penetration and incorporation. From Jul. 2020 to Jun. 2021, 19,652cc bone grafts have been supplied to he different hospitals/clinics throughout the country based on demand.

1.7 Amniotic membrane conjugated with carbon nanotubes (CNTs) to heal burn wound in wister rat

T. A. Arafat, M. L. Hossain, P. C. Karmakar, M. H. Adnan, A. Siddika, M. Arifuzzaman, M. S. Rahman, N. Akhtar and S. M. Asaduzzaman

Burn injuries have disastrous effects on the affected patients making them susceptible to wound infection and septicemia which cause physical and psychological disabilities as well as death; and require better treatment alternatives. Amniotic membrane (AM) has been used in burn wounds for centuries for its low immunogenicity; anti-inflammatory, angiogenic, anti-fibrotic and antimicrobial properties besides promoting epithelization by excreting EGF, IL-8, IGF-1 that support epithelization and differentiation of cells.On the other hand, Carbon nanotubes exert antimicrobial properties, reduce inflammation, promotes fibroblast migration and myofibroblast differentiation. In this research Carbon nanotube-based AM hydrogel was applied to treat burn wounds in the preclinical trial (Female Wister Rat) and formulated CNTs+AM hydrogel showed remarkable effectiveness comparative to others.

1.8 Fabrication of hydroxyapatite-collagen hybrid biocompatible composite scaffold for bone tissue engineering

M. L. Hossain, T. A. Arafat, P. C. Karmakar, M. H. Adnan, A. Siddika, M. Arifuzzaman, M. S. Rahman, N. Akhtar and S. M. Asaduzzaman

The biomaterials which are major components of scaffolds play a vital role in bone tissue engineering. The selection of appropriate material to fabricate a scaffold to be used in bone tissue engineering application is a critically significant step towards the construction of a tissue-engineered product. In this research, hydroxyapatite-collagen based scaffolds were prepared and physical, chemical and mechanical properties were determined which showed desirable properties for an ideal scaffold. Cytotoxicity and brine shrimp lethality test showed no toxic effect of the scaffolds on cells, so the scaffolds were suitable for the study *invivo.*

1.9 Synthesis of titanium nanoparticle-based amniotic hydrogel for in vivo burn wound healing

M. L. Hossain, P. C. Karmakar, T. A. Arafat, M. H. Adnan, A. Siddika, M. Arifuzzaman, M. S. Rahman, N. Akhtar and S. M. Asaduzzaman

Titanium nanoparticle is widely used in various biomedical applications and has shown excellent biocompatibility while using as a graft material for wound healing. However, human amniotic membranes are globally used as ideal wound and burn dressing material for decades. In this study, Titanium nanoparticle-based amniotic hydrogel was prepared at a low cost that was compatible withthe skin, cost-effective, enabled a high percentage of wound contraction and enhanced faster epithelization than other applied gels and can be used as a good therapeutic agent that has a promising effect to treat burn and wound.

2. Seminar/Symposium/Conference/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Md. Liakat Hossain	The synergistic and complementary effect of gamma-irradiated human amniotic membrane and plants derived gels on burn and wound healing: a new hope in regenerative engineering	Institute of Tissue Banking and Biomaterial Research, Atomic Energy Research Establishment (AERE),Savar,Dhaka-1349	26 Nov. 2020	AERE, Savar
Md. Shaifur Rahman	Human amniotic fluid and urine as the sources for mesenchymal stem cells of renal origin with versatile regenerative potential	Institute of Tissue Banking and Biomaterial Research, Atomic Energy Research Establishment (AERE),Savar, Dhaka-1349	27 Jun. 2021	AERE, Savar

3. Public and Professional Awareness

To save the lives of thousands of people, ITBBR arranges various awareness programmes throughout the country. People are being informed thattissue transplant surgeries improve life quality. A single tissue donor

can save the life of several people. In our country, the majority of people are familiar with the concept of blood transfusion and organ transplantation but the concept of tissue transplantation is somewhat new to them. To make the concept familiar and to inspire tissue donation seminars were arranged at different hospitals. Besides, the discussion meetings with physicians are arranged regularly to increase professional awareness. The institute is doing its best for the improvement of human life and thus contributes a lot to the health sector by consolidating tissue banking activities.

4. Service Rendered and Revenue Income

Jul. 2020 - Jun. 2021, 5,060 pieces of radiation sterilized amnion membrane allografts (including eye grafts) and 14,379cc bone grafts (including 2 deep frozen massive bone allograft, 38 frozen cranial bone autograft and 79 vial demineralized bone granule) have been supplied to the different hospitals/clinics throughout the country based on demand.

Nature/name of service	No. of sample	Revenue income
Supply of bone tissue allografts	14,379	5,94,750 /-
Supply of amniotic membrane allografts	5,060	78,300 /-
Total	19,439	6,73,050 /-

NUCLEAR MEDICINE

NATIONAL INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (NINMAS), SHAHBAG

Objectives

- Render specialized medical services to the people using nuclear technology.
- Improve and upgrade Nuclear Medicine facilities in Bangladesh.
- Conduct training of physicians, physicists, radiopharmacists and technologists in the field of nuclear medicine.
- Conduct academic and research activities.
- Coordinate and standardize the activities of all nuclear medicine establishments of BAEC.

Activities

1. Services

1.1 Clinical Services

Diagnostic Activities

- The Institute is equipped with 2 PET-CT facilities. PET-CT scan is very useful for early diagnosis and staging of cancer for the people of Bangladesh.
- The institute is equipped with three SPECT, one SPECT-CT and one planar Gamma camera. The Scintigraphic studies are: Bone scan, Brain scan, Kidney (DTPA, DMSA), GFR, Hepatobiliary, HIDA, Lymphoscintigraphy, GI bleeding, Thyroid Scan, parathyroid, Salivary, Cardiac and Testicles, Lung Perfusion etc.
- Thyroid Imaging and Uptake.
- BMD (Bone Mineral Densitometry) for early detection of osteoporosis/osteopenia.
- Conventional and Power and Color Doppler Ultrasound Imaging: At present there are 5 Color Doppler's including one 4D, one 3D and three 2D machines. All sorts of diagnostic USG, including normal B-scan of different organs, HRUS of superficial organs and Color Doppler of vascular system are routinely performed.
- Hormone Analysis: By using the RIA and modern CLIA techniques the In-vitro division is estimating all thyroids related hormones like T3, T4, TSH, FT3, FT4, LH, FSH, pituitary hormones, estrogen,

progesterone, prolactin, testosterone, follicular stimulating and luteinizing hormones, Vitamin D, parathormone and Tumor Marker: Thyroglobulin, etc.

- Screening of Congenital Hypothyroidism in Newborn Babies: In-vitro Division is also playing an important role in the screening of Congenital Hypothyroidism by Newborn Screening with the aid of Dissociation Enhanced Lanthanide Fluorescence Immunoassay (DELFIA) technique in Dried Blood Spot (DBS) method; implementation of the ADP Project "Screening of Congenital Hypothyroidism in Newborn Babies (Phase 2).

Therapeutic Activities

- The therapeutic component of our activity is extensively in the treatment of thyroid cancer and hyperthyroid patients using I-131.
- Strontium-90 for pterygium, corneal neovascularization and squamous cell carcinoma of the conjunctiva.
- I-131 labeled MIBG for diagnosis and therapy of neuroendocrine tumors.

2. Academic Activities

- NINMAS is the only institute in the country where postgraduate degrees like MD (Nuclear Medicine) course which have been conducted for the medical graduates under Bangabandhu Sheikh Mujib Medical University (BSMMU). In last academic session, ten (10) residents were admitted for MD course of 5 years duration.
- One Physician from abroad has been doing his MD (Nuclear Medicine) after completion his IAEA fellowship training in NINMAS.
- Weekly journal review as continuous education program was conducted on recent Nuclear Medicine and Allied Sciences related works regularly in this institute.
- Scheduled lectures were delivered routine to post graduate students (MD, MS) of different disciplines of BSMMU, BIRDEM, NIKDU, NICVD, NSH, NICRH, NICDH and Heart Foundation and students are placed for 15-30 days for practical demonstration.
- Collaborator of the 'Multi Disciplinary Team Approach consultation in between oncologists, Head neck surgeons, Pathologists and palliative care units along with Nuclear Medicine specialists of NINMAS for clinical management of complicated and academic cases.
- Collaborator of the training program for work safety in a COVID-19 pandemic crisis.

3. Cyclotron and Molecular Imaging

IBA Cyclone 18/9 is a dual particle accelerator/cyclotron whose proton energy is 18 MeV and deuteron energy is 9 MeV. This IBA cyclotron was commissioned at the basement of the F Block at BSMMU campus which is operated by NINMAS, BAEC. The cyclotron is capable to produce positron emitters radionuclide, namely, ^{18}F, ^{15}O, ^{13}N, ^{11}C and other isotopes from solid targets for Positron Emission Tomography (PET) imaging. Presently the cyclotron has been exclusively used for the production of ^{18}F for ^{18}F-FDG PET imaging. ^{18}F-FDG is supplied to the NINMAS, INMAS, Dhaka, Combined Military Hospital (CMH), Evercare Hospital Dhaka (EHD), Medinova Medical Services Limited and Institute of Nuclear Medical Physics (INMP), Savar regularly twice in a week The Cyclotron facility is also capable of producing ^{18}F-NaF, ^{18}F-FLT and ^{18}F-MISO.

4. Training/Workshop/Seminar/Conferences Hosted

Title of the event	Organizer	Date	Place	No. of participants
In-house training of the trainers (TOT) to prepare presentations for educating NINMAS staff to assure health safety during Covid-19 pandemic in Bangladesh as a Corona preparedness protocol	NINMAS, Dhaka	13-16 Jul. 2020	NINMAS, Dhaka	32
2021 Bangladesh- KOICA Spring Workshop on Clinical Nuclear Medicine.	NINMAS, Dhaka and KOICA	17 Feb. - 26 May 2021	NINMAS, Dhaka	35

Title of the event	Organizer	Date	Place	No. of participants
2020 Bangladesh- KOICA Summer Workshop on Clinical Nuclear Medicine.	NINMAS, Dhaka and KOICA	9 -17 Aug. 23 Sep. 2020	NINMAS, Dhaka	35
In-house training decorum of office staff on Covid-19 situation as Corona Preparedness protocol	NINMAS, Dhaka	25-27 May 2020	NINMAS, Dhaka	40
In-house training decorum of office staff on Covid-19 situation as Corona Preparedness protocol	NINMAS, Dhaka	16 Mar. 2020	NINMAS, Dhaka	70

5. Manpower Development and Training Program

Title of the event	Date	Place	No. of participants
In-house training of the trainers (TOT) to prepare presentations for educating NINMAS staff to assure health safety during Covid-19 pandemic in Bangladesh as a Corona preparedness protocol	13-16 Jul. 2020	NINMAS, Dhaka	32
32nd National conference and annual general meeting of Bangladesh Society of Ultrasonography (BSU)	27 Nov. 2020	Virtual Meeting	330
Analytical technique for the measurement of neonatal TSH from Dried Blood Spot (DBS)	23 Sep. 2019	NINMAS, Dhaka	150
Training on dried Blood Spot (DBS) Sampling Procedure for the Screening of Congenital Hypothyroidism in Newborn Babies	5 Nov. 2020	Chattogram Maa O Shishu Hospital, Chattogram	150
Training on "Dried Blood Spot (DBS) Sampling Procedure for the Screening of Congenital Hypothyroidism in Newborn Babies	8 Nov. 2020	250 Bed District Sadar Hospital, Cox's Bazar	100
Training on dried blood spot (DBS) sampling, preservation and diagnostic procedure for Congenital Hypothyroidism Screening	30 Jun. 2021	NINMAS, Dhaka	200
In-house training decorum of office staff on Covid-19 situation as Corona Preparedness protocol	16 Mar. 2020	NINMAS, BAEC	70
In-house training decorum of office staff on Covid-19 situation as Corona Preparedness protocol	25-27 May 2020	NINMAS, BAEC	40
Regional Training Course on Set-up of Cyclotron Facility for Radiopharmaceutical Production	28 Jun. - 2 Jul. 2021	Korea Institute of Radiological and Medical Sciences	1

6. Seminar/Symposium/Conference/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. F. Begum	Therapeutic Nuclear Medicine	SMMB	2 Jul. 2021	Virtual
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. F. Begum, Dr. Z. Jabin, Dr. S. Quddus, Dr. A. K. M. F. Bari , Dr. R. Perveen, Dr. P. Akhter, Dr. U. Islam, Dr. F. Haque, Dr. T. Mandal, Dr. P. Mutsuddy and Dr. J. Ferdous	Mother-Baby-Iodine: The Importance of Iodine on the women and her Baby	BTS	30 May 2021	Dhaka
Dr. F. Begum	4th Annual Conference and Scientific Webinar on "Thyroid Disorders and Surgery"	BTS	19 Mar. 2021	Dhaka

Name of the participant	Title of the event	Organizer	Date	Place
Dr. S. M. F. Begum, Dr. S. Sultana Dr. F. Begum, F. Begum, Z. Jabin, Dr. N. Sultana, Dr. S Quddus, Dr. F. Nasreen, Dr. J. Ferdous, N. Hossain, Dr. T. Mandal, Dr. R. Perveen, Dr. P. Mutsuddy, Dr. U. Islam, Dr. P. Akhter, Dr, R. Perveen, Dr. U. Islam, Dr. F. Haque, Dr. P. Mutsuddy and Dr. J. Ferdous	2021 Bangladesh-KOICA Spring Workshop on Clinical Nuclear Medicine	NINMAS, Dhaka and KOICA	17 Feb.-26 May 2021	NINMAS
Dr. F. Begum and Dr. N. Sultana	15th International Conference on Radiopharmaceuticals Therapy	WARMTH	5-6 Dec. 2020	Virtual
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. F. Begum, Dr. S. Quddus, Dr. Z. Jabin, Dr. R. Perveen, Dr. P. Akhter, Dr. U. Islam, Dr. F. Haque, Dr. S. Quddus, Dr. T. Mandal, Dr. P. Mutsuddy, Dr. J. Ferdous and Dr. A. K. M. F. Bari	32nd National Conference of Bangladesh Society of Ultrasonography	BSU	27 Nov. 2020	Dhaka
	International Conference on Molecular Imaging and Clinical PET-CT in the Era of Theranostics (IPET-2020)	IAEA	24-26 Nov. 2020	Virtual
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. F. Begum, Dr. S. Quddus , Dr. Z. Jabin, F. Begum, Dr. R. Parveen, Dr. P. Akhter, Dr. U. Islam, Dr. F. Haque, Dr. T. Mandal, Dr. P. Mutsuddy and Dr. J. Ferdous	Bangladesh: KOICA Summer Workshop Weekly one Seminar for 3 Months	KOICA	11 Aug. 2020	Virtual
Dr. Z. Jabin	Webinar: Precision Medicine Moves Fast - How One of the Nation's Leading Oncology Practices is Staying Ahead	Precision Medicine at Texas Oncology	14 Jul. 2020	NINMAS Dhaka
	Webinar: Selecting the Best HPGE Detector for NM application	Mirion Technologies	23 Jul. 2020	NINMAS Dhaka
	AI, Machine Learning and Data Science	Precision Medicine Leaders Summit	24 Jul. 2020	NINMAS Dhaka
	Webinar: Remote Clinical Trial Monitoring in the time of COVID-19: Working Safer and Smarter	The Journal of Precision Medicine	29 Jul. 2020	NINMAS Dhaka
	Webinar: New Insight into Dietary Behaviour Using NMR Profiling.	Bruker Biospin	29 Jul. 2020	NINMAS Dhaka
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. Z. Jabin, Dr. S. Quddus, Dr. R. Perveen, Dr. P. Akhter, Dr. U. Islam, Dr. F. Haque, Dr. T. Mandal and Dr. J. Ferdous	Webinar: Abdominal Ultrasound	AFSUMB GE Webinar	6 Sep. 2020	NINMAS Dhaka

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Z. Jabin	Webinar: The Impact of COVID-19 on Healthcare - Challenges and Solutions	Med Tek 2020	23 Sep. 2020	NINMAS Dhaka
	Webinar: Precision Diagnostics	The journal of Precision Medicine	24-25 Sep. 2020	Virtual
	Webinar: Advances in Proton and Heavy Ion treatment for Cancer	BMPA	2 Oct. 2020	Virtual
	Webinar: Effective dose: Thriving or dying?	IOMP	6 Oct. 2020	Virtual
	Webinar: Precision Medicine - Virtual Series Community Oncology	The journal of Precision Medicine	13 Oct. 2020	NINMAS Dhaka
	Webinar: Treatment Plan Evaluation and Optimization Based on Radiobiologic Parameters	BMPA	23 Oct. 2020	Virtual
	Onine Continuing Professional Development Program: Liver ultrasound	BSU and Mindray	6 Nov. 2020	Virtual Event
	Webinar: Siemens Healthineers Shape 21: Insights and innovations to shape the future	Siemens Healthineers Shape 21 Forum	17 Nov. 2020	Virtual
	Webinar: Challenging Cases in Imaging Cardiac Amyloidosis: Read with the Experts	American Society of Nuclear Cardiology	20 Apr. 2021	Virtual
	Webinar: Facing Unknowns and Challenges: COVID-19 Testing in the Vaccine Era	Diagnostics for Precision Medicine	11 May 2021	NINMAS Dhaka
	Webinar: PET/CT PSMA: Pitfall and Artifacts	The Canadian Association of Nuclear Medicine	19 May 2021	Virtual
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. A. K. M. F. Bari Dr. Z. Jabin, Dr. S. Quddus, Dr. R. Perveen, Dr. P. Akhter, Dr. U. Islam, Dr. F. Haque Dr. T. Mandal, Dr. P. Mutsuddy and Dr. J. Ferdous	Webinar: World Thyroid day 2021	NINMAS	26 May 2021	NINMAS Dhaka
Dr. Z. Jabin	Webinar: Promoting Academic Integrity in Research and Professional Ethics	Turnitin South Asia	11 Jun. 2021	Virtual
	Webinar: Cardiac Sarcoidosis	The Canadian Association of Nuclear Medicine	16 Jun. 2021	Virtual

Name of the participant	Title of the event	Organizer	Date	Place
	Webinar: Covid-19 Pneumonia Lung Ultrasound (LUS) - Theoretical aspects and practical demonstrations	Global Ultrasound	21 Jun. 2021	NINMAS Dhaka
	Webinar: The Evolution of Cardiac PET: Two perspectives from starting a program and evolving to acute care	The Canadian Association of Nuclear Medicine	30 Jun. 2021	Virtual
Dr. N. Sultana	Covid Research Meeting with Brighton and Sussex Medical School	IAEA	10 Jul. 2020	Virtual
	Using Ultrasound to Diagnose and Guide Management of Endometrial and Myometrial Pathology	ISUOG	25 Jul. 2021	Virtual
	Virtual world congress ISUOG 2020	ISUOG	16-18 Oct. 2020	Virtual
	4th CRP Meeting	IAEA	19 Apr. 2021	Virtual
	Virtual World Congress ISUOG	ISUOG	16-18 Oct. 2020	Virtual
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. Sharmin Quddus, Dr. R. Perveen, Dr. P. Akhter, Dr. Dr. U. Islam, Dr. F. Haque, Dr. T. Mandal, Dr. P. Mutsuddy and Dr. J. Ferdous	Thyroglobulin and its implications in Treatment and monitoring of Thyroid Cancer	INMAS, Dhaka	24 Jul. 2020	INMAS
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. S. Quddus, F. Begum, Dr. Z. Jabin, R. Perveen, P. Akhter, Dr. U. Islam, Dr. F. Haque, Dr. T. Mandal, Dr. P. Mutsuddy and Dr. J. Ferdous	2020 Bangladesh-KOICA Summer Workshop on Clinical Nuclear Medicine	NINMAS, Dhaka and KOICA	9, 11, 17 Aug.- 23 Sep. 2020	NINMAS
Dr. S. M. F. Begum, Dr. S. Sultana Dr. S. Quddus, Dr. R. Perveen Dr. P. Akhter, Dr. U. Islam, Dr. F. Haque, Dr. T. Mandal, Dr. P. Mutsuddy, Dr. J. Ferdous and M. Anwar-ul-Azim	Radionuclide Imaging of Brain: Current and Future Perspective of Bangladesh		24 Aug. 2020	Virtual
	ICRT 2020		5-6 Dec. 2020	Virtual
	4th National Conference and Annual General Meeting.	BTS	26 Feb. 2021	Virtual
	Virtual workshop on Leading Edge Ultrasonography (WFUMB)	Seoul National University	5- 6 Mar. 2021	Virtual
Dr. S. M. F. Begum, Dr. S. Sultana, Dr. R. Perveen, Dr. P. Akhter, Dr. R. Perveen, Dr. U. Islam, Dr. F. Haque, Dr. S. Quddus, Dr. T. Mandal, Dr. P. Mutsuddy and Dr. J. Ferdous	Hyperthyroidism in Pregnancy	BITMIR	21 May 2021	Virtual
	Thyroid disorders in Bangladesh	BSMMU	26 May 2021	Virtual
	Hyperthyroidism in Pregnancy	BITMIR	8 May 2021	Virtual

Name of the participant	Title of the event	Organizer	Date	Place
	Start up launching programme of PTU at NINMAS	Renata Pharmaceuticals Ltd.	1 May 2021	Virtual
	Month long Thyroid Awarness Programme, Jan. 2021	BUHS and BTS	6 Jan. 2021	Virtual
	ICRT 2020	-	5- 6 Dec. 2020	Virtual
	Prof Dr. Jun Hatazawa's lecture on stroke and application of nuclear medicine	NINMAS	17 Aug. 2020	Virtual
M. Anwar-ul-Azim	First Project Virtual Coordination Meeting of IAEA/RCA Project RAS6097 Enhancing Capacity and Capability for the Production of Cyclotron based Radiopharmaceuticals (RCA)	IAEA	10-11 Sep. 2020	Virtual
	International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu (ICSTB-2021)	BCSIR	11-13 Mar. 2021	BCSIR Dhaka
Dr. T. Mandal	Management of contrast media associated adverse events and usages of isomolar contrast media in Virtual radiological imaging.	GE Health Limited	30 May 2021	Virtual
	Current trends in Nuclear Cardiology virtual event hosted by the BIR in associate	The British Institute of Radiology	3 Jun. 2021	Virtual
Dr. N. Fahmi Ali	eHealth to strengthen frontline NCD and mental health services	WHO, SEAR	2 Jul. 2020	Virtual
	RECOVERY TRIAL, Randomized Evaluation of COVID-19 Therapy	WHO Bangladesh	5 Jul. 2020	Virtual
	SNMMI 2020 Annual Meeting, Virtual Edition	Society of Nuclear Medicine and Medical Imaging	11-14 Jul. 2020	Virtual
	Breast Cancer Pathology and Molecular Biology	Bangladesh Society for Breast Cancer Study	17 Jul. 2020	Virtual

Name of the participant	Title of the event	Organizer	Date	Place
	SNMMI 2020 Annual Meeting, Virtual Edition	Society of Nuclear Medicine and Medical Imaging	11-14 Jul. 2020	Virtual
	Pregnancy associated Breast cancer	Breast Unit Bangladesh	18 Jul. 2020	Virtual
	Medical Ultrasound in Covid -19 era, Personal Protection in ultrasound practice in Covid era, Covid-19 Lung infection and It's Diagnosis	BSU	7 Aug. 2020	Virtual
	For Bangladesh 2020 KOICA Summer Workshop: Radiopharmaceutical Chemistry from Clinical needs of Theranostics	Korea International Cooperation Agency (KOICA)	11 Aug. 2020	Virtual
	The 11th AAAH Webinar Series 2020: Occupational risk protection of health care workers Episode 1: Country experiences from the WHO three Regions (EMR, SEAR and WPR) on measures to ensure occupation	The Asia Pacific Action Alliance on Human Resources for Health (AAAH), WHO SEARO, WHO WPR, WHO EMR	11 Sep. 2020	Virtual
	International Workshop on Workload Indicators of Staffing Needs (WISN)	WHO Bangladesh	14 Sep. 2020	Institute of Public Health, Dhaka.
	First Coordination Meeting of RCA Project: Empowering Regional Collaboration among Radiotherapy Professionals through Online Clinical Networks (RCA)- RAS6096	IAEA RCA Project: RAS6096	15-16 Sep. 2020	Online Webinar

7. Collaboration Work(s)

7.1 IAEA TC Project

- IAEA TC Project, Developing Human and Infrastructure for Cyclotron Based Diagnostic Positron Emission Tomography Radiopharmaceutical Production and Radiation Treatment Facilities for Cancer Patients (BGD6028), Dr. Mohammad Anwar-Ul-Azim, National Project Counterpart (NPC).
- IAEA TC Project Interregional Technical Cooperation (TC) project of International Atomic Energy Agency (IAEA), Strengthening Capabilities of Member States in Building, Strengthening and Restoring Capacities and Services in Case of Outbreaks, Emergencies and Disasters (INT0098), Dr. Mohammad Anwar-Ul-Azim, National Project Counterpart (NPC).

7.2 RCA Project

- RCA e-Learning module development on Graves' disease under RCARO project (www.rcaro.org/elearning), Place: South Korea (electronic correspondence). Signing date: 30 May, 2019. Period of work: Sep., 2019; Prof. Dr. Zeenat Jabin.
- IAEA RCA Project (No. RAS/6/087), Enhancing Medical Physics Services in Developing Standards, Education and Training through Regional Cooperation, Md. Nahid Hossain, Alternate National Project Counterpart (ANPC).
- IAEA Reginal Cooperation Project (Code: RAS6097), Enhancing Capacity and Capability for the Production of Cyclotron Based Radiopharmaceuticals, Dr. Mohammad Anwar-Ul-Azim, Alternate National Project Counterpart (ANPC).
- RCA Project (No. RAS6096), Empowering Regional Collaboration among Radiotherapy Professionals through Online Clinical Networks, Field of Activity: 26 - Radiation oncology in cancer management Sustainable Development Goal: 3 - Ensure healthy lives and promote well-being for all at all ages; Dr. Nabeel Fahmi Ali, Alternate National Project Counterpart (ANPC).

7.3 CRP (Coordinated Research Project with IAEA) Project

- CRP Project (No. E13044), PET CT in the evaluation of locally advanced breast cancer, under the research contact locally advanced breast cancer (LABC) neo-adjuvant chemotherapy assessment: A prospective comparative effectiveness study of MRI versus whole body PET-CT versus dedicated breast PET (PEM), Investigator: Prof. Dr. Shamim Momtaz Ferdousi Begum.
- Coordinated Research Project (Code No. E13043, IAEA Research Contact No. 20402), Enhancing Capacity of Neuroimaging and Biomarkers: Application in early stage alzheimer's disease with Comorbidities, Chief Scientific Investigator, Dr. Nasreen Sultana.

7.4 Korea International Cooperation Agency project

- KOICA (Korea International Cooperation Agency) project, Infrastructure Strengthening of Nuclear Medicine in Bangladesh for Treatment of Non-communicable disease, 2018-2020, local coordinator and advisor of Bangladesh, Prof. Dr. Shamim Momtaz Ferdousi Begum.

7.5 Ministry of Science and Technology Project

- Government ADP project, Establishment of Positron Emission Tomography Computed Tomography (PET-CT) Technology with Cyclotron facilities; Project Director: Prof. Dr. Md. Nurul Islam.
- Government ADP Project: Screening of Congenital Hypothyroidism in Newborn Babies (Phase 2); Project Director, Dr. Mohammad Anwar-Ul-Azim.
- Investigation of plasma vitamin D and Prostate Specific Antigen (PSA) in Drug Addicted Person in Bangladesh: An Approach towards Treatment Management Project under Special allocation for Science and Technology 2020-21 F, Project Director: Dr. Mohammad Anwar-Ul-Azim.
- Research Project under Special Allocation for Science and Technology, Performance Evaluation of Nuclear Medicine Imaging Modalities and Development of Functional Capability with Image Quality, Principal Investigator: Md. Nahid Hossain.

8. Research and Development Work(s)

8.1 Sternal bone metastases from differentiated thyroid carcinoma: A single institutional experience

Z. Jabin, J. Ferdous, F. Haque, Z. U. Rasha, A. Sattar and F. Begum

The incidence of distant metastases from differentiated thyroid cancer (DTC) is not too high. Sternum, manubrium, clavicles are close to neck area and loco-regional hematogenous spread are often unstoppable. Treatment dilemma, multidisciplinary team approach and experiences with few exceptional cases of DTC with metastases to the sternum are being followed up to observe the outcome. Some patients were treated with difficulties as they were resistant to radio-iodine therapy (RAIT). Sternal resection for metastasis followed by RAIT with or without radiotherapy appears to offer prolonged survival with improved quality of life (QOL). We are following up multiple cases of sternal mass with or without H/O, radical surgical resection of the

sternal mass but proved to be a metastasis from DTC (mostly follicular carcinoma of the thyroid), appearing before or years after total thyroidectomy and RAIT. We recommend surgical resection of the metastasis as a curative or palliative measure in DTC patients to maximize the effect of subsequent RAIT.

8.2 Vitamin D status among the differentiated thyroid cancer patients attending NINMAS

Z. Jabin, J. Ferdous, U. Islam, F. Haque and F. Begum

This is an ongoing cross sectional observational study of the thyroid division of National Institute of Nuclear Medicine and Allied Sciences (NINMAS). More than 1100 patients who were treated with total thyroidectomy followed by different doses of radioiodine therapy were enrolled in this study. Patients with normal PTH levels were included only. Serum levels of vitamin D, Calcium, PTH were measured and data on histological type and stage of DTC, patient's occupation, sun exposure history and chief complaints were obtained along with informed consent. Based on vitamin D status, study subjects were stratified in three groups: a) vitamin D deficiency (VDD), reflecting levels under the established threshold of <20 ng/ml; b) vitamin D insufficiency (VDI), reflecting levels 20-<30ng/ml; c) vitamin D sufficiency (VDS), reflecting levels 30-100ng/ml. Concurrent evaluation of vitamin D status of caring physicians were done to find possible factors influencing the lifestyles, ethnicity and environment.

8.3 Assessment of Neoadjuvant chemotherapy response in locally advanced breast cancer (LABC) in comparison with MRI versus whole body PET/CT

S. M. F. Bedum, T. Mandal and P. Mutsuddy

This study aims to prospectively investigate the diagnostic accuracy of MRI versus whole body PET/CT, prone PET/CT and dedicated breast PET (PEM) for assessment of response to neoadjuvant chemotherapy in breast cancer patients with pathologic complete response (pCR) as reference standard. Accurate pathological diagnosis of tumor mass before treatment and careful examination of specimens after treatment are main objectives in the diagnostic process of neoadjuvant-treated breast cancer. To achieve the first objective, multiple core biopsies are taken for initial diagnosis and pathology specimen is obtained from mastectomy or lumpectomy at completion of treatment.

8.4 Assessment of Neoadjuvant chemotherapy response in Locally Advanced Breast Cancer (LABC) in comparison with MRI versus whole body PET/CT

S. M. F. Bedum, T. Mandal, P. Mutsuddy and M. Ahmed

This study aims to prospectively investigate the diagnostic accuracy of MRI versus whole body PET/CT, prone PET/CT and dedicated breast PET (PEM) for assessment of response to neoadjuvant chemotherapy in breast cancer patients with pathologic complete response (pCR) as reference standard. Accurate pathological diagnosis of tumor mass before treatment and careful examination of specimens after treatment are main objectives in the diagnostic process of neoadjuvant-treated breast cancer. To achieve the first objective, multiple core biopsies are taken for initial diagnosis and pathology specimen is obtained from mastectomy or lumpectomy at completion of treatment.

8.5 TN-RAS6093-1901188-strengthening capacity to manage non-communicable diseases using imaging modalities in Radiology and Nuclear Medicine (RCA)

M. A. B. Siddique, T. Mandal, P. Mutsuddy and R. Afrin

The study targets to enhance capacity to diagnose non communicable diseases (NCDs) using radiology and nuclear medicine. This study will contribute to the better management (diagnosis and treatment) of NCDs in the RCA region, and a reduction of premature mortality.

8.6 Outcome of radioactive iodine therapy in patient with differentiated thyroid carcinoma with lung metastases

The objective of this study is to find out the outcome of radio iodine therapy in DTC with lung metastases. In this study all patient with DTC had undergone for radio iodine ablation. All of them will be followed up from 2001 to still now. Repeated radio iodine therapy was given in most of the patient. Follow up done fourmonthly by measuring FT3, TSH,Tg,TgAb, USG. If necessary CT scan, MRI even PET-CT has done. It will be find out their prognostic factor, outcome, disease progression , remedy and above all help to choose correct dose and treatment options for them.

8.7 Outcome of radioactive iodine therapy in patient with differentiated thyroid carcinoma associated with B-RAF mutation

D. P. Akhter

The objective of this study is to find out the association of BRAF mutation in DTC. In this study all patient with DTC will be prepared for radio iodine ablation. All the DTC patient will get radioactive iodine ablation (RAIA). All of them will be followed up for one year. Follow up will be done three monthly by measuring FT3, TSH, Tg, TgAb, USG and finally after one year large dose whole body iodine scan (DxWBS) will be performed. If necessary CT scan, MRI even PET-CT will be done. After one year of follow up outcome of these patients following radioactive iodine ablation will be observed. It will be easier to predict their outcome, disease progression and above all help to choose correct dose and treatment options for them.

8.8 Outcome of radioactive iodine therapy in patient with differentiated thyroid carcinoma with lung metastases

D. J. Ferdous and D. U. Islam

The objective of this study is to find out the outcome of radio iodine therapy in DTC with lung metastases. In this study all patient with DTC had undergone for radio iodine ablation. All of them will be followed up from 2001 to still now. Repeated radio iodine therapy was given in most of the patient. Follow up done four monthly by measuring FT3, TSH, Tg, TgAb, USG. If necessary CT scan, MRI even PET-CT has done. It will be find out their prognostic factor, outcome, disease progression, remedy and above all help to choose correct dose and treatment options for them.

8.9 Characterization Of Loss Of Parathyroid Gland During Total Thyroidectomy In The Management Of Differentiated Thyroid Carcinoma

S. N. Bally, F. Rahman and N. F. Ali

The goal of my work is to promote preservation of parathyroid gland in differentiated thyroid carcinoma patients as their calcium metabolism is a tedious and cumbersome correctional process afterwards. To open new windows for the exploration of aforementioned territory in other affiliated institutes to broaden spectrums of medical intervention.

8.10 Empowering regional collaboration among radiotherapy professionals through online clinical networks (RCA)

S. Sharmin and N. F. Ali

Congenial harmonics established between 28 country counterparts in preparatory meeting of First Virtual Tumour Board; First Virtual Tumour Board and kick off for ASPRONET (Asia Pacific Radiation Oncology Network); ASPRONET Cases shared in online VTB; CLP4NET Moodle platform launched with know-hows as a case discussion; CLP4NET provides academic information setting an online education forum for all experts partaking and Global online cooperation established between multinational panel of experts with active discussion on complex clinical scenarios.

8.11 M-Health in management of post-surgical, post ablative cases of differentiated thyroid carcinoma-an institutional review", MPH in Epidemiology Research Proposal, Bangladesh University of Health Sciences (BUHS)

N. F. Ali, F. Rahman and S. N. Bailey

The Corona pandemic has set the world into turmoil and even more so the health system. Regular visits for patient follow-up is a risk for both health care provider and patient. Telemedicine and m-health have proved an amazing hospital management alternative cutting patient costs in terms of travel expenses and nosocomial infections. Simultaneously it saves work hours that are otherwise lost in travel.

This institutional review highlights these very aspects with respect to Differentiated thyroid carcinoma cases undergoing telemedicine follow ups at the National Institute of Nuclear Medicine and Allied Sciences (NINMAS), Bangladesh Atomic Energy Commission (BAEC). The employed platforms for patient follow-ups include WhatsApp and the LIS system of patient reporting modality.

9. In-House Researches

- Survey of Quality of life in thyroid carcinoma patients with long term levothyroxine supplementation; Prof. Dr. Fatima Begum and coworkers.
- Pattern and analysis of high antiTgAb levels in Thyroid Carcinoma Patients; Prof. Dr. Fatima Begum and coworkers.
- Individual monitoring of Internal Exposure for Nuclear Medicine Workers in NINMAS through in vitro bioassay techniques. Prof. Ferdoushi Begum and coworkers.
- Estimation of Internal Radiation Doses for Occupational Workers Due to ^{131}I Radionuclides by Using MONDAL Software. Prof. Ferdoushi Begum and coworkers.
- Evaluation of Internal exposure of Nuclear medicine personnel in NINMAS Dhaka through in vivo and in vitro bioassay techniques. Prof. Ferdoushi Begum and coworkers.
- Assessment of Environmental Toxicity of Some Waterfall Areas of Bangladesh by PIXE Technique and Radionuclides detection Using Gamma Spectrometry. Prof. Ferdoushi Begum and coworkers.
- Evaluation of PET-CT in gastrointestinal carcinoma, Prof. Dr. Shamim Momtaz Ferdousi Begum, Dr. Abu Bakker Siddique and coworkers.
- Role of PET-CT in evaluation of treatment response in lung carcinoma, Prof. Dr. Shamim Momtaz Ferdousi Begum and coworkers.
- Experience of PET-CT in adult lymphoma, Prof. Dr. Fatima Begum and coworkers.
- Experience of PET-CT in breast cancer, Prof. Dr. Shamim Momtaz Ferdousi Begum and coworkers.
- Protocol development for the contraindication of stress myocardial perfusion study in main trunk stenosis in collaboration with cardiologists, Prof. Dr. Shamim Momtaz Ferdousi Begum, Dr. Tapati Mandal and Dr. Pupree Mutsuddy.
- Followup for intervention adopted in reversible perfusion defect in MPI, Prof. Dr. Shamim Momtaz Ferdousi Begum, Dr. Tapati Mandal and Dr. Pupree Mutsuddy.
- Longterm Follow up of radioiodine treated thyroid carcinoma with lymphnodes metastases, Prof. Dr. Fatima Begum, Dr. Sharmin Quddus, Dr. Farhana Haque, Dr. Sharmin Reza, Dr. Rahima Perveen and Dr. Urnas Islam.
- Role of posttherapy scan in evaluation of hidden lungs metastases in patients with differentiated thyroid carcinoma- Dr. Sharmin Quddus, Dr. Farhana Haque and Co-workers.
- Metastases in unusual sites from differentiated thyroid carcinoma, Dr. Rahima Perveen, Dr. Urnas Islam and co-workers.
- Duplex study of vertebral arteries in patients, Dr. Fazlul Bari and coworkers.
- Assessment of carotid vessels in DM and TIA, Dr. Nasreen Sultana and coworkers.
- Musculoskeletal ultrasonography of different limb joints and injury, Dr. Fazlul Bari, Dr. Abu Bakker Siddique and coworkers.
- Duplex study of uterine artery to predict pre- eclampsia. Case- control study, Dr. Abu Bakker Siddique and coworkers.
- Duplex study of penile vessels in erectile dysfunction (Pharmaceutical augmented), Dr. Abu Bakker Siddique, Dr. Fazlul Bari.
- Elastoscan of thyroid nodule, Dr. Fazlul Bari and coworkers.
- Less fetal movements and oligohydraamnios associated with high S/D ratio of umbilical artery, Dr. Nasreen Sultana and co-workers.

10. Development Work(s)

- Screening of Congenital Hypothyroidism with the aid of Dissociation Enhanced Lanthanide Fluorescence Immunoassay (DELFIA) and Immunoradiometric Assay (IRMA) technique from Dried Blood Spot (DBS) samples, Dr. Mohammad Anwar-Ul-Azim and coworkers.

- Investigation Of Plasma Vitamin D and Prostate Specific Antigen (PSA) in Drug Addicted Person In Bangladesh: an Approach Towards Treatment Management, Anwar-ul-Azim and coworkers.
- Establishment of a RT-PCR Laboratory under IAEA Regional Cooperation Project (INT0098), Anwar-ul-Azim and coworkers.
- External Quality Assurance Services (EQAS) Proficiency Testing for Immunoassays is Being Performed at CLIA Laboratory of In-Vitro Division, Anwar-ul-Azim and coworkers.
- Development and Upgrading of Hot-lab facilities of NINMAS, Prof. Ferdoushi Begum, Md. Nahid Hossain and coworkers.
- Development/Improvement of the radioactive waste management procedure and facility at the Institute, Prof. Ferdoushi Begum, Md. Nahid Hossain and coworkers.
- Development of the shielding structure at different lab of the institute to ensure the minimum radiation dose in the room, Prof. Ferdoushi Begum, Md. Nahid Hossain and coworkers.
- Development of COVID19 safety protocol for NINMAS patient management and PET-CT imaging procedure, Prof. Dr. Shamim Momtaz Ferdousi Begum and coworkers.
- Development of SOPs for PET-CT technical, patient management and both patient and staff safety, Prof. Dr. Shamim Momtaz Ferdousi Begum and coworkers.
- Introduction of Telemedicine for PET-CT patient during COVID crises, Prof. Dr. Shamim Momtaz Ferdousi Begum and coworkers.
- Initiated telemedicine during Covid-19 pandemic situation since Apr. 2020 to give suggestions for thyroid related patients from Thyroid Division, NINMAS. Prof. Dr. Fatima Begum and coworkers.
- Capacity building of the entire telemedicine team of Thyroid Division to ensure better quality of service, Prof. Dr. Fatima Begum and coworkers.
- Initiated and facilitated infrastructure upgradation, especially for safe patient handling of Thyroid Division, Prof. Dr. Fatima Begum and coworkers.
- Prepared Standard Operating Procedure (SOP) for safe patient handling during Covid-19 for staff and physicians for Thyroid division, Prof. Dr. Fatima Begum and coworkers.
- Installation of view box in reporting room for viewing CT, MRI and X-ray reports of the patients, Prof. Dr. Zeenat Jabin and coworkers.

11. Repair, Maintenance and Renovation Works

- Worked for installation of pedal operated basins in front of NINMAS and overall improvement of infrastructure of NINMAS to deal with Covid-19 situation. Such as-screen tables were designed and made for protection of physicians and medical personnel, Prof. Dr. Fatima Begum and coworkers,
- Pedal operated some basins for doctors and patients, provision of pedal operated flush system in few toilets, Prof. Dr. Fatima Begum and coworkers.
- Oversee the QC Programme of Nuclear Medicine Instruments and Assisted in repair and Maintenance of various equipment, Prof. Ferdoushi Begum, Coworkers.
- Maintenance of Ultrasound machine.

12. Others

- NINMAS is offering prompt, easy to contact and consult specialized telemedicine service since Mar., 2020 under the guidance of Bangladesh Atomic Energy Commission to meet the demands of the patients during COVID-19 pandemic situation.
- Thyroid division is successfully operating this service monitored by the head of thyroid division and our director madam at a minimum cost (electronic payment method).

13. Service Rendered and Revenue Income

Name of service	No. of patient/sample	Revenue income
Number of Patients	44,947	5,88,56,573/50
Blood Samples Analysis	22,678	
Newborn Screening: Sample	1,32,739	
Congenital Hypothyroidism patient: positive cases	59	

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), DHAKA

Introduction

Institute of Nuclear Medicine and Allied sciences is one of the oldest nuclear medicine in this country and it was established in 1961 in the Dhaka Medical College premises. At present this institute included different technologies like PET-CT, SPECT CT, Dual Headed Gamma Camera, BMD, Thyroid scanner and 2D and 3D Ultrasound machine. Significant numbers of patients' health care services are offered from this institute as regular basis. Objective: To render specialized medical services by using nuclear technology and conduct academic and research activities.

Activities

1. Research and Development Work(s)

- To provide the attachment training to the post graduate medical students in their MD, MS residency program and also conducted M.Sc thesis work for different universities.

2. Academic

- Clinical rotational training for postgraduate students of different disciplines (MD/MS) under BSMMU.
- Clinical rotation for undergraduate students of Dhaka Medical College.

3. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
Weekly Seminar	Every Sunday	INMAS, Dhaka	15

4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Prof. Jasmine Ara Haque, Prof. Dr. Fatema Sultana Haque, Prof. Dr. Shankar Biswas, Prof. Rubina Begum, Dr. Farhana Rahman, Dr. Rawnak Afrin, Dr. Sadia Hossain, Dr. Mohona Hossain, Dr. Mahmudur Rahman, Mozumder, Dr. Afroza Akhter, Dr. Shaila Sharmin and Dr. Sabrina Islam	BSU VIRTUAL Workshop on Scrotal Ultrasound	Bangladesh Society of Ultrasonography	16 Jul. 2021	Dhaka
	BSU VIRTUAL Workshop on Breast Ultrasound	Bangladesh Society of Ultrasonography	23 and 30 Apr. 2021	Dhaka
	BSU VIRTUAL Workshop on Liver Ultrasound	Bangladesh Society of Ultrasonography	23 Oct. 2020	Dhaka
	VIRTUAL Workshop on Thyroid disorder and Surgery	Thyroid Society Bangladesh	19 Mar. 2021	Dhaka
	VIRTUAL Workshop on Thyroid disorder and Nuclear Medicine	Thyroid Society Bangladesh	31 Jan. 2021	Dhaka
Prof. Dr. Shankar Biswas, Dr. Rawnak Afrin, Dr. Afroza Akhter, Dr. Shaila Sharmin and Dr. Sabrina Islam	SNMMI 2021 Virtual Annual Meeting	Society of Nuclear Medicine and Molecular Imaging	11-15 Jun. 2021	Virtual

Name of the participant	Title of the event	Organizer	Date	Place
Prof. Jasmine Ara Haque, Prof. Dr. Fatema Sultana Haque, Prof. Dr. Shankar Biswas, Prof. Md. Selim Reza, Prof. Rubina Begum, Dr. Farhana Rahman, Engr. Mizaur Rahman, Dr. Rawnak Afrin, Dr. Sadia Hossain, Dr. Mohona Hossain, Dr. Mahmudur Rahman Mozumder, Dr. Afroza Akhter, Dr. Shaila Sharmin, Dr. Tania Sultana and Dr. Sabrina Islam	Workshop on CT, SPECT-CT, SPECT and Ultrasound Machine, INMAS, Dhaka	Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur	20-24 Jun. 2021	INMAS, Dhaka.
Prof. Dr. Shankar Biswas, Dr. Afroza Akhter and Dr. Shaila Sharmin	Current trends in Nuclear Cardiology virtual event	British Institute of Radiology	3 Jun. 2021	Virtual
Dr. Afroza Akhter	PET-CT in cardiology	British Institute of Radiology	17 May 2021	Virtual
Dr. Afroza Akhter and Dr. Shaila Sharmin	AI and machine learning in Radiology: Practical considerations for implementation in the era of COVID 19	SGCRWIRES 2021	24 Apr. 2021	Webinar
All Doctors	PET-CT interesting cases	ANMB	17 Apr. 2021	Webinar
	Vitamin-D Deficiency and its association with Magnesium Deficiency: Current concepts	INMAS, Dhaka	25 Mar. 2021	INMAS, Dhaka
	4th National conference and Annual General Meeting of Bangladesh Thyroid Society	Bangladesh Thyroid Society	19 Mar. 2021	Webinar
	24 WFUMB Centre of Education Workshop: Leading edge ultrasonography	WFUMB	5-6 Mar. 2021	Webinar
Dr. Afroza Akhter and Dr. Shaila Sharmin	WIRES masterclass: Plugging in to less commonly encountered embolisations	SGCRWIRES 2021	13 Mar. 2021	Webinar
Dr. Rawnak Afrin, Dr. Afroza Akhter and Dr. Shaila Sharmin	Hepatobiliary imaging for daily practice	SGCRWIRES 2021	27 Feb. 2021	Webinar
Dr. Shankar Biswas, Dr. Afroza Akhter and Dr. Shaila Sharmin	MPI Basic and Clinical Implication	Interactive Professional Development Initiatives (IPDI) Virtual Classroom	26 Feb. 2021	Webinar
Dr. Afroza Akhter and Dr. Shaila Sharmin	Update in prostate MRI	SGCRWIRES 2021	30 Jan. 2021	Webinar
All Doctors	International conference on Radiopharmaceutical Therapy ICRT 2020	WARMTH	5-6 Dec. 2020	Virtual
Dr. Rawnak Afrin, Dr. Afroza Akhter and Dr. Shaila Sharmin	MSK Radiology- All that matters	SGCRWIRES 2021	28 Nov. 2020	Webinar
All Doctors	International conference on molecular imaging and clinical PET-CT in the era of Theranostics (IPET 2020)	IAEA	24-26 Nov. 2020	Vienna (virtual)
	32nd National Conference	BSU	27 Nov. 2020	Webinar

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Afroza Akhter	Navigating Journal Peer Review: A Guide for Authors and Reviewers	Wiley Asia-Pacific	12 Nov. 2020	Webinar
All Doctors	Pitfalls in myocardial perfusion scintigraphy reporting	ANMB	8 Nov. 2020	Webinar
	CPD on chronic liver disease ultrasound	BSU	6 Nov. 2020	Webinar
Dr. Afroza Akhter and Dr. Shaila Sharmin	ASNC2020: Annual Scientific Sessions	American Society of Nuclear Cardiology	9sep. 2020-7 Oct. 2020	Webinar
All Doctors	Webinar on Abdominal Ultrasound	AFSUMB	6 Sept. 2020	Webinar
	Musculoskeletal SPECT/CT: Broadening the horizon	ANMB	9 Aug. 2020	Webinar
Prof. Jasmine Ara Haque, Dr. Shankar Biswas and Prof. Rubina Begum	Clinical application of PET-CT scan in Oncology	Dept. of Radiotherapy and Oncology, DMCH	26 Jun. 2021	DMCH
Dr. Rawnak Afrin	Basic of Coronary CT Angiogram Coronary MRI	BSRI	2 Apr. 2021	Webinar
	Special Webinar on Covid-19	BSRI	3 Jul. 2021	Webinar
	BSRI Webinar on 1st Trimester anomaly Scan	BSRI	24 Jul. 2020	Webinar
	RAD AID Interventional Radiology	RAD AID Interventional	8 Jul. 2020	Webinar
	Head and Neck Radiology	Indian College of Radiology	28 Aug. 2021	Webinar
Dr. Sabrina Islam	BSU VIRTUAL Workshop on Breast	Bangladesh Society of Ultrasonography	23 Apr. 2021	Dhaka

5. Collaboration Work/MoU

Routinely performing "Preoperative assessment of sentinel lymph node detection by radioisotope scanning and gamma probe guided breast conservative surgery in breast cancer patient"- a collaboration work between Sheikh Hasina National Institute of Burn and Plastic Surgery and Scintigraphy division, INMAS, Dhaka, BAEC.

6. Extracurricular

- Participated in zoom meeting organized by Directorate General of Health Services (DGHS) on Stakeholder consultations on what policy approaches need to be undertaken in Bangladesh on Sex Selection/to address GBSS/Son preference (Date: 27 Jun. 2021).
- Participated in online course developed by Directorate General of Health Services (DGHS) and offered through Muktoopath on Coronavirus diseases (Covid-19).
- Participated in online course developed by BRAC and offered through Muktoopath on Covid-19 awareness and prevention.
- Received "Certificate of Appreciation" as COVID-19 warrior from Directorate General of Health Services (DGHS) for outstanding efforts in the 10 months long voluntary programme of COVID-19 Syndromic case Management by tete-consultation.

- Received "Certificate of Reviewing" from the editors of International Journal of Infectious Diseases, Elsevier.
- Participated in online course- Infection prevention and control (IPC) for Novel Coronavirus (COVID-19), organized by Health Emergency programme of WHO.
- Participated in online course- Emerging respiratory viruses, including COVID-19: methods for detection, prevention, response and control, organized by Health Emergency programme of WHO.
- Contribution of data for the INCAPS COVID study as a member of INCAPS COVID Investigators Group, IAEA. Manuscript of International Impact of COVID-19 on the Diagnosis of Heart Disease, from the worldwide study was published in the Jan. 19 issue of the Journal of the American College of Cardiology (JACC).
- Participated in INCAPS COVID 2, to re-assess the impact of the COVID-19 pandemic on cardiovascular testing as a INCAPS COVID Investigators Group, IAEA.
- Active member of Quick Response Team (QRT), BAEC providing health care services through telemedicine in COVID-19 patient management.
- Participated in the meeting for proposal and planning of establishment of radiation hazards management specialized hospital/medical center near Ruppoor Nuclear power plant, as a committee member.
- Participated in roster duty of Ekushe Book Fair 2021, stall (743-744).

7. Service Rendered and Revenue Income

Name of service	No. of patient/sample	Revenue income
Sample analysis (including blood sample) Regular Patient Service	35,876	3,39,03,450/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), MITFORD

Introduction

INMAS, Mitford is situated in the campus of Sir Salimullah Medical College and Mitford Hospital Campus in the old part of Dhaka city.

Objectives

- Application of Nuclear technology in Medical services.
- To improve and upgrade nuclear medicine facilities in Bangladesh.
- To conduct academic and research activities.

Activities

1. Clinical Services

1.1 Diagnostic service

- Scintigraphic scan includes Bone scan, Renal scan (DTPA, DMSA), HIDA scan, Hepatobiliary scan, Thyroid scan and Parathyroid scan, Lymphoscintigraphy, Salivary gland scaning.
- All sort of diagnostic USG including normal B-Scan of different organ, HRUS of superficial organs.
- Duplex study of vascular system.
- In Vitro diagnostic services includes hormone analysis like T_3, T_4, FT_3, FT_4, TSH, FSH, LH Prolactine, Testosterone, Eestrogen, Progesterone. Different types of thyroid antibody and tumor marker i.e.Tg are routinely performed in this institute.

1.2 Therapeutic service

Therapeutic activities include radioiodine therapy of thyroid cancer and hyperthyroid patients.

2. Research and Development Work(s)

- Association between serum FT3 level and adverse outcomes in patients with acute ST segment elevation.

- Determination of active phase of bony metastatatic lesion by three phase bone scan.
- The functional state of salivary gland in Ca. Thyroid patient after getting radioiodine ablation.

3. Manpower Development and Training Program

Title of event	Date	Place	No of participant
In-house training on office decorum during this corona pandemic	10 Aug. 2020	INMAS, Mitford	12
Basic concept of computer hardware. Operation of MS word, MS excel	17 Nov. 2020	INMAS, Mitford	4
গবেষণাগারে দূর্ঘটনা/জরুরী অবস্থায় প্রাথমিক করণীয় সম্পর্কে প্রশিক্ষণ	19 Dec. 2020	INMAS, Mitford	5
উত্তম চর্চা প্রণয়নে নির্দেশনাসমুহ	20 Jan. 2020	INMAS, Mitford	5
অগ্নি নিরাপত্তা সচেতনার লক্ষ্যে হাতে-কলমে প্রশিক্ষণ	7 Mar. 2021	INMAS, Mitford	7

4. Seminar/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Hosne Ara Rahman, Dr. Samira Sharmin and Dr. Afroza Nazneen	24th WFUMB COE workshop (Virtual workshop)	BSU	5-6 Mar. 2021	Dhaka
Dr. Hosne Ara Rahman, Dr. Jamiul Hossain, Dr. Samira Sharmin and Dr. Afroza Nazneen	32th National Conference and AGM of BSU (Virtual Meeting)	BSU	27 Nov. 2020	Dhaka
Dr. Hosne Ara Rahman	মহামারি ও আপদকাল মোকাবেলায় বিশেষ প্রশিক্ষণ কর্মশালা	BAEC, Dhaka	28 Oct. 2020	BAEC, Dhaka
Dr. Hosne Ara Rahman, Dr. Jamiul Hossain, Dr. Samira Sharmin and Dr. Afroza Nazneen	4th Natioanl Conference and Annual General Meeting of BTS. (Scientific Webinar on Thyroid disorder and Surgery)	Bangladesh Thyroid Society	19 Mar. 2021	Dhaka
Dr. Simon Salekin	Enhencing innovative capacity in public service	BAEC	11-12 Mar. 2021	BAEC HQ
Dr. Hosne Ara Rahman and Dr. Afroza Nazneen	BSU Workshop on Breast Ultrasound (Virtual webinar)	BSU	23 and 30 Apr. 2021	Dhaka
Dr. Hosne Ara Rahman	The Importance of Iodine on the women and her baby (Virtual webinar)	BTS	30 May 2021	Dhaka
Dr. Hosne Ara Rahman	Management of Hypothyroidism and hyperthyroidism (Virtual webinar)	BSMMU	11 Jun. 2021	Dhaka

5. Stakeholder meeting

বিজ্ঞান ও প্রযুক্তি মন্ত্রণালয় কর্তৃক আয়েজিত শুদ্ধাচার/উত্তমচর্চার বিষয়ে অংশীজনদের সঙ্গে অবহিতকরণ/মতবিনিময় সভার কার্যক্রম পরিচালনা, ১৩ই জুন ২০২১, ইনমাস, মিটফোর্ড অডিটোরিয়াম।

6. Others

- Scheduled Lectures were delivered to M.Phil/MD/MS students of different discipline of SSMCH, Mitford.
- Scheduled Lectures were delivered to MD (Nuclear Medicine) students.
- Monthly in-house meeting and Seminar is held regularly.

7. Service Rendered and Revenue Income

Name of service	No. of patient	Revenue income
USG	13241	1,25,98,850/-
Scintigraphy service	1681	
I 131 Therapy	32	
Blood Sample Analysis	7899	
Total	22,853	1,25,98,850/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), CHATTOGRAM

Objective/Introduction

Institute of Nuclear Medicine and Allied Sciences, Chittagong is one of the oldest Nuclear Medicine Institute in Bangladesh and was established in 1970. With the vision to render specialized medical services to the people using nuclear technology for peaceful uses of atomic energy to achieve self-reliance for overall socio-economic development. This institute is presently functioning with facilities like Dual Head and Single Head SPECT Gamma Camera, SPECT-CT, CT Scanner, Thyroid Scanner, Ultrasonogram, Colour Doppler and In-Vitro Laboratory for Radioimmunoassay (RIA) with Computerized Gamma Well Counter and other necessary facilities.

Activities

1. Patient Services

1.1 Radionuclide imaging

Bone Scan, Renogram, Renal Scan, Thyroid Scan, Liver Scan, RBC Scan, Parotid scan, Testicular scan, Parathyroid scan, HIDA scan etc.

1.2 Radionuclide Therapy

- Radio Iodine therapy for thyrotoxicosis and Ca-thyroid patients.
- Radiation therapy after pterygium operation of eye.

1.3 Radioimmunoassay

T3, T4, TSH, FT3, FT4, and TG and also several other hormones like LH, FSH, Prolactin, Testosterone, Progesterone, Oestradiole, AFP and Cortisol etc.

1.4 Ultrasound

- General Ultrasound (Whole Abdoment, Lower/Upper Abbomen, Pregnancy profile, HBS, KUB etc.)
- High Reslution Ultrasound (Thyroid, Scrotum, Breast, Endocavitary Studies etc.).

1.5 Colour Doppler

- Lower Limbs, Upper Limbs, Carotid Arteries, Testis, Pregnancy etc.

1.6 Thyroid Clinic

- Thyroid cancer, hyperthyroidism, hypothyroidism patients came for treatment and follow up.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
Training on Govt. Office Management and Skills Development (Virtual Online platform)	18 Jul. 2020- 20 Jul. 2020	INMAS, CTG	1
Training on Microsoft Project (**Virtual** Online)	13 Sep. 2020- 17 Sep. 2020	INMAS, CTG	1
Training on e-Nothi Course (**Virtual** Online)	7 Oct. 2021	INMAS, CTG	1
Operational training on SPECT-CT, SPECT, Immunochemistry Machine	13 Jun. 2021- 17 Jun. 2021	INMAS, CTG	9

3. Other

Eleven students of Chattogram Poly Technique Institute participated in a three months Nuclear Medicine Instrumentations training in our Institute and successfully completed that training.

4. Service Rendered and Revenue Income

Name of service	No. of patient	Revenue income
Patient Service	44,633	2,74,62,700/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), MYMENSINGH

Objective/Introduction

Institute of Nuclear Medicine and Allied Sciences (INMAS), Mymensingh as an organization of Bangladesh Atomic Energy Commission is committed to peaceful use of Atomic Energy in the field of medicine. INMAS, Mymensingh has been started its work in 1989 using Nuclear technology in the Department of Radiology of MMCH occupying 3 rooms only naming as Nuclear Medicine Centre. At present it stands in its own 3 storied building in the north-east corner of MMCH. Recently it is able to add the prestigious PET-CT project which is going to build a separate 6-storied building in its own campus. All the major Nuclear Medicine investigations and Ultrasound imaging are done in this Institute. This Institute offer Nuclear Medicine therapy services in hyperthyroidism and thyroid cancer. All the investigations and therapy offered by the Institute in a subsidized cost as determined by the commission and adjusted time to time. This Institute is also a hub of radioimmunoassay performing about 26 types of hormone and cancer marker studies. A host of senior and junior qualified and skilled Doctors and technologists are working in this Institute. They are all dedicated to offer best therapeutic and investigation skill to the service of humanity.

Activities

- Medical services: Diagnosis of diseases and treatment of a number of diseases.
- Research, Development and Academic activities.
- Developing facility to start post graduate MD residency course in Nuclear Medicine under BSMMU.
- To provide attachment training to the Post graduate medical students in their MD, MS residency program.

1. Manpower Development/Training Program

Title of the event	Date	Place	No. of participant
Whole Body SPECT/CT Versus Planar Bone Scan with Targeted SPECT/CT for Metastatic Workup	24 Jan. 2021	INMAS, Mymensingh	16
In-house Training on Annual performance agreement (APA)	28 Dec. 2020	INMAS, Mymensingh	14

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Prof. Dr. M Nasim Khan, Dr. Shakila Zaman Rima, Dr. Nazmun Nahar and Dr. Fahima Akter Dowel	15th International Conference on Radiopharmaceutical Therapy (ICRT)	WARMTH	5-6 Dec. 2020	Dhaka
Prof. Dr. M Nasim Khan, Dr. Shakila Zaman Rima and Dr. Fahima Akter Dowel	Breast Workshop	BSU	30 Apr. 2021	Dhaka

Name of the participant	Title of the event	Organizer	Date	Place
Prof. Dr. M Nasim Khan, Dr. Nadiruzzaman, Dr. Shakila Zaman Rima, Dr. Nazmun Nahar and Dr. Fahima Akter Dowel	4th Annual National Conference and Scientific Meeting of BTS	BTS	19 Mar. 2021	Dhaka
Dr. Shakila Zaman Rima and Dr. Fahima Akter Dowel	32nd National Conference of BSU	BSU	27 Nov. 2020	Dhaka

3. Collaboration Work(s)

IAEA RCA Project (RAS 6079), Strengthening Hybrid Imaging in Nuclear Medicine in Asia.

4. Lecture Delivered

- Series of lectures were arranged on SPECT-CT for doctors, scientist and scientific staff of INMAS, Mymensingh.
- Series of lectures on radiation control and safety were held on during this period for scientific staffs of INMAS, Mymensingh.
- Post graduate students of MD (Radiology and Imaging) and MS (Surgery, Pediatric surgery), Diploma Endocrine Medicine of MMC attended in a series of classes on Nuclear Medicine in this Institute.

5. Others

- The Institute provides research facility for post graduate students of MD, MS, M Phil and PhD program.
- Radioimmunoassay laboratory provide services to different research programs of different discipline of medical sciences.
- This Institute provides facility to perform research program in association with other institutes such as MMC and BAU, Mymensingh.

6. Service Rendered and Revenue Income

Name of service	No. of patient	Revenue income
Sample analysis (including blood sample)	38,080	2,90,23,120/-
Ultrasound including doppler investigation service	18,577	82,60,820/-
Nuclear investigation service	2,004	12,25,500/-
Patient service including radioiodine therapy and follow-up	733	8,21,000/-
Total	59,394	3,93,30,440/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), SYLHET

Objective/Introduction

Institute of Nuclear Medicine and Allied Sciences, Sylhet is located at the North-East part of the country. It was established in the year of 1980 at Sylhet M.A.G Osmani Medical College campus. The institute provides both diagnostic and therapeutic services by using nuclear technologies and ultrasound system to improve the health care services to the people of greater Sylhet division. The institute also provides academic and research activities to upgrade the knowledge regarding nuclear medicine among the professionals.

Activities

1. Clinical Services

1.1 Diagnostic

- 2D/3D Ultrasonogram (USG), Transvaginal sonogram (TVS), Elastrography,High resolusion USG of superficial organs and color Doppler study of vascular system are routinely performed.

- Thyroid related hormones, gonadal hormones of both male and female, tumor markers vitamin-D, parathyroid hormone are regular diagnostic procedures.
- Different radionuclide scanning and thyroid uptake study are being performed regularly.
- Bone Mineral Densitometry (BMD) are CT Scan a routine examination procedure now.

1.2 Therapeutic

- Treatment of thyroid cancer and hyperthyroidism are regular ongoing procedures.
- Treatment is also being given to hypothyroidism, simple goiter, nodular goiter etc.

2. Academic Activities

- Post Graduate Residency Training in Nuclear Medicine for MS and MD students of Sylhet MAG Osmani Medical College.
- Lectures given for the undergraduate medical students regarding Nuclear Medicine technologies and ultrasound.
- The institute participates to the regular journal club of Sylhet MAG Osmani Medical College.
- Scientific seminars on different publications and new cases take place time to time.

3. Seminor/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Kamrun Nahar	Training on Public financial management by online	NAPD	31 Aug. - 6 Sep. 2020	Dhaka
Dr. Arshad Hossain	Clinical Training on CT, SPECT CT, SPECT and Ultrasound	7 INMAS, upgradation Project	20-24 Jun. 2021	INMAS, DHAKA
Abdullah Al Manun	Operational Training on SPECT CT, SPECT and Immunochemistry	7 INMAS, upgradation Project	13-17 Jun. 2021	INMAS, Chattogram

4. Service Rendered and Revenue Income

Name of service	Number of patient	Revenue income
Patient Service	19,107	1,13,91,150/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), RAJSHAHI

Objective/Introduction

Institute of Nuclear Medicine and Allied Sciences (INMAS), Rajshahi is located North West part of the country. This Institute provides services to the people of greater Rajshahi and nearby districts using nuclear technology and Ultrasound system and made a great impact in this region of the country for betterment of health services.

Activities

1. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
MD (Oncology) Residency course training	12-17 Sep. 20	INMAS, Rajshahi	4
Training on Medical Technology (Laboratory), IHT, Rajshahi	23 Jan.-2 Feb. 21 23 Feb.-4 Mar. 21 24 Mar.-3 Apr. 21 24 Apr.-3 May 21	INMAS, Rajshahi	33

Title of the event	Date	Place	No. of participant
Training on Medical Technology (Laboratory), IHT, Sirajgonj and Chittagong	2-11 Mar. 21	INMAS, Rajshahi	7
Training on Fire drill	23 Mar. 21	INMAS, Rajshahi	49
Training on APA	4 Mar. 21	INMAS, Rajshahi	11

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Principal and Vice Principal of RMCH, Director of RMCH, Civil Surgeon and Doctors of RMCH	Seminar on Enhance Capacity of Institute of Nuclear Medicine and allied Sciences (INMAS), Rajshahi	INMAS, Rajshahi	14 Jun 21	INMAS, Rajshahi
All Officer's and Staff, INMAS, Rajshahi and Doctors of RMCH	Seminar on World Thyroid Day-2021	INMAS, Rajshahi	30 May 21	INMAS, Rajshahi
All Officers	KOICA Summer workshop 2020 (Virtual meeting)	SNUH, Korea	11Aug. 20	SNUH, Korea
Prof. Dr. Mostofa Shamim Ahsan	Meeting on APA 2020-2021	BAEC	16 Nov. 20	BAEC
Prof. Dr. Mostofa Shamim Ahsan	Meeting on APA 2020-2021	BAEC	20 Jun. 21	BAEC
Prof. Dr. Mostofa Shamim Ahsan and Md. Shariful Islam Chowdhury	Meeting on Radioisotope Demand Analysis	INST, AERE	22 Jun. 21	INST, AERE

3. Service Rendered and Revenue Inccome

Name of service	No. of patient	Revenue income
Patient Service	33,679	2,20,40,140/-
Sample Analysis (including blood sample)	35,504	-
Total		2,20,40,140/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), DINAJPUR

Objective/Introduction

Institute of Nuclear Medicine and Allied Sciences, Dinajpur was established in the year 1982 at Dinajpur Sadar Hospital campus to serve the endemic goiter zone of greater Dinajpur and Rangpur district. In the following decades the Institute served a huge number of patients with Thyroid Disorders. The main objective is to serve goitre affected person both in diagnosis and treatment. At the stage of establishment institute only confined to treat Thyrotoxic patient by 131-I but at present we also treat Thyroid Cancer affected person by 131-I ablation in a adition to toxic patient treatment. Thyroid disease related research activities also done in this institute for the last decades.

Activities

1. Research and Development Work(s)

Application of Nuclear Medicine technique in the diagnosis of Thyroid disorder was established in INMAS, Dinajpur since 1982. Patients were referred here from different hospitals and private practitioners to evaluate the Thyroid gland and Thyroid hormone related disorders. 99_mTC pertechnetete Thyroid scan for thyroid scientigraphy, RIA and IRMA for hormonal assay are frequently performed procedures in our institute. Recently we also doing Thyroid hormone assay and different cancer marker assay, serum D3 level by our

recently siemens machine with CLIA Methods. We evaluate different Thyroid disorder and treat toxic goiter and Thyroid cancer patients. A 06 (six) stored new building was established by a project "Enhancing Capacity of INMAS at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur". With this project, SPECT-CT Machine , DUAL Head SPECTand colour Doppler Ultrasonography Machine was introduce, We are doing different types of Nuclear Medicine imasing like Bone scan, Renogram, Renal Scan by SPECT Machine and CT San of Chest Abdomen, Brain, orbit by our recently establishied SPECT-CT Machine, Since its establishment in month of Nov. 2020, We performed HRCT-chest of Corona affeeted patient. In addition to performing routing Ultrasonography,We also recently introduce Fetal Anomally Scan, NT-Scan in our obstetries USG department. We also introduce SPECT-CT Scan (Fusion image) recently with the newly established Dual Head SPECT. Since Nov. 2020, We performed 651 Chest imasing of Corona affeeted patient up to Jul. 2021.

2. Repair, Maintenance and Renovation Works

Under the project of Enhancing Capacity of INMAS at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur Renovation works and installed Thyroid Uptake System, BMD Machine, Color Doppler Ultrasonography, Dual Head SPECT, Dual Head SPECT-CT Machine.

3. Services

3.1 Diagnostic

In-vivo technique

- Thyroid Scanner: This test is performed with thyroid scanner to determine the function of thyroid gland.
- Nuclear Imaging: Diseases of bone, brain, liver, kidney, thyroid gland etc. are detected by taking images of the respective organs with Dual Head SPECT.
- BMD: Bone Mineral Densitometry (BMD) is used to assess bone mineral content of the patient for detection of osteoporosis and osteopenia.
- Renogram: This test is performed with SPECT machine to determine the functional status of kidneys.
- SPECT-CT: HRCT-Chest, CT-Abdomen with or without contrast, CT-Brain, CT-orbit, paranasal sinus, cervival spine, mastoid bones routinely done and fusion image (SPECT-CT) of different cancer attected patient also performed here.

In-vitro technique

Thyroid related hormones (T_3, T_4, TSH, FT_3, FT_4, Tg and Antithyroid Antibody) are being estimated in the lab by Radio Immunoassay (RIA) technique and CLIA method. (ii) Serum D_3 level. Tumor Marker also done by our introduced recently established Siemens analyser with CLIA methods.

Ultrasonogram with color Doppler

Ultrasonogram both conventional and Color Doppler ultrasound available here. In addition with routine USG we performe, Foetal anomaly Scan, NT-Scan routinely.

3.2 Therapeutic

Radioactive Iodine (I-131) is used for treatment of thyrotoxicosis and thyroid cancer patient.

4. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
Clinical/Operational Training on SPECT, SPECT-CT and Immunochemistry	13-17 Jun. 2021	INMAS, Chottagram	4
Clinical/Operational Training on SPECT, SPECT-CT and Ultrasound	20-24 Jun. 2021	INMAS, Dhaka	1

5. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Eti Rani Poddar, Aditional Secretary, MOST, Dhaka; Babul Mia, Deputy Secretary, MOST, Dhaka; Dr. B. K. Bose; Dr. Parvwz Shohel Rana; Dr. Mrs. Israt Sharmin and Dr. Morshad Alam and many other Doctor(s)	Activities of INMAS, Dinajpur	INMAS, Dinajpur	13 Mar. 2021	INMAS, Dinajpur
Prof. Dr. Sanowar Hossain, Chairman, BAEC, Dhaka; Prof. Dr. Ashok Kumar Paul, Mebber (Bio-Science), BAEC; Prof. Dr. Shamim Momtaz Ferdousi Begum, Md. Zahangir Alam, Dr. B. K. Bose, Dr. Md. Ab. Kuddus, Dr. Md. Nozmul Hasan, Dr. Saki Md. Zakiul Alam and many other Doctor	Activities of INMAS, Dinajpur	INMAS, Dinajpur	22 Mar. 2021	INMAS, Dinajpur
Dr. B. K. Bose, Dr. Tauhil Al Hasan, Dr. Towhidul Islam, Dr. Shymol Kumar Roy, Dr. Md. Gaddafi Shikder, Dr. Md. Moshiur Rahman and many other Doctor	Training on COVID 19 Case Management and Infection Prevention Control	INMAS, Dinajpur	1 Apr. 2021	INMAS, Dinajpur
Dr. B. K. Bose, Dr. Tanvirul Hasan, Dr. Md. Khayerul Alom, Dr. Atia Jahan Shanta, Dr. Md. Imrul Kayse, Dr. Md. Shiltan Chandra Das and many other Doctor	Training on COVID 19 Case Management and Infection Prevention Control	INMAS, Dinajpur	4 Apr. 2021	INMAS, Dinajpur

6. Service Rendered and Revenue Income

Name of service provided	No. of sample/patient	Revenue income
Patient Service	580	1,56,000/-
Sample Analysis (including blood sample)	5,654	25,44,300/-
Thyroid Scan, Ultrasonography and others	2,252	39,10,140/-
Total	8,486	66,10,440/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), RANGPUR

Objective/Introduction

Institute of Nuclear Medicine and Alliad Sciences, Rangpur is located in the northern part of the country in the premises of Rangpur medical College Hospital. The Institute provides diagnostic and therapeutic services to the people of Northern part of Bangladesh covering greater Rangpur, part of greater Bogra and Dinajpur using Nuclear technology and ultrasound system. Since inception in 1989 the Institute made a great impact in this region for the betterment of health services.

Activities

1. Research and Development Work(s)

By using invivo and in vitro nuclear techniques and ultrasound various R and D programmes are going in relation to hypothyroidism, thyrotoxicosis thyroid cancers, renal diseases foetal maturity and hepatobiliary diseases scientific discussions on journals collected through Internet are done time to time.

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Md. Murshed Ali	Regional Training Course on Hybrid Imaging and Therapeutic Nuclear Medicine Technologies and Its Applications in Thyroid Conditions Including Liver and Prostate Cancer Theragnostics to be held at Lahore	IAEA	8-19 May 2017	Faisalabad in Pakistan
	2 "Pre-Shipment Visit on Nuclera tof-Pet with Associate Accessories" to be held at Philips Healthcare	visit	17-23 Sep. 2017	Clevland, Ohio, USA
	"The Clinical Training on Color Doppler with 4D Ultrasound" Project	Training	13-19 Oct. 2018	India
	"Clinical, Operational and Service training of Dual Head SPECT-CT" at Mediso Imaging System Ltd.	Project	1-12 Apr. 2019	Budapest, Hungry
	"Society of Nuclear Medicine and Molecular Imaging (SNMMI)-at during	Annual Meeting	22-25 Jun. 2019	Anaheim, California, USA
	The Regional Workshop on Nuclear Medicine Applications (SPECT and PET) in the Diagnosis of Neurological Conditions	Project	29 Jul.-2 Aug. 2019	Tokyo, Japan
	Chinical and Operational Training on Bone Mineral Densitometry (BMD) at Medilink, 393 Rue Charles Lindbergh, 34130 Mauguio	Project	18-24 Nov. 2019	France
Dr. Mrs. Sadia Afroz Choudhury	Regional Training Course On the Development and Clinical Application of Radiosynovecctomy Agents	IAEA	14-18 Nov. 2016	Quezon City in Philipines
	Clinical Training on High Grade Color Doppler Ultrasound	Project	19-31 Aug. 2019	India
	Nuclear Technology Seminar-2019: Basic Radiation Knowledge for School Education Course	IAEA	24 Oct.-8 Nov. 2019	Japan
Dr. Musrat Jahan	Regional Training Course On the Development and Clinical Application of Radiosynovecctomy Agents	IAEA	14-18 Nov. 2016	Quezon City in Philipines India
	Clinical Training on High Grade Color Doppler Ultrasound	Project	19-31 Aug. 2019	Japan
	Nuclear Technology Seminar-2019: Basic Radiation Knowledge for School Education Course	IAEA	24 Oct.-8 Nov. 2019	
Md. Shafiqul Islam	Clinical, Operational and Service training of Dual Head SPECT-CT" at Mediso Imaging System Ltd.	Project	1-12 Apr. 2019	Budapest, Hungry
Md. Wares Ali	Operational Training program of the Single Head Gamma Camera	Project	24-28 Jun. 2019	Hungary

3. Academic

- The Institute is carrying out academic activities in collaboration with the department of physiology, endocrinology, gyenocology and oncology dept of Rangpur Medical College Hospital.

- Arranged scientific and technical discussions on Nuclear Medicine and Ultrasonography for our newly appointed doctors and scientists.

4. Service Rendered and Revenue Income

Name of service	No. of patient	Revenue income
Patient Service	17,706	1,01,25,950/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), KHULNA

Objective/Introduction

- To provide diagnostic and Therapeutic services to the patients using nuclear technology and ultrasound system and to conduct academic and research activities.
- To promote better understanding of nuclear medicine services among the medical professional.
- To improve and upgrade nuclear medicine facilities concerning local perspectives.
- To facilitate research and development works in the relevant fields.

Activities

1. Research and Development Work(s)

- Out come of neonatal brain ultrasound in perinatal asphyxia with hypoxic ischemic enapholopathy.
- RiskStratification of Thyroid Nodule in ultrasoundbasedon ACR TIRADS.
- Outcome of Radioiodine ablation in pediatric patients with differentiate Thyroid Carcinoma.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
In-house Training on Annual Performance Agreement (APA)	21-23 Nov. 2020	INMAS, Khulna	6

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Jharna Das and Dr. Md. Jahangir Alom	To inform about the facility of "Enhance Capacity of Nuclear Medicine and Allied Sciences (INMAS), at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur" Project for Physician	INMAS, Khulna and "Enhance Capacity of Nuclear Medicine and Allied Sciences (INMAS), at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur" Project	5 Jun. 2021	Khulna

4. Academic

- Post-graduate students and Internee doctors of Medicine Department, Khulna Medical College received training of Thyroid disease management from Thyroid Clinic.
- Arranged Seminar on Nuclear Medicine, Ultrasound procedures and related subjects monthly.
- To provide six (06) months honorary training on Nuclear Medicine and Ultrasound.

5. Service Renderd and Revenew Income

Name of service	No. of patient	Revenue income
Patient Service	30,273	1,68,49,970/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), BARISHAL

Objective/Introduction

The Institute of Nuclear Medicine and Allied Sciences, Barishal is situated in the Campus of Sher-e-Bangla Medical College and Hospital. It was established in the year of 1989 with the objective to serve the people of the southern most part of the country. The Institute delivers its services mostly to the patients attending the Sher-e-Bangla Medical College Hospital and also to the people of the Barishal Division and as well as people of the neighbouring districts like Madaripur, Gopalgong, Pirojpur, Bagerhat etc. The Institute is equipped with one dual head SPECT and another single head gamma camera, thyroid uptake system and three ultrasonography machine with Colour Doppler, Elastoscan and 3D/4D facilities and a RIA Laboratory. The Institute supplies amniotic membrane for burn patients and bone chips for orthopedic injury.

Activities

1. Services

1.1 Diagnostic

- **Ultrasonography and Color Doppler:** Ultrasonography is the main diagnostic tool of the Institute. More than 50% of patients are handled through this system. Sonography of abdominal organs, thyroid gland, pediatric brain, testes, mammary gland, eye ball, joints, musculoskeletal system etc. are highly popular among the referring physicians. Colour doppler study of the peripheral vessels, carotid arteries and other organs is being done routinely. Elastoscan, endocavitary scan and 4D Ultrasonography of fetus and different organs are also done here.
- **RIA laboratory:** Serum T_3, T_4, TSH, FT_3, FT_4, FSH, LH, Prolactin, Progesterone, Testosterone, Tg, Anti TgAb, TPO Ab, TMAb are confidently estimated weekly and fortnightly.
- **Nuclear Medicine:** Bone scan, Renal scan, Renogram, Liver-spleen scan, Hepatobiliary scan, Meckel's Scan, Thyroid scan, MIBI scan and whole body ^{131}I scans are routinely done.

1.2 Therapeutic activities

- I-131 therapy: I-131 therapy is given to Hyperthyroid and Ca- thyroid patients.
- Follow-up: Toxic and Ca-thyroid Patients are followed up periodically for the rest of their lives.
- Beta-radiation: Beta-radiation is applied to Postoperative Pterygium patients using Sr-90 source.

2. Research and Development Work(s)

- Outcome of radioiodine therapy in well differentiated Ca thyroid patients.
- Pathologies found in high resolution neck Ultrasonography.

3. Repair and Maintenance

- Renovation of RIA lab with a new gamma counter.
- Installed water purifiers for safe drinking water for patients and staffs.

4. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
Arranged In-house Training for Officer and Staff INMAS, Barishal	Aug. 2020- Mar. 2021	INMAS, Barishal	30
Honorary training course on Ultrasonography and Nuclear Medicine for doctors	Jul. 2020-Dec. 2020	INMAS, Barishal	1

5. Collaboration Work(s)

Institute collects blood samples from the newborn babies as part of country wide screening of neonatal congenital hypothyroidism program under the National ADP project 'Screening of Congenital Hypothyroidism in newborn babies (phase-2)'.

6. Service Rendered and Revenue Income

Name of the service	Number of patient	Revenue income
Patients service including Ultrasound and etc.	23,970	1,28,50,410/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), FARIDPUR

Introduction

Institute of Nuclear Medicine and Allied Science (INMAS), Faridpur was established along with other three institute in Mitford, Commilla and Bogra as a common project. The institute is situated in the premises of Faridpur medical college hospital. The foundation stone was led on 15 Sep. 1995, construction was completed in early 1997 and the institute started running in Oct. 1997. Patients from greater Faridpur district and adjacent areas usually attend the institute to receive nuclear medicine services. The institute has been rendering services through its following scientific divisions.

- Nuclear scanning/scintigraphy
- Thyroid division
- In-vitro Nuclear Medicine
- Therapeutic Nuclear Medicine
- Ultrasound division

Activities

1. Services

Principal activities of the institute is to render diagnostic and therapeutic service to the patients. A large number of patients attend the institute for ultrasonogram, thyroid function studies, radioisotope scan and for estimation of different hormones. The institute also render therapy for thyrotroxicosis and ca-thyroid patients.

2. Research and Development Work(s)

- Duplex study of inferior thyroid arteries and correlation with biochemical status.
- Study of ovulation by ultrasound in female infertility.
- Duplex study of pregnancy for early detection of IUGR.

3. Manpower Development and Training Program

- Certificate training on Research methodology and scientific article writing, held in Dhaka 18-20 Jul. 2020. by Dr Afrida Khanam, Medical officer, INMAS, Faridpur.
- Scientific training on Covid-19 overview and way to management, APA, Administrative rules and PPR for officers and stuff organized by INMAS, Faridpur 6-11 Mar. 2021.

4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date
Dr Shankar Kr Dey and Dr Afrida Khanam	2020 KOICA Summar workship on "Radiopharmaceutical chemistry from clinical needs of theranostics" (Zoom webinar)	KOICA	11 Aug. 2020
Dr Shankar Kr Dey and Dr Afrida Khanam	24th WFOMB COW workship on leading edge USG. (Zoom meeting)	BSU	5-6 Feb. 2021
Dr Shankar Kr Dey and Dr Afrida Khanam	3rd National Conference of BSU (Zoom webinar)	BSU	27 Nov. 2020
Dr Shankar Kr Dey and Dr Afrida Khanam	4th National conference of Bangladesh Thyroid Society (Zoom webinar)	BTS	19 Mar. 2021
Dr Shankar Kr Dey and Dr Afrida Khanam	Breast ultrasound workshop (Zoom webinar)	BSU	23, 30 Apr. 2021

5. Service Rendered and Revenue Income

Name of the service	Number of patient	Revenue income
Patients service including Ultrasound and Doppler, Scintigraphy, radioiodine therapy	9,246	1,12,29,450/-
Blood sample and analysis	10,888	
Total		1,12,29,450/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), BOGURA

Objective/Introduction

The Institute of Nuclear Medicine and Allied Sciences, Bogura is a government institute of specialized and applicable research oriented health services. The government fund and labors are totally used here for public health service and mankind. The main objective of the Institute is to apply Atomic Energy in a safe and peaceful way for the well being of mankind, rather than to use it in destruction. The Institutue is mainly involved with diagnosis and treatment of various human diseases using radiopharmaceuticals. Academic and research activities are also performed here. Gamma Camera, Thyroid Uptake System, Gamma counter, Pterygium Applicator, Ultra sonogram and other associated ultra-modern equipments are available in this Institutue.

Activities

1. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
In House Training Course on Radioactive Waste Management and Clinical advancement in USG and Color Doppler	20 Aug. 2020	INMAS, Bogura	6
In House Training Course on Transfer Provisions and Jobs (salary and Allowances) Orders	24 Aug. 2020	INMAS, Bogura	16
In House Training Course on Serum Procedure and Collimators Description	25 Aug. 2020	INMAS, Bogura	18
In House Training Course on Familiarization with Gamma Camera Console and Fundamentals of Radiation Protection External and Internal	17 Sep. 2020	INMAS, Bogura	16
In House Training Course on History of Nuclear Medicine in BD and Brain SPECT Diamox Scan	24 Sep. 2020	INMAS, Bogura	5
In House Training Course on The Public Servants (Retirement) Act 1974 and (Retirement) Rules -1975	27 Sep. 2020	INMAS, Bogura	13
In House Training Course on Legal Basis For Radiation Protection in Nuclear Medicine Practices and Carcinoma Thyroid Uptake Management	15 Oct. 2020	INMAS, Bogura	5
In House Training Course on Assay Procedure and Assay Count	18 Oct. 2020	INMAS, Bogura	19
In House Training Course on The Government Servants (Conduct) Ruls-1979 and The Government Servants (Pension and Gratuity)	20 Oct. 2020	INMAS, Bogura	14
In House Training Course on রোগীদের সাথে কর্মকর্তা/কর্মচারীর আচরন and Thyroid PET Brain Scan	16 Nov. 2020	INMAS, Bogura	5
In House Training Course on LH/FSH and Contamination and Decontamination Procedures	19 Nov. 2020	INMAS, Bogura	19

In House Training Course on The public Employees discipline (Punctual Attendance) Ordinance-1982 and Bangladesh Services Festival Allowance.	22 Nov. 2020	INMAS, Bogura	13
In House Training Course on এপিএ বিষয়ে (কৌশলগত ও আবশ্যিক কৌশলগত বিষয়সমূহ) পাঁচ ঘন্টা প্রশিক্ষণ প্রদান	29 Nov. 2020	INMAS, Bogura	10
In House Training Course on গবেষণাগারে দূর্ঘটনা/জরুরী অবস্থায় প্রাথমিক করণীয়	8 Dec. 2020	INMAS, Bogura	25
In House Training Course on FT4/ TSH Related and Rediation Monitoring	15 Dec. 2020	INMAS, Bogura	19
In House Training Course on Treatment of Thyrotoxicosis and Bone Scan- Differentiation Between Metastatic and Arthritic Changes	22 Dec. 2020	INMAS, Bogura	5
In House Training Course on Retirement Benefits and Eligibility Conditions and Rules For Receiving Pension.	27 Dec. 2020	INMAS, Bogura	13
In House Training Course on Myocardial Perfusion Imaging and Biophysics of Ultrasound Machine	19 Jan. 2021	INMAS, Bogura	5
In House Training Course on Different Kind of Leave Rules and The Provident Funds Act-1925	23 Jan. 2021	INMAS, Bogura	13
In House Training Course on Sources Used in Nuclear Medicine and Crystal and Positioning Logic	26 Jun. 2021	INMAS, Bogura	20
In House Training Course on Myocardial Perfusion Imaging and USG Of Genitourinary System	17 Feb. 2021	INMAS, Bogura	6
In House Training Course on The IAEA Safety Standard and Energy Discrimination and Plus Height analysis	20 Feb. 2021	INMAS, Bogura	18
In House Training Course on পেনশন যোগ্য ৫-২৪ বৎসর চাকুরিকালের মধ্যে পেনশন প্রাপ্তির শর্ত এবং পেনশনারদের প্রাপ্য বিভিন্ন ভাতা	22 Feb. 2021	INMAS, Bogura	13
In House Training Course on Biophysics of Ultrasound Machine and Basics and pitfall of Color Doppler Ultrasonography	18 Mar. 2021	INMAS, Bogura	6
In House Training Course on Radiation Safety for Patients and Occapational Workers and Kit Preparation/Hit Storage	21 Mar. 2021	INMAS, Bogura	17
In House Training Course on Digital Document Numbering Method and Govt Telephone, Cellular, Fax, Internet Policy-2018	23 Mar. 2021	INMAS, Bogura	14
In House Training Course on Reporting of Renogram and USG Of Hepatobiliary System- Overview	4 Apr. 2021	INMAS, Bogura	6
In House Training Course on Radiation Quantities and units and Prolaction	5 Apr. 2021	INMAS, Bogura	19
In House Training Course on Office Management and বাসা ভাড়া সংক্রান্ত অন্যান্য নির্দেশাবলী	6 Jun. 2021	INMAS, Bogura	15

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the Participant	Title of the event	Organizer	Date	Place
Md. Faruk Hossin	International e- Conference on Physics -2021	BPS and DU	5 Feb. 2021- 7 Feb. 2021	Online Platform

3. Service Rendered and Revenue Income

Name of service	No. of sample/patient	Revenue income
Patient Service	7,447	35,70,760/-
Sample Analysis (including blood sample)	12,078	86,88,620/-
Total	19,525	1,22,59,380/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), CUMILLA

Introduction

Institute of Nuclear Medicine and Allied Sciences (INMAS), Comilla is established in 1996 which located at Cumilla Medical College Campus, Cumilla. This institute provides diagnostic and therapeutic service by using nuclear medicine technique, Ultrasound and Color duplex studies of the Patients east part of Bangladesh covering Cumilla, Noakhali, Chandpur, Laxmipur, Feni Etc.

Activities

1. Academic

- Director of INMAS delivered lectures on Nuclear Medicine to under graduate level of Cumilla Medical College 5th years.
- Delivered lectures in Moinamoti Medical College (Pvt.) 3rd-5th years.
- Arrange honorary training (6 Months) for 02 Doctors on nuclear medicine and Ultrasound in the institute.

2. Manpower Development and Training Program

- Dr. Sumaya Alam (MO) MD is in Course for Nuclear Medicine.
- Dr. Md. Reajul Islam, Director and Chief Medical Officer training on BMD Machine in France on 14th to 20th Apr. 2020 arranged by Medilink, France due but for Covid-19 .
- Dr. Md. Reajul Islam, Director and Chief Medical Officer Training in Vienna, Austria 16-18 Mar. 2020 was also due but due to Covid-19 not attened the meeting.

3. Service Renderd and Revenue Income

Name of service	No. of patient	Revenue income
U.S.G, Color Doppler, BMD, Therapy, Therapy 3 days Cabin, Post-operative thyroid Cancer, Radiation Cabin 6 days, Follow up Thyroid Scan, Renal Scan, Bone Scan, Anomaly Scan, Testicular Scan, Renogram/GFR and RIA	16,091	1,05,93,700/-

INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), COX'S BAZAR

Objective

- Ensuring the safe uses of nuclear medicine in diagnostic and therapeutic procedures.
- Ensuring the clinical use of radionuclides applied in nuclear medicine.
- Development of skilled human resources in the field of nuclear science and technology.
- Ensuring safety and peaceful use of nuclear energy.
- Expanding the uses of nuclear technology in medical service.
- Increase research capacity in science and technology.
- To increase transparency and ensure accountability in official activities.
- Bringing dynamism in performance and increasing the quality of service.

Activities

1. Services

- Providing services by regular follow up of thyroid patients.
- Radio Iodine Therapy.
- Scintigraphy and Ultrasound Services.
- RIA Activities.
- Clinical research in nuclear medicine and thyroid disorders.

2. Manpower Development and Training Program

Title of the event	Date	Place	No. of participant
In-house training course on office manners and general behavior	23-27 Aug. 2020	INMAS, Cox's Bazar	11

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Prof. Dr. Md. Sayeedul Alam	4th National conference and Annual General Meeting of Bangladesh Thyroid Society	NINMAS	19 Mar. 2021	NINMAS
Dr. Priyanka Podder	4th National conference and Annual General Meeting of Bangladesh Thyroid Society	NINMAS	19 Mar. 2021	NINMAS
K. M. Mahabub Morshed	A Follow-up Training Course on Environmental Radioactivity Monitoring Course -2021	Training Institute	10-14 Jan. 2021	AERE, Savar

4. Service Rendered and Revenue Income

Name of service	No. of patien/samples	Revenue income
Patient Service	4,503	26,31,950/-
Sample Analysis (including blood sample)	7,048	
Total		26,31,950/-

III. ENGINEERING AND GENERAL SERVICES

ENGINEERING DIVISION (ED), BAEC HQ

Introduction

Bangladesh Atomic Energy Commission has been engaged in research and development (R and D) activities in the various fields of Nuclear Science and Technology in the country. Under the Charter of Bangladesh Atomic Energy Commission, Engineering Division (ED) has been entrusted with the responsibilities for installation, testing and operation of various scientific, nuclear and engineering facilities and building up and maintenance of physical infrastructures for smooth operation of R & D programs of BAEC. This division is also actively involved in the implementation of 2400 MW Rooppur Nuclear Power Project (RNPP) at Pabna. Following activities have been performed by Engineering Division during 2020-2021periods.

Activities

1. Contribution for implementing ADP projects (both completed and ongoing)

1.1 Works contributing under the project "Enhance Capacity of Institute of Nuclear Medicine and Allied Sciences (INMAS) at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur are as follows.

- Planning, designing, estimating and supervision of renovation works of old INMAS buildings.
- Construction of six storied new building in Dinajpur, three storied in Khulna and Rajshahi, one storied in Chittagong and also vertical extension in Rangpur.
- Construction and installation of lift, AC, Sub-station are in progress.
- Construction of new gate and guard room at INMAS Dhaka.
- Construction and supervision of auditorium buildings under the project.

1.2 Works contributed for planning, designing, estimating and construction of Three Storied new residential building under the project Development of Human Resources and Establishment of Residential Accommodation Facilities for the Radiation Testing and Monitoring Laboratory at Mongla.

1.3 Works contributing under the project Establishment of Institute of Nuclear Medicine and Allied Sciences (INMAS) at 8 Medical Collage Hospital Campuses in the country at Dhaka, Khustia, Jessore, Cox's Bazar, Gopalgonj, Pabna, Satkhirah are as follows.

- Planning, designing, estimating and supervision of all new INMAS buildings are in progress.
- Construction, installation of substations, lifts, ACs, pumps and other related mechanical and electrical works are in progress.

1.4 Works contributed under the project Capacity build-up of Nano and Nano-bio Technological laboratory at Material Science Division, AEC, Dhaka are as follows.

- Planning, designing and estimation for renovation of laboratories of Material Science division at AECD.
- Installation, testing and commissioning of Air Conditioning system and other related mechanical and electrical works.

1.5 Works contributed under the project Establishment of Positron Emission Tomography-Computed Tomography (PET-CT) with Cyclotron facilities" at AERE, Savar are as follows.

- Installation, testing and commissioning of 1000KVA new Sub-station.
- Installation, testing and commissioning of 300KVA generator and other related electrical and mechanical works.

1.6 Works contributed for the project Balancing, Modernization, Refurbishment and Extension (BMRE) of Safety Systems of the 3 MW TRIGA Mark-II Research Reactor Facilities.

1.7 Wworks contributed for the project Establishment of Cyclotron and PET-CT at Institute of Nuclear Medicine and Allied Sciences (INMAS) Mymensingh and Chittagong and Cyclotron facilities at Institute of Nuclear Medical Physics (INMP), Savar.

1.8 Works contributed for the project Establishment of Calibration and Quality Control Facilities for Radiotherapy, Diagnostic Radiology and Neutron.

2. Works accomplished by Engineering Division in (2019-2020) under Revenue Budget

Engineering Division is one of the most important divisions of this organization, as it is responsible to smoothly operate the overall R & D activities of BAEC by creating various facilities, work and services. Some completed works and related services rendered within the financial year 2019-2020 are as follows.

2.1 At BAEC HQ

- Supplying, fitting and fixing of office furniture for Human Resources Division at BAEC, HQ.
- Supplying, installation, testing and commissioning of split, cassette and window air conditioners at BAEC, HQ.
- Supply, installation, testing and commissioning of 300KVAR PFI System, 1500KVA Sub-station at BAEC, HQ.
- Repair and maintenance work for NSSSD, QMD, Engineering Division, Medical Clinic at BAEC, HQ.
- Separation and modification of telephone and intercom distribution board at BAEC, HQ.

- Completed various civil, electrical and mechanical works under Vertical Extension works of Paramanu Bhaban at BAEC, HQ,
- Digital topographical survey of BAEC, Housing, Banani and digitalization of the old AERE master plan.
- Supply, installation, testing and commissioning of 5 [2.5x2] Ton split Air Conditioner at BAEC, HQ.
- Renovation works of 2nd floor corridor at BAEC, HQ, Agargaon, Dhaka.
- Supplying, fitting and fixing of vertical venetian blinds of Physical Science Division at BAEC, HQ, Dhaka.
- Supplying, Fitting, and fixing office furnitures at chairman Office secretariat of BAEC, HQ. Dhaka.
- Supplying, testing and printing of RFID Proximity Card at BAEC, HQ.
- Supplying of electrical goods for BAEC (HQ).
- Renovation/repair and maintenance work of room no 701 at HQ.

2.2 At BAEC Housing Colony, Banani

- Renovation/repair and maintenance works of boundary wall at BAEC Housing Colony, Banani.
- Renovation/repair and maintenance works of flat No HB-05 and 07 at BAEC, housing colony, Banani Dhaka.
- Renovation/repair and maintenance works of Flat No D-10, ANNEX-05 and 09 at BAEC, housing colony, Dhaka.
- Supply, installation, testing and commissioning of submersible pump set and related works at BAEC, housing colony.
- Renovation/repair and maintenance works of Flat No D-10, ANNEX-05 and 09 at BAEC, housing colony, Dhaka.
- Renovation/repair and maintenance works of Flat No: D-3, HB-9 and pump house at BAEC, housing colony, Dhaka.
- Renovation/repair and maintenance works of C-06, at BAEC, housing colony, Bananai, Dhaka.
- Renovation/repair and maintenance works of flat No: servant quarter 05 and waste and removing debris at BAEC, housing colony, Banani, Dhaka.
- Renovation/repair and maintenance works of Flat No Annex-01, C-05, 16 and D-09 at BAEC housing colony, Dhaka.
- Renovation/repair and maintenance works of flat No C-19 at BAEC, HQ.
- Renovation/repair and maintenance of flat No C-01, 10and 11 at BAEC housing colony, Dhaka.

2.3 At AERE campus

- Supply, installation, testing and commissioning of outdoor LED display billboard [18.5ft x 13ft] at AERE, Savar, Dhaka.
- Construction of 2 no’s, gate and gate house in front near side of road adjacent to guest house) at BSMEC, Cox’s bazar.

2.4 At NINMAS and INMAS

- Renovation/repair and maintenance works at INMAS, Cumilla.
- Renovation/repair and maintenance works at INMAS, Bogura Old Campus.
- Repair and maintenance works at INMAS, Mitford, Dhaka.

3. Completed services

Engineering Division is one of the most important divisions of this organization, as it responsible to smoothly operate the overall R & D activities of BAEC by creating various facilities, work and services. Some services completed within the financial year 2019-2020 are as follows.

- Works contributing under the project Modernization of Food and Radiation Biology Facilities, AERE, Savar.
- Planning, designing, estimating and supervision of vertical extension of old IFRB building and others related renovation works.
- Construction and installation of lift, AC, Sub-station are in progress.
- Rendered various services related to planning, designing, drawing and sanitation work (civil, electrical, mechanical and sanitary) at various divisions/facilities of BAEC HQ, Agargaon, Dhaka.
- Rendered various services related to planning, designing, drawing and sanitation works (civil, electrical, mechanical and sanitary) at various facilities of Bangladesh Atomic Energy Researches Establishment, Savar, Dhaka.
- Rendered various services related to planning, designing, drawing, sanitation works (civil, electrical, mechanical and sanitary) at various facilities of BAEC Housing Colony, Banani, Dhaka.
- Rendered planning and designing services (civil, electrical, mechanical and sanitary) contributed to various facilities at Bangladesh Atomic Energy Regulatory Authority (BAERA).
- Rendered planning and designing services (civil, electrical, mechanical and sanitary) contributed to various facilities of INMASs (Dhaka, Shylhet, Rajshahi, Chittagong, Dinajpur, Rangpur, Khulna).
- Providing technical expert services in various Centers/institutes/different projects of BAEC and other National Projects outside BAEC like, Department of Environment, Ministry of Commerce (Bangladesh Trade Portal Enhance Project), University Grant commission (UGC) and Bangladesh Museum of Science and Technology etc.

4. Preparation of Development Project Pro-forma (DPP)

- Establishment of Calibration and Quality Control Facilities for Radiotherapy, Diagnostic Radiology and Neutron project.
- Establishment of Cyclotron and PET-CT at Institute of Nuclear Medicine and Allied Sciences (INMAS) Mymensingh and Chittagong and Cyclotron facilities at Institute of Nuclear Medical Physics (INMP), Savar project.
- Balancing, Modernization, Refurbishment and Extension (BMRE) of Safety Systems of the 3 MW TRIGA Mark-II Research Reactor Facilities project.
- Construction of New Residential Buildings and Infrastructure Development of Existing Residential Area of Bangladesh Atomic Energy Commission project.

ENGINEERING AND GERNERAL SERVICE (EGS) DIVISION, AECD

Objective

Engineering and General Service Division provides engineering and technical services to research and development activities in the Atomic Energy Centre, Dhaka (AECD). This division has six sections: Electrical, Refrigeration and Air Conditioning System, Plumbing, Workshop, Glass Blowing, Utility and Civil Engineering section to support divisional activities. This division also provides all utility related service such as electricity, water supply, ventilation, air-conditioning system, civil works etc. through the respective sections. During the reporting period (01 Jul. 2020 - 30 Jun. 2021) this division received over 84 jobs requisition from different division of AECD, RNPP, BAEC HQ and AERE.

Activities

1. Electrical Section

Electrical section has done major 22 jobs for Administration, store and procurement branch. A few are

- Repair electrical line in directors room, accounts and library section.
- Tube lights were replacement in sitting rooms, corridors and Director's room.
- Repair and replace tube lights in Officers sitting room.

- Repair and adjust lights in CTBTO cell.
- Repair guard rooms fans and lights in several times.
- Repair and adjust lights in library.

Electrical section has done major 18 jobs for chemistry division. A few are

- Light repair in ACL, Trace Analysis Lab,
- Fume hood fan repair and fixed in Chemistry lab.
- Replacement of combined switch in ACL laboratory.
- Two fan repair Chemistry lab.
- Repair AC power and circuit breaker in Chemistry lab.
- A exhaust fan replace in Chemistry division.
- Repair and maintenance light and combined switch socket in Health Physics Division
- Light and energy bulb fixed in NDT division.
- Furnace and exhaust fan repaired in MSD.

2. Refrigeration and Air-Conditioning System Section

- Total thirteen AC were repaired in Administration, Accounts, store and library section.
- Total ten AC were repaired (i.e. gas charge, circuit, compressor, blower etc) for all Labs in Chemistry Division.
- One AC was repaired in Health Physics Division (HPD).
- One AC was repaired in NDT Division.
- Two AC were repaired in the Experimental Physics Division (EPD).
- One AC was repaired in the Material Science Division (MSD).
- Two AC were repaired in the Electronics Division (ED).

3. Plumbing Section

- Basin and water supply line repaired, toilet flash and low down repaired, soap holder fixed, Water purifier plant repaired in Chemistry Division.
- Hand shower, chair, door lock for Officers room repaired, window repaired for sittingroom in Administration Division.
- Water tap fixed and repaired for Electronics Division.
- Repaired Basin and toilet flash for Analytical Chemistry Laboratory.
- A strong concrete basement made for drinking water tank under EGS supervision.

4. Workshop Section

During the reporting period this Division performed 2 jobs requisition and completed all the works successfully. Made punch holes for EGS division and patch cutting in a MS pipe according to sample in RAC section.

5. Glass Blowing Section

During the mentioned period, this section has performed two glass related work for AERE Savar and MS research student.

CENTRAL ENGINEERING FACILITIES (CEF), AERE

Introduction

CEF mainly works in construction of infrastructures and installation, repair and maintenance of the necessary equipments as well as providing the different services within Atomic Energy Research Establishment

(AERE). The fundamental works of CEF are to help all the institutions of AERE to carry out various sorts of R & D work by providing essential technical supports. It has been taking care of the engineering facilities within AERE campus as per requirements. CEF takes the responsibility of formulating all engineering related jobs like as designing, planning, installation, operation and maintenance of all facilities of AERE, the largest research complex of Bangladesh Atomic Energy Commission (BAEC). Electrical power supply system, gas supply system, water supply system, air conditioning system civil and sanitation system of AERE are the prime concern of CEF. In essence, it provides services in designing, development, construction, technical support, implementation and maintenance of the infrastructures developed at AERE.

Activities

Mechanical Engineering Division, CEF

Repair, Maintenance and Renovation Works

- Supplied drinking water which is used in different Institute of the office side and residential area of AERE colony.
- Repaired colony side 25 HP centrifugal pumps 3A, 3B and 3D.
- Replacement electric motor of colony pumps 3C.
- Repaired office side 25 HP centrifugal pumps 2A.
- Rewinding and repaired electric motor of office side pump 2B.
- Repaired office side 41HP submersible pump-motor including of spare parts, consumable materials servicing works at AERE.
- Installation and modification works of ball cock for overhead water tank of colony building at AERE, Savar.
- Installation and modification of underground water pipe line of AERE colony.
- Repaired and maintained underground water pipeline of office side at AERE.
- Cleaning and washing works of underground and overhead water tank at AERE campus.
- Operated and maintained two deep-well turbine pump and six centrifugal pumps regularly.
- Installation 16 Nos. new split and window type air cooler (5 ton, 2 ton and1.5 ton) at INST, IFRB, IE, ICS, TAD, and CAD building.
- General servicing around 35 Nos. of window and split type A/C in all institutes at AERE.
- Repaired 20 Nos. of window and split type AC at INST, IFRB, TI, IE, ICS, VIP guest house, TAD, Cafeteria, INM and CAD building.
- Replaced around 10 Nos. of blowers of window and split type, 20 Nos. of compressor of AC and refrigerator and repaired around 15 Nos. of refrigerator and fridge in different institutes of AERE.
- Repaired other refrigeration systems (Cooling incubator, Dehumidifier etc.) at AERE.
- Operated and maintained the central air conditioning Plant of INST auditorium.
- Overhauling, repairing, servicing, testing and commissioning of 133 ton once thru' air conditioning, ventilation and exhaust system at RIPD, INST, AERE.
- Installation and refilling works of fire extinguisher at AERE.
- Replaced around 25 Nos. gas burner of residential colony at AERE.
- Replaced of damage water heater from VIP guest house of room no. 2 and installed new 15 letter automatic electric water heater with modification of existing water line.
- Provide modification and fitting fixing works with RCC plat form of over head water tanks of officer's hostel at AERE colony.

Electrical Engineering Division, CEF

Repair, Maintenance and Renovation Works

- Electrical repaired and maintenance work of laboratory at NRCD, INST at AERE.
- Electrical power line repaired of laboratory at RNPD, INST at AERE.
- Electrical repaired of street lights at AERE.
- Electrical repaired of security lights of IRPT, SIU, EI and INST building at AERE.
- Wiring of new internet brought bend line of PBGED, IFRB at AERE.
- Electrical repaired of LT line of Uttara bank AERE, EPZ branch at AERE.
- Electrical repair and maintenance work of research laboratory related machineries.
- Electrical repaired and maintenance work of security lights at residential colony at AERE.
- Electrical repaired of ceiling fan of IE, INM and CAD building at AERE.
- Painted fan, gates and other equipment at AERE office and residential area.

Civil Engineering Division, CEF

Repair, Maintenance and Renovation Works

- Repaired, maintenance and modification work central cafeteria at AERE.
- Repaired and painting works of IBD heat control chamber of IFRB.
- Constructed of a septic tank with new sewerage line and other related works of ladies toilet of INSTat AERE.
- Made pocket gate and closed the pocket gate after installation the equipments of energy building 1st floor at AERE.
- Repair, maintenance and modification work of CEF old building 1st floor toilet zone at AERE.
- Repaired and maintenance work of (a) quarter No. D-1/1, F-2/2, F-2/3, D-2/6 (b) Supplying 2 glass self, 1 bib cock and water tap line repaired of quarter No. E-1/8, (c) Sewerage line repaired of quarter no. E-4/11 and (d) supplied and fitting-fixing 5 wooden door to staff hostel at AERE.
- Repaired, maintenance and modification work of different institutes of AERE.
- Constructed front place of ATM both of Uttara Bank Limited, AERE.

Workshop Engineering Division, CEF

Repair, Maintenance and Renovation Works

- Repaired, maintenance works of main gate at AERE.
- Made steel rack for laboratory research work of different institute at AERE.
- Repaired and maintenance work of window glass, door lock, door frame and shutter for different Institutes of AERE.
- Provide welding and Marching works as the requirement of different institute at AERE.

IV. INTERNATIONAL AFFAIRS DIVISION (IAD), BAEC HQ

Introduction

International Affairs Division (IAD), Bangladesh Atomic Energy Commission (BAEC), has been maintaining assigned liaisons regularly with the international organizations and foreign countries since its inception. The liaisons are bordered normally to the nuclear technology transfer, improvement of nuclear instrumentation, establishing nuclear power plants and development of human resources for the peaceful application of nuclear science and technology in the country. Under BAEC's supervision, IAD directly communicates with international organizations to get international projects and simultaneously monitors the progress of the

implementing projects. To strengthen the overall nuclear capability of the country, this division makes liaison for foreign trainings, fellowships and scientific visits for scientists, engineers, doctors, geologists, technicians and administration personnels. In the financial year 2020-2021, IAD has processed nominations of approximately 150 participants for various online international programmes in different countries (except Russia). IAD also works to arrange expert missions, international meetings, workshops, seminars, trainings, etc. in BAEC as well as in the country. To enhance R & D (Research and Development) works, IAD plays an important role to execute bilateral and multilateral agreements with foreign countries. Moreover, to fulfill the international obligations related to nuclear safeguards and non-proliferation of nuclear weapons, IAD has also been in constant communication with the International Atomic Energy Agency (IAEA), United Nations Organization (UNO) etc. A brief description of the activities of IAD during the period of "Jul. 2020 - Jun. 2021" is presented below:

Activities

1. Technology transfer

BAEC has been receiving technical assistances mainly from IAEA through Technical Cooperation (TC) Projects, Regional Cooperation Agreement (RCA) and Regional Cooperation Non-Agreement (Non-RCA) Projects, Coordinated Research Projects (CRP) and other special projects of IAEA. As the assigned liaison point of IAEA, IAD is liable to monitor the progresses and outputs of these projects, the reports and to submit the reports to the IAEA, to arrange expert visits, scientific visits, trainings and fellowships for the scientists involved with these projects. IAD also helps the project counterparts to organize training courses, seminars, meetings, etc. in the country.

1.1 Technical Cooperation (TC) projects

In the financial year 2020-2021, IAD worked for Twelve (12) ongoing TC projects and simultaneously to obtain new TC projects in different priority fields of development perspective of the country. The TC projects are covering the thematic areas on establishing nuclear power, nuclear agriculture, human health (nuclear medicine), environment and water resources.

1.2 Regional Cooperative Agreement (RCA) Projects

RCA is an intergovernmental agreement among IAEA member states of East Asia and Pacific region. The projects among the twenty two countries of this region are commonly known as RCA Projects. Such projects are involved in research, development and training activities in the related fields of nuclear science and technology through sharing of regional resources including facilities, equipment and expertise as well as exchange of knowledge. IAD coordinated and liaised for Nineteen (19) RCA projects covering different nuclear fields namely- Agriculture, Human Health, Industry, Environmental Protection and Water Resources.

1.3 Non- RCA Projects

These projects are Asian Region Based projects supported by IAEA Technical Cooperation (TC). In these projects, countries from Middle East are also involved with the twenty two RCA countries. In the reported year, IAD coordinated for Thirty Eight (38) Non-RCA projects covering Nuclear power planning, Sustainability of Nuclear Institute, Nuclear Capacity Enhancement, Strengthening Radioactive Waste Management and Radioactive Exposure Control, Irradiation, Physical Protection, Strengthening Health Support, etc.

1.4 Coordinated Research Projects (CRPs)

Bangladesh avails IAEA research supports through the Coordinated Research Projects (CRPs) too. Such research activities are normally conducted by the research institutes of both the developing and developed countries those are member of IAEA on the same research area of interest. IAEA funds a portion of the project's cost, IAD liaisons for a number of Fifteen (15) CRP projects covering the research area of Food and Agriculture, Human Health, Physical and Chemical Sciences, Nuclear Installation Safety, Nuclear Fuel Cycle, Nuclear Security Culture and Waste Technology Besides BAEC, scientific institutes and Universities of Bangladesh such as ICDDR,B, Dhaka University, Bangladesh Agricultural University (BAU), Radiation Oncology Department of the Hospitals Centre for Woman and Child Health, are involved with CRPs.

2. Projects of the Forum for Nuclear Cooperation in Asia (FNCA)

IAD is the focal point to implement the FNCA projects. The framework of this forum specified to various vital nuclear fields such as: utilization of research reactors, utilization of radioisotopes in agriculture,

application of radioisotopes and radiation for medical use, public information of nuclear energy and radiation safety and radioactive waste management, safety culture of nuclear energy, human resources development. The present members of this forum are Japan, Mongolia, Kazakistan, Australia, Bangladesh, China, Indonesia, Republic of Korea, Malaysia, Philippines, Thailand and Viet Nam. In the financial year 2020-2021, IAD liaised for a number of seven (7) FNCA projects.

3. Exchange of experience and expertise

Exchange Programs under the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and Nuclear Safety Research Association (NSRA) of Japan invite nuclear researchers from neighboring Asian countries to Japan and dispatches Japanese experts to other countries. As the focal point of this program, IAD processed the necessities in favor of the selected scientists, engineers, doctors and technicians of BAEC. Both of these exchange programs are heplful to gather state-of-the-art technical knowledge and to perform high grade research activities in Japan for contributing to build up and to strengthen nuclear base and nuclear safety works in BAEC.

4. Follow-up Training Course (FTCs) Instructor Training Courses (ITCs), Advance Instructor Training Courses (AITCs) and Oneline Training Courses (OTCs)

During the reported period, three Follow-up Training Courses (FTCs) are conducted in Dhaka with the help of Japanese and Bangladeshi experts. Through the FTCs Sixty Three (63) participants are trained in different areas of nuclear science and technology. About Twenty Two (22) participants have completed ITC, AITC and OTC during the period. All the courses have been conducted online due to Covid-19 pandemic situation.

5. Database of Foreign Visitors

From Jul. 2008, IAD has been maintaining database for the foreign visits of employees of BAEC. This includes various conferences, meetings, trainings, workshops organized by TC, RCA, Non-RCA, FNCA, ANSN etc. Officials from BAEC, MoST and other organizations have attended conferences, meetings, workshops and availed significant number of fellowships and trainings in the reported period under TC, RCA and FNCA projects. IAD has processed approxmately 170 (one hundred seventy) number of participants' participation for the various online international events.

V. NUCLEAR POWER AND ENERGY DIVISION (NPED), BAEC HQ

Introduction

Nuclear Power and Energy Division (NPED) is one of the most important divisions of Bangladesh Atomic Energy Commission (BAEC). NPED is playing a vital role to implement the nuclear power program in Bangladesh. From the very beginning of this division, it has been working in the research and development works for the implementation of nuclear power program in Bangladesh. NPED is playing a role of liaison among BAEC, Ministries of the Government of Bangladesh, International Atomic Energy Agency (IAEA), and Vendor Countries to coordinate and implement the fast track project of the Government of Bangladesh "Construction of Rooppur Nuclear Power Plant (RNPP) Project", NPED is also playing an important role to select another site for nuclear power plant in the southern region of the country with the project "Probable site selection for construction of nuclear power plant in the southern part of Bangladesh".

Activities

1. Construction of Rooppur NPP Unit-1 and Unit-2 Under the project of Construction of Rooppur Nuclear Power Plant (RNPP) Project

In case of the construction of 'Rooppur NPP' Unit-1, the concreting work of inner containment wall has been completed up to +43.4 m and the installation work of Dome will start soon at a height of +44.5 m. The concreting work of accident localization area slab is completed 100% at a height of +14.45 m. The installation work of the Pressurizer is going on at a height of +14.6 m. The concreting work of Spent fuel pool wall is 100% completed up to +23.00 m and the work of concreting of the containment part has been completed up to +22 m. The reinforcement work of reactor cavity wall up to +26 m height and the casting work up to + 23.3 m height is 100% completed. The concreting work of outer containment wall is 100% completed up to + 16.3 m height. Reactor Polar Crane has been installed at a height of +38.5 m. The concreting work of inner wall and

outer wall of Adjacent Structure has been completed 100% up to +18.45 m height. The construction work of Adjacent Structure slab is 100% completed up to a height of +16.45 m. The concreting work of Beam of Transportation portal has been completed up to +21.1 m height. The inner concreting work of inner wall and outer wall of reactor auxiliary building is 100% completed from height of +4.75 m to height of +8.3 m. The concreting work of slab in UMA part of Turbine building is 100% completed up to a height of + 16.00 m. The concreting work of turbine set column has been completed up to a height of +12.20 m. The concreting work in UMX part is currently going on from +6.7 m to +16.00 m. In the UBA section, reinforcement work of slab from +6.8 m to + 12.24 m is in progress. Condenser Tank and separate collector tank have been installed in the turbine building and work is underway to establish a vibro isolation spring. The concreting work of all slabs and beams of Unit water demineralization plant is 100% completed up to a height of +3.90 m. The concreting work of column has been completed at an altitude of +6.80 m to + 16.00 m. The construction work of Outer Walls, Inner Walls and Columns of Normal operation power supply building is 100% completed from -3.8 m to 0.00 m. Besides, the construction work of different columns, turbo-generator, embedded parts of turbine building of Unit-1 is going on at different heights.

In case of the construction of 'Rooppur NPP' Unit-2, the concreting work of Inner containment wall up to +38.5 m height is 100% completed. The concreting work of slab of ACA floor wall is 100% completed up to +8.04 m. The concreting work of Outer Containment Wall has been completed up to +8.55 m height and the reinforcement work up to +6.04 m to +14.4 m height has been completed 100%. The reinforcement work of contour wall and adjacent structure wall up to +8.35 m and the casting work up to +8.75 m has been completed. The concreting work of outer counter wall of Reactor Auxiliary Building has been completed from -5.400 m to -0.050 m height. The casting work of Slab up to -0.50 m has been completed. The reinforcement work of Contour wall is 100% completed from -0.050 m to + 4.7 m height. The concreting work of inner column of turbine building has been completed up to +16.00 m. The concreting work of slab at a height of +4.8 m in UBA part is in progress. The Slab of Normal Operation Power Supply Building has been completed from -3.600 to -4.650 m height and its work is in progress up to -4.550 m height. The reinforcement work of grid line column of Unit water demineralization plant has been completed up to a height of +6.8 m. The concreting work of Slab has been completed up to +16.00 m. Besides, the construction work of different partition wall, peripheral wall, turbo generator slab of Unit-2 is going on.

In case of the construction work of cooling tower of 'Rooppur NPP', the concreting work of Ring Foundation of the first Cooling Tower of Unit-1 has been completed from -3.85 m to -2.35 m height. The Racker Column installation of the second Cooling Tower is in progress for Unit-1. The concreting work of 21 blocks of the first Cooling Tower of the Unit-2 has been completed from -3.95 m to-2.75m. The concreting work of Ring Foundation of Second Cooling Tower of Unit-2 has been completed 100% and the concreting work of second stage has been completed up to -3.950 m.

In the scope of the General Contract, to construct the 'Rooppur NPP', the manufacturing of Long-Term Manufacturing Equipment (LTME) and other equipment of 'Rooppur NPP' is going on in different manufacturing companies appointed by JSC Atomstroyexport. In case of Unit-1, Reactor Pressure Vessel, 4 Steam Generators, 2 Reactor Coolant Pumps and Pressurizers have already been delivered in the project area and the installation work is currently in progress. In case of Unit-2, Reactor Pressure Vessel and 2 Steam Generators have been manufactured and shipped to Bangladesh. Bubbler tank has been installed in the reactor of Unit-2. Full scope analytical simulator has been installed at the training center. Complete steam Turbine set, Condenser ball cleaning system, turbo generator, complete turbine condenser, 6 Reactor Coolant Pump and other equipment have been sent to Bangladesh. Core baffle, 2 PGB pump high pressure heater, LBJ tank, reactor Upper unit, Generator Rotor, Generator stator, Polar Equipment like crane grid has reached in Bangladesh. Inspectors of the BAEC are working in various manufacturing plants of the Russian Federation to supervise the manufacturing process of various equipment for the construction of 'Rooppur NPP'. Besides, regular monitoring is being done in related to the inspection of the equipment manufacturing plant from Bangladesh Embassy in Moscow. As per General Contract for 'Rooppur NPP' construction, the Russian side is providing training for operational and maintenance personnel of 'Rooppur NPP'.

The experts of India are providing consultancy services within the framework of the 'Rooppur NPP' project. Indian experts provided consultancy services to the construction of 'Rooppur NPP' during this period in different field such as Commissioning documentation review, quality control and nonconformance

management; Quality of Mechanical Equipment and Piping; Quality of Civil Construction and Erection Works for NPP; Cooling Tower and Water Intake Structure, Design Review and construction management; and Power output System for 'Rooppur NPP'.

Under the project "Probable site selection for construction of nuclear power plant in the southern part of Bangladesh", Center for Environmental and Geographic Information Services (CEGIS) performed desktop study based on available data and information for primarily selected 15 sites in the southern part of Bangladesh. The Technical Committee of the project recommended Acceptance/Rejection criteria for the screening of primarily selected sites in accordance with the guidelines of the International Atomic Energy Agency (IAEA), the Bangladesh Atomic Energy Regulatory Authority (BAERA), and the Department of Environment (DOE). According to the Acceptance/Rejection criteria recommended by the Technical Committee, CEGIS conducted study and a report was submitted. In the light of the analysis results of the submitted report, out of 15 sites, 5 sites namely, (1) Nishanbari (East), Taltoli Upazila, Barguna; (2) Kumirmara and Padma mouzas, Sadar Upazila, Barguna (3) Nishanbari (West), Taltoli Upazila, Barguna; (4) Char Montaz, Rangabali Upazila, Patuakhali; and (5) Moudubi, Rangabali Upazila, Patuakhali were identified as candidate site. The site specific studies were conducted for these 5 candidate sites. The Seismic and Geotechnical studies were conducted by Bangladesh University of Engineering and Technology (BUET) in the candidate sites. On the other hand, the Geological, Geophysical and Geotechnical studies were performed by Department of Disaster Science and Management, University of Dhaka, and the Hydrological and Hydrogeological studies were carried out by the Institute of Water Modeling (IWM) in the candidate sites.

A Technical Committee was formed by the BAEC for the evaluation and finalization of the submitted reports for the project. In light of the reviewer comments, reports were finalized and approved by the appropriate authorities. According to the Seismic and Tectonic studies, the Geological, Geophysical and Geotechnical studies, and the Hydrological and Hydrogeological studies of the 5 candidate sites, the Nishanbari (East), Barabagi Union, Taltoli Upazila, Barguna site was ranked as the first position among the candidate sites. The analysis of the technical aspects of the site survey reports were conducted in the meeting of the Technical Committee of the project as well as experts comments, recommendations were made to conduct further studies on 'whether the proposed sites are situated in the 'Active Delta Basin' or not'; 'the analysis of demand, transmission and distribution of generated electricity'; 'the arrangements for transportation of heavy equipment (by road or by sea)'; 'the economic survey'; 'whether the Fish Sanctuary or the Hilsha Sanctuary, the Reserved Forest, etc. situated among the initially identified sites or not'; and 'the Initial Environmental Examination (IEE) of the initially identified sites and the detailed Environmental Impact Analysis (EIA) of the finally selected site'. It is also necessary to formulate policies on 'Assessment for Siting and Site Ranking Criteria' with the assistance of BAERA, considering the context of Bangladesh. It is also recommended by the Technical Committee for the project that a new annual development project may be undertaken to carry out the mentioned studies and other necessary activities to select the preferred candidate site for the construction of a nuclear power plant in the southern part of the country.

2. Manpower Development and Training Program

Title of the event	Date	Place	No of participants
Orientation and Beginner's Training Course for Newly Recruited Officers, Construction of Rooppur Nuclear Power Plant Project	3-7 Jan. 2021	Rooppur NPP Site Office	90
Orientation and Beginner's Training Course for Newly Recruited Officers Construction of Rooppur Nuclear Power Plant Project	25-28 Jan. 2021	Rooppur NPP Site Office	84
A seminar on "Site Selection for Construction of Nuclear Power Plant in Bangladesh"	1 Feb. 2021	Auditorium, AECD	37
Orientation and Beginner's Training Course for Newly Recruited Officers, Construction of Rooppur Nuclear Power Plant Project	15-18 Feb. 2021	Rooppur NPP Site Office	29
PC Based VVER-1200 Simulator Training	28 Feb. - 4 Mar. 2021	Simulator Room, AECD	80
A seminar on "Site Selection for Construction of Nuclear Power Plant in Bangladesh"	24 Jun. 2021	Auditorium, AECD	60

3. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Md. Zahedul Hassan	Achievement of Milestones, Assessment of Progress and Readiness and quality Inspection of Equipment Manufacturing for the construction of Rooppur Nuclear Power Plant as well as Negotiation Meeting of Additional Agreement of Nuclear Fuel Supply Contract	RNPP Project	24 May- 6 Jun. 2021	Russian Federation
Md. Hasinur Rahman	Inspection of the Long Term Manufacturing Equipment (LTME) no. 29: Full Scale Simulator (FSS) for the construction of Rooppur Nuclear Power Plant	RNPP Project	15 -31 Mar. 2021	Russian Federation
Engr. Mahmud Hossain	Inspection of the Manufacturing of LTME for the construction of Rooppur Nuclear Power Plant	RNPP Project	21 May-31 Jul. 2020 01-31 Aug. 2020	Russian Federation
Dr. Mohammad Khalaquzzaman	In Inspection of the Manufacturing of LTME for the construction of RNPP Project	RNPP Project	25 Aug. 2020-22 Dec. 2020	Russian Federation
Dr. Md. Kabir Hossain	Inspection of the Long Term Manufacturing Equipment (LTME) no. 29: Full Scale Simulator (FSS) for the construction of Rooppur Nuclear Power Plant	RNPP Project	15 -31 Mar. 2021	Russian Federation
Dr. Syed Masud Rana	Inspection of the Manufacturing of LTME for the construction of Rooppur Nuclear Power Plant	RNPP Project	2 May-31 Jul. 2020 1-31 Aug. 2020	Russian Federation
Gazi Muhammad Borhan Uddin	Inspection of the Manufacturing of LTME for the construction of Rooppur Nuclear Power Plan	RNPP Project	25 May-22 Aug. 2021	Russian Federation
Mohammad Ashraful Huq	Inspection of the Manufacturing of LTME for the construction of Rooppur Nuclear Power Plant	RNPP Project	21 May-31 Jul. 2020 1-31 Aug. 2020 25 May-22 Aug. 2021	Russian Federation
Alok Kumer Saha	The 5th International Conference on Civil Structural and Transportation Engineering (ICCSTE'20)	ICCSTE' 20	12-14 Nov. 2020	Virtual Conference
	The 5th International Conference on Advances in Civil Engineering (ICACE-2020)	ICACE-2020	4-6 Mar. 2021	Chattagram Bangladesh
Mohammad Omar Faruk	Inspection of the Long Term Manufacturing Equipment (LTME) no. 29: Full Scale Simulator (FSS) for the construction of Rooppur Nuclear Power Plant	RNPP Project	15-31 Mar. 2021	Russian Federation
Md. Ruhul Amin	Inspection of the Manufacturing of LTME for the construction of RNPP Project	RNPP Project	25 Aug. 2020-22 Dec. 2020 28 Dec. 2020- 30 Jun. 2021	Russian Federation

4. Stakeholder Meeting

- A bilateral meeting between the Hon'ble Minister of Ministry of Science and Technology, and the Hon'ble President of JSC Atomstroyexport and the Deputy Director General of Rosatom, regarding the progress of "Rooppur Nuclear Power Plant Project", was held on 07th Aug. 2020 through Video Conferencing.
- The 9th meeting of the Project Implementation Committee (PIC) convened by the Chairman BAEC of the project "Rooppur Nuclear Power Plant Project" under Annual Development Programme (ADP) was held on 17th Aug. 2020 in BAEC committee room, Agargaon, Dhaka.
- The 9th meeting of the Project Steering Committee (PSC) convened by the Senior Secretary, Ministry of Science and Technology of the project "Rooppur Nuclear Power Plant Project" under Annual Development Programme (ADP) was held on 27th Aug. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Project Director for the purpose of reviewing the current works and determining the tasks in related to the progress of "Rooppur Nuclear Power Plant Project" was held on 06th Sep. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by Member Planning of Technical Working Group of the Project "Probable Site Selection for Construction of Nuclear Power Plant in the Southern Part of Bangladesh" for the evaluation Draft Final Report of Seismic and Geotechnical Study submitted by Bureau of Research, Testing and Consultation (BRTC), Bangladesh University of Engineering and Technology (BUET), was held on 15th Sep. 2020 in Alpha Conference Room, BAEC Agargaon, Dhaka.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology on the implementation progress review of the "Rooppur Nuclear Power Plant Project" until Sep., 2020 was held on 20th Sep. 2020 from the meeting room of the Ministry of Science and Technology through Video Conferencing.
- A virtual meeting on the nuclear program of Bangladesh between Project Director of the "Rooppur Nuclear Power Plant Project", with the representatives of Nuclear Infrastructure Development Section of the International Atomic Energy Agency (IAEA) was held on 23rd Sep. 2020 through Video Conferencing.
- A Joint Training Advisory Commission (JTAC) meeting of Bangladesh side convened by the Member Engineering to review 'Training Document Package TR. U0.0009' and to achieve Milestone was held on 5th Oct. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by Member Planning Member Planning of Technical Working Group of the Project "Probable Site Selection for Construction of Nuclear Power Plant in the Southern Part of Bangladesh" for the evaluation of Final Report on Surface Water Hydrology Study by Institute of Water Modelling (IWM) was held on 11th Oct. 2020 in Alpha Conference Room, BAEC Agargaon, Dhaka.
- A meeting of technical committee formed by BAEC convened by the Member Engineering to evaluate the construction and erection works performed by 10th Oct. 2020 under the General Contract of the construction of "Rooppur Nuclear Power Plant Project", was held on 12th Oct. 2020 in BAEC committee room, Agargaon, Dhaka.
- A meeting convened by the Additional Secretary (Nuclear Power), Ministry of Science and Technology in related to the details discussions of internal matters of the "National Nuclear and Radiological Emergency Preparedness and Response (NNREPR) Plan" was held on 12th Oct. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology in related to the obligations of Safe Guards related Agreement and the Additional Protocol under the State Systems of Accounting for and Control of Nuclear Material Mission (ISSAS) conducted by the IAEA was held on 13th Oct. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by Member Planning of Technical Working Group of the Project "Probable Site Selection for Construction of Nuclear Power Plant in the Southern Part of Bangladesh" for the evaluation of Final Report on Ground Water Hydrogeology by Institute of Water Modelling (IWM) was held on 13th Oct. 2020 in Alpha Conference Room, BAEC, Agargaon, Dhaka.

- A meeting convened by the Senior Secretary, Ministry of Science and Technology in related to the Working Group for the preparation of International Atomic Energy Agency (IAEA) mission to evaluate the measures taken for the safeguards in Bangladesh on nuclear materials and the activities for infrastructure of safeguards, was held on 15 Oct. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Member Engineering on Technical Review and Recommendation for Approval of package from 2020.01 to 2020.06 under the General Contract of "Rooppur Nuclear Power Plant Project" was held on 18-22 Oct. 2020 in BAEC committee room, Agargaon, Dhaka.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology in related to the International Physical Protection Advisory Service (IPPAS) mission of IAEA to review and evaluate the physical protection and nuclear security arrangements of nuclear materials, radioactive materials and installations and the overall infrastructure of the state agencies involved in these activities to ensure the peaceful use of nuclear energy in the country was held on 29th Oct. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Member Engineering to evaluate the training documents of manpower training of the training center of "Rooppur Nuclear Power Plant Project" sent by Atomstroyexport according to the Appendix-14 of General Contract, was held in 2 to 5, 8 to 9, 25 to 26, and 29 to 30 Nov. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- The 7th meeting of the technical committee for regular monitoring of the project implementation progress, the review of the project related technical issues, and providing decision on the construction of "Rooppur Nuclear Power Plant project", convened by the Hon'ble Minister of Ministry of Science and Technology was held on 5th Nov. 2020 in the meeting room of Bangabandhu Sheikh Mujibur Rahman Novo Theater, Dhaka.
- A meeting convened by the Member Engineering to discuss the construction of Electric Condensate Pubm-1,2 and Heat Liner Water Heaters of "Rooppur Nuclear Power Plant project", held on 8 Nov. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Member Physical Science to create Baseline Data of background radiation level, environmental radioactivity, chemical concentration of the environment of the area of Rooppur Nuclear Power Plant Project was held on 10 Nov. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology in related to the International Physical Protection Advisory Service (IPPAS) mission of IAEA to review and evaluate Legal framework for physical protection of nuclear and radioactive substances and nuclear installations and the overall infrastructure of the state agencies involved in these activities to ensure the peaceful use of nuclear energy in the country was held on 17 Nov. 2020 in the meeting room of the Ministry of Science and Technology.
- The meeting of the Working Group to cooperate the Emergency Preparedness Review (EPREV) Mission 2022 and Follow-up Mission of IAEA for the evaluation of the national infrastructure of the institution/ministry responsible for the prevention and remedial action taken in order to effectively deal with the impact or damage of a possible nuclear or radiological accident or incident in Bangladesh, convened by the Senior Secretary, Ministry of Science and Technology was held on 19 Nov. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Director QMD to accomplish Incoming Inspection for the achievement of the milestone of Supply Equipment (SU) (Non-LTME) of Rooppur Nuclear Power Plant Project, was held from 22 - 24 Nov. 2020 in Rooppur Project Site Office, Rooppur, Ishwardi, Pabna.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology, in related to National Coordination Committee for Safeguards Infrastructure of National Policy for Nuclear Safeguards and Management of Nuclear Material according to IAEA guidelines, was held on 25 Nov. 2020 in the meeting room of the Ministry of Science and Technology.

- A meeting convened by the by the Member Engineering for the opinion and recommendation in related to (1) Additional Agreement (Specification of Equipment and Delivery Schedule in 2019-Part-7), (2) Additional Agreement (Specification of Equipment and Delivery Schedule in 2020-Part-6), and (3) Additional Agreement (Specification of Equipment and Delivery Schedule in 2021-Part-2) was held on 2 Dec. 2020 through Video Conferencing.
- A Joint Training Advisory Commission (JTAC) meeting of Bangladesh side convened by the Member Engineering to review 'Training Document Package TR. U0.0010' and to achieve Milestone was held on 3rd Dec., 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Member Engineering bilateral and technical discussion for Design Information Verification (DIV) and Inspection at BDB and BDA (Facilities Code), on the occasion of Inspection of IAEA Safeguards Team was held from7 to 8 Dec. 2020 in Rooppur Project Site Office, Rooppur, Ishwardi, Pabna.
- A meeting convened by the Member Engineering for discussion to achieve Milestones for sent Documentation Package No. 2020.10, 2020.11, 2020.12 and 2020.12 of the Construction of "Rooppur Nuclear Power Plant Project" was held on 9 Dec. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- The 10th meeting of the Project Implementation Committee (PIC) convened by the Chairman BAEC of the project "Rooppur Nuclear Power Plant Project" under Annual Development Programme (ADP) was held on 10 Dec. 2020 in BAEC committee room, Agargaon, Dhaka.
- A Joint Training Advisory Commission (JTAC) meeting of Bangladesh side convened by the Member Engineering to review 'Training Document Package TR. U0.0011' and to achieve Milestone was held on 10th Dec., 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Member Engineering on Technical Review and Recommendation for Approval of Working Document and Work Execution Plan for packages 2020.07, 2020.08, and 2020.09 under the General Contract of Rooppur Nuclear Power Plant Project was held on 10-15 Dec. (except holidays), 2020 in BAEC committee room, Agargaon, Dhaka.
- A joint meeting of the Joint Training Advisory Commission (JTAC) between Bangladesh and the Russian Federation convened by the Member Engineering for the quality and successful implementation of manpower training under Appendix 14 of General Contract, was held from 12th to 17th Dec. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology for the discussion on Evaluation of Manufacturing Process of Turbine Hall Pipelines and Turbine Hall Pipelines Manufacturing Plant of "Rooppur Nuclear Power Plant Project" was held on 13th Dec. 2020 through Video Conferencing.
- The 10th meeting of the Project Steering Committee (PSC) convened by the by the Senior Secretary, Ministry of Science and Technology of the project "Rooppur Nuclear Power Plant Project" was held on 14th Dec., 2020 through Video Conferencing.
- A joint meeting of the Joint Training Advisory Commission (JTAC) between Bangladesh and the Russian Federation convened by the Member Engineering to review Training Document Package TR. U0.0013 and to achieve Milestone, was held on 19th Dec. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Member Engineering for post discussion for Design Information Verification (DIV) related Safeguards Inspection by IAEA Safeguards Inspector was held on 23rd Dec. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by the Member Physical Science to finalize the draft 'Communication Plan-2021' for public awareness of the "Rooppur Nuclear Power Plant Project" was held from 23rd to 24th Dec. 2020 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- A meeting convened by Member Planning of Technical Working Group of the Project "Probable Site Selection for Construction of Nuclear Power Plant in the Southern Part of Bangladesh" for the evaluation of Final Report of Geological and Geophysical Study submitted by Department of Disaster Science and

Management, University of Dhaka was held on 10th -11th Jan. 2021 in Alpha Conference Room, BAEC Agargaon, Dhaka.

- A meeting convened by the Senior Secretary, Ministry of Science and Technology in related to National Coordination Committee of The International Physical Protection Advisory Service (IPPAS), conducted by IAEA was held on 12th Jan. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology to formulate opinions and recommendation in related to National Coordination Committee of Safeguards Infrastructure under the State Systems of Accounting for and Control of Nuclear Material Mission (ISSAS) conducted by the IAEA was held on 12th Jan. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Member Physical Science to finalize the draft Memorandum of Understanding between NESCO Limited and Bangladesh Atomic Energy Commission for the operation and maintenance works of 33/11 kV GIS substation of Green City.
- The 1st meeting of Working Group to cooperate the Integrated Regulatory Review Service (IRRS) Mission of IAEA for overall review and evaluation of existing legal and regulatory infrastructure issues in accordance with safety standards to ensure the safety and peaceful use of nuclear energy in Bangladesh, convened by the Senior Secretary, Ministry of Science and Technology was held on 20 Jan. 2020 in the meeting room of the Ministry of Science and Technology.
- The 2nd meeting of Working Group to cooperate the Emergency Preparedness Review (EPREV) Mission of IAEA for the evaluation of the prevention and remedial action taken in order to effectively deal with the impact or damage of a possible nuclear or radiological accident or incident in Bangladesh, convened by the Senior Secretary, Ministry of Science and Technology was held on 20 Jan. 2020 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Member Physical Science on Technical Review and Recommendation for Approval of Working Document and Work Execution Plan for packages 2020.10, 2020.11, and 2020.12 under the General Contract of "Rooppur Nuclear Power Plant Project" was held from 20th to 28th Jan. 2021 in BAEC committee room, Agargaon, Dhaka.
- A meeting convened by the Director QMD for auditing in Sonargaon Steel Fabricate Ltd. and discuss with sub-contractor of JSC ASE was held from 24th to 26th Jan. 2021 in Dhaka.
- A meeting convened by the Director IAD to finalize amendment proposal of the Integrated Work Plan (IWP) was held on 2nd Feb., 2021 in BAEC committee room, Agargaon, Dhaka.
- A meeting convened by Member Planning of Technical Working Group of the "Probable Site Selection for Construction of Nuclear Power Plant in the Southern Part of Bangladesh" for the evaluation of Final Report of Seismic and Geotechnical Study submitted by Bureau of Research, Testing and Consultation (BRTC), Bangladesh University of Engineering and Technology (BUET) was held on 27th Jan. 2021 in Alpha Conference Room, BAEC Agargaon, Dhaka.
- A meeting convened by the Member Physical Science in related to the Financial and Technical proposals of BAEC laboratories to create Baseline Data of background radiation level, environmental radioactivity, chemical concentration of the environment of the area of "Rooppur Nuclear Power Plant Project" was held on 3rd Feb. 2021 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- The 8th meeting of the Technical Committee for regular monitoring of the project implementation progress, the review of the project related technical issues, and providing decision on the construction of "Rooppur Nuclear Power Plant Project", convened by the Hon'ble Minister of Ministry of Science and Technology was held on 4th Feb., 2021 in the meeting room of the Ministry of Science and Technology.
- The 2nd meeting convened by the Senior Secretary, Ministry of Science and Technology in related to National Coordination Committee of the International Physical Protection Advisory Service (IPPAS), conducted by IAEA was held on 17th Feb. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology to formulate opinions and recommendation in related National Coordination Committee for Safeguards Infrastructure under the

State Systems of Accounting for and Control of Nuclear Material Mission (ISSAS) conducted by the IAEA was held on 24th Feb. 2021 in the meeting room of the Ministry of Science and Technology.

- The 11th meeting of the Project Implementation Committee (PIC) convened by the Chairman BAEC of the project "Rooppur Nuclear Power Plant Project" under Annual Development Programme (ADP) was held on 10th Mar. 2021 in BAEC committee room, Agargaon, Dhaka.
- The 11th meeting of the Project Steering Committee (PSC) convened by the Senior Secretary, Ministry of Science and Technology and coordinated by Project Director of the project "Rooppur Nuclear Power Plant Project" was held on 14th Mar. 2020 in the meeting room of the Ministry of Science and Technology.
- The 15th meeting convened by the Principal Secretary to the Hon'ble Prime Minister on Fast Track Project Monitoring Task Force, was held on 13th Apr. 2021 through Video Conferencing from the office of the Hon'ble Prime Minister
- A meeting convened by the by the Member Physical Science to finalize the Computer Based Training System (CBTS) module for the training center sent by Atomstroyexport under Appendix 14 of General Contract, was held from 10th to 11th May 2021 in Rooppur NPP Bhaban, 4 Kazi Nazrul Islam Avenue, Shahbagh, Dhaka.
- The 12th meeting of the Project Implementation Committee (PIC) convened by the Chairman BAEC of the project "Rooppur Nuclear Power Plant Project" under Annual Development Programme (ADP) was held on 31st May 2021 in BAEC committee room, Agargaon, Dhaka.
- Meetings of the National Coordinating Committee of the four missions of the IAEA (ISSAS, IPPAS, EPREV IRRS), to review the overall progress in the light of the decisions taken earlier to address these missions, convened by the Senior Secretary, Ministry of Science and Technology were held at different times on 13 Jun. 2021 from the meeting room of the Ministry of Science and Technology through Video Conferencing.
- The 3rd meeting convened by the Senior Secretary, Ministry of Science and Technology in related to National Coordination Committee of the international physical protection advisory service (IPPAS), conducted by IAEA was held on was held on 16th Jun. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting of Working Group for cooperation and preparatory activities in related to the Integrated Regulatory Review Service (IRRS) Mission of IAEA for overall review and evaluation of existing legal and regulatory infrastructure issues in accordance with safety standards to ensure the safety and peaceful use of nuclear energy in Bangladesh, convened by the Senior Secretary, Ministry of Science and Technology was held on 16th Jun. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting of Working Group for cooperation and preparatory activities in related to the Emergency Prepardness Review (EPREV) Mission of IAEA in Bangladesh, convened by the Senior Secretary, Ministry of Science and Technology was held on 17th Jun. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting convened by the Senior Secretary, Ministry of Science and Technology in related to National Coordination Committee for Safeguards Infrastructure under the State Systems of Accounting for and Control of Nuclear Material Mission (ISSAS) conducted by the IAEA was held on 17th Jun. 2021 in the meeting room of the Ministry of Science and Technology.
- A meeting convened the Senior Secretary, Ministry of Science and Technology in related to the prevention and remedial action taken in order to effectively deal with the impact or damage of a possible nuclear or radiological accident or incident in Bangladesh, to measure baseline data of background radiation level, environmental radioactivity, chemical concentration of the environment of the area of "Rooppur Nuclear Power Plant Project" was held on 22 Jun. 2021 in the meeting room of the Ministry of Science and Technology.

VI. NUCLEAR SAFETY, SECURITY AND SAFEGUARDS DIVISION (NSSSD), BAEC HQ

Objective/Introduction

- To fulfill the obligations under International Treaties, Agreements, Protocols and Conventions related to Nuclear Safety and Radiological Emergencies including Safeguards and Physical Protection of nuclear and radioactive materialshaving in the BAEC.
- To maintain safeguards procedures of the State Systems of Accounting for and Control of Nuclear Material (SSAC).
- To ensure the physical protection of nuclear material and radioactive sources and associated installations of BAEC.
- On behalf of BAEC, this Division has been acting as the focal point of different well-known strategic partner namely International Atomic Energy Agency (IAEA), U.S. Department of Energy (U.S. DOE), Japan Atomic Energy Agency (JAEA), Forum for Nuclear Cooperation in Asia (FNCA) and Asia-Pacific Safeguards Network (APSN) for the issues of nuclear safeguards, safety, security and physical protection of radioactive materials and associated facilities.

Activities

1. Manpower Development and Training Program

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Md. Shakilur Rahman	Workshop on Developing and Improving the Safety Culture for the Development of a National Nuclear Power Programme	IAEA and BAERA	14-17 Jun. 2021	Dhaka, Bangladesh
Dr. Md. Shakilur Rahman	Webinar Series to Strengthen the Implementation of UN Security Council Resolution 1540 (2004) in South Asia and Mongolia	UNRegional Centre for Peace and Disarmament in Asia and the Pacific	1, 8 and 15 Dec. 2020	Online Event
Dr. Abid Imtiaz	FNCA 2020 Online Workshop on Nuclear Security and Safeguards Project	PNRI and MEXT	19 Feb. 2021	Online Event
H. M. Borhanul Alam	Briefing Session on Nuclear Materials, Nuclear Facilities, Nuclear Safety and Security in Bangladesh	NBR	31 Dec 2020	Dhaka, Bangladesh
H. M. Borhanul Alam	Online Regional Training Course on Additional Protocol Commodity Identification	ISCN, JAEA	9-10 Feb. 2021	Online Event
H. M. Borhanul Alam	FNCA 2020 Online Workshop on Nuclear Security and Safeguards Project	PNRI and MEXT	19 Feb. 2021	Online Event
H. M. Borhanul Alam	Workshop on Developing and Improving the Safety Culture for the Development of a National Nuclear Power Programme	IAEA and BAERA	14-17 Jun. 2021	Dhaka, Bangladesh

2. Collaboration Work(s)

- NSSS Division has been working as the national focal point for Bangladesh's Integrated Nuclear Security Support Plan (INSSP).
- This Division has been continuing research on 'Factors that Influence Culture for Safety, Organizational Culture and Human Performance at Nuclear and Other Facilities in Bangladesh' under the IAEA Coordinated Research Project (code no. I22004), Organizational Culture Basis for Successful Performance in Nuclear Power Plants. A conceptual model of organizational and human factors was developed as they interact with the national cultural dimensions of Bangladesh based upon the work of Hofstede. In order to

capture these factors and collect data, survey has been going on to validate the model against the IAEA framework of safety culture.

- This Division has been continuing participation in the 'Nuclear Security and Safeguards Project' under the cooperation activities of FNCA. Bangladesh participated in the 10th Online Workshop on this Project held 19 Feb., 2021.
- Supervision of security enhancement activities at the nuclear and radiological facilities of AERE and in parallel to the governmental and private hospitals of the country having radiotherapy machines consisting of radioactive sources and concealed radioactive materials therein under the Basic Ordering Contract (BOC) No. 11968-AD8, Rev. 1 between BAEC and Battelle Memorial Institute (BMI) of U.S. Department of Energy.

VII. PLANNING AND DEVELOPMENT DIVISION (PDD), BAEC HQ

As a premier research organization of the country, Bangladesh Atomic Energy Commission (BAEC) has been engaged in research and development activities in different disciplines of nuclear science and technology. BAEC contributes to socio-economic development of Bangladesh through peaceful applications of atomic energy. In according to National Science and Technology Policy, BAEC is giving continuous effort for upgrading and extension of different laboratories as well as for human resources development through Annual Development Projects.

In its continuation, 12 (Twelve) projects of Bangladesh Atomic Energy Commission (BAEC) were incorporated in the Annual Development Program (RADP) of 2020-2021.

Activities

The total RADP allocation of the year 2020-2021 for implementation of ongoing projects of BAEC was Tk. 1036607.50 Lakh. Out of this granted allocation, Tk. 1017086.30 Lakh had been spent up to 30 Jun., 2020 making an implementation rate of 98.12%. BAEC has proposed 12 (Twelve) new projects to the concerned Ministry for the year 2020-2021. The entire picture on the advancement of all the development projects are shown in Table-1.

1. Advancement of the Development Project of BAEC under RADP

(Taka in lac)

Sl. No	Name of the project, project implementation period	Estimated cost total (F.E)	Cumulative expen. upto Jun. 2020 (F.E)	Revised allocation for the year 2020-2021 (F.E)	Expenditure during 1st Jul. 2020 to 30th Jun. 2021	% of expen. against allocation upto 30th Jun. 2021	Achievement of the projects
	On-Going Projects						
1.	Construction of Rooppur Nuclear Power Plant, Apr. 2016 - Dec. 2025	11309291.28 10120000.00	3174085.17 2333582.12	1016678.00 179200.00	998801.88 179200.00	98.24% 99.85%	On going
2.	Development of Human Resources and Establishment of Residential Accommodation Facilities for the Radiation Testing and Monitoring Laboratory, Mongla, Apr. 2017 - Jun. 2021	1825.00 0.00	1373.50 0.00	403.00 0.00	402.77 0.00	99.94% 100%	Completed Jun. 2021
3.	Enhance Capacity of Institute of Nuclear Medicine and Allied Sciences (INMAS) at Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Dinajpur and Rangpur, Jul. 2017 - Jun. 2021	21303.00 12142.00	16965.00 10890.00	3290.00 992.00	3290.00 992.00	100% 100%	Completed Jun. 2021
4.	Sitting for Nuclear Power Plant in the Southern Part of Bangladesh. Jul. 2017 - Jun. 2021	977.34 0.00	692.92 0.00	216.00 0.00	215.00 0.00	95.00% 99.54%	Completed Jun. 2021

Sl. No	Name of the project, project implementation period	Estimated cost total (F.E)	Cumulative expen. upto Jun. 2020 (F.E)	Revised allocation for the year 2020-2021 (F.E)	Expenditure during 1st Jul. 2020 to 30th Jun. 2021	% of expen. against allocation upto 30th Jun. 2021	Achievement of the projects
5.	Establishment of Institute of Nuclear Medicine and Allied Sciences (INMAS) at 8 Medical Collage Hospital Campuses in the country, Jul. 2017 - Jun. 2023	62228.80 19520.00	9312.95 0	7600.00 0	6100.00 0	80.26 95.00%	On going
6.	Establishment of Calibration and Quality Control Facilities for Radiotherapy, Diagnostic Radiology and Neutron, Jul. 2018 - Jun. 202	4679.15 2810.60	1542.50 884.00	870.00 390.00	870.00 390.00	92.59% 100%	On going
7.	Technical Survery Project for High Power Nuclear Research Reactor in Bangladesh, Jul. 2018 - Jun. 2021	822.58 0	267.01 0	156.50 0	156.50 0	100% 100%	Completed Jun. 2021
8.	Establishment of Cyclotron and PET-CT at Institute of Nuclear Medicine and Allied Sciences (INMAS) Mymensingh and Chattogram and Cyclotron facilities at Institute of Nuclear Medical Physics (INMP), Savar, Jul. 2018 - Jun. 2022	67300.00 3237.00	2677.25 365.00	5457.00 0	5457.00 0	100% 100%	On going
9.	Improvement and modernization of the laboratory Facilities of Institute of Electronics, Jul. 2018 - Dec. 2021	3553.70 2156.00	781.88 486.83	308.00 90.00	232.10 90.00	75.36% 100%	On going
10.	Balancing, Modernization, Refurbishment and Extension (BMRE) of Safety Systems of the 3 MW TRIGA Mark-II Research Reactor Facility at AERE, Savar, Dhaka, Jul. 2018 - Jun. 2021	8543.58 4180.14	905.32 0	613.00 0	613.00 0	100% 100%	On going
11.	Screening of Congenital Hypothyroidism in Newborn Babies (Phase-2), Jul. 2018 - Jun. 2021	4770.16 1200.00	2993.51 910.00	1000.00 40.00	996.50 40.00	99.65% 100%	On going
12.	Strengthening of existing gamma source of Bangladesh Atomic Energy Commission, Jan. 2021 - Jun. 2023	4670.00 4215.00	0 0	16.00 0	16.00 0	100% 100%	On going
Total		11490141.76 1093660.58	3211597.31	1036607.50 180712.00	1017086.30 180712.00	98.11% 99.84%	-

2. Advancement of the Development Project (Approved and unapproved) of BAEC under ADP

Sl. No	Name of the project, approval status and implementation period	Approval status	Estimated cost Total	Proposed ADP for the year of 2020-2021	Remarks
Proposed new-project					
1.	Enhance Capacity of Institute of Nuclear Medicine and Allied Sciences (INMAS) at Mitford, Cumilla, Faridpur, Barishal and Bogura Jul. 2021 - Jun. 2024	Unapproved	15300.00 8700.00	0	Under processing for approval of planning commission
2.	Modernization of Laboratories and Enhancement of Service Capacity of 3 Divisions (Chemistry Division, Health Physics Division, Experimental Physics Division) of Atomic Energy Centre, Dhaka. Jul. 2021 - Jun. 2024	Unapproved	4989.00 3438.00	0	Waiting for approval from the Planning Commission.

Sl. No	Name of the project, approval status and implementation period	Approval status	Estimated cost Total	Proposed ADP for the year of 2020-2021	Remarks
3.	Modernization and expansion of services and research facilities of the Institute of Tissue Banking and Biomaterial Research	Unapproved	17,380.14 1,995.00	0	Waiting for approval from the Planning Commission.

VIII. QUALITY MANAGEMENT DIVISION (QMD), BAEC HQ

Introduction

In this fiscal year Quality Management Division (QMD)continued its active participation in the activities of RNPP Construction Project.Moreover, the Scientists of this Division were also involvedin some other tasks like updating "Service Profile Booklet", updating "BAEC Service Regulations" in light of Bangladesh Atomic Energy Commission Act, 2017, finalizing criteria on "warding Medals to Scientists of BAECin 9 Categoriesin order to encourage them in Scientific Research on the Occasion of Celebrating Birth Centenary of Father of the Nation Bangabandhu Sheikh Mujibur Rahman", updating draft of quality procedure, preparing research paper on IMS in BAEC, updating SafetyAnalysis Report (Quality Assurance part) of TRIGA Mark II Research Reactor, updating Zilla Quota for BAEC employees under 14-20 Grades, forming Bio-data Evaluation Committees under approved procedure, preparing combined seniority list under different recruitments, performing duties as other different Committee Members and some other tasks in relation to Innovation team, best practice list updating, comments on drafts of different acts and policies etc.

Activities

1. RNPP Construction Project Related Activities

- Performed duties as Incoming Control Inspection Team Member at Rooppur Nuclear Power Plant (RNPP) Construction Site for Long Term Manufacturing Equipment (LTME)and Non-LTME [(Supply Equipment (SU)]. In this fiscal year several Incoming Control Inspections at the site were carried out.
- Performed duties as Member of the Joint Training Advisory Commission (JTAC) for conducting Training Program of Rooppur NPP Operating Personnel under Appendix 14 of General Contract.
- Performed duties as Technical Committee Member for the Evaluation of Construction and Erection Works of Rooppur NPP.
- Performed duties as Committee Member to review the Health, Safety and Environment related activities linked with Rooppur NPP Implementation.
- Performed duties as Member of the Entry Level Test conduct committee for the training of Rooppur NPP Operating Personnel in Russian Federation.
- Performed duties as Member of the committee formed to conduct knowledge assessment under qualification maintenance of the trainees who have returned after the completion of their training in Russian Federation as per Appendix-14 under General Contract.
- Performed duties as Convener of the committee formed to visit, inspect and audit sub-contractor organizations namely Bangladesh Building Systems Ltd. (BBSL) and Sonargaon Steel Fabricate Limited appointed by General Contractor JSC ASE to review, scrutinize and analyze their previous experience, technical experience of manufacture, technological amenities, inspection and test plan, monitoring and QA of production, scrap management, work execution plan for manufacturing of steel structure etc.
- Performed duties as Convener of the committee formed to visit, inspect and audit sub-contractor organization namely Energypac Engineering Ltd. (EEL) appointed by NIKIM Atomtsroy a sub-contractor organization of the General Contractor JSC ASE to review, scrutinize and analyze their previous

experience, technical experience of manufacture, technological amenities, inspection and test plan, QA programme and QMS, work execution plan etc.

- Actively involved in reviewing training documents as per Appendix-14 under General Contract.
- Actively involved in reviewing RNPP Construction Project related documents.
- Participated in several Milestone Achievement associated meetings.
- Participated in several Equipment Specification related meetings.
- Performed duties as Member of the committee formed to examine and supervise installation and pre-commissioning activities of Long Term Manufacturing Equipment (LTME) [Full Scale Simulator-(FSS) and Analytical Simulator (AS)].
- Performed duties as Member of the committee formed in relation to LTME supply and Documentation package.

2. Performing duties as other different Committee Member

- Performed duties as Member of the Editorial Board of the BAEC Journal of Nuclear Science and Applications.
- Performed duties as Member of Departmental Promotion Committee-3 of BAEC.
- Performed duties as Topical Group Leader of Safety Assessment for Asian Nuclear Safety Network (ANSN).
- Performed duties as National Project Team (NPT) Member for IAEA Non-RCA Project RAS0080.
- Performed duties as Member of the Review Committee for the new Annual Development Project before submitting to the Ministry.
- Performed duties as Member of the Evaluation Committee 1.

3. Other Activities

- Forming Bio-data Evaluation Committees 1, 2, 3, 4, 5, 6 as per Procedure for forming Committees for Evaluating Bio-Data of Officers and Staff (BAEC/SOP-017)
- QMD Scientists were actively engaged in updating Safety Analysis Report (Quality Assurance part) of TRIGA Mark II Research Reactor.
- Preparing Combined Seniority List under different recruitments
- Updating Zilla Quota for BAEC employees under 14-20 Grades
- Best Practice updating
- Updating BAEC Service Regulations in light of Bangladesh Atomic Energy Commission Act, 2017.
- Updaing “Service Profile Booklet” of BAEC
- Finalizing criteria on “AwardingMedals to Scientists of BAECin 9 Categoriesin order to encourage them in Scientific Research on the Occasionof Celebrating Birth Centenary of Father of the Nation Bangabandhu Sheikh Mujibur Rahman”
- Comments on drafts of different Acts anf Policies for Institutions other than BAEC
- QMD Scientist delivered duties as the member of some important committees/team like, innovation team, committee for sorting out applications for appointment, etc.
- QMD personnel delivered duties as the members of some other committees.

4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Md. Quamrul Huda	TN-BGD 1013-2005250-Virtual training on fundamentals of boiling two phases flow and its measurement.	IAEA	8-9 Dec. 2020	Virtual

Name of the participant	Title of the event	Organizer	Date	Place
	Inspection of the Long Term Manufacturing Equipment (LTME) no. 29: Full Scale Simulator-(FSS) for the construction of Rooppur Nuclear Power Plant.	BAEC	15-31 Mar. 2021	Russian Federation

IX. SCIENTIFIC INFORMATION DIVISION (SID), BAEC HQ

Introduction

Scientific Information Division plays the key role to collect, select, process and provide information to a wide range of stakeholders concerned with the R & D activities of BAEC. In addition, SID acts as an liaison between BAEC and the government on one hand and public, press etc on the other hand.

Activities

- Compilation, Editing and Publication of Scientific Journals, Periodicals reports, Annual Reports, Popular scientific articles, Brochure, Proceedings, Souvenir, leaflet, etc. related to R & D works of BAEC.
- Collection, selection, processing for storage and dissemination of information in the field of scientific research and technological development of all branches of sciences with particular emphasis to the nuclear technology research and development.
- Maintaining liaison with the News media, TV, Radio, etc. to disseminate news of scientific programs, symposia, conference, seminar, workshop, training etc. under R & D and service activities of BAEC.
- Updating information/documents in the website.
- Selection, acquisition and distribution of Books, Journals, Magazines, Annual report, Scientific News Letter and other scientific documents.
- Processing nomination of BAEC scientists to attend various National Seminar, Symposium, Conference, Workshop etc.
- Processing nomination of BAEC Scientists for award at home and abroad.
- Preparing reports and providing information for the National Assembly/Ministry of Science and Technology and other relevant government authorities relating to BACE activities.
- Publishing tender/notification/press release of BAEC in the daily newspapers.
- Taking and displaying of photographs in different occasions of BAEC and documentation of printed photographs for further use etc.
- Compilation, Editing and Publication of diary/telephone index/guide books, booklets, yearly calendar, etc.
- Collection and upgrade the abstract of published scientific papers in BAEC website www.baec.gov.bd.

The Key Responsibilities

Description of work	Quantity	Remarks
Publishing BAEC Annual Report 2019- 2020	300	Published, distributed and uploaded to the BAEC website *www.baec.gov.bd*
Arranging/Attending science fair/digital fair	2	Successfully completed
Publishing BAEC Diary 2021	1100	Published and distributed
Publishing telephone directory 2021 in Bangla	640	Published and distributed
Publishing Tender/Advertisement etc. to the newspaper	45	Published in the 110 daily newspapers
Newspaper clipping	240	Successfully completed
Press release on training, workshop conducted by BAEC and other BAEC programmes	1	Published in the daily newspapers

Description of work	Quantity	Remarks
Photographic service (processed, printed and supplied)	1500	Distributed to the relevant divisions, organizations, etc.
Processed nominations of BAEC scientists to attend various scientific/technical/workshop/ seminar etc. arranged locally by different academic/professional institutes	55	Nomination letters were distributed to the relevant participants
Provide National Parliamentary questions and answers	1	Successfully completed
Provide Parliamentary Committee Report	5	Successfully completed
Provide BAEC information for Preparation of Ministry Annual Report	3	Successfully completed
Preparation of annual performance agreement 2019-2020 between BAEC and MOST and Different Inst./Centre/ Unit with BAEC	48	Successfully completed
Preparing APA reports of BAEC	18	Successfully completed
Providing input for different bilateral contract/MoU/ international conference/meeting	2	Successfully completed
Preparing and providing opinions on the issues, acts, laws, etc.	25	Successfully completed
Preparing and providing monthly report to MOST	12	Successfully completed
Preparing and providing Election manifesto report to MOST	12	Successfully completed
Preparing and providing National Integrity Strategy (NIS) Report	5	Successfully completed
APA Report uploaded to APAMS of Cabinet Division	5	Successfully completed
Printing BAEC Annual Calendar 2020	2500	Successfully completed
Inhouse training	50 hours	Successfully completed
Uploaded different programs/video photographs in BAEC facebook	32	Successfully uploaded

X. HUMAN RESOURCES DIVISION (HRD), BAEC HQ

Objective/Introduction

The Human Resource Management approach remains integrated to the organization's core strategy and vision. It seeks to optimize the use of human resources for the fulfillment of organizational goals. This strategic and philosophical context of Human Resources Development and Management makes it more purposeful, relevant, and more effective compared to the traditional Establishment approach. With this view, the Human Resources Division (HRD) is launched in BAEC. The HRD Division is working directly under the Chairman and bears the prime responsibility for the enhancement of skills and management of human resources of BAEC. The HD Division is aiming at continuation its activities in full fledges even in COVID-19 Pandemic situation.

Activities/Program(s)

1. Research and Development Work(s)

Being a Research Reactor (RR) utilization expert (NAA), the Director HRD is also engaged in R and D activities using the 3 MW TRIGA Mark-II RR and mentoring the Neutron Activation Analysis Group of INST, AERE, Savar.

2. Academic Activities

Working under the program of academic collaboration with different Departments of various Universities through the supervision of Ph. D., M. Phil. and M. Sc. students.

3. Manpower Development and Training Program

Notices were circulated requesting nominations of candidates and necessary actions were taken to select the candidates for the following national training program.

- Organized day long Innovation workshop on 9th Nov., 2020 with 19 participants from different institutes of BAEC.
- Organized two days Training Workshop on Innovation on 11-12 Mar. 2021 with 18 participants from different institutes of BAEC in cooperation with the a2i.
- Convener of the Notional Seniority Committee of BAEC Officers.
- Nomination procedure of BAEC employees to attend various training program conduct by different organizations e.g. BIAM, NAPD, RPATC, EIB etc. are being handled by the Human Resources Division of BAEC.

4. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the Participant	Title of the event	Organizer	Date	Place
Dr. Syed Mohammod Hossain	International e-Conference on Physics 2021	Bangladesh Physical Society, Frontier of Physiscs USA and Dhaka University	5-7 Feb. 2021	Webnair
	8th Meeting of the RCA Mid-term Strategy Coordination Working Group	IAEA, RCA	4 - 5 Feb. 2021	Webnair
	Mid-Term Project Meeting; ME-RAS0080-1907637	IAEA	29-30 Oct. 2020	Virtual Meeting

5. Collaboratio Work(s)

5.1 Collaboration to Arranged Memorandum of Understanding (MoU) between BAEC and CUET (Chittagong University of Engineering and Technology) dated on 21 Dec. 2020 .

5.2 Ccollaborative work(s) with international bodies

- Worked as a member of IAEA RCA Mid Term Strategy Coordination Group.
- Worked as the NPC of the Project RAS-0080.
- Worked as the ANPC of the Project RAS-0079.
- Work with JAEA Steering Committee as a BAEC representative.

5.3 Collaboration to the ADP projects

Worked with several ADP projects as the Convener of TEC, Official Cost Estimate, TOC, etc. Committees.

6. BAEC Mitigated

- দক্ষ জনবল গড়ে তোলার লক্ষ্যে বাপশক এর বিভিন্ন কেন্দ্র/প্রতিষ্ঠান/ইউনিট/বিভাগে কর্মরত কর্মকর্তা/কর্মচারীবৃন্দের মাঝে বিভিন্ন সময়ে ২০টি মনোনয়ন আহবান।
- বাপশক এর বিভিন্ন সভা/কার্যক্রমের ৪ টি প্রতিবেদন তৈরী।
- বাপশক এর বিভিন্ন কার্যক্রম বাস্তবায়ন।
- ইনোভেশন কর্মপরিকল্পনা ২০১৯-২০২০ প্রণয়ন, বাপশক তথ্য বাতায়নে প্রকাশ, ইনোভেশন সংক্রান্ত প্রশিক্ষণ আয়োজন, কর্মপরিকল্পনা বাস্তবায়ন ও বাস্তবায়নের লক্ষ্যে প্রাক্কলন তৈরী এবং প্রশাসনিক অনুমোদন।
- সমঝোতা স্বাক্ষর সংক্রান্ত কার্যক্রম পরিচালনা।

- অনলাইনে প্রশিক্ষণ আয়োজন।
- বাপশক তথ্য বাতায়নে উদ্ভাবন কার্যক্রম সংক্রান্ত সেবা বক্স অন্তর্ভুক্তকরণ।

7. Others

- Working as the Innovation Officer of BAEC. Give logistic supports to the BAEC related to human resources development, management and other relevant activities under both revenue and projects.
- Got appointment and worked as External Examiner for PhD in Chemical Engineering Candidate of University Brunei Darussalam, Brunei.
- Worked as a Member of the Syllabus Formation Committee in M. Sc., Dept. of Nuclear Engineering, University of Dhaka.
- Worked as a member of Editorial Board of BAEC Journal Nuclear Science and Applications.
- Review papers for the following Journals: Radiochimica Acta, Dhaka University Journal of Applied Science and Engineering (DUJASE), Nuclear Science and Applications.
- Worked as an Innovation Officer of BAEC.

XI. SCIENTIFIC INFORMATION UNIT (SIU), AERE

Objectives

The main responsibilities of the Scientific Information Unit (SIU) are to furnish documentation of the scientific achievements attained in different Institutes/Units of the Atomic Energy Research Establishment (AERE) and to collect and preserve scientific documents to be used primarily by the scientists of AERE conducting research and development (R & D) activities in nuclear science and technology. Another important involvement of the Unit is to extend required co-operation and coordination in documenting (both electronic and traditional) seminars/symposiums/workshops etc. held in AERE. In the domain of public relation the Unit gets involved in attending the official delegates both from home and abroad, and visitors and guests of AERE.

Activities

1. **Publication of AERE Technical Report (Vol. 25):** The major documentation activity within the reporting period involves publication of the AERE Technical Report, vol. 25 by the SIU. The report covers the activities and achievements of AERE in 2019. The Unit has published a number of internal reports of different institutes/units of AERE.
2. **Acquisition of Books and Journals:** In the period under report, the Unit collected 32 books of different titles to be used by the scientists/researchers of AERE.
3. **Co-operation in Seminars/Symposia/Workshops held in AERE:** The Unit extended technical co-operation (photography) in documenting the seminars/symposia/workshops held in AERE.
4. **Attendance to Delegates/Visitors:** For Covid-19 pandemic situation the Unit has no arranged the visit programs.
5. **E-journal Service:** The Unit has been serving e-journals with the help of HINARI/AGORA/OARE from 2008. Users can download required articles from scientific books and journals from different publishers which are available in the internet.
6. **Database Service:** The Unit provides on-line database and e-catalogue searching facilities.
7. **Fax service:** Fax services are available at the Unit with the modern fax machine for receiving and sending official documents to and from AERE.
8. **Current Awareness Service (CAS) and Selective Dissemination Service (SDS):** Books/journal's etc. are listed on the basis of recent collections to inform the scientists and researchers at AERE.
9. **News Clipping Compilation and Preservation:** News concerning Bangladesh Atomic Energy Commission (BAEC), Rooppur NPP project and in general nuclear science and technology published in

daily newspapers are clipped to the Notice Boards of different institutes/units of AERE for dissemination and awareness of scientists of AERE.

10. Routine Services

The routine services rendered during the period under report includes (i) photography and documentation service in different national day ceremonies/programmes (ii) photographic service to the officials/employees of AERE for official purpose and (iii) reprography service etc.

XII. TRAINING INSTITUTE (TI), AERE

Introduction

The Training Institute (TI) of Bangladesh Atomic Energy Commission (BAEC) is situated in Atomic Energy Research Establishment (AERE) campus, Ganakbari, Ashulia, Savar, Dhaka. It is a four storied building complex having total floor area of 36,395 sq. ft. The ground floor is used for the sitting accommodation of the Director, Course Coordinator, Experts, Scientists and Administrative staffs. The other floors and rooms are used for the accommodation of trainees and trainers during training period. It has been built for the Human Resource Development (HRD) for BAEC as well as for the country. The country's first Nuclear Power Plant (NPP) of Bangladesh is going to be established soon at Rooppur, Pabna. A good number of efficient manpower in different fields will be required in that plant. Considering all these necessities TI is conducting different kinds of training programs round the year as per the approval of BAEC.

Activities

1. Manpower Development and Training Program

Title of the Event	Date	Place	No. of participants
Training Course on Public Procurement Regulation-2008 (PPR-2008)	11-22 Oct. 2020	TI	24
FTC on Nuclear and Radiological Emergency Preparedness Course at BAEC	22 Nov- 3 Dec. 2020	TI	22
FTC on Environmental Radioactivity Monitoring Course at BAEC	10-14 Jan. 2021	TI	23
FTC on Reactor Engineering Course at BAEC	7-25 Feb. 2021	TI	19
Total			88

2. Seminar/Symposium/Conference/Workshop/Meeting Attended

Name of the participant	Title of the event	Organizer	Date	Place
Dr. Ananda Kumar Das	Meeting of Joint Training Advisory Commission (JTAC) of RNPP	HR Division of RNPP	7-11 Mar. 2021	Rooppur, Pabna
	Workshop on Training and E-learning management	MOST	14-15 Mar. 2021	BSMR Novo Theatre, Dhaka
	Meeting for Acceptance of Full Scale Simulator of RNPP (Virtual)	HR Division of RNPP	30 May 2021	Rooppur, Pabna
Mofakkharul Islam Chowdhury	Provisional Agenda of a Virtual Side Event of 64th IAEA GC	FIHRDC-AE/WERC	23 Sept. 2020	WERC, Fukui, Japan
	Workshop On-line Accommodation Service Management	MOST	11 Mar. 2021	BSMR Novo Theatre, Dhaka
	Workshop on Library Management System	MOST	16 Mar. 2021	BSMR Novo Theatre, Dhaka

3. Workshop Conducted

Title of the workshop	Date	Place	No. of participants
Workshop on Covid-19 Pandemic Situation and necessary Safety Measures to follow	3 Nov. 2020	TI	14

4. Lecturer Delivered

Dr. Ananda Kumar Das has delivered a series of Lectures on i) Basics of Crystallography, ii) Materials Properties of a Nuclear Power Reactor, iii) Degradation or Damage of Materials due to Radiation Exposure, iv) Basics of Radiation Physics, v) Disaster Management (Bangladesh Perspective), vi) Official Courtesy and vii) Good Practices etc. in the Follow-up Training Courses and other courses arranged in TI within 2020-21 fiscal years.

5. Service Rendered and Revenue Income

Type of service	Revenue income
Dormitory Rent	98,100/-
Course Fee	48,000/-
Total	1,46,100/-

XIII. FINANCE AND ACCOUNTS DIVISION (FAD), BAEC HQ

Activities

1. Revenue Budget Allocation, Fund Release and Source of Fund

(Taka in lac)

Code	Head of Accounts	Source of Fund 2020-2021			
		Allocation from Govt.	Received from BAEC own income	Received from Unspent (Own Income)	Total Received
3631101	Salary Support	8,367/-	-	-	8,367/-
3631102	Allowance Support	7,186/-	-	-	7,186/-
3631103	Goods and Service Support	2,551/-	4.214/-	-	6,765/-
3631104	Pension and Retirement Support	4,127/-	-	-	4,127/-
3631108	Research Grant	300/-	91/-	-	391/-
3631199	Others Grant	408/-	19/-	-	427/-
	Sub-Total:	22,939/-	4.324/-	-	27,263/-
3632102	Machineries Grant	888/-	129/50	435/78	1,453/-
3632104	Building and Structure Construction	182/-	218/-	-	400/-
3632105	Information and communication Technology Grant	70/-	3/-	-	73/-
3632106	Others Capital Grant	40/-	25/50	-	65/50
Sub-Total		1,180/-	376/-	435/78	1,991/78
Total		24,119/-	4.700/-	435/78	29,254/78

2. Center/Institute Wise Revenue Budget Allocation

(Taka in lac)

Sl. No.	Name of the Centre/Institute	Revenue Budget Allocation
1.	BAEC Head Quarter, Dhaka	3,459/-
2.	Works Branch, BAEC Dhaka	1,085/-
3.	BAERA Dhaka	490/-
4.	Atomic Energy Centre, Dhaka	2,638/-
5.	A ERE Savar	7,161/-
6.	National Institute of Nuclear Medicine and Allied Sciences, Dhaka	1,203/-
7.	Institute of Nuclear Medicine and Allied Sciences, Chattogram	283/-
8.	Institute of Nuclear Medicine and Allied Sciences, Rajshahi	310/-
9.	Institute of Nuclear Medicine and Allied Sciences, Dinajpur	220/-
10.	Institute of Nuclear Medicine and Allied Sciences, Sylhet	182/-
11.	Institute of Nuclear Medicine and Allied Sciences, Dhaka	604/-
12.	Institute of Nuclear Medicine and Allied Sciences, Barishal	239/-
13.	Institute of Nuclear Medicine and Allied Sciences, Khulna	293/-
14.	Institute of Nuclear Medicine and Allied Sciences, Rangpur	342/-
15.	Institute of Nuclear Medicine and Allied Sciences, Mymensing	463/-
16	Institute of Nuclear Medicine and Allied Sciences, Bogura	333/-
17.	Institute of Nuclear Medicine and Allied Sciences, Cumilla	251/-
18.	Institute of Nuclear Medicine and Allied Sciences, Faridpur	258/-
19.	Institute of Nuclear Medicine and Allied Sciences, Midford	350/-
20.	Institute of Nuclear Medicine and Allied Sciences, Cox’s Bazar	157/-
21.	Atomic Energy Centre, Chattogram	280/-
22.	BSMEC Cox’s Bazar	155/-
23.	RNPP Pabna	146/-
24.	RTML Mongla	100/-
25.	Foreign Exchange Branch, BAEC Dhaka	2,245/78
26	Pension and retirement benefit Branch, BAEC Dhaka	4,127/-
27.	Service Charge Branch, BAEC Dhaka	1,880/-
Total		29,254/78

XIV. SUPERVISION OF THESIS

ATOMIC ENERGY CENTRE (AEC), DHAKA

Chemistry Division, AECD

1. Joint Supervision: Dr. S. B. Quraishi, "Evaluation of lead and chromium content in beef collected from selected markets of Dhaka city and population health risk assessment", M. Sc. hesis (Rubel Akand), Institute of Nutrition and Food Science, University of Dhaka, 2020.
2. Joint Supervision: Dr. S. B. Quraishi, "Health risk assessment of Bangladeshi consumers to heavy metals via dietary intake of edible oil", M. Sc. thesis (Maroofa Haque), Department of Food and Nutritional Science, College of Home Economics, 2020.
3. Joint Supervisor: Dr. S. B. Quraishi, "Heavy metal accumulation in meat, liver, kidney of chicken and the potentiality of health risk", M. Sc. thesis (Md. Ariful Islam), Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Tangail, 2020.
4. Joint Supervisor: Dr. S. B. Quraishi, "Heavy metals source identification from liquid cow milk and feed and possible human health risk implications in Bangladesh", M. Sc thesis (Sharmin Sultana), Department of Environmental Science, Faculty of Mathematical and Physical Science, Jahangirnagar University, 2021.
5. Joint Supervisor: Dr. S. B. Quraishi, "Heavy metal pollution in surface water and sediment: a preliminary assessment of upstream of Shitalakshya River", B. Sc. thesis (Booshra Ahmed), Department of Environmental Science, Faculty of Science and Technology, Bangladesh University of Professionals, 2021.
6. Joint Supervisor: Dr. S. B. Quraishi, "Heavy metal pollution in surface water and sediment: a preliminary assessment of downstream of Shitalakshya River", B. Sc. thesis (Shamaila Islam), Department of Environmental Science, Faculty of Science and Technology, Bangladesh University of Professionals, 2021.
7. Joint-supervisor: Dr. Y. N. Jolly, "Impact of industrial wastewater on fish species", B. Sc. thesis (Maheen Mehnaz), Department of Environmental Science, Bangladesh University of Professionals, January 2021.
8. Joint-supervisor: Dr. T. R. Choudhury, "Accumulation of metals in some arthropods, mollusks and marine fishes of Kuakata areas in Bangladesh and their impact on Brain and Ovary", M. S. thesis (Khatunejannat), Department of Zoology, University of Dhaka, 2021.
9. Joint-supervisor: Dr. T. R. Choudhury, "Heavy metal contamination appraisal in roadside perennial trees, soil and dust: A tool for monitoring urban metal pollution", B. Sc. thesis (Maisha Binte Sultan), Department of Environmental Science, Bangladesh University of Professionals (BUP), Bangladesh, 2021.
10. Joint-supervisor: Dr. T. R. Choudhury, "Accumulation of heavy metals in insects, fish and prawn of coastal areas of Sitakunda Upazila and their histo-pathological evidence in brain and ovary", M.S. thesis (Jakia Sultana), Department of Zoology, University of Dhaka, 2021.
11. Joint-supervisor: Dr. T. R. Choudhury, "Accumulation of heavy metals in some insects and fishes of Shitalakhshya River bank area and their efficacy on brain together with overy", M. S. thesis (Selina Akter), Department of Zoology, University of Dhaka, 2021.
12. Joint-supervisor: Dr. T. R. Choudhury, "Association of serum copper level with the development of oral submucous fibrosis in patients having betel nut chewing habit", M. S. thesis (Afroza Sultana), Department of Oral and Maxillofacial Surgery, BSMMU, 2021.
13. Joint-supervisor: Dr. T. R. Choudhury, "Determination of heavy metal concentrations in roadside perennial plants, soil and dust of Dhaka South City Corporation, Bangladesh", B. Sc. thesis (Tasnim Ahshan), Department of Environmental Science, Bangladesh University of Professionals (BUP), Bangladesh, 2021.

Health Physics Division, AECD

14. Joint-supervisor: Selina Yeasmin, "Measurement of radioactivity and evaluation of radiological hazard in soil and coal samples collected from Barapukuria coal mine area in Dinajpur, Bangladesh", B. Sc. thesis (M. I. A. Chowdhury), Department of Nuclear Engineering, University of Dhaka, Mar. 2021.
15. Joint-supervisor: Selina Yeasmin, "Measurement of natural radioactivity and radiological hazard of different paint samples collected from local markets of Bangladesh using gamma spectrometry system", M. Sc. thesis (Asif Ahamed Apon), Department of Nuclear Engineering, University of Dhaka, Jun. 2020.
16. Joint-supervisor: Selina Yeasmin, "Measurement of radioactivity in powdered milk and evaluation of the corresponding annual effective dose", M. Sc. thesis (Md. Sadik-E-Dunia Sarker), Department of Physics, Jahangirnagar University, August 2020.
17. Joint-supervisor: Dr. Mohammad Sohelur Rahman, "Real-Time radiation monitoring around BSMMU Hospital campus by in-situ method", M. S. thesis (Abdullah Tareque), Department of Physics, Jagannath University, October 2020.
18. Joint-supervisor: Selina Yeasmin, "Measurement of the activity concentration of natural radionuclides (^{226}Ra, ^{232}Th and 40K) in soil samples and associated health hazards in Chandpur District, Bangladesh", M. Sc thesis (Md. Shahabuddin), Department of Physics, Jagannath University, Dec. 2020.
19. Joint-supervisor: Dr. Mohammad Sohelur Rahman, "Assessment of radiation hazard in indoor and outdoor environment of DMCH campus by in-situ method", B. Sc. thesis (Fabiha Shafi Mim), Department of Environmental Sciences, JU, January 2021.
20. Joint supervisor: Dr. A. K. M. Mizanur Rahman, "Accidental and Retrospective Dosimetry Using Glass Material as Natural Dosimeter by TL Method", B. Sc. thesis (Md. Rashedul Islam Imon), Department of Nuclear Engineering, Dhaka University, Mar. 2021.
21. Joint supervisor: Dr. A. K. M. Mizanur Rahman, "Glow curves analysis of different types of thermoluminescent dosimeters", B. Sc. thesis (Md. Abu Sayed), Department of Nuclear Engineering, Dhaka University, Mar. 2021.
22. Joint-supervisor: Dr. Mohammad Sohelur Rahman, "Real-time radiation monitoring around two hospital campuses in dhaka by in-situ method", M. S. thesis (Abdullah Al Shuhan), Department of Physics, JU, Apr. 2021.
23. Joint-supervisor: Dr. Mohammad Sohelur Rahman, "Continuous indoor radiation monitoring at atomic energy centre dhaka campus by thermoluminescent dosimeter", M. S. thesis (Avijit Biswas), Department of Physics, JU, Apr. 2021.
24. Joint-supervisor: Dr. Mohammad Sohelur Rahman, "Real-time radiation monitoring in Tejgaon thana of Dhaka city by in-situ method", M. S. thesis (Md. Ashiqur Rahman), Department of Physics, JU, Apr. 2021.

Materials Science Division, AECD

25. Co-supervisor: Dr. Engr. Sheikh Manjura Hoque, *"*Silica coated iron oxide nanoparticles for environment remediation and nuclear waste management", M. S. thesis (Md. Al Mamun), Departmentof European Master in Nuclear Energy (EMINU), Sep. 2020.
26. Co-supervisor: Dr. Engr. Sheikh Manjura Hoque, *"*Evaluation of remineralization potential of nano-hydroxyapatite on tooth enamel surface: an in-vitro study", M. S. thesis (Risa Naser), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Sep. 2020.
27. Co-supervisor: Dr. Engr. Sheikh Manjura Hoque, *"*Preparation of Cobalt Ferrite nanoparticles by co-precipitation method and coated with dextran for mri contrast of brain and cancer treatment by hyperthermia", M. S. thesis (Habiba Binte Kashem), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Sep. 2020.
28. Co-supervisor: Dr. Engr. Sheikh Manjura Hoque, "An in-vitro study on acquired remineralization of enamel by nano-hydroxyapatite, sodium fluoride and polyetheylene oxide", M. S. thesis (Nazifa Zaman Khan), Department of Applied Chemistry and Chemical Engineering, University of Dhaka, Sep. 2020.

29. Co-supervisor: Dr. Engr. Sheikh Manjura Hoque, "A histological study on the effects of synthesized hydroxyapatite on the eruption of rat incisors", M. S. thesis (Md. Abdul Ali Kayes), Department of Applied Chemistry and Chemical Engineering,University of Dhaka, Sep. 2020.
30. Joint-Supervisor: Dr. Engr. Sheikh ManjuraHoque, *"Synthesis*, characterization, and performance evaluation of Fe_3O_4 nanoparticle as MRI contrast agent and hyperthermia", M. Sc. thesis (Fahima Afrin Reet*e),* Dept. of Pharmacy, North South University, Sep. 2020.
31. Joint-Supervisor: Dr. M. N. I Khan, "Role of vanadium substitution in tailoring the structural, electrical and magneticproperties of $Mn_{0.6}Zn_{0.4}V_xFe_{2-x}O_4$ ferrites synthesized by conventional ceramic method", M. Sc. Thesis (*Amita Hossain*), Department of Physics, University of Dhaka, Mar. 2020.
32. Joint-Supervisor: Dr. M. N. I Khan, "Zr and Co binary doped multiferroicity in $SrTiO_3$", M. Sc. thesis (Sarwar Hossain Faysal), Department of Electrical and Electronic Engineering, University of Dhaka, May 2020.
33. Joint-Supervisor: Dr. M. N. I Khan, "Synthesis and study the multiferroic properties of Ce and Fe co-doped strontium ferrites" M. Sc. thesis (Tarique Hasan), Department of Electrical and Electronic Engineering, University of Dhaka, May 2020.
34. Joint-Supervisor: Dr. M. N. I Khan, "Influence of Cr content on electric and magnetic properties of Cu-Mg ferrites Nanoparticles", M. Sc. thesis (Sumi Akther), Department of Physics, University of Dhaka, May 2020.
35. Joint Supervisor: Dr. Md. Al-Mamun, "Synthesis and characterization of GO-$CoNiFe_2O_4$nanocomposite prepared by in-situ sol-gel auto combustion method", M. Sc. thesis (Ommay Habiba), Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University, Jul. 2020.
36. Joint Supervisor:Dr. Md. Al-Mamun, "Hydrothermal synthesis of nickel doped cobalt ferrite/ functionalized multi-wall carbon nanotube nanocomposite: Structural and magnetic characterization", M. Sc. thesis (Md. Al-Fahat Hossain), Department of Physics, Khulna University, Khulna, Dec. 2020.
37. Joint-Supervisor: Dr. Harinarayan Das, "Synthesis and characterization of $MgFe_2O_4$/ZnO nanocomposites by sol-gel method for biomedical applications", M. Sc. thesis (Rehana Akter Ruma), Department of Physics, Jagannath University, Sep. 2020.
38. Co-supervisor: Dr. Md. Al Mamun, "Preparation of sodium alginate-graphne oxide composite beads and its application as an adsorbent for the removal of Cr (III) from aqueous solution", M. S. thesis (Marzia Islam Mari), Department of Applied Chemistry and Chemical Engineering University of Dhaka, Sep. 2020.
39. Co-supervisor: Dr. Md. Al Mamun, "Synthesis and characterization of carbon dots obtained from D-(+)- glucose and its application as a Cr(III)ion sensor", M. S. thesis (Rahnuma Rimi), Department of Applied Chemistry & Chemical Engineering University of Dhaka, Sep. 2020.

Accelerator Facilities Division, AECD

40. Joint-Supervisor: Dr. Md. Joynal Abedin, "Elemental analysis and pollution assessment of some soil samples of Chittagong and Cox's Bazar Beach Areas", Ph. D. thesis (Laila Zaman), Department of Physics, Jahangirnagar University, August 2020.

ATOMIC ENERGY CENTRE (AEC), CHATTOGRAM

41. Co-supervisor: Dr. Shahadat Hossain, "Radiation dose rate evaluation from natural and anthropogenic radioactivity in soil and industrial wastes of nasirabad industrial area, Chittagong, Bangladesh", M. Phil thesis (Mohammed Didarul Alam Majumder), Department of Physics, Chittagong University of Engineering and Technology, January, 2021.

INSTITUTE OF RADIATION AND POLYMER TECHNOLOGY (IRPT), AERE

42. Supervisor/Co-supervisor: Md. Serajum Manir, "Preparation and characterization of gelatin/chitosan /PVA blend film improved by gamma radiation to use as biodegradable packaging materials", M. S.

thesis (Refah Tasnim, Roll-19051069), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.

43. Supervisor/Co-supervisor: Md. Serajum Manir, "Hydrothermal synthesis and characterization of copper oxide/biocl/tio_2 nanocomposite to use as a photocatalyst", M. S. thesis (Md. Maruf Hasan, Roll-19051064), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.
44. Supervisor/Co-supervisor: Md. Serajum Manir, "Preparation and characterization of BIOBR/MOO3/SNO nanocomposite for photocatalytic application", M. S. thesis (Most. Miesha Maliha, Roll-19051061), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.
45. Supervisor/Co-supervisor: Md. Serajum Manir, "Effective removal of textile dye from effluent water by gamma irradiated hydrogel based on PO/CMC/Acrylic Acid Blend", M. S. thesis (Mahmudul Hasan Galib, Roll-19051070), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.
46. Supervisor/Co-supervisor: Md. Serajum Manir, "Effect of acrylic acid on starch-acrylamide blend hydrogel assisted by gamma radiation for textile dye removal", M. S. thesis (Nasim Ahmed, Roll-19051062), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.
47. Supervisor/Co-supervisor: Md. Serajum Manir, "Synthesis and characterization of iodine doped titanium dioxide loaded peo-chitosan blend for wound dressing application", M. S. thesis (Abdullah Al Kowsar Mahmud, Roll-19051091), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.
48. Supervisor/Co-supervisor: Md. Serajum Manir, "Synthesis and characterization of iodine doped titanium dioxide loaded peo-chitosan blend for wound dressing application, development of di-sensitized solar cell based on pomegranate die extract", M. S. thesis (Dewan Shabbir Ahmed, Roll-PH-14022), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.
49. Supervisor/Co-supervisor: Md. Serajum Manir, "Preparation and characterization of gamma radiation induced grapheneoxide/peo/chitosan blend hydrogel for removal of antibiotic from waste water", M. S. thesis (Sultana Razia, Roll-19051099), Department of Chemistry, Hajee Mohammad Danesh Science and Technology University, 2021.

INSTITUTE OF NUCLEAR SCIENCE AND TECHNOLOGY (INST), AERE

Nuclear Radiation and Chemistry Division, INST

50. Joint Supervisors: Dr. Salma Sultana, Md. Saifur Rahaman, Shah Md Marzuk Hasnine and Tanvir Ahmed, "Preparation and characterization of PEO/Xanthan Gum/Bantonite clay hydrogel and its application for dye removal", M. S. thesis (Taslima Akter), Dept. of Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University (NSTU), Noakhali, Jun. 2021.
51. Joint Supervisors: Dr. Salma Sultana , Md. Saifur Rahaman Shah Md Marzuk Hasnine and Tanvir Ahmed, "Preparation and characterization of PVP/Cellulose/PSSA hydrogel and its application for dye removal", M. S. thesis (Afiza Moriom), Dept. of Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University (NSTU),Noakhali, Jun. 2021.
52. Joint Supervisors: Dr. Salma Sultana, Md. Saifur Rahaman, Shah Md Marzuk Hasnine and Tanvir Ahmed, "Preparation and characterization of PEO/Starch/PSSA hydrogel and its application for dye removal", M. S. thesis (Sakib Hossain Bhuiyan), Dept. of Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University (NSTU),Noakhali. May 2021.
53. Joint Supervisors: Dr. Salma Sultana, Md. Saifur Rahaman, Shah Md Marzuk Hasnine and Tanvir Ahmed, "Preparation and characterization of Chitosan/PSSA/Acrylamide hydrogel and its application for dye removal", M. S. thesis (Md. Yakub Molla), Dept. of Department of Applied Chemistry and Chemical Engineering, Noakhali Science and Technology University (NSTU), Noakhali, May 2021.

54. Joint Supervisor: Dr. Nazia Rahman, "Application of glycidyl methacrylate grafted non-woven polyethylene fabric in water treatment", M. S. thesis (Omme Habiba), Department of Chemistry, Jahangirnagar University, January 2021.
55. Joint Supervisor: Dr. Nazia Rahman, "Preparation of radiation grafted non-woven polyethylene fabric adsorbent for the removal of methyl orange Dye", M. S. thesis (**S**adoara Sadika), Department of Chemistry, Jahangirnagar University, January 2021.
56. Joint Supervisor: Farah Tasneem Ahmed, "Human health risk assessment of surface water, ground water near DEPZA area, Savar, Dhaka", B. Sc. thesis (Nasim Ahmed), Department of Chemical Engineering, Jashore University of Science and Technology, Jul. 2020.
57. Joint Supervisor: Farah Tasneem Ahmed, "Effects of kitchen compost, quick compost and biochar on the transfer of Cd from a seasonally flooded sandy loam soil to Red amaranth (*Amaranthus cruentus*)", M. Sc. thesis (Reyad Hossain Arif), Department of Environmental Science and Resource Management, Mawlana Bhasani Science and Technology University, December, 2020.
58. Joint Supervisor: Farah Tasneem Ahmed, "Determination of Cd, Pb, Cr, Cu, Zn and Ni in liver and kidney of cows and bulls and its' health risk assessment", M. Sc. thesis (Md. Kabir Hossen), Department of Environmental Science and Resource Management, Mawlana Bhasani Science and Technology University, December, 2020.
59. Joint Supervisor: Farah Tasneem Ahmed, "Heavy metal pollution and assessment of health risk from road side agricultural land nearly Dhaka-Aricha highway", M. Sc. thesis (Saiful Islam), Department of Environmental Science and Resource Management, Mawlana Bhasani Science and Technology University, Apr. 2021.
60. Joint Supervisor: Farah Tasneem Ahmed, "Assessment of heavy metal concentration together with ecological and human health risk from Dhaleshwari river sediment of tannery vicinity area", M. Sc. thesis (Avilash Sarker), Department of Environmental Science and Resource Management, Mawlana Bhasani Science and Technology University, Apr. 2021.

Reactor and Neutron Physics Division, INST

61. Supervisor: Dr. Mohammad Amirul Islam, "Study on concentration and distribution of uranium and thorium in sands of potential regions of Bangladesh", M. Sc. thesis (Md. Saydur Rahman), Department of Nuclear Science and Engineering, Military Institute of Science and Technology, Mirpur, Dhaka Submitted on Feb. 2021.
62. Joint-supervisor: Dr. Mohammad Amirul Islam, "Determination of major and trace elements in two new environmental reference materials using neutron activation analysis", M. Sc. thesis (Md. Toufiqul Islam), Physics Discipline, Khulna University, Khulna Submitted on Jun. 2021.
63. Joint-supervisor: Dr. Rahat Khan, "Elemental distribution in Dhaleshwari river sediment near a tannery effluent discharge point", M. Sc. thesis (Sydur Rahman Gazi), Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh, 2020.
64. Joint-supervisor: Dr. Rahat Khan, "Environmental radioactivity monitoring of an urban river sediment affected by tannery effluents", M. Sc. thesis (Sharmin Sultana Rumi), Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh, 2020.
65. Joint-supervisor: Dr. Rahat Khan, "Nutritional and trace elemental cycling in Sal (*Shorea robusta*) trees", M. Sc. thesis (Boloram Karmaker), Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Santosh, Tangail-1902, Bangladesh, 2020.
66. Joint-supervisor: Dr. Rahat Khan, "Evaluation of water quality and human health risk of heavy metals along with major anions and cations present in the tap water of Dhaka city (South)", M. Sc. thesis (Shabiha Hosssin), Department of Environmental Science, Bangladesh University of Professionals, Mirpur Cantonment, Dhaka 1216, Bangladesh, 2021.

67. Joint-supervisor: Dr. Rahat Khan, "Supply water quality assessment and preliminary health risk appraisal of Dhaka city (North)", M. Sc. thesis (Amit Hasan), Department of Environmental Science, Bangladesh University of Professionals, Mirpur Cantonment, Dhaka 1216, Bangladesh, 2021.
68. Supervisor: Dr. Shahzad Hossain, "Synthesis and structural studies of copper doped barium zirconium cerate for application in solid oxide fuel cell", M. S. thesis (Md. Sydur Rahman Bappy), Department of Physics, University of Dhaka, November 2020.
69. Supervisor: Dr. Shahzad Hossain, "Structural and thermal characterizations of SrNd0.65Zr0.35O3-δ for an application in solid oxide fuel cells", M. S. thesis (Md. Maznu Mia), Department of Physics, University of Dhaka, May 2021.

Reactor Physics and Engineering Division, INST

70. Joint-Supervisor: Dr. Md. Jahirul Haque Khan, "A study on shield design parameters of semi-industrial Co-60 gamma-irradiation facility at gamma source division of institute of food and radiation biology", B. Sc. thesis (Shamsuddin Ahmed) Department of Nuclear Engineering, University of Dhaka, May 2021.
71. Joint-Supervisor: Dr. Md. Jahirul Haque Khan, "Analysis of the LEU Core neutronics parameters of 3 MW TRIGA Mark-II research reactor by the deterministic diffusion code TRIGAP", B. Sc. thesis (Md. Hasan Reza), Department of Nuclear Engineering, University of Dhaka, May 2021.

Isotope Hydrology Division, INST

72. Joint Supervisor: Dr. Ratan Kumar Mojumder, "Appraisal of water quality and characteristics of cetp effluent site in Dhaleshwari River, Savar, Bangladesh", B. Sc. (Hon's) Report (Hazzaz Bin Hassan), Department of Environmental Science, Bangladesh University of professional, Dhaka, Mar. 2021.
73. Joint Supervisor: Dr. Md. Moniruzzaman, "Hydrogeochemical characteristics and groundwater quality assessment by using isotopes and GIS techniques at sadar upazila, Chapai Nawabganj district, Bangladesh", M. S. Report (Shamim Ahamed), Department of Geology and Mining, University of Rajshahi, Mar. 2021.
74. Joint Supervisor: Dr. Md Moniruzzaman, "Hydrochemistry and isotopic assessment of groundwater at nachole upazila, chapainawabganj district, Bangladesh", M. S. Report (Mst. Suborna Khatun), Department of Geology and Mining, University of Rajshahi, Mar. 2021.

Tandem Accelerator Facilities Division, INST

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Insect Biotechnology Division, IFRB

76. Joint supervisor: Dr. M. Khan, "Improvement of the oriental fruit fly, *Bactrocera dorsalis* (Hendel) (Diptera:Tephritidae) management using semiochemical for simultaneous application of SIT and MAT", M. Sc. thesis (Md. Azharul Islam), Department of Zoology, Jagannath University, Jun. 2021.
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Molecular Radiobiology and Biodosimetry Division, IFRB

78. Supervisor: Dr. A. Y. K. Md. Masud Rana**,** "A study on the role of PPRA gene on radiation resistance capability of deinococcusradiodurans", B. Sc. thesis (Jurana Jahan Deepti), Dept. of Biochemistry and Molecul ar Biology, Gono Bishwabidyalay, Savar, Dhaka, October 2020.

INSTITUTE OF TISSUE BANKING AND BIOMATERIALS RESEARCH (ITBBR), AERE

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INSTITUTE OF ELECTRONICS (IE), AERE

Solar Cell Fabrication and Research Division, IE

82. Supervisor: S. M. Amir-Al-Zumahi, "Innovative solar cell application for natural dyes recovered from different plants", M. S. thesis (Md. Nasim Alam), Department of Physics, Jahangirnagar University, Jun. 2021.
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Very Large Scale Integration (VLSI) Technology Division, IE

84. Co-supervisor: Abdul Al Mortuza, "Study the influence of Bi doping and gamma radiation on structural and optical properties of α- MoO3: Bi (Bismuth) nanobelt", M. Sc. thesis (Mostafa Kamal), Physics Department, Jahangirnagar University, January 2021.
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INSTITUTE OF NUCLEAR MEDICINE AND ALLIED SCIENCES (INMAS), RAJSHAHI

90. Co-supervisor: Prof. Dr. Shamim Ahsan, "Correlation between BMI and LH/FSH ratio in PCOS women Causing infertility", MD thesis (Dr. Hosne Ara Sonia), Department of Obstetrics and Gynecology, Rajshahi Medical College Hospital, Mar. 2021.

NUCLEAR SAFETY, SECURITY AND SAFEGUARDS DIVISION (NSSSD), HQ

91. Co-supervisor: Dr. Md. Shakilur Rahman, Tanjim Siddique, "Role of 4-dimensional computed tomography in highly conformal radiotherapy, M. Phil thesis (Ramaa Lingaiah), Department of Physics, Jahangirnagar University, 2021.

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Health Physics and Radioactive Waste Management Unit, INST

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INSTITUTE OF FOOD AND RADIATION BIOLOGY (IFRB), AERE

Insect Biotechnology Division, IFRB

32. "Mass rearing of parasitoid *Braconhebetor* Say (Hymenoptera: Braconidae) on the host Indian meal moth *Plodiainterpunctella*Hübner (Lepidoptera: Pyralidae)", M. F. Hossain. 28th Dec. 2020, IFRB, AERE, Savar.
33. "Managing and controlling *aedes* vector populations using the sterile insect technique: Bangladesh work plan", K. Seheli, RAS5082 1st Meeting, 18th Mar. 2021, Seibersdorf, Austria (virtual).
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INSTITUTE OF ENERGY SCIENCES (IES), AERE

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INSTITUTE OF COMPUTER SCIENCE (ICS), AERE

Nuclear Cyber Security Division, ICS

43. "Secure online card transaction model: Securing online transaction using two-factor authentication", N. K. Datta, M. S. Islam, I. H. Showrov, M. M. Alam, M. A. Uddin and M. H. Ali, International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu, BCSIR, Dhaka, Bangladesh, 11-13 Mar. 2021.

Software Engineering Division, ICS

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INSTITUTE OF ELECTRONICS, IE

General Electronics Division, IE

45. "Decision support technique for prediction of acute lymphoblastic leukemia subtypes based on artificial neural network and adaptive neuro-fuzzy inference system", M. Z. H. Majumder, A. Khaer, M. J. N. Mahi, M. S. I. Babu and S. K. Aditya, 5th International Conference on inventive Systems and Control (ICISC 2021), JCT College of Engineering and Technology, Coimbatore, India, 7-8 Jan. 2021.

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54. "II Numerical modelling of the rate-dependent characteristics of laterally loaded single piles in D. Sand", A. K. Saha, M. Saitoh, N. R. Shrestha and C. S. Goit, 5th International Conference on Advances in Civil Engineering (ICACE-2020), CUET, Chattagram, 4349, Bangladesh, 4-6 Mar. 2021.

NUCLEAR SAFETY, SECURITY AND SAFEGUARDS DIVISION (NSSSD), BAEC HQ

55. **"**Risk versus benefit of radiations including the principles of radiotherapy", D. M. S. Rahman, lecture delivered for MD Residency (Nuclear Medicine) Phase-B, 4 Apr. 2021, NINMAS, BSMMU, Dhaka.
56. "The Basics of Radiation and Radiation Protection", D. M. S. Rahman, lecture delivered for seminar program on Physics in Medicine", 16 Sep. 2020, Khawja Yunus Ali Cancer Centre, Sirajgonj, under establishment of calibration and quality control facilities for radiotherapy, diagnostic radiology and neutron project.
57. "Radiotherapy for the treatment of cancer: Bangladesh perspective", D. M. S. Rahman, lecture delivered webinar on indigenous and interdisciplinary approaches for sustainable development", 5 Sep. 2020, Barisal, Bangladesh.
58. "Radiotherapy quality assurance: Bangladesh perspective", lecture delivered in the seminar program on Physics in Medicine", D. M. S. Rahman, 7 Feb. 2021, Cancer Center, North East Medical College and Hospital, Sylhet under establishment of calibration and quality control facilities for radiotherapy, diagnostic radiology and neutron project.

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59. "Challenges faced and addressed in the preparedness of the COVID-19 situation in nuclear medicine departments in Bangladesh", F. Nasreen, 15th International Conference on Radiopharmaceutical Therapy (ICRT 2020), 5-6 Dec. 2020 (virtual).
60. "Prenatal sonographic diagnosis of congenital high airway obstruction syndrome", N. Sultana[1], A. Sarker, M. Asma, A. Sharmin, N. Mahbub, T. Parveen, S. Quddus, R. Parveen and T. Mandal, International Conference on ISUOG, (2020).
61. "Antenatal diagnosis of aneurysmal mmalformation of the vein of galen: A case report with the application of color doppler ultrasound", N. Sultana, T. Parveen, A. Sarker, S. Quddus, R. Parveen, A. Sharmin, M. Asma and N. Mahbub, International Conference on ISUOG, (2020).

62. "Ultrasonography of twin reversed arterial perfusion sequence", R. Parveen1, N. Sultana1, A. Sarker1, S. Quddus, M. Asma, A. Sharmin, N. Mahbub and T. Parveen, International Conference on ISUOG (2020).
63. "Differential diagnosis of dementia an application of easy z score imaging system in brain SPECT", N. Sultana, Confrontiers.com/dementia-conference, 2020 (virtual).
64. "Sternal bone metastases from differentiated thyroid carcinoma: A single institutional experience", Z. Jabin, 15th International Conference on Radiopharmaceutical Therapy (ICRT 2020) of WARMTH, 5-6 Dec. 2020 (virtual).
65. "Installation of auto DELFIA: A new addition in Bangladesh for the screening of congenital hypothyroidism in newborn babies", S. C. Biswasarma, M. A. Islam, M. A. Azim, M. J. Uddin, M. Mamun, M. A. Kabir and S. Khatun, International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu, BCSIR, Dhaka, Bangladesh, 11-13 Mar. 2021.
66. "Outcome of newborn screening movement for the early diagnosis and treatment of congenital hypothyroidism in Bangladesh: From pilot to ongoing phase-2 study", M. A. Islam, S. C. Biswasarma**,** M. A. Azim, M. J. Uddin, M. Mamun, M. A. Kabir and S. Khatun, International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu, BCSIR, Dhaka, Bangladesh, 11-13 Mar. 2021.
67. "Evaluation of automated synthesis of [^{18}F] fluorocholine using a modified GE tracer lab MX module on the basis of radiochemical yield and quality control", M. J. Uddin, M. A. Azim, Y. H. Cho, C. S. Yoon, W. Jin In, J. B. Park and Y. S. Lee, International Conference on Science and Technology for Celebrating the Birth Centenary of Bangabandhu, BCSIR, Dhaka, Bangladesh, 11-13 Mar. 2021.
68. "Management of thyroid cancer during corona crisis", F. Begum, Seminar of Bangladesh Thyroid Society, Dhaka, 11 Jul. 2020 (virtual).
69. "Role of NINMAS in thyroid disorders evaluation and management", F. Begum, Seminar of Department of Endocrinology, Bangabandhu Sheikh Mujib Medical University, Dhaka, 21 May 2021.
70. "Association of BRAF V600E mutation in recurrent and metastatic differentiated thyroid carcinoma: Experiences in three cases", P. Akhter**,** J. Ferdous and F. Begum, National Conference and Annual General Meeting. Souvenir, Bangladesh Thyroid Society, 4th National Conference and Annual General Meeting, 26 Feb. 2021.
71. "Role of nuclear medicine in management of thyroid diseases", F. Begum, NINMAS as celebration of World Thyroid day, 26 May 2021.
72. "The Impact of COVID-19 on the Thyroid Function", Z. Jabin, Keynote Speaker of the NINMAS webinar on World Thyroid day, 26 May 2021.
73. "Dosage, administration, side effects and precautions of PTU administration", Z. Jabin, Startup launching program of PTU (Propylthiouracil) at National Institute of Nuclear Medicine and Allied Sciences, 1 May 2021.
74. "Subclinical thyroid disease: An overview of INMAS, Cox's Bazar", P. Podder, K. M. M. Morshed, R. Chakma, S. C. Biswasarma, M. S. A. Prince, 4th National Conference and Annual General Meeting, Webinar Conference, 19 Mar. 2021.
75. "Association of BRAF V600E mutation in recurrent and metastatic differentiated thyroid carcinoma: Experiences in three cases", P. Akhter, J. Ferdous and F. Begum, 4th National Conference and Annual General Meeting, Bangladesh Thyroid Society, 26 Feb. 2021.

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76. Workshop on APA, J. A. Haque and M. S. Reza, INMAS, Dhaka, 10 Mar. 2021.
77. "^{99m}Tc-MIBI rest myocardial perfusion imaging (MPI) and ^{18}F-FDG cardiac PET for viability assessment before revascularization following myocardial infarction: Experience in Bangladesh", S. K. Biswas, A. Akhter, A. W. Chowdhury, F. Ahmed, M. Ahmed, S. Reza, F. Rahman, R. Afrin, S. Islam, S. Sharmin, M. Majumder, M. Hossain, S. Hossain, R Begum, F. S. Haque and J. A. Haque, 61st Annual Scientific Meeting of the Japanese Society of Nuclear Medicine (JSNM), 2021.

78. "Childhood thyroid malignancy: 10 years' experience in Institute of Nuclear Medicine and Allied Sciences (INMAS), Dhaka Medical College Campus, Dhaka, Bangladesh", S. Sharmin, A. Akhter, F. S. Haque, R. Begum, S. K. Biswas, F. Rahman, R. Afrin, M. Hossain, S. Hossain, M. R. Mozumder, S. Islam and J. A. Haque, 4th National conference and Annual General Meeting of Bangladesh Thyroid Society, Webinar Conference, 19 Mar. 2021.
79. "Persistently raised thyroglobulin level in a well differentiated thyroid cancer patient having no structural evidence of disease surveyed by 131I-WBS and 18F-FDG PET", A. Akhter, S. Sharmin, S. Islam, R. Yasmeen, M. Hossain, S. Hossain, M. R. Mozumder, R. Afrin, F. Rahman, S. K. Biswas, S. Reza, R. Begum, F. S. Haque and J. A. Haque, 4th National conference and Annual General Meeting of Bangladesh Thyroid Society, Webinar Conference, 19 Mar. 2021.
80. "MPI basic and clinical implication", Shankar Kumar Biswas, organized by Interactive Professional Development Initiatives (IPDI), 26 Feb. 2021 (virtual).
81. "Vitamin-D deficiency disorder and role of calcium, magnesium and zinc in its absorption", S. Islam, organized by INMAS, Dhaka, 25 Mar. 2021.
82. "General Scintigraphy", M. Hossain, organized by project director of project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 20 Jun. 2021.
83. "Clinical application of SPECT-CT", J. A. Haque, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 20 Jun. 2021.
84. "Application of medical physics in nuclear medicine and imaging", M. S. Reza, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 20 Jun. 2021.
85. "General management of thyroid diseases", R. Begum, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 22 Jun. 2021.
86. "Role of CT for fusion imaging", R. Afrin, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 22 Jun. 2021.
87. "Maintenance of medical Equipments", M. M. Rahman, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 22 Jun. 2021.
88. "Management of thyroid carcinoma", F. S. Haque, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 23 Jun. 2021.
89. "High resolution ultrasonography", S. Hossain, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 23 Jun. 2021.
90. "Myocardial perfusion imaging", S. K. Biswas, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 23 Jun. 2021.
91. "Duplex ultrasonography", F. Rahman, organized by project director of Project- Enhance capacity of INMASes at Dhaka, Chattogram, Rajshahi, Khulna, Sylhet, Dinajpur, Rangpur, 24 Jun. 2021.
92. "Good clinical practice on breast cancer (imaging perspective)", R. Afrin, organized by Bangladesh Society for Breast Cancer Study, 3 Mar. 2021.
93. "Management of post operative hypocalcaemia", M. M. Islam, INMAS, Dhaka, 8 Mar. 2021.

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94. "Anatomy of breast ultrasound", A. Naznin, BSU Workshop on Breast Ultrasound, 23 Apr. 2021 (virtual).

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95. "New era of nuclear medicine and its clinical application an advanced step for INMAS, Khulna", J. Das, Scientific Seminar, 5 Jun. 2021.

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96. "B-mode ultrasonography of breast", S. Z. Rima, F. A. Dowel, N. Nahar and M. N. Khan, Breast Ultrasound workshop of BSU, 23 Apr. 2021, Dhaka.
97. "Parathyroid Imaging : Role of SPECT/CT", N. Nahar, S. Z. Rima, F. A. Dowel, Nadiruzzaman, R. K. Chakraborty and M. N. Khan, INMAS, Mymensingh, 23 Feb. 2021.

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98. "Gynaecological and obstetric ultrasonography, triad and triumph", R. Islam, Workshop Cum Training, INMAS, Dhaka, 15 Jul. 2019,.

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99. "Thyroid disease profile analysis among patients coming to INMAS, Cox'sBazar", K. M. M. Morshed, P. Podder, M. A. Hasnat, F. Akter, M. ShafiqualIslam, A. Al Persi and M. S. Prince, 4th National Conference and Annual General Meeting, NINMAS, Dhaka, 26 Feb. 2021.
100. "Sub-clinical thyroid disease: An overview of INMAS, Cox's Bazar", P. Podder, K. M. M. Morshed, R. Chakma, S. C. Biswasarma and M. S. A. Prince, 4th National Conference and Annual General Meeting, NINMAS, Dhaka, 26 Feb. 2021.

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101. "Lead equivalent test for radiography room to ensure the radiation protection", M. Parvej, M. M. Aye, S. Paul and A. Hashim, 15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), 2020 (virtual).
102. "Normal reference value for thyroid uptake of Technetium-99m pertechnetate for the Bangladeshi population", H. M. M. Munna, M. Parvej, M. F. Ferdous and G. A. Zakaria, 15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), 2020 (virtual).
103. "Radiation dose assessment around patients in SPECT (single photon emission computed tomography) units for DTPA renogram and bone scan", B. Hasan, M. S. Reza, M. M. Parvej, N. Karmaker, H. A. Azhari and G. A. Zakaria, 15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), 2020 (virtual).
104. "Comparison of compensation BED(s) by changing the planned BED of either normal tissue or tumor or balancing both", M. S. Sultana, M. M. Pervej, N. Sultana, M. A. Hasnat, S. Alim and M. M. Ahasan, 15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), 2020 (virtual).
105. "Investigation of dose confirmation by comparing the monitor unit of resultant treatment plan and of manual input", N. Sultana, M. M. Parvej, M. S. Sultana, M. A. Hasnat, S. Alim and M. M. Ahasan, 15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), 2020 (virtual).
106. "Importance of adaptive radiotherapy in head and neck cancer", S. Alim, M. M. Parvej, M. A. Hasnat, N. Sultana, M. S. Sultana, J. Hosen, K. Islam and M. M. Ahasan, 15th International Conference on Radiopharmaceutical Therapy (ICRT) of World Association of Radiopharmaceutical and Molecular Therapy (WARMTH), 2020 (virtual).

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107. "Qualitative assessment of jar and bottled water available in Chattogram city corporation area for Drinking Purpose", S. Bhanja, M. R. Karim, S. Hossain, N. U. Doulah, N. Deb and M. R. Khan, 11 Mar. 2021.

Published by : Scientific Information Division, Bangladesh Atomic Energy Commission
Paramanu Bhaban, E-12/A, Agargaon, Sher-e-Bangla Nagar, Dhaka-1207
Phone: 880-2-58160534, Fax: 880-2-8181842, 8181845
E-Mail: sidbaec@yahoo.com, Web: www.baec.gov.bd

Printed by : Natundhara Printing Press
314/A, Elephant Road, Dhaka-1205
Cell: 01711 019 691, 01911 294 855