DEPARTMENT OF SCIENCE AND TECHNOLOGY

PHILIPPINE NUCLEAR RESEARCH INSTITUTE

2013 Annual Report

About Us

The Philippine Nuclear Research Institute (PNRI), formerly the Philippine Atomic Energy Commission, has been the center of nuclear science and technology activities in the country since 1958. The PNRI is mandated to develop and regulate the safe and peaceful uses of nuclear science and technology in the Philippines.

Our Vision

The PNRI is an institution of excellence in nuclear science and technology propelled by a dynamic and committed workforce in the mainstream of national development.

Our Mission

"We contribute to the improvement of the quality of Filipino life through the highest standards of nuclear research and development, specialized nuclear services, nuclear technology transfer and effective and efficient implementation of nuclear safety practices and regulations."

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Message from the Secretary

I wish to congratulate the officials and staff of the Philippine Nuclear Research Institute (PNRI) for another productive year – adding to the DOST family's series of impressive accomplishments for 2013.

The Philippines encountered pressing challenges this 2013, and it was during these trials that the PNRI had proven once again the relevance of nuclear technology in providing capacitating tools, to help us address these diverse range of problems, including but not limited to agriculture, health and medicine, environment, industry, disaster mitigation, and education - such as the DOST-PNRI smart-farming initiatives which are set to increase the efficiency and productivity of farmers, and the promotion of technologies that can fight red-tide to help our environmental marine industry.

Further, with its brand new facilities, it is commendable that the PNRI continues to provide a wide range of services to various clients in the commercial, government, academic and medical sectors, costing a fraction of the cost for services abroad - on top of its active promotion and diffusion of knowledge and appreciation of the public for nuclear matters.

The nuclear regulatory functions of the PNRI, which is perhaps one of its most critical functions, continues to help ensure the safety and security of our country, as well as enhancing our nuclear preparedness and response. The PNRI's strong partnership with the International Atomic Energy Agency and its support to the ASEAN Regulatory Network, should help us ensure that we are always updated with latest developments in the global nuclear security.

I commend the PNRI family for their intensifying activities and commitment to service, standing firm amidst the myriad of difficulties they encountered. I am confident that they will be able to soar higher, as they continue to provide better and smarter solutions to protect our Filipino countrymen in terms of nuclear science and technology.

Mabuhay!

MARIO G. MONTEJO
Secretary

Message from the Director

On behalf of the officials and staff of the Philippine Nuclear Research Institute (PNRI), I am pleased to submit our accomplishments for the year 2013.

This year, the PNRI has once again taken the lead in promoting the peaceful applications of nuclear and radiation technologies while ensuring their safe and secure utilization for the benefit of the Filipino people.

The PNRI has treaded new grounds in its R and D activities and nuclear services to support the government's thrust for inclusive growth, environmental protection, and disaster management. Mutation breeding and nutrient management studies have been initiated to improve the agronomic properties and yield of adlai which is being promoted in the country as a substitute for rice. Nuclear and isotopic techniques are being employed to investigate nutrient uptake and water use efficiency in corn production to improve agricultural management practices. Nuclear and isotopic techniques have also been employed to identify and trace the sources of pollutants being discharged to Manila Bay from the Pampanga River Basin. Stable isotopes have been used to determine the status and health of the waters, corals, and white sand of Boracay Island. The PNRI is undertaking a comprehensive monitoring of radon, a naturally-occurring radioactive gas from the decay of uranium and thorium, along the north-central segment of the Philippine fault and the East and West Valley Fault System with the objective of using radon as a possible indicator of an impending earthquake.

In the area of nuclear safety and security, the PNRI has shifted its personnel monitoring services to the newer optically-stimulated luminescence (OSL) dosimeters to provide better monitoring of radiation exposure. Under a trilateral cooperation of the International Atomic Energy Agency (IAEA), the Nuclear Energy Corporation of South Africa and the PNRI, a total of 16 spent high activity radioactive sources (SHARS), mostly cobalt-60 from teletherapy sources of hospitals and irradiators from PNRI, were conditioned and stored in long-term storage stainless steel canisters ensuring the safety and security of these sources.

The PNRI fulfills its mandate to preserve and maintain national nuclear safety and security as the country contributes to the global nuclear safety and security regime for nuclear and radioactive sources. The PNRI has remained steadfast in its licensing and evaluation of radiation facilities as well as its inspection and enforcement activities to ensure that the codes of PNRI regulations are being complied with by licensees. In cooperation with local collaborators, the PNRI continues its partnership with the IAEA, the European Commission (EC), and other countries notably the USA to fight the threat of nuclear terrorism.

Part of the Institute's mandate to promote the peaceful uses of nuclear science and technology is to increase public awareness and knowledge among various stakeholders. The Nuclear Training Center has continued to conduct training courses, seminars and workshops. This year, the PNRI is proud to announce the upcoming establishment of its Neutron School aimed to build knowledge and competence on neutron science among its young recruits as well as undergraduate students from interested universities. As a culmination of its nuclear information campaign to generate awareness of the Filipino people on the beneficial uses of nuclear S and T, the PNRI celebrated the 41st Atomic Energy Week on the second week of December.

Finally, the Institute closed the year with feelings of fulfillment and recognition as its scientists bagged awards for 13 papers published in internationally-recognized journals during the first DOST International Publication Awards Ceremonies held in December.

We could not have achieved these without the steadfast support of the Department of Science and Technology (DOST), the various departments which have partnered with us, and our technical cooperation with the IAEA and other international institutions, our bilateral partners, and our officials and staff who share the passion of bringing the benefits of the atom to the world.

We thank Juan and Juana Dela Cruz for walking with us this past year.

ALUMANDA M. DELA ROSA, Ph.D.
Director

Generation of New Knowledge and Technologies

Living up to its stature as a research & development institute (RDI) under the Department of Science and Technology umbrella, the PNRI continues with its research endeavors intended to benefit the Filipino through the unique benefits offered by nuclear technology. Spanning areas of interest such as agriculture, health, industry and the environment, research and development initiatives have likewise branched out seeking to respond to growing climate change concerns.

FOOD AND AGRICULTURE

Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production

Rice

PNRI continued to undertake studies on rice *(Oryza sativa L.)* to develop mutants with desirable agronomic traits and low to intermediate amylose content using radiation-induced mutation.

From the seventh generation (M_7) of plants previously irradiated at 200 and 300 Gy, a total of seven mutant lines with low to intermediate amylose content were identified by quantitative method and confirmed through a molecular technique using simple sequence repeat markers. On the other hand, plants with high amylose content were observed from the control or unirradiated (IR72) and check variety (IR64).

From the fifth generation (M_5) of plants irradiated at 20 and 40 Gy by ion beam at Takasaki Ion Accelerator for Advanced Radiation Application in Japan, high tillering plants with long panicle were selected for further evaluation.

Under the Forum for Nuclear Cooperation in Asia project, PNRI conducted a study on the use of organic farming (biofertilizer) for sustainable agriculture using two native varieties irradiated at 200 and 300 Gy. At 200 Gy, the variety "Umangan" had about 59 percent increase in the number of seed per panicle over the control at the first generation (M_1) planting while the "Native Borie" variety had a 19 percent increase in the number of tillers per plant as compared to the control.

Adlai

PNRI started to conduct studies on improving the quality of adlai - a tall grain-bearing tropical plant which is being promoted in the country as a substitute for rice. PNRI agriculturists evaluated the growth and yield performance of the Ginampay adlai variety which had been irradiated with 100 Gy gamma rays under different levels of nitrogen fertilizer applications.

Results of the evaluation showed that: (1) the plant height of irradiated adlai increased significantly with the application of 120-90-60 kilogram per hectare (kg/ha) of nitrogen, phosphorous and potassium (NPK), and (2) the yield of adlai increased by about 60 percent (936 kg/ha) over the control with 120-90-60 kg/ha treatment of NPK. Yields of adlai from the other applications of NPK were as follows: 904 kg/ha or a 54 percent increase over the control for those treated with 90-90-90 kg/ha NPK and 750 kg/ha or 28 percent increase for those applied with 60-90-60 kg/ha NPK.

Mungbean

The Institute has developed high-yielding mungbean *(Vigna radiata)* [L.] R. Wilczek mutants with improved protein content using mutation techniques.

This year, two mutant varieties were further evaluated. From the Psj-B-11-176 variety previously irradiated with gamma rays at 400 and 600 Gy, PNRI obtained significant differences in plant height, number of pods per plant, number of seeds per pod and grain yield. Significant results were also obtained for variety VC 2917, specifically on the number of pods per plant, and grain yield. As in the fifth generation (M_5), no increase in the percentage of protein content was obtained from the sixth generation (M_6) of the irradiated mungbean seeds.

Fruit Crops

To develop high-value fruit crops (mangosteen and cashew) with improved qualities through induced mutations, in-vitro culture and molecular techniques, PNRI continues to maintain mangosteen and cashew plants in the field and screenhouse through routinary cultural practices, and in-vitro of mangosteen cultures/plantlets regenerated from control and irradiated seeds.

Mangosteen. The evaluation for changes in height of 34 mangosteen trees was pursued. The trees consist of seven control (unirradiated) and

High tillering rice plants irradiated at 40 Gy by ion beam

Mutant lines with low to intermediate amylose content were selected from plants previously irradiated at 200 Gy.

Grains of adlai at maturity

Schefflera 'Sparkles'

Cordyline 'Aleta' *as putative mutant*

Soil and plant tissue sampling of corn (30 days after planting) in Alucao, Sta. Teresita, Cagayan

27 trees irradiated with doses ranging from 5 to 40 Gy. Trees irradiated at 20 Gy were found to be the shortest with an average height of 87 centimeters (cm). Those irradiated at 10 Gy were the tallest with an average tree height of 232 cm.

For micropropagation of experimental plants using vegetative parts, tiny shoots were regenerated from nodal and shoot tip sections of cotyledons cultured in Murashige Skoogs (MS) medium with and without the addition of 1 to 5 parts per million benzyl adenine. In-vitro maintenance of mangosteen plantlets/ cultures regenerated from control (unirradiated) and irradiated seeds was done by reflasking/sub-culturing in freshly-prepared MS medium.

Cashew. Data on the yield of the control (unirradiated) and four irradiated cashew trees that showed promising characteristics of harvested fruits in 2011 and 2013 were further evaluated.

Results showed that trees irradiated with 100 Gy gamma rays gave the highest average nut weight of 9.5 grams while trees irradiated with 300 Gy produced the most number of fruits (110 fruits) per tree.

Ornamental Plants

The Agriculture Research Section continued to develop mutant varieties of ornamental plants with improved characteristics and quality. Noteworthy results for this year are the following:

- Flowering of the putative mutant *Cordyline* 'Aleta' for the first time in October 2013. Microscopic observation revealed that the pollen fertility of *C.* 'Aleta' is 67 percent. Interestingly, the inflorescence which lasted for seven days formed four fruits which may generate the second generation (M_2) if it will yield viable seeds.

- The application for registration of the mutant variety of *Schefflera* 'Sparkles' was endorsed by the National Seed Industry Council (NSIC) Technical Working Group on ornamental crops to the NSIC Technical Secretariat in August 2013. The *Schefflera* sp., a native to Batangas province popularly known as five-fingers, mutated to two variegated second generation (M_2) plants from open-pollinated seeds.

PRECISION FARMING TO ENHANCE AGRICULTURAL PRODUCTIVITY

Nuclear Analytical Techniques in Improving the Soil Test Calibration and Fertilizer Recommendation for Corn Production

Isotope tracer techniques, using nitrogen-15 (^{15}N), are applied by PNRI to investigate nutrient uptake, retention of soil nutrients, and water use efficiency in corn production to improve agricultural management practices. The study is being carried out in identified experimental sites in Isabela and Cagayan Valley, Region 2 and at the Central Luzon State University Water Resources Management Water Station.

Field trials on the application of equal amount of fertilizers to soils with low, medium and high nutrient status for one cropping season showed a higher crop yield response (kg crop per yield per kg applied fertilizer) in soil with low fertility level than in soil with high nutrient status. This simply shows that at very high fertilization rate, the excess amount of nutrients not utilized by the crops is wasted and lost to the environment. Thus, higher fertilizer utilization efficiency can be achieved and nutrient losses will be reduced if the right amount and timing of application will be considered.

Assessing and Optimizing Irrigation System Performance for Corn Production: Minimizing Field Water Losses

To cope with the declining availability of fresh water for agriculture, it is necessary to adopt water saving techniques. In line with this, PNRI undertakes a study to assess furrow irrigation system and to minimize field losses such as deep percolation and surface runoff.

The study involved the following: (1) determination of the infiltration function of the dominant soil types

using double ring infiltrometer; (2) monitoring of soil water dynamics by automated soil moisture meter (Diviner 2000TM) and standard gravimetric method; and (3) measurement of irrigation water inflow and outflow by rectangular flumes. The data obtained in the study served as inputs to the volume balance model, a mathematical tool used to evaluate the furrow irrigation application efficiency considering water distribution along the furrows and below the soil.

The initial evaluation and optimization of the volume balance model showed satisfactory results. The model gave a coefficient of determination of 98 percent when used to validate the actual field data on water distribution along the furrow and below the soil. This optimized model will then be utilized as basis for the preparation of future corn furrow irrigation systems procedural manual.

Water Balance and Loss Assessment of the Upper Pampanga River and Magat Integrated Irrigation Systems

Smart-farming and precision technologies, enhanced by nuclear analytical techniques, are being applied in this study to reduce nutrient and water losses in rice and corn production, thereby increasing the irrigated area and crop productivity.

In support of this activity, PNRI fabricated a prototype low-cost equipment for air moisture sampling/ collection and analysis of its oxygen-18 (^{18}O) signatures which will then be used to calculate soil water evaporations and crop transpirations during different stages of crop growth. The calculations are crucial in understanding its eco-hydrological processes and their underlying mechanisms, and in improving the establishment and validation of hydrological models at the ecosystem scale for better water management.

Effects of Biofertilization and Nitrogen Levels on Nitrogen Nutrition of Grain Cereals

The PNRI, in collaboration with the Philippine Rice Research Institute (PhilRice) and the Bureau of Soils and Water Management (BSWM), conducts this study to: (1) test the efficacy of biofertilization (*Azospirillum* spp inoculants) on rice and corn; (2) establish the best combination of biofertilizer and inorganic nitrogenous fertilizer for enhanced growth performance and yield of grain cereals; and (3) directly quantify the contribution of biological nitrogen fixation (BNF) to the nutrition of the crops.

Initial results of the study showed that the yield response and nitrogen uptake in both biofertilized rice and corn were comparable to that of inorganic fertilization. This may imply that biofertilization may have added to the total nitrogen nutrition of the crops. The direct quantification on the contribution from BNF by nitrogen-15 isotope dilution technique is currently being undertaken using an isotope ratio mass spectrometer.

Efficacy of Gamma Sterilization Technique for Biofertilizer Carrier Production

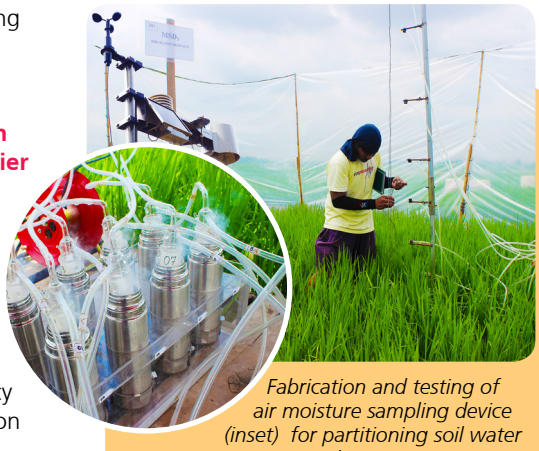
The current method of sterilizing the biofertilizer carrier is by autoclaving which demands a lot of time and energy. To explore an alternative to this method, PNRI agriculturists evaluated the efficacy of gamma irradiation as sterilization technique for biofertilizer carrier production.

The results of evaluation showed that a dose equal to or higher than 20 kGy was effective in the sterilization of unwanted microbial population in newly mixed biofertilizer carrier samples. Analysis also showed that the gamma irradiation technique is more economical, efficient and practical compared to autoclaving method especially in large-scale production.

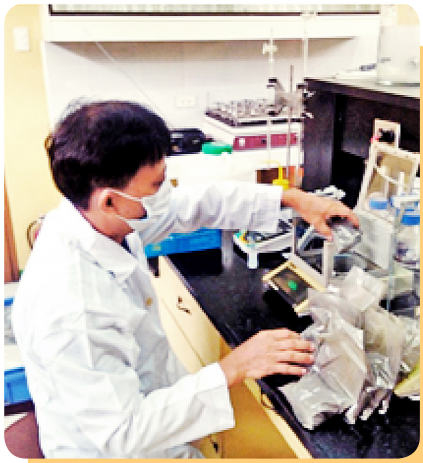
Isotope Techniques and Fertigation to Improve Water and Nutrient-use Efficiencies of Mungbean

The main objective of the study is to increase uptake efficiency and reduce loss of soil nutrient and water resources in mungbean production through isotope techniques and fertigation.

Monitoring and measurement of soil moisture using Soil Moisture Neutron Probe



Fabrication and testing of air moisture sampling device (inset) for partitioning soil water evaporation and crop transpiration



Preparation of biofertilizer carrier prior to gamma irradiation

Field visit of the project staff at the fertigation experimental site at the National Soil and Water Resources Research and Development Center in Bulacan

Feeding of adult irradiated and unirradiated Brontispa longissima in the laboratory

The experiment was carried out at the Bureau of Soils and Water Management - National Soil and Water Resources Research and Development Center (BSWM-NSWRRDC), Bulacan and Tanay Stations. Initial results showed a significant increase in biomass and grain yield as well as greater savings in terms of manpower and water resource utilization in the first cropping season. To validate the initial results, a second cropping was conducted to implement the following activities: fertigation set-up, nitrogen-15 isotope labeling of fertigation water, thinning, continuous monitoring and maintenance of the standing crop.

Evaluation of the Effects of Radiation-modified Carragenan and Chitosan on the Growth and Yield of Mungbean

Radiation-degraded polysaccharides can induce various kinds of bioactivities such as growth promotion of plants, suppression of heavy metal stress on plants, anti-microbiological and anti-viral activities. Previous PNRI studies indicated that irradiated polysaccharides, such as alginate, chitosan or carrageenan, are effective as plant growth promoters (PGP). The current study shows that irradiated chitosan and carrageenan are very effective as plant growth promoters in mungbean plants.

Pot experiments (three replicates per treatment) conducted at PNRI indicated that irradiated carrageenan was more efficient than irradiated chitosan as growth promoter. Foliar spraying with irradiated carrageenan at a concentration of 60 parts per million (ppm) on mungbean plants can increase the yield up to 419 percent and reduce the number of days to flowering by around 16 days. For chitosan, physiological effects were optimum at 40 ppm.

PEST CONTROL

Effect of Gamma Irradiation on the Sterility of *B. longissima* (Gestro)

As part of the project entitled "Development of integrated pest management strategies against *Brontispa longissima* (Gestro) and other palm species", the PNRI, in collaboration with the Philippine Coconut Authority in Albay, undertakes a study on determining the radiation dose that will cause sterility in *B. longissima* — one of the most destructive insect pests of coconut and other palm species. The study involves the exposure of adult males or females of *B. longissima* to different doses of gamma radiation at the PNRI Gammacell-220 irradiator. Adult males that emerged or developed from pupae irradiated with doses ranging from 20 to 50 Gy were then mated with unirradiated females.

Results showed that: (1) egg hatch decreases as dose increases; (2) at 40 Gy, eggs laid by unirradiated females mated with irradiated males hatched into larvae but did not develop into adults; (3) at 50 Gy, an unirradiated female laid one egg but failed to hatch into larva and mortality of adults was about 30 percent at 14 days after irradiation; and (4) complete sterility of adult females irradiated with doses ranging from 20 to 40 Gy was observed.

HEALTH AND MEDICINE

Development of Safe, Quality and Shelf-Stable Filipino Ethnic Foods for Immuno-compromised Patients and Calamity Victims

In collaboration with a team of nutritionists and dieticians in a government hospital, the Biomedical Research Section continued to use gamma irradiation for developing safe, shelf-stable and ready to eat food for immuno-compromised patients and for victims of calamities such as typhoons and earthquakes. Irradiation has been proven effective in providing safe and quality food by killing the pathogenic microorganisms that cause spoilage without significantly altering the physico-chemical, sensory and nutritional qualities of the irradiated food.

Cooked Chicken Adobo

Further studies on the effectiveness of irradiation on this ethnic food showed that adobo inoculated with pathogens, *E. coli* and *Listeria*, had non-detectable pathogen counts . On the other hand,

non irradiated adobo exhibited high pathogen counts even up to 60 days in frozen condition.

No significant difference in the protein and Vitamin B1 contents was observed between the irradiated (25 kGy) and non-irradiated chicken adobo.

Brown Rice

The study on using radiation to assess the physico-chemical, microbiological and nutritional qualities of brown rice (RC 160 variety) and to extend its shelf life is an ongoing undertaking of PNRI.

This year, results of the microbiological analysis of brown rice during storage showed that: (1) a minimum dose of 1 kGy gamma radiation is effective in decontaminating the mold and yeast counts in brown rice; (2) irradiated samples were comparable with the non-irradiated lots in terms of pH, moisture and amylose content; (3) protein and fat contents of the treated and non-treated brown rice have similar values; and (4) irradiation has no effect on the qualities of brown rice packed in vacuum and non-vacuum conditions during four months storage. Further studies will be conducted to assess other important parameters and to determine the maximum shelf-life of irradiated brown rice.

Fresh Fruits

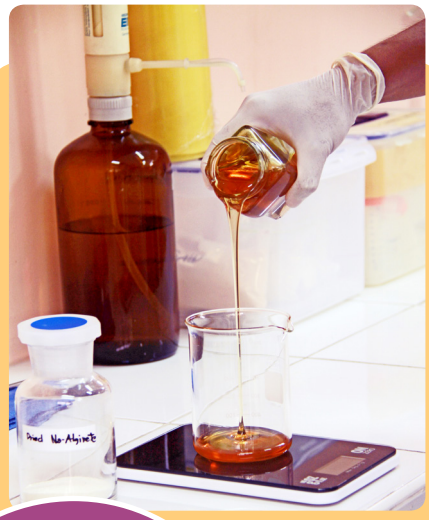
Research study on the effectiveness of irradiation as a method to ensure microbial safety and quality of pre-cut fresh fruits like melon and mangoes showed a significant reduction in microbial population for fruits packed in vacuum condition and irradiated at a minimum dose of 3 kGy.

Development of Honey Alginate Wound Dressing

PNRI has developed a honey-alginate wound dressing in 2012 which was suitable for radiation sterilization at 25 Gy in its final packaged form. The patent for the wound dressing and its manufacturing process has been filed at the Intellectual Property Office under Patent Application No 1-2012-000219.

For this period, PNRI produced a total of 1,665 radiation-sterilized honey alginate wound dressings of three different sizes (2 x 2, 3 x 3 and 6 x 6 inches) for physico-chemical tests, animal tests and pre-clinical trials.

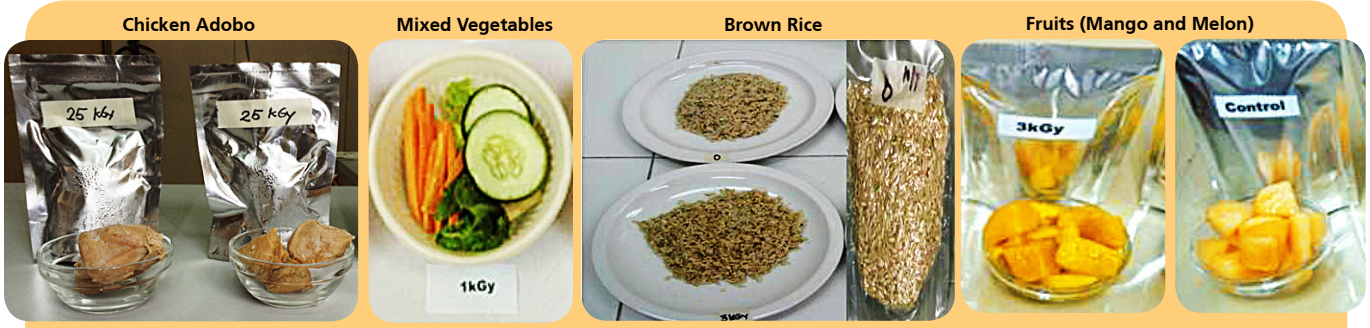
Physico-chemical evaluation showed that the honey alginate wound dressing has a slightly acidic pH (pH 4.4) which is lower than that of alginate alone (pH 5.5). Wound dressings with slightly acidic pH creates unfavorable environment for bacterial growth, and are thus preferred as ideal wound dressing.



Honey alginate wound dressing developed by the PNRI

Animal trials were done in cooperation with University of the Philippines Los Baños (UPLB) Bee Program Veterinary Medicine to determine the wound enhancing property of the wound dressing. Tests conducted on mice showed that the wound dressing has good or comparable performance with the commercial antibiotic used in treating wounds.

Pre-clinical trials performed at three government hospitals to determine the effectiveness of the dressing to human patients showed promising results. Tests for the absorption rate of the



Complete meal for immuno-compromised patients

Formulated hemostats in powder (top photos), granular (middle) and gauze forms (bottom photos)

Feeding of adult mosquitoes (Aedes aegypti) in screen cage

alginate containing wound dressing revealed the ability of the dressing to contain the wound fluid that it has already absorbed. Moreover, sterility tests conducted on irradiated honey alginate dressing have shown no viable microorganisms and that samples tested remained sterile for the 14-day incubation period. Initial sterility tests performed for the wound dressings that were produced with the new packaging material (PET-PE), showed that all of the dressings were negative of any microorganism.

Hemostatic Agents from Radiation-Modified Polysaccharides and their Derivatives

PNRI has an ongoing study on the development of a hemostatic material/ agent from radiation modified-polysaccharides and derivatives that is comparable or superior to the imported products currently available in the market.

Various natural and synthetic polymers were tested for potential hemostatic capability through whole blood clotting experiments. Both the raw materials and later their combination formulated into hydrogels were tested. Initial screening demonstrated the efficiency of polyvinyl pyrollidone (PVP), polyethylene oxide (PEO), carboxymethyl kappa-carrageenan (CMKC) and carboxymethyl cellulose (CMC) in stimulating blood clotting.

Blood variation during whole blood clotting further discerned materials which had the highest hemostatic capability, as well as to test their endurance at higher volumes of blood. Commercial products like medical gauzes, Celox® and Quikclot® were tested for comparison. Most of the hydrogels (in granular form) showed greater efficiency than gauze and Celox® even at higher blood volumes. Quikclot®, on the other hand, was able to give competitive capability in the whole blood clotting experiment. Platelet adhesion assay was carried out as a supplementary test and showed once again the effective pro-coagulation activity of CMKC, CMC and PEO/KC hydrogels but they were not as efficient as Quikclot®, suggesting the product's advantage in primary hemostasis.

Sterile Insect Technique Using Gamma Irradiation

Development of Sterile Insect Technique for Dengue Mosquito Vector *Aedes Aegypti* Using Gamma Irradiation

A sterile insect technique for the dengue mosquito vector, *Aedes aegypti*, is being developed at PNRI using gamma irradiation as an alternative method of control.

This year, *Aedes* mosquitoes were continuously reared in steel cage cubicles at the PNRI laboratory as source of test insects. Radiosensitivity studies were conducted using different developmental stages of *Ae. aegypti* viz. egg, larva and pupa using doses ranging from 20 to 100 Gy. Unirradiated lot served as the control.

Results showed that the egg was the most sensitive to irradiation, followed by the larva and pupa. Pupal irradiation of *Ae. aegypti* showed that adult emergence was not considerably affected with varying doses of gamma radiation. At 100 Gy, there was no emergence of adult capable of flight.

Based on polymerase chain reaction analyses conducted at the University of Manila, persistent occurrence of dengue virus samples were obtained from 1st to 10th generations of the mosquitoes. The virulence of the transmitted virus has been verified up to the second generation in the mouse assay.

ENVIRONMENTAL PROTECTION AND MANAGEMENT

Nuclear Analytical Techniques in Harmful Algal Bloom Studies

Field Detection System for Saxitoxin: A Novel Approach Using the Receptor Binding Assay Technology

The Receptor Binding Assay (RBA) developed by PNRI has been recently validated and accepted by the Association of Official Analytical

Chemists (AOAC) as a standard method of analysis for paralytic shellfish poisoning (PSP). PSP is the most common form of seafood poisoning in the Philippines brought about by harmful algal blooms or "red tide".

In the interest of promoting the use of RBA and to apply the method for in situ (field) detection of PSP toxins, a novel analog of mu-conotoxin has been developed by the Institute and evaluated as ligand in RBA. Recently, the Chemistry Research Section, in collaboration with the International Atomic Energy Agency and the Marine Science Institute of the University of the Philippines-Diliman, worked toward the optimization of the process for ligand production (specifically, the radiolabeling procedure), and assay development.

PNRI has evaluated several factors, conditions, and procedures, from which a 'working protocol' for the gamma-based RBA was established. Initial evaluation has demonstrated the potential for a semi-quantitative 'go-or-no go' test to detect saxitoxin, one of the PSP toxins, with sensitivity comparable to the current RBA method. Subsequent work will focus on a systematic validation and further adaption of the proposed protocol to an assay format that is more suitable for field use. A detailed study of other factors that could affect assay performance will also be carried out.

Nuclear and Isotope Techniques Applications in Water Resources Management

IAEA Water Availability Enhancement (I-WAVE) Project

The International Atomic Energy Agency Water Availability Enhancement Project (IWAVE) aims to enhance the availability and sustainability of freshwater (with an emphasis on groundwater) through science-based, comprehensive assessments of national water resources. In collaboration with the Mines and Geosciences Bureau (MGB) and the National Water Resources Bureau (NWRB), PNRI implements this project in the following study areas: Water Resources Region 2 (WRR 2) covering the provinces of Cagayan, Isabela, Quirino, Nueva Vizcaya, and parts of Kalinga and Mountain Provinces; and WRR 10, covering the provinces of Misamis Oriental, Bukidnon, Agusan del Sur and Norte, Dinagat Islands, and Surigao del Norte.

IWAVE involves the use of isotope hydrological techniques coupled with classical hydrogeochemical methods to improve the understanding of recharge processes, origin of recharge, and residence time of groundwater at appropriate local scales to contribute to the national assessment of freshwater resources in the country. The isotopes utilized include ^{18}O, ^{2}H, ^{3}H, ^{14}C and $^{3}H/He$ and CFC.

From 26 municipalities in Region 2 and 40 municipalities in Region 10, PNRI researchers have obtained isotopic and physico-chemical data which could provide preliminary assessment on the nature of recharge and water types of the groups of groundwater. These data will be integrated with hydrogeological data for a more effective groundwater assessment.

Nuclear Analytical Techniques in Marine Environment

Assessment of Nutrient Loading from Various Sources Into the Manila Bay

The basic problem in controlling nutrient loads into the Manila Bay is the difficulty to distinguish among contributions from natural sources and various point and non-point nitrogen (N) sources, such as fertilizers, animal waste, and sewage. Identifying the source of nitrogen in downstream reaches of surface water using chemical properties alone is complicated because, nitrogen compounds are not ideal for use as tracers.

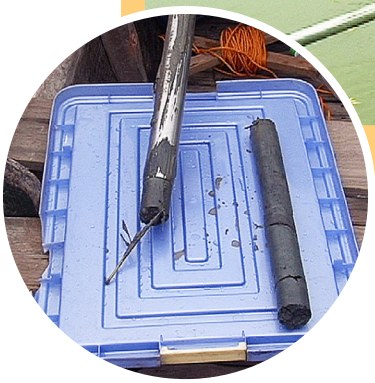
This study made use of the unique diagnostic capability of stable isotope techniques to trace the various anthropogenic inputs of nitrogenous compounds in the Pampanga River Basin. The multi-isotope approach was used because nitrogen isotopes alone have been shown to be inadequate in

PNRI research specialist performs gamma counting to measure radioactivity in the Receptor Binding Assay, a technique that is currently being developed and evaluated for in-situ detection of paralytic shellfish toxins

PNRI undertakes sampling missions in Regions 2 (Luzon) and 10 (Mindanao) for groundwater age determination using isotope techniques with IAEA expert Takuya Matsumato.

Manila Bay Map

Sediment sampling using suction auger



providing definite signatures due to overlapping signals and changes in the isotopic signal with denitrification in aquatic environments. Thus, the isotopes of nitrogen and oxygen in dissolved nitrate, oxygen and hydrogen in water, and carbon and nitrogen in particulate organic matter, plant tissues, and top soil, were determined.

The ^{15}N and ^{18}O compositions of dissolved nitrate in the Pampanga River Basin. These yielded the following signatures for the different sources: livestock and fishery -> inorganic fertilizer; croplands -> soil N; domestic -> soil N and sewage/septic. Croplands did not reflect the signature of synthetic fertilizer but that of the nitrification of NH_4 fertilizer. Information provided by the ^{18}O values in meteoric water indicated that nitrification was the main pathway for nitrate production in the study area.

Characterization of the non-point N-sources based on the Isotopic fingerprints obtained from the point sources. These revealed that domestic, cropland, livestock, and fishery influenced the isotopic composition of the materials but domestic and croplands provided the most significant influence. Generally, the mixing of cropland and domestic sources of N occurred. Livestock also contributed to a lesser extent. The signature coming from livestock activity which consistently exhibited that of synthetic nitrate fertilizer indicates a direct input from such sources in the river system.

Relative contribution of the dominant sources (domestic, cropland, and livestock) to the total nutrient load from the basin. This was estimated using a three source-two-tracer isotope mixing mode based on $\delta^{13}C$ and $\delta^{15}N$ values. The model revealed that cropland sources generally contributed the most to pollutant loading during the wet season, from 22 to 98 percent, while domestic waste contributed higher in the dry season, from 55 to 65 percent.

A two-source-one isotope mixing model, using $\delta^{13}C$ values. This was used to determine the extent of terrestrial input in the offshore Manila Bay environment. The relative contribution of terrestrial inputs into the Manila Bay was estimated from the isotopic composition of the off shore surface sediments. The mixing model showed that 17 to 30 percent of the organic matter deposited in the Bay comes from terrestrial activities from the Pampanga River basin, mostly from agriculture.

Applications of Isotope and Geochemical Techniques to Uncover Sources of Organic Nutrient Contamination in the Neritic Zone of Boracay Island

The DOST Grants-in-Aid funded study uses stable isotopes to determine the status and health of the waters, corals, and white sand of Boracay Island, and the origin of contaminants which have been held responsible for algal blooms in the area. The sample collection and field data measurements have been completed in 12 sites in Boracay and nearby islands. Pre and post-monsoon samples of seawater, biota, sediment, sewage, surface water and groundwater were collected and analyzed for water chemistry, sediments and microbial load.

Results show that areas in Boracay are contaminated by coliform bacteria and blue green algae (cyanobacteria) with high or unusual levels of nitrogen or phosphorus in seawater and sediments. These algal blooms are caused by septic sewage and canal outflows, land-based run-offs and submarine groundwater discharges. Some corals are also contaminated with inorganic fertilizers. In some areas, researchers also detected lead, chromium and zinc, which indicate pollution caused by human activity and/or organic matter decomposition. Using various isotopes of elements found in seawater, biota and sediments such as tritium, oxygen-18, nitrogen-15 and carbon-13, PNRI researchers identified the sites where these contaminants are abundant.

While disproving the local misconception that the algae eventually turns into the well-renowned Boracay white sands, the study has also demonstrated the practicality of applying isotope–based techniques in conjunction with other chemical methods for the tracking down of the sources of nutrient contamination in polluted systems. The study will provide the scientific basis for the Department of Environment and Natural Resources, Department of Tourism and local government units in the area for formulating future policies and actions such as zoning ordinances and establishment of wastewater treatment plants, among others.

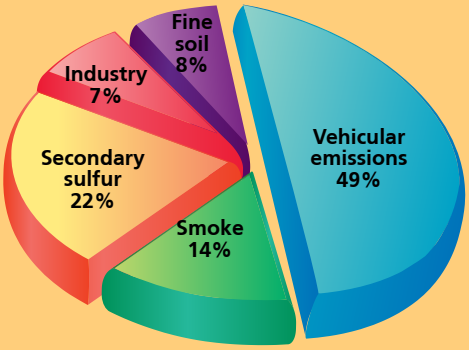
Air Pollution Studies Using Nuclear and Related Analytical Techniques

To demonstrate the important use of nuclear and related analytical techniques to generate multi-element data for use in receptor modeling, the PNRI continues to monitor particulate matter in the PM_{10} range (fractionated into coarse or $PM_{2.5-10}$ and the fine or $PM_{2.5}$ fractions). Black carbon and organic carbon/elemental carbon data are also generated.

Gent sampler set-up at an air monitoring station

Air Pollutant Source Identification and Apportionment Studies

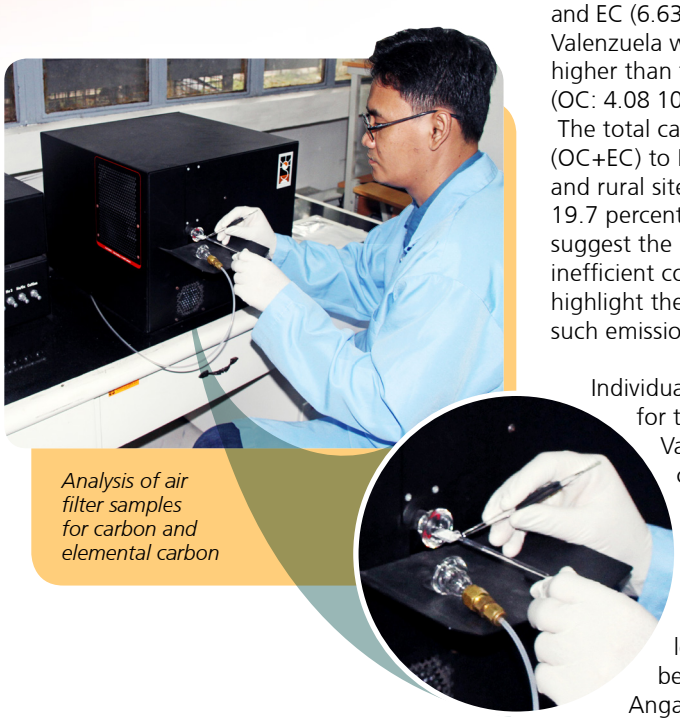
Air particulate pollution continues to be of great concern in Metro Manila. Since 2001, PNRI monitoring stations at the Ateneo de Manila University (ADMU) in Quezon City; Valenzuela City and Saint Pedro Poveda College in Pasig City showed $PM_{2.5}$ in exceedance of the World Health Organization (WHO) long-term guideline value of $10\mu/m^3$. Through the use of nuclear and related analytical techniques (NATs) and receptor modeling, particulate matter fractionation (PMF) sources of air pollutants were identified and apportioned. PMF results in the ADMU sampling site showed that about 49 percent of the fine particulates come from vehicular emissions. Other sources are smoke (14 percent), secondary sulfur (22 percent), fine soil (8 percent) and industry (7 percent).



Apportionment of the Air Pollution Sources Using Positive Matrix Factorization at the Ateneo De Manila University (ADMU).

Organic Carbon/Elemental Carbon. A study on the organic carbon/elemental carbon in an urban site (Valenzuela City, Metro Manila) and a rural (Angat, Bulacan) site in the Philippines from September 2011 to August 2012 was undertaken by a PNRI research specialist as part of the researcher's masteral thesis entitled "Carbonaceous particulate matter characterization in an urban and a rural site in the Philippines". The results of the study were published in the Journal of Atmospheric Pollution Research 5: 245-252.

The study involved measurements of the concentrations of organic carbon (OC) and elemental carbon (EC) in $PM_{2.5}$ at the two sites by thermal-optical reflectance analysis following



Analysis of air filter samples for carbon and elemental carbon

IMPROVE – A protocol. Results of the study showed that the Philippine sites have intermediate OC concentrations and greatly elevated EC levels as compared to neighboring countries in Asia. Moreover, OC (8.00 10 μg m^{-3}) and EC (6.63 10 μg m^{-3}) levels in Valenzuela were two to three times higher than those in Angat (OC: 4.08 10 μg m^{-3}, EC: 2.29 μg m^{-3}). The total carbon contributions (OC+EC) to $PM_{2.5}$ mass for the urban and rural sites were 38.9 and 19.7 percent, respectively. These suggest the presence of highly inefficient combustion sources and highlight the need for the regulation of such emissions.

Individual OC and EC fractions for the two sites showed that Valenzuela is dominated by carbon fractions which points to vehicular, industrial and culinary sectors as the possible main emission sources. While generally having lower concentrations and being less EC-dominated, Angat had remarkably higher levels of the EC fraction which suggests a unique EC source in the area.

Characterization of Carbonaceous Aerosol Emissions of Different Combustion Sources

Preliminary data on this project were collected from April to May 2013. The data were obtained from air particulate samples obtained from cars which used unleaded gasoline, diesel and liquefied petroleum gas (LPG) for fuel and from three tricycles composed of 2-stroke and 4-stroke types and having either premium or unleaded fuel. All samples were collected within a 15-minute duration with the vehicle revving at a stationary position. These samples have also been coded according to the type of vehicle and type of fuel used by the vehicle. Thermal-optical analyzer (OCEC by Sunset Laboratories) was used to analyze the collected air particulate samples for organic and elemental carbon levels.

The OCEC fractionation observed from the aerosol samples from unleaded gasoline, diesel-fueled cars and LPG-fuelled taxi indicated distinct differences in the OCEC profiles for the different vehicular sources considered in the preliminary study.

Further study will include combustion sources limited to vehicular emissions, tyre pyrolysis, and biomass burning. Data generated will form the basis for establishing fingerprints for these combustion sources for use in refining/ improving the resolution of source apportionment studies. Better resolved air pollutant sources will lead to a better understanding of air quality. Thus, preventive or mitigation measures can be air pollutant source-specific, leading to better air quality management for the improvement of air quality in the area.

Improvised set-up for the collection of air particulate samples from the tail pipes of vehicles

Environmental Radioactivity Monitoring

Radiological Impact Assessment of the Fukushima Nuclear Accident in the Philippine Marine Environment

To further assess the possible impact of the Fukushima Daiichi Nuclear Power Plant accident which occurred in 2011, PNRI researchers continued to collect and analyze seawater and biota samples in the country's marine environment for presence of the radionuclides cesium-134 (^{134}CS) and cesium-137 (^{137}Cs). Gamma spectrometry using a High Purity Germanium (HPGe) detector was used to determine the concentration of the radionuclides in marine samples taken from the Ilocos region, Quezon

Province (Polillo Island) near Benham Rise, Camarines Sur, Sarangani Bay and Lagonoy Gulf.

Average activity concentration of ^{137}Cs in seawater samples was found to be 1.0 ± 0.3 Bq/m^3. This value is within the range of values for ^{137}Cs in seawater reported in the Asia-Pacific Marine Radioactivity Database (ASPAMARD), which ranged from 0.3–11.5 Bq/m^3. ^{134}CS was not detected in any of the seawater samples analyzed. Likewise, concentration of ^{137}Cs in fish samples (alumahan, bariles, bolador, dilis and galunggong) from Sarangani Bay was found to be all below detection limit (<0.89 Bq/kg).

Marine Scientific Research (MSR) Cruise - As a member of the Department of Foreign Affairs (DFA) Technical Working Group on Marine Scientific Research (MSR), the PNRI had the opportunity to collaborate with the DFA's Ocean Concerns Office on the applications of foreign countries to conduct cruises within the Philippine maritime jurisdiction. This year, PNRI participated in the MSR cruise conducted by the National Fisheries University of Japan in November 2013 on board the Japanese fisheries training vessel Koyo Maru to collect seawater samples in the West Philippine Sea. The seawater samples collected during the cruise are currently being analyzed.

ASPAMARD Management - The Philippines, through PNRI, serves as the focal point for compiling the Asia Pacific Marine Radioactivity Database (ASPAMARD). PNRI addressed suggestions from the Member States to revise the template forms used for submission of data on radionuclide concentrations in seawater, sediment and marine biota in the Asia Pacific region. As of 2013, nine RCA Member States have already submitted data to PNRI. The data will be evaluated by IAEA experts once all Member States have provided their inputs. The results of the evaluation will then be uploaded in the Marine Radioactivity Information System (MaRIS).

Radioactivity Monitoring in PNRI Grounds and Vicinities

In line with PNRI's environmental monitoring program, the Health Physics Research Section measures ambient gamma radiation and analyzes environmental samples for radioactivity.

Collection of seawater samples in the West Philippine Sea during the Koyo Maru cruise for the analysis of anthropogenic radionuclides ^{134}Cs and ^{137}Cs

The PNRI generated quarterly radioactivity monitoring data within PNRI grounds and measured ambient gamma radiation in the cities of Baguio, Davao, General Santos and Sarangani.

Results of the average ambient gamma radiation measurements within PNRI grounds was found to be 55± 9 nanosievert per hour (nSv/hr). This value is within the normal background level in PNRI which ranged from 42 to 60 ± 7 nSv/hr. The average level of radioactivity in selected sites in Baguio City was found to be 38± 5 nSv/hr while the average ambient gamma radiation measurements in Davao City, General Santos City and Sarangani City were 42±5, 40±5 and 43±5 nSv/hr, respectively. These values are within the normal background levels and do not pose any hazard to the general public.

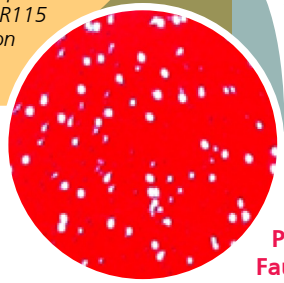
Ambient gamma radiation monitoring within PNRI grounds

Radiological Assessment of NORM/TENORM in the Philippine Environment

PNRI collected and analyzed samples of naturally-occurring radioactive materials (NORM) and technologically-enhanced NORM (TENORM) used in industrial materials to determine

Installation of new VSAT antenna reflector at NDC-PH in PNRI for transmission of data to the CTBTO International Data Center

Track density measurement of radon gas using LEICA-DME trinocular microscope (inset: Processed LR115 film spots are radon emanations (10x)



the radioactivity concentrations of potassium-40 (^{40}K), thorium-232 (^{232}Th) and uranium-238 (^{238}U) progenies in the samples. A gamma spectrometer with HPGe detector was used for the analysis.

Analysis of the samples (e.g raw coal, shale, gypsum, limestone, silica and cement) obtained around the vicinity of Northern Cement Corporation in Sison, Pangasinan and in HOLCIM Cement Manufacturing Plant in Davao City indicated an average ambient gamma dose rate of 46 nanosieverts per hour (nSv/hr). External exposure to this radiation level does not pose harm to the public.

Management of CTBTO Stations in the Philippines: RN52 and NDC-PH

The Philippines, through PNRI, has been participating in the global monitoring of radiation released in the environment from nuclear testing and accidents as part of its commitment under the Comprehensive Nuclear –Test- Ban Treaty Organization (CTBTO). This commitment entails continuous management of the daily operation (24/7) and maintenance of the RN52 radionuclide monitoring station in Tanay, Rizal and the National Data Center (NDC-PH) at PNRI which receives International Monitoring System (IMS) data from the International Data Center in Vienna, Austria.

This year, the Institute undertook the following activities: (1) installation of automatic transfer switch, data acquisition system and temperature and humidity sensor at RN52 station; (2) installation of new VSAT antenna reflector at NDC-PH; and (3) renewal of radio station licenses for CTBTO Stations in the Philippines (RN52 in Tanay, NDC-PH at PNRI, seismic stations AS79 in Davao City and AS80 in Tagaytay City).

Radon Monitoring of the Philippine Fault and the Valley Fault System

The objectives of this project are to use radon, a naturally–occurring radioactive gas, as precursor of an impending quake along the north-central segment of the Philippine Fault (PF) and Valley Fault System(VFS) and to contribute in strengthening the monitoring program being undertaken by PHIVOLCS along the north-central segment of the PF and VFS.

PNRI conducted monthly measurement of radon gas using two approaches: the short-term in-situ soil/gas radon monitoring using an electronic portable radon gas detector (Durridge RAD-7) and the long-term alpha track detector system. Gamma ray spectrometric measurements of potassium (K), uranium (U), thorium (Th) and dose rates were made using RS-230 gamma ray spectrometer to collect radiometric data of the rocks along the fault system.

In-situ monitoring system. The Institute carried out measurement of radon soil/gas, K, U, Th and dose rates along 27 established stations along the West and East Valley Fault from Rodriguez, Rizal at the north end and of Muntinlupa City at the southmost end. There are 14 stations being measured along the fault and 10 points along one traverse station across the West Valley Fault. There are only four stations subjected to radiometric measurements along the East Valley Fault.

Radon values measured range from 3.3 to 245 counts per minute (cpm). The low radon values were obtained at the East Valley Fault at less than 20 cpm. Higher radon levels ranging from 40 to 245 cpm were obtained at West Valley Fault.

Measurements obtained by PNRI during the whole year showed no major deviations from previous readings which suggest none to very low seismic activities within the Valley Fault System. PNRI also evaluated any possible effect to the Valley Fault System by the Bohol earthquake (M-7.2) that occurred on October 15, 2013. The radon readings before and after the event obtained no anomalous values higher than 245 cpm. The 245 cpm value is the highest radon gas emanation value obtained from previous readings obtained in the area.

Long-Term Radon Measurements in Soil Using LR115 Alpha Track Detector. Radon measurement in the soil employing LR-115 alpha track plastic detector for earthquake monitoring was carried out along the north-central segment of the Philippine fault in

north-Central Luzon and the Valley Fault System which transected a major portion of Metro Manila.

Along the Philippine fault, the results showed elevated radon concentrations in the months of April to May then dramatically dropped towards the subsequent periods. These high radon concentrations gave rise to several anomalies which were correlated to the magnitude 4.5 quake that occurred on December 18, 2013 with epicenter at San Quintin, Pangasinan. This quake was felt in areas transected by the north-central segment of the Philippine fault.

Moreover, a magnitude 4.2 earthquake occurred 12 kilometers northeast of Dingalan, Aurora on September 7, 2013. This quake possibly induced stress in some adjoining radon monitoring stations, particularly along the Gabaldon fault which is within the strain radius and was manifested by the slight increase in radon concentrations prior to seismic event.

Towards the Valley Fault System, the radon values exhibit large fluctuations which could be ascribed to changing weather conditions. The radon values are discernibly higher along the West Valley Fault System which is considered more seismically active than the East Valley Fault System. During the period of measurement, no seismic activity was reported; however, four spike-lie radon anomalies probably attributed to physical changes in the environment and not related to induce of stress were manifested in different occasions.

Enhancing Cytogenetic Biological Dosimetry Capabilities of the Philippines

As part of the Institute's activities on nuclear emergency preparedness and routine monitoring of radiation exposures, the PNRI conducts studies on establishing a dose-response calibration curve for reliable estimate of absorbed radiation dose of individuals suspected of having accidental radiation exposure or occupational overexposures. The study includes in-vitro irradiation of blood samples from normal and healthy donors for dicentric analysis of chromosomes.

As preparatory work for the actual irradiation of blood samples, calibration activities for dosimeter readers were undertaken using nanodot dosimeters irradiated at the cobalt therapy facility of the Veteran's Memorial Hospital in Quezon City. Blood samples from eight healthy individuals, together with the calibrated dosimeters, were irradiated at varying doses using the above mentioned facility to ensure that the desired doses to be delivered to the blood samples are accurate for a reliable dose-response calibration curve. Once all the samples have been analyzed, a final calibration curve for the chromosome dicentric assay will be established.

Blood samples and OSL nanoDot dosimeter irradiation using the cobalt-60 radiotherapy unit of Veterans Memorial Hospital

HARNESSING EMERGING TECHNOLOGIES TO BOOST INDUSTRY COMPETITIVENESS

Radiation Grafting of Non-Woven Matrices and Natural Fibers for Metal Adsorption

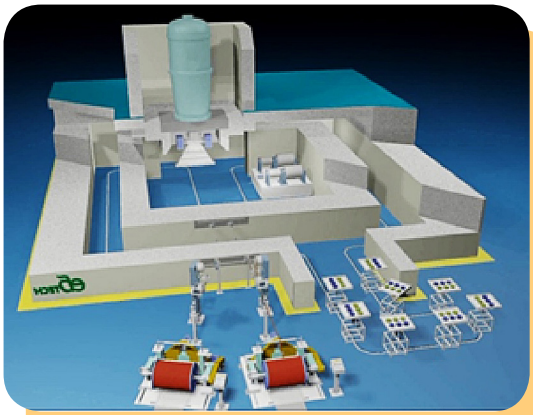
Radiation-induced grafting is widely used for expanding the utilization of synthetic and natural polymeric materials. This is achieved by modifying the original polymers through introduction of graft polymer chains which contain functional groups that are responsible for the new properties of the polymer material. Through this technique, the Chemistry Research Section developed a metal ion adsorbent based from abaca/polyester nonwoven fabric obtained from the Philippine Textile Research Institute. The adsorbent is synthesized using electron beam pre-irradiation technique followed by emulsion grafting of glycidyl methacrylate with subsequent ring opening reaction of the epoxy groups with ethylenediamine.

Using batch adsorption, the researchers found that the synthesized adsorbent has greater nickel and copper adsorption capacity and higher rate of adsorption than a commercial ion exchange resin.

A PNRI research specialist uses the nitrogen gas line to prepare the grafting reaction vessel.

Grafted abaca/polyester nonwoven fabrics

Allanite (center) and monazite (extreme right) mineral grains are separated by hand from bulk samples with the aid of a stereomicroscope (extreme left).



A typical Electron Beam Facility by EB Tech in South Korea, who provided the same model to PNRI

Institution and Capacity Building for the Establishment of an Electron Beam Facility

Through an IAEA Technical Cooperation project which started in 2009 and later through a DOST-GIA project that started in 2012, PNRI is currently developing its capability in utilizing the electron beam (EB) technology for the development of functional materials for industrial, health and environmental applications.

The shielding of the EB facility was completed, the auxiliary systems (ventilation, cooling, conveyor and electrical service entrances) were installed and the construction of Phase 1 of the EB facility building is nearing completion. The installation and commissioning of the facility is scheduled by the middle of 2014, after which trial runs on different samples will be conducted.

The EB facility's dosimetry system was also installed by Dr. Florent Kuntz of Aerial Technology Resource Center (the supplier of the equipment), during his visit to PNRI in December 2013.

Establishment of a Centralized Cyclotron Facility

As a result of the pioneering efforts of the task force, comprising of representatives from PNRI, Office of the Government Corporate Counsel (OGCC), Public Private Partnership Center of the Philippines (PPPCP), Technology Research Center (TRC), National Kidney Transplant Institute (NKTI), nuclear medicine practitioners, and potential hospital partners to establish a centralized medical cyclotron facility, the construction of K Health Corporation's cyclotron facility at NKTI compound has begun. It is expected to be completed in 2014. The cyclotron will produce the radiopharmaceuticals, particularly the medical isotopes used as tracers in PET-CT imaging. These tracers will be used by local hospitals with or who will be putting up PET or PET/CT centers. Having this advanced and world-class nuclear medicine imaging service is a milestone in centralized nuclear medicine in the country.

DEVELOPMENT AND APPLICATIONS OF HIGH TECHNOLOGY MATERIALS

Rare Earths, Thorium and Uranium Minerals: Characterization and Applications

The characterization of rare earth and mineral samples found in Palawan using neutron and other techniques is an ongoing activity of the Applied Physics Research Section (APRS). In support of this activity, APRS completed an Instructional Manual on Introduction to X-ray Fluorescence (XRF) Analysis using an americium-241 radioisotope source. This manual covers introductory concepts on X-ray interaction with matter, theoretical background on the calculation of fluorescence peak intensities and basic experiments on XRF using the radioisotope source.

Moreover, two zoom stereomicroscopes were procured and installed to obtain a more accurate separation of thorium-bearing allanite minerals from sand samples from Ombo, Palawan before performing X-ray diffraction

and Mossbauer analysis. These have now been used in the preliminary investigation in Ombo, Palawan to determine the degree of crystallinity and the valency and occupancy of the various iron sites and their correlation to geological and metamictization processes that the mineral has undergone. The stereomicroscopes will also be used in improving the undergraduate thesis undertaken by BS Physics students under the supervision of APRS. The thesis entitled "A Comparison of the Thorium Content of Allanite, Monazite and Zircon in Sand samples from Palawan Using X-Ray Flouresence" identified the thorium content of each individual mineral for three sand samples from different sites in Palawan using only a simplified calculation method.

Characterization of the Natural Radioelement Signatures of Porphyry Copper-Gold Deposits in the Philippines

Using a radiation-based technique (called gamma ray spectrometry) and atomic absorption spectrometry, PNRI determined the concentrations of copper and other industrial elements of soil, rock and drill core samples from Dipidio, Kasibu, Nueva Vizcaya and soil samples from Kingking, Pantukan, Compostela Valley.

This year, PNRI analyzed 307 soil samples for cadmium and 229 for chromium from the mineralized area hosting the Dinkidi porphyry copper-gold deposit in Dipidio, Kasibu, Nueva Vizcaya and from Kingking, Pantukan, Compostela Valley. The concentration of the metals ranged from 0.5 to 3.6 mg/kg for cadmium and 12 to 156 mg/kg for chromium. These trace elements are also being evaluated, aside from their economic significance, to determine if they can be used as pathfinders in the exploration for porphyry copper-gold deposits.

Verification Survey for Radioactive Rare Earth Minerals in Northern Palawan

The PNRI, with funding assistance from the Nuclear Research Foundation, Inc., implemented this project to delineate and determine the geochemical and radiometric characteristics of the rare earth elements thorium – uranium anomalies in northern Palawan and some parts of southern and northern Palawan. This is being carried out by field gamma ray spectrometric survey, stream heavy mineral sampling and analysis by fluorimetry, X-ray fluorescence and atomic absorption spectrometry.

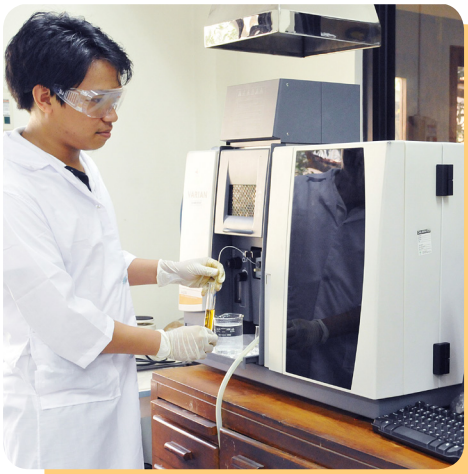
This year, PNRI completed 256 gamma ray spectrometric measurements in 64 data stations, and analyzed samples of heavy mineral panned concentrates, soil and hot spring water in the following areas: (1) Minara-Arutayan-Iraan area in the Municipality of Roxas and Barotuan Taberna-Diapila and Teneguiban -San Fernando areas in the Municipality of El Nido and the Aborlan, Isaub and Iraan-Aborlan rivers in the Municipality of Aborlan, southern Palawan.

The most interesting result of the undertaking was PNRI's discovery of a radioactive hot spring located within Barangay Barotuan in El Nido. The highest gamma ray measurements in soil near the pool of the Makinit hot spring were 399.1 mg/kg uranium and 1,482 mg/kg thorium.

Extraction of Uranium and Other Valuable Materials from Phosphoric Acid

PNRI conducted a pre-feasibility study for the purpose of extracting uranium, rare earth, and other valuable elements from wet phosphoric acid for economic and environmental benefit in the Philippine commercial industry (e.g. fertilizer industry). In-situ gamma-ray spectrometric measurements for uranium and thorium, including dose rate readings in sieverts, were undertaken at the Philippine Phosphate Fertilizer Corporation (PHILPHOS) in Isabel, Leyte to determine the radioactivity concentration of uranium and thorium in the residues and scales that may have accumulated within the industrial pipes of the fertilizer plant.

Results showed that the wet phosphoric acid contains uranium (60–80 mg/kg), vanadium (70–124 ppm), chromium (84–100 ppm), zinc (86–176 ppm), strontium (19–21 ppm), cadmium (5–16 ppm), thorium (1–2 ppm) and total rare earths (18–20 ppm). Aside from the uranium content found, the wet phosphoric acid also contains valuable rare earth elements which may indicate a more economic benefit of extraction.



Elemental analysis using the Atomic Absorption Spectrometer (AAS)

Measurement of potassium, uranium, thorium by gamma ray spectrometry over soil in a hot spring

The preliminary characterization of the phosphate ores and wet phosphoric acid from the Philippine Phosphate Fertilizer Corporation has been completed and the report was submitted for publication in the Philippine Nuclear Journal.

Provision of Quality S and T Services

The PNRI takes to heart the spirit of service to a diverse clientele by performing nuclear analytical services, radiation protection services, irradiation and isotope application as the need or demand arises. Its highly-specialized facilities, equipment and manpower are at the disposal of those who require them, at a quality which comes from years of capacity-building and human resources development.

GAMMA IRRADIATION SERVICES

The Institute continues to provide gamma irradiation services to clients from industrial, medical, government and academic sectors using the Gammacell 220 and the Multipurpose Irradiation Facility (MIF). These services are extended through exposure of samples to a predetermined dose of gamma radiation from a cobalt-60 source inside the irradiation facilities for sterilization, reduction of microbial load, research and other applications.

Gammacell 220

This year, the Irradiation Services Section rendered 97 technical services using this facility to irradiate 554 samples for 28 clients, 18 of which came from the academe and 10 from government research and development institutes. The samples irradiated for research purposes in the facility consisted of small volumes of seeds, ornamental plants, Barako coffee beans, azolla, onions, carabao mangoes, gabi, saba and candaba shoots, blood, *Aedes aegypti pupae*, mosquito eggs and larvae, coconut leaf beetles, mice and optically stimulated luminescence (OSL) dosimeters.

Multipurpose Irradiation Facility (MIF)

This facility has been used for the irradiation of 46,780 bags and boxes of products and samples in order to serve the needs of 66 clients, 51 of which came from the industrial sector, 11 from the academe and 4 from government institutions.

The products irradiated in bulk for commercial purposes include spices, herbal products, dehydrated vegetables, food seasonings, cosmetics (raw materials and accessories), dye, bottles and caps for eye droppers and contact lens solutions, glass vials, medical devices (packs, drapes and covers, calibrated glass, fistula dressing kits, membrane filters), Bio-N substrates and frozen bone grafts.

The samples irradiated for research purposes were chicken adobo, brown rice, fresh vegetables, corn, banana shoot tips, male flowers of cucumber and melon, piña and pineapple fibers, non-woven fabric and cellulose, polymers, carrageenan, chitosan, simulants, packaging materials, water with plastic packaging, hemostat gel, hydrogel, honey alginate dressing, hydrophila, lactic acid, titanium dioxide, AgPAA, nanoparticles, bacteria, *Aedes aegypti* pupae and coconut leaf beetles.

RADIATION PROTECTION SERVICES

Aiming to prevent unnecessary exposure to ionizing radiation and to ensure that radiation doses received by occupationally exposed workers and members of the public are controlled to within the safe limits, PNRI renders radiation protection services to licensed users of radioactive materials and other radiation emitting devices (e.g. X-ray machines). The services provided were the following:

Personnel Monitoring Services: Personal dosimeters such as thermoluminescent dosimeters (TLDs) and the newer optically stimulated luminescence (OSL) dosimeters were provided to about 5,800 workers who are occupationally exposed to radiation to monitor and assess their external radiation exposures. The Institute stepped up its OSL personnel monitoring service, increasing the number of issued units tenfold while phasing out its film badge service.

Standardization and Calibration Services - Through the Secondary Standards Dosimetry Laboratory (SSDL), the PNRI establishes and maintains the national standards for protection level radiation qualities. As in previous years, calibration of the radiation/nuclear instruments and equipment used in various institutions/hospitals were also conducted in the SSDL to ensure accurate and reliable measurements.

Radiation Control Services- Services such as area/air monitoring, swipe sample analysis and leak testing

Loading of products in tote boxes before irradiation

Tote boxes inside the irradiation cell

of sealed radioactive sources were conducted to make sure that work areas and operation conditions of radiation-emitting devices in authorized facilities are in accordance with national radiation safety standards.

Radioactive Waste Management- This covers the collection and proper/safe disposal management of spent (unused) sealed sources and solid wastes generated by licensed users of radioactive materials such as dismantled nuclear gauges containing spent/disused sealed radioactive sources and spent/ disused sealed radioactive source assembly.

Rental of radiation detection instruments (such as survey meters) by authorized users/ facilities for area monitoring around radiation emitting devices in their workplace.

PNRI radiation protection staff performs calibration of Optically-Stimulated Thermoluminescence (OSL) dosimeters (Inset)

CONDITIONING OF SPENT HIGH ACTIVITY RADIOACTIVE SOURCES (SHARS)

With assistance from the International Atomic Energy Agency (IAEA) and the Nuclear Energy Corporation of South Africa (NECSA), the PNRI conducted the meticulous process of conditioning Spent High Activity Radioactive Sources (SHARS) in April. These high-risk radioactive sources, ranging from 100 terrabecquerels (TBq) to 10 petabecquerels (PBq), usually come from radiotherapy units in hospitals used to treat cancer cells and tumors, or irradiation sources used for research purposes such as the sources used in the different PNRI laboratories.

The conditioning project aims to ensure the safe and secure management of these SHARS to protect the public from overexposure as well as to protect the

Calibration of a survey meter in the Secondary Standards Dosimetry Laboratory

RADIATION PROTECTION SERVICES* 2013		
Personnel radiation monitoring	• 11,930 OSLs issued • 11,840 TLDs issued	• 3200 individuals served* • 738 institutions served • 2600 individuals served* • 197 institutions served *individuals are monitored every two months
Calibration of radiation detection instruments	• 534 units of survey meters • 64 units of contamination meters • 408 units of pen dosimeters	• 399 institutions served • 57 institutions served • 133 institutions served
Leak testing of sealed radioactive sources	• 84 on-site leak testing • 10 off-site leak testing	• 14 institutions served
Output calibration of brachytherapy sources	• 12 units calibrated	• 9 institutions served
Output calibration of teletherapy sources	• 2 units calibrated	• 2 institutions served
Calibration of activity meters	• 10 units of activity meters (dose calibrators)	• 10 institutions served
Iodine-131 activity measurement Iodine-125 low dose measurement	• 11 measured • 8 measured	• 1 client served • 1 client served
Area/Air monitoring	• 13 services rendered	• 1 client served
Rental of survey meters and moisture density gauge	• 163 survey meters • 4 moisture density gauges	• 163 institutions served • 4 institutions served
Management of spent sealed sources	• 10 spent sealed sources	• 9 institutions served

radioactive sources from possible covert action. NECSA assisted PNRI in assembling a mobile hot cell at the PNRI Radioactive Waste Management Facility. The hot cell shields the operators from radiation while allowing them to remove the spent sources from their old units and store them into long-term storage shields, reducing the radiation reaching the surface to acceptable levels.

A total of sixteen (16) Cobalt-60 sources with a total activity of 204 TBq were conditioned at PNRI – thirteen from teletherapy units and three from irradiators. The SHARS were stored in two units of long-term storage shields, which exhibited a maximum contact dose rate that is well below the contact limit for the safe transport of radioactive materials.

An assembled mobile hot cell for conditioning spent high activity radioactive sources

NUCLEAR-BASED ANALYTICAL SERVICES

Using nuclear-based and related techniques, the Nuclear Analytical Techniques Application (NATA) Section offers its services to clients who are mostly engaged in either research and/or regulatory functions, especially for non-radioactivity certification of products prior to trading and exports. Most of the services rendered were for gammametric analysis of food and foodstuff and related samples by gamma spectrometry, followed by gross-alpha beta analysis of drinking water and well water samples by liquid scintillation counting. Both procedures are accredited and certified under ISO/IEC 170 25:2005. Four clients submitted seven samples for detection of synthetic acetic acid adulteration in Philippine vinegar by liquid scintillation counting and isotope ratio mass spectrometry. Thirteen clients submitted fifteen samples for radon analysis.

For 2013, NATA analyzed 447 samples from 158 clients. The decrease in services compared to 2012 may be due to less stringent monitoring by regulatory agencies two years after the Fukushima nuclear power plant accident.

ESTABLISHMENT OF TECHNETIUM-99m (^{99M}TC) GENERATOR FACILITY

PNRI has already applied for and is currently awaiting the release of all necessary permits and/or licenses for the product and the operation of the newly-established Molybdenum-99/Tc-99m generator production facility at the PNRI Radioisotope Laboratory. Once operational, the facility will be able to supply the local ^{99m}Tc requirements of around 35 hospitals with nuclear medicine centers at lower costs than imported radiopharmaceuticals. Technetium-99m makes for about 80 percent of nuclear medical procedures such as imaging and scanning of various internal organs (brain, lungs, kidney, liver, thyroid and bone), as well as diagnosis of metabolic disorders.

In establishing quality control procedures for the newly-built facility, the PNRI Isotope Techniques Section upgraded the laboratories and equipment for ^{99m}Tc production and has undertaken training abroad for the operation of the ^{99m}Tc facility and related equipment. The radiochemical and microbiological laboratories were established to facilitate quality control procedures which will ensure that

Sample analysis for isotope hydrology studies at the Isotope Ratio Mass Spectrometry Laboratory

MICROBIOLOGICAL TESTS

The Biomedical Research Section offers microbiological analysis for medical/pharmaceutical and food products. This year, there were 15 clients who submitted 31 samples for microbiological analysis. Out of the 31 samples, 28 were medical products that were analyzed for sterility tests and three were food samples submitted for bioburden tests.

ENGINEERING SERVICES

This year, the Engineering Services Section provided assistance in the repair and maintenance of PNRI equipment; rendered electronic services to PNRI offices and laboratories to keep their electronic equipment operational; provided technical expertise particularly in the design, construction and decommissioning of equipment involving nuclear and radioactive sources such as cobalt-60 and cesium-137 irradiators, source holders for iron-55 and other radioactive materials and neutron-based or related laboratory equipment. The Section also continued to provide assistance in the construction and installation of electrical components of PNRI facilities such as the Isotope Techniques Section building.

The PNRI GammaGen Technetium-99M Generator

The Technetium-99m (^{99m}TC) hot cell facility inside the Radioisotope Laboratory building

Dispensing of microbiological media to petri dish for analysis

the quality of ^{99m}Tc eluate meets the standards required of the product for medical purposes. A high purity Germanium detector was also installed and tested for performance. This was made operational for the conduct of radionuclide purity test for the ^{99m}Tc eluate. Likewise, a hand and foot monitoring device was acquired for radiation safety of the personnel working at the facility.

The production/quality control team of the ITS also underwent training programs. In-house training was provided during the installation, and on-the-job training applications in accredited laboratories were also submitted to the IAEA. Members of the section were also sent for further training with Perkin Elmer specialists in Singapore to learn the operation and maintenance of newly acquired chromatography equipment which is an important tool in the quality control of the Tc^{99m} in radiopharmaceuticals.

RADIOTRACER AND SEALED SOURCE APPLICATIONS

Gamma Ray Column Scanning

PNRI, through the Isotope Techniques Section (ITS), promotes the gamma-ray column scanning technology to help improve the maintenance capabilities of local industries, particularly for oil refineries and petrochemical plants. Using gamma rays from controlled radioactive sealed sources, it shows the conditions inside process columns and

vessels real-time without interrupting production, allowing for more physical inspection, thereby saving the operation valuable time and resources.

To provide more competitive gamma column services, the section worked on enhancing its manpower capability through participation in a regional training course on gamma column scanning technology conducted by the PTT Global Chemical Public Company Limited Aromatics Complex in Rayong, Thailand. The ITS also upgraded its scanning system which basically consists of the radiation source, detector, a ratemeter, a winch system and a laptop computer for data logging. For more robust, efficient and radiation safe scanning services, the following components of the system were also upgraded: source holder, detector holder, winch assembly and software for data acquisition.

CYTOGENETIC COUNSELLING

The Biomedical Research Section accepts services for cytogenetics analysis for occupationally exposed workers. This is to determine whether a person, whose work entails the use of radioisotopes, has been exposed to radiation. A total of 19 overseas Filipino workers serving as industrial radiographers of a British company in Angola submitted themselves, as required by their company, for this test using their blood samples.

Analysis of human chromosomes

GAMMA RAY SPECTROMETRY APPLICATION

The use of gamma ray spectrometry-a nuclear technique-as an added exploration tool in the search of economic porphyry copper-gold is being extended by PNRI in support of the mining and minerals industry. Primarily intended to detect concentrations of potassium, uranium and thorium, gamma-ray spectrometry has since been used in a number of applications by industries heavily involved in geological explorations, such as oil and mining firms. The technique can be adopted by exploration/mining companies and/or the expertise and instrumentation of PNRI can be used to service these exploration/mining companies in their quest for this type of mineral deposits.

A Science Research Specialist of Isotopes Techniques Section performs gamma-ray scanning at a petrochemical plant.

Portable gamma ray spectrometer

Ensuring the Safety and Security of Radioactive Sources

The PNRI, through its Nuclear Regulatory Division (NRD), regulates the use of nuclear and radioactive materials in the country as mandated by Republic Act 2067 and RA 5207, both as amended, and Executive Order 128. The NRD also implements the PNRI Policy on Internal Nuclear Regulatory Control Program, coordinates nuclear and radiological emergency preparedness and response activities, and undertakes activities in support of international commitments on nuclear safety, safeguards and security of nuclear and radioactive materials and facilities.

REGULATIONS AND STANDARDS DEVELOPMENT

PNRI, through the Regulations and Standards Development Section (RSDS), formulates nuclear safety policy and develops standards, licensing requirements, regulations, and criteria consistent with internationally acceptable guidelines and best practices to further enhance safety and security in the use of radioactive materials. RSDS is also tasked to issue administrative orders and regulatory guides to assist licensees in complying with regulatory requirements. This year, the RSDS has developed, reviewed and revised regulations and administrative orders as well as issued information notices in support of the institute's regulatory framework.

Code of PNRI Regulations (CPRs)

Three (3) CPRs were approved and published in the Official Gazette. CPR Part 25 - "Licenses for Commercial Providers of Nuclear Technical Services" and CPR Part 27 "Security Requirements in the Transport of Radioactive Material" were published under Volume 109 No.7 (18 February 2013) and Volume 109 No. 47 (25 November 2013), respectively. The final draft of the revised CPR Part 13 "Licenses for Medical Use of Unsealed Radioactive Material" was approved for publication on 23 December 2013.

Other Regulatory Documents

PNRI continued to develop regulatory guides, administrative orders and information notices to provide its licensees with necessary information and technical support aimed at improving compliance with regulatory requirements. In line with this, a Regulatory Guide for CPR Part 16 "Licenses for the Use of Radioactive Sources Contained in Industrial Devices" was approved for implementation by the Office of the PNRI Director on 13 May 2013. Two Administrative Orders were also approved for publication. A.O. No 02, Series of 2011 "Regulatory Criteria in Determining Severity of Violation(s)" was published on May 13, 2013 under Volume 109 No. 19 while AO No. 01, Series of 2013 - Adoption of the IAEA Safety Standards SSR-6, "Regulations for the Safe Transport of Radioactive Material- 2012 Edition" was approved on 29 November 2013. Moreover, the following information notices were issued to licensees: Information Notice No. 2013-01 "Revised Regulations: CPR Part 25, "Licenses for Commercial Providers of Nuclear Technical Services", Information Notice No. 2013 – 02 "PNRI Administrative Order No. 02 Series of 2011, "Regulatory Criteria on Determining Severity of Violation(s)".

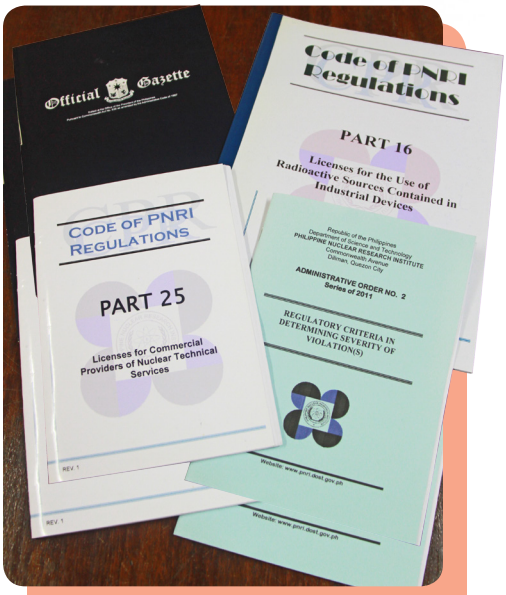
Technical and Legal Assistance

The RSDS coordinated the development and signing of the Memorandum of Agreement (MOA) between the PNRI and the Office of the Government Corporate Council (OGCC). The MOA provides support to the PNRI concerning all matters pertaining to its legal and regulatory framework. The MOA was signed January 17, 2013 by the PNRI Director and the Head of the OGCC.

The RSDS maintains a wide and broad scope information exchange with other governmental regulatory agencies. This cooperation provided an opportunity for cooperation and assistance with regards to our respective regulatory framework and programs. The staff regularly participates in the programs of other government agencies such as the Department of Justice, Department of Environment and Natural Resources, Central Bank of the Philippines, Anti-Terrorism Council Program Management Center, and Department of Health.

Regulatory Conference and Focus Group Discussion

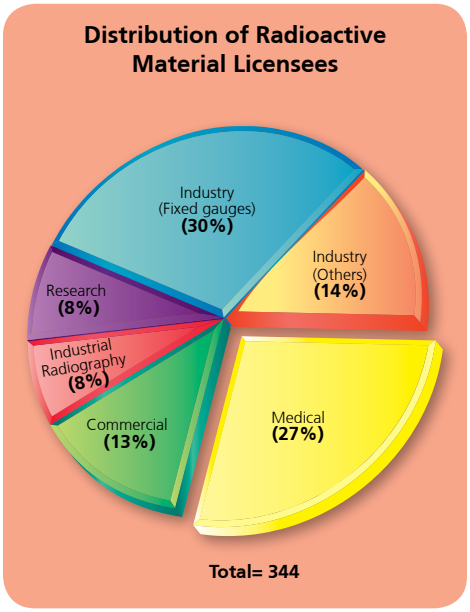
The RSDS conducts regulatory conferences with stakeholders and other interested parties to discuss significant revisions, amendments and updates



Code of PNRI Regulations Part 25 and Administrative Order No. 02 series of 2011 published in the Official Gazette; Regulatory Guide Part 16 completed for use of licensees

CPR Part 13 Focus Group Discussion held at the NRD Conference Room in July 2013.

A PNRI inspector verifies radiation levels at a nuclear industrial gauge



on its regulatory requirements and other regulatory activities. This year, PNRI held a regulatory conference with representatives from different medical institutions operating a nuclear medicine facility to discuss the revision of CPR Part 13, "Licenses for Medical Use of Radiopharmaceuticals". It was attended by 52 participants including, among others, the Philippine Society of Nuclear Medicine (PSNM), Professional Regulations Commission (PRC), Philippine Society of Endocrinology and Metabolism (PSEM), Philippine Organization of Medical Physicists (POMP), and the Center for Device Regulation, Radiation Health and Research (CDRRHR) of the Food and Drug Administration. A focus group discussion followed on July 31, 2013 to tackle specific issues on the training requirements of authorized users and medical physicists.

LICENSING REVIEW AND EVALUATION

This year, PNRI approved 282 out of the 379 license applications for authorization to use, possess, produce, store, sell or import radioactive materials. The 282 licenses consisted of 38 amended, 17 new and 228 renewed licenses for the following: (1) industrial applications such as density, level and thickness gauging of products/ materials; (2) medical applications such as diagnosis and treatment of diseases; (3) commercial applications such as the sale and distribution of radioactive materials; (4) industrial radiography; (5) research and education; and (6) operation of a medical cyclotron.

A total of five licenses were terminated for the year due to completion of their projects involving the use of radioactive materials. License exemption certificates were granted to seven institutions because the items imported from other countries do not contain radioactive material or the activities of the radioactive material are in exempt quantities. A total of 520 certificates of release were likewise issued to licensed users and suppliers for release of shipments of imported radioactive materials from the Bureau of Customs. In line with its Internal Regulatory Program, PNRI issued/renewed authorizations for the use of radioactive materials in twelve of its facilities/ laboratories that are used for research and development, nuclear training and provision of nuclear and allied services.

INSPECTION AND ENFORCEMENT

One of the core regulatory functions of PNRI is the conduct of inspection and audit of facilities and licensed radioactive materials to ensure compliance with PNRI safety and security regulations and standards, license conditions and implementation of the radiation safety program.

For 2013, the Inspection and Enforcement Section (IES) conducted a total of 163 regulatory inspections — 151 of these were announced. Eight facilities were inspected unannounced which were deemed necessary to verify regulatory concerns and issues. Follow up inspection on one facility was conducted to verify that corrective actions submitted were in place and implemented appropriately. In addition, two special inspections and one investigative inspection were completed as part of the process for regulatory oversight.

The IES imposed enforcement actions to licensees who were found to have violated significant requirements stated in the Code of PNRI Regulations. Four Notices of Violation were issued to users of radioactive materials in the medical, industry and industrial radiography sectors. Submitted corrective actions were reviewed and evaluated and found acceptable for implementation so that the identified non compliances are prevented from recurring. The IES monitored licensees who have noncompliance and concerns identified and follow up letters were sent for those who failed to give corrective actions on dates required.

IES evaluated the corrective actions and evidences presented by the licensees in their response letters and a total of 157 evaluation reports were prepared and issued in 2013. Moreover, PNRI, through IES, in accordance with the duly

issued PNRI Order, took into custody one unit Niton XRF analyzer containing Americium-241 sealed source from an erring licensee who violated safety and security requirements.

A total of 75 licensees were served for the 5,409 issued authorizations to transport radioactive materials comprising mostly of radiopharmaceuticals and sealed sources moved to and from different destinations in the country.

In accordance with the Institute's Internal Regulatory Control Program, the IES conducted inspections of critical and research laboratories and facilities of PNRI where radioactive materials are handled and used. Nine facilities were inspected and found to be operating in accordance with the PNRI safety policy and are in compliance with pertinent requirements and regulations.

SAFEGUARDS AND SECURITY

IAEA Nuclear Safeguards Inspections and Nuclear Material Accounting

PNRI, through the Nuclear Safeguards and Security Section (NSSS), hosted the annual physical inventory verification inspection of International Atomic Energy Agency (IAEA) safeguards inspectors of the Philippine Research Reactor-1 (PRR-1) at PNRI in December. Five nuclear material accounting reports were submitted to the IAEA for this activity.

The Section also carried out inspections at Locations Outside Facilities (LOF) with depleted uranium used as shielding materials at Atlantic Gulf & Pacific Company of Manila (Batangas Fabrication Facility) and NDT Phils. Inspection Services. From this inspection, six reports for depleted uranium under the LOF were generated.

As part of the Philippine's reporting obligations under Article 2a of the Additional Protocol (AP) to the Agreement Between the Philippines and the IAEA for the Application of Safeguards, the NSSS submitted 12 reports which included Export of Annex II items and Update of AP declarations from 1 January – 31 December 2012. These activities were carried out in support of the international nuclear safeguards commitment with the International Atomic Energy Agency (IAEA) on Non-Proliferation of Nuclear Weapons Treaty and the physical protection of nuclear and other radioactive materials and facilities in the country.

Global Threat Reduction Initiative (GTRI): Project Management

The GTRI is a comprehensive global initiative of the US Department of Energy (US DOE) that aims to address the issue of nuclear security around the world and reduce the threat of nuclear terrorism. The Philippines, through PNRI, has been participating in activities under this initiative which include enhancement of security system upgrades in hospitals/medical centers and PNRI facilities.

Pursuant to the Basic Ordering Agreement with US DOE/Pacific Northwest National Laboratory (PNNL) under the Task Order No.7, PNRI conducted inspections at eight hospitals and PNRI facilities with installed security upgrades to evaluate the quarterly preventive maintenance activities of the security contractor. A total of four quarterly reports on the results of the inspections/evaluations were submitted to the US DOE through the PNNL. The NSSS also assisted the US GTRI Team in the conduct of site assessments of the facilities.

As part of the ongoing effort by PNRI under the GTRI Initiative, the National Nuclear Security Administration of the US DOE turned over to PNRI two secure radiological transportation vehicles as part of a broader cooperative effort to help combat nuclear and radiological terrorism in the Philippines. The two vehicles are standard cargo vehicles, customized with extra security features specifically designed in coordination with PNRI to provide a more secure means of transporting radiological material within the Philippines.

NSSS also hosted national workshops and training in collaboration with the

Physical Inventory Verification inspection at the temporary storage of slightly irradiated fuels at PRR-1

Site assessment with US GTRI experts

PNRI-DOST Director Dr. Alumanda M. dela Rosa with (from L-R) David Duhamel of Oakridge National Laboratory, US; Brian Reed of National Nuclear Safety Administration - US Department of Energy; and Kimberly Anderson, Oakridge National Laboratory at the turnover ceremony of two customized secure radiological transportation vehicles (inset) at PNRI on 27 Aug 2013 attended by US DOE/GTRI country manager and ORNL security transport experts

US DOE, Australian Nuclear Science and Technology Organization and the IAEA. (See Appendices on Table 7 on page 51.)

Megaports Initiative

In coordination with the Bureau of Customs (BoC) and the Philippine Ports Authority, the PNRI continued its participation in this United States Department of Energy initiative which involved monitoring for illicit shipment of nuclear and other radioactive materials in container vans and cargo from abroad using the radiation monitoring system installed at the Ports of Manila.

This year, a container of metal rods used as agitator in metal tank was returned to the port of origin after having been found by BoC Central Alarm System (CAS) terminal operators and PNRI to be contaminated with cobalt-60, a radioactive element. The container had a maximum dose rate of 0.708 microsievert per hour (μSv/hr).

With regards to the radiation portal monitor (RPM) detection system installed at the Cebu International Port in 2012, the following activities were undertaken with the US Megaports Team: Conduct of a one-day Awareness Seminar for Senior Management in January 2013 which was participated in by 35 supervisors and senior managers of Cebu BOC and CPA, and a three-day Operational Readiness Training Course for 28 BOC and CPA operators to impart to the designated CAS operators the knowledge and skills to effectively and efficiently operate the RPM detection system and to respond to an alarm.

PNRI participants performing an exercise during the Instructor Training Course on Nuclear and Radiological Emergency Preparedness in Tokai-Mura, Ibaraki, Japan

RADIOLOGICAL IMPACT ASSESSMENT

In support of the nuclear regulatory activities of the Nuclear Regulatory Division, the Radiological Impact Assessment Section (RIAS) performed a pre-assessment study to determine the radiological hazards and effects brought about by the resulting neutrons that are emitted from the Buchler neutron calibrator. The calibrator contains 176 gigabecquerels of Americium-241 and is coupled with Beryllium material to produce neutrons. The study also includes dose mapping within the PNRI Isotope Techniques Section where the calibrator is currently stored.

The RIAS also conducted a follow-up laboratory analysis of the passive alpha track detectors installed in a former nitrated thorium facility which includes collections of tap drinking water at site and nearby houses for alpha analysis of natural thorium.

NATIONAL EMERGENCY PREPAREDNESS AND RESPONSE

As part of the activities on updating and enhancing the PNRI's emergency preparedness program, RIAS prepared the latest draft of the National Radiological Emergency Response and Preparedness Plan (RADPLAN) for review by participating agencies. The revisions cover the roles and responsibilities of participating agencies, the new organizational structure based on the additional list on the types of emergencies specifically the threat from terrorism, among others.

In addition, the PNRI tested its procedures for PNRI Response Initiators as well as the conduct of drills and exercises in simulated real time emergency scenarios.

RIAS also spearheaded the conduct of the Follow-up Training Course on Nuclear and Emergency Preparedness and Response in cooperation with Japan Atomic Energy Agency and PNRI Nuclear Training Center.

Among other important activities accomplished were the establishment of the PNRI Radiological Emergency Monitoring and Control teams on-duty for 15-day cycle, participation to the IAEA Incident and Emergency Centre ConvEx-1A Exercise, and submission of a proposal for the acquisition of new radiation protection equipment for the Nuclear Response Support Center.

DEVELOPMENT OF A NATIONAL RADIOACTIVE WASTE DISPOSAL FACILITY

Radioactive waste and disused radioactive sources are envisaged to be disposed of in near surface and borehole disposal facilities. The safety of the proposed repositories will be assured by a system of engineered barriers as well as the natural or geological barriers provided by the site. These barriers will isolate the waste from contaminating the human environment.

The PNRI, with the support of the International Atomic Energy Agency (IAEA), is in the process of further characterizing a preferred site for the envisioned repository concepts. In terms of geologic material, both rock and soil materials are present in the site. The rocks correspond to the andesites. The soils refer to the residual soils, colluvial soils and alluvial soils. A 100 meter borehole was drilled to further characterize the subsurface soil, rock and water level. It was also aimed to investigate the presence of a monolithic block of intact rocks suitable for the BOSS (borehole disposal of disused sealed sources) system.

Results of the drilling investigation show a 14.5 meter thick soil mantle consisting of clay of varying plasticity. The underlying rock formation (from 14.5 meters until the termination of the borehole at about 92 meters) is characterized as andesitic pyroclastics; specifically, agglomerate, tuff and tuff breccias. The range of rock quality designation (RDQ) of extracted rock cores is wide, from nil to 25 percent to as high as 96 percent (excellent rock quality). Core samples were subjected to x-ray diffraction and x-ray fluorescence analysis.

Conceptual Design

The near surface disposal facility will consist of 4 large pits measuring 180 m x 75.5 m. The 4 pits will be divided into 1 x 200 liter pit with a proposed capacity of 68,600 drums and a 3 x 400 liter pit each containing 90,000 drums or a total of 158,600 drums. These drums shall carry an equivalent of about 50,000 cubic meters of radioactive waste.

The borehole facility for disused radioactive sources is about 100 meters deep with its lower 70 percent designated for disposal and the remaining 30 percent for plugging. The 30-meter distance between the surface and the disposal zone is intended as a provision against human intrusion. These two sections and their corresponding purpose shall be considered in the design of other structures and civil works within the project site.

Based on the conceptual design, preliminary engineering analysis and design was carried out to come up with indicative quantities and costs. The need for a comprehensive study to ensure durability of materials, particularly concrete, is emphasized considering the necessary service life of the structures.

Technical visit to the project sites by the IAEA Technical Officer

Presentation to the international experts on the progress of the long term management of disused radioactive sources

Diffusion of Knowledge and Technologies

Extension and outreach likewise play a crucial role in the activities of the Institute and such is reflected in its extensive information, education, communication and business development efforts carried throughout the year. Cognizant of the value of imparting to varied stakeholders the safe and judicious use of radioactive and nuclear materials and technologies, the Institute is ceaseless in its campaign to educate and bring to the interested sectors an informed appreciation of the benefits of nuclear science. In that way, its activities are brought down from the proverbial ivory tower to the level of the public at large.

NUCLEAR TRAINING

The Nuclear Training Center (NTC) conducts regular training courses for medical practitioners, science educators, researchers, technicians and other professionals for capacity building in the field of nuclear science and technology.

For 2013, the NTC conducted 37 technical training courses for 738 professionals and technicians from different government and private institutions/agencies. The courses consisted of 14 radiation safety courses for industrial users; three on radioisotope techniques; one on nuclear science and technology for high school science teachers and one on nuclear technology for university/college faculty; and one on nuclear power. A total of 15 courses on nondestructive testing and two for welding inspectors were also conducted in cooperation with the Philippine Society for Non-Destructive Testing, Inc. (PSNT)

This year, a milestone in the training of NDT personnel in the Philippines was achieved with the accreditation of PNRI, through the NTC, by Lufthansa Technik Philippines (LTP) as NDT training provider per European Standard EN4179 (Aerospace series – qualification and approval of personnel for nondestructive testing). LTP personnel can now avail themselves of the NDT training services conducted at PNRI and the PSNT. Previous trainings of LTP personnel were availed of only in foreign countries.

As part of the Institute's service to undergraduate students, PNRI provided on-the-job training at different facilities and laboratories to 112 college students from 31 schools/universities and research thesis advisorship to 23 high school and college students from five schools/ universities.

of a program and facility for setting up of the PNRI Neutron School. This is aimed at building competence and expertise of young researchers on nuclear science and technology.

As a preparatory testing to the 2014 official start of the neutron school, the APRS conducted a two-week training session from April to May, participated in by 11 on-the-job trainees from five universities. The training consisted of lectures and practical activities such as gamma spectrometry using sodium iodide, neutron activation of gold and indium foils in a neutron howitzer and neutron flux mapping inside the americium-beryllium

As a result of the training, students from the Eulogio Amang Rodriguez Institute of Science and Technology and the Polytechnic University of the Philippines were able to prepare their theses entitled "Neutron Flux Mapping inside the Americium-Beryllium Neutron Calibrator" and "Neutron and Gamma Flux Measurement in a Californium-252 Source Storage Drum Using Boron Trifluoride Neutron Detector and Sodium Iodide Scintillation Detector", respectively.

The APRS also conducted a one week training workshop on Monte Carlo transport calculations with Dr. Luka Snoj, a visiting expert from the International Atomic Energy Agency, as lecturer. The participants of the workshop included PNRI staff, undergraduate students and medical physicists.

The setting up of the laboratory for conducting neutron experiments using californium-252 obtained from the PNRI Radioactive Waste Facility (Cf-252) is ongoing and nearing completion.

PNRI trainees conducting an exercise at the Nuclear Training Center

Participants of the Training Workshop on Monte Carlo Transport Calculations pose with IAEA Expert Dr. Luka Snoj (7th from right) and Dr. Pablo P. Saligan, Associate Scientist, DOST (6th from right)

CAPACITY BUILDING IN THE USE AND OPERATION OF SMALL NEUTRON SOURCE

Establishment of a Neutron School

The Applied Physics Research Section (APRS) spearheaded the establishment

NUCLEAR INFORMATION, EDUCATION AND COMMUNICATION

To enhance awareness, knowledge and understanding of the public on nuclear science and technology, PNRI through the Nuclear Information and Documentation Section (NIDS) informs, educates and communicates the basics on nuclear science and technology, nuclear safety and security through various strategies.

First issue of the PNRI Online Newsletter

PNRI information officer explains the applications of nuclear S & T in agriculture to visitors of the PNRI exhibit at the Northern Luzon Cluster S & T Fair in Benguet State University

PNRI Nuclear Regulatory Division Chief Teofilo V. Leonin Jr. being interviewed at Net 25 TV program "Pambansang Almusal"

Development/Distribution of Information Materials

NIDS produced and updated three new flyers on nuclear technology applications along with the 2012 Annual Report. Around 16,000 nuclear information materials were distributed to about 4,200 clients. Other information materials in the form of exhibit banners on PNRI technologies and nuclear services were also produced and displayed during six science and technology fairs, namely, (1) Radiation Processing as a Post-Harvest Treatment of Food; (2) Receptor Binding Assay for Red Tide Toxin; (3) Plant Growth Promoter from Radiation-Modified Natural Polymers; and (4) Nuclear Techniques for Efficient Nutrient and Water Management for Rice and Corn Production. The banners were produced with partial financial assistance from the Technology Application and Promotion Institute. NIDS also produced one set of exhibits (posters on panel boards) for the 41st Atomic Energy Week celebration.

Various stakeholders were also updated and kept informed on the technologies and activities of the Institute through the online issue of the PNRI Newsletter, which was produced by NIDS. The first issue was posted in December at the PNRI website (www.pnri.dost.gov.ph).

Educational Tours and Nuclear Awareness Seminars

In coordination with the PNRI technical groups, around 2,041 visitors composed mostly of students from 83 schools nationwide, availed themselves of the guided educational tour of the Institute's facilities and laboratories, lecture-demonstrations and video showings on nuclear science and technology. Information was likewise provided to more than 1,000 walk-in visitors and individuals who inquired through phone or email/website. A total of 18 nuclear awareness seminars for 648 clients were conducted with the cooperation of the Nuclear Training Center and PNRI technical staff.

Participation in Special S & T Events

Through the PNRI's nuclear information and communication program, the Institute promoted nuclear technologies and its beneficial uses to more than 4,000 clients through exhibits in six science and technology events in Metro Manila and in the regions in Luzon, Visayas and Mindanao.

Nuclear S & T Promotion Through Media Linkages

NIDS arranged and coordinated 20 television and radio interviews of PNRI officials and technical staff on PNRI programs and projects, nuclear power and nuclear technology applications. NIDS also prepared a total of 17 press releases on PNRI technologies and services. These were distributed to the quad media (print, radio, television and cyber) for dissemination to the public.

Meanwhile, a press conference attended by 24 media representatives was conducted during the 41st Atomic Energy Week (AEW) celebration at PNRI in December 2013.

S & T EVENT	DATE	VENUE	No. of Visitors*
DOST National Science and Technology Week (NSTW) — Expo Science Exhibit 2013	July 23-27, 2013	SMX Convention Center, Mall of Asia, Pasay City	1,500
Southern Luzon Cluster S & T Fair and Exhibit	September 12-14, 2013	Sky Ranch, Tagaytay City	500
Northern Luzon Cluster S & T Fair and Exhibit	September 30-October 4, 2013	Benguet State University, Kilometer 6, La Trinidad, Benguet	1,200
Visayas Cluster S & T Fair and Exhibit	October16-18, 2013	SM City Mandurriao, Iloilo City	400
Mindanao Cluster S & T Fair and Exhibit	November 6-10, 2013	Almont Inland Resort, Butuan City	200
41st Atomic Energy Week	December 9-13, 2013	PNRI, Commonwealth Avenue, Diliman, Quezon City	1,175

* students, investors, entrepreneurs and public

Library Services

This year, the Library acquired 235 volumes of publications composed of 28 volumes of books and 186 volumes of journals through gift donations and exchanges from local and foreign institutions/organizations. These publications, together with other library holdings, were made available to 2,280 clients, composed mostly of students/ researchers.

MANAGEMENT INFORMATION SYSTEM

The PNRI, through its Management Information System Section (MISS), continued to develop and manage the Institute's computerized systems and computer softwares . This year, MIS implemented three new information systems, namely, the Radiation Protection Services Information System; Regulatory Authority Information System; and Gamma Irradiation Services Information System. These information systems, once rolled out and operationalized will allow for easier management of relevant information in the conduct of technical services and regulatory functions of the Institute.

To comply with the DOST Website Policy, the PNRI public website was converted and migrated into a Joomla platform. It has also started converting the same website into the new template prescribed by DOST which will be launched in 2014. The PNRI e-mail system was upgraded into a stable version of the VMWare Zimbra system which resolved the problems encountered in the previous set-up, e.g. rejection of some legitimate mails with attachments.

A number of information systems were continuously maintained. These include the following : Personnel Management and Monitoring System, payroll program, administration of the PNRI's local area network and internet connectivity, and equipment inventory system. Moreover, MISS provided IT Help Desk services to 384 PNRI personnel for software and network-related problems and requirements in the Institute.

BUSINESS DEVELOPMENT

PNRI pursued its efforts in bringing its products and services to end-users, adopters, and collaborators for commercialization, in order to attain self-reliance and a higher degree of sustainability for the Institute.

Research on Conotoxin - In October 2013, PNRI and the University of the Philippines (UP)- Diliman have jointly filed an application to the Intellectual Property Office of the Philippines for patent of the findings of a collaborative research on conotoxin. This work represents the first step toward the commercialization of the nuclear technology product with application for the detection of paralytic shellfish toxins. The research was funded by DOST and the International Atomic Energy Agency and was carried out in 2005-2008 as a project component of the Harmful Algal Bloom Phase II Program spearheaded by PNRI and UP Marine Science Institute.

PVP-Carrageenan Hydrogel Technology - A prospective adopter in the healthcare industry is now in the process of conducting the technical evaluation of the technology using their own facilities and resources. This is to ascertain its viability in terms of production and distribution.

Technetium-99m - The application for a trademark registration for PNRI's brand of Technetium-99m has been filed at the Intellectual Property Office of the Philippines. The stylized words of GammaGen is now a registered trademark and thus, a legally protected intellectual property of the Institute. It will form part of the commercial license to prospective commercial adopters.

A Memorandum of Agreement was forged with the Technology Resource Center (TRC) for the distribution and prospective marketing of Technetium-99m generators. Technical surveys were also conducted in some hospitals in Metro Manila namely, Saint Luke's Medical Center, Veterans Memorial Hospital and V. Luna General Hospital. The purpose of the survey is to know the requirements of each nuclear medicine department and to have an idea of the prevailing market prices.

The Technetium-99m generator

PNRI Biomedical Research Section Head Zenaida M. De Guzman facilitates a focus group discussion at the Department of Agriculture.

COMMERCIAL IRRADIATION FACILITY

Focus Group Discussion on Commercial Irradiation - The Department of Agriculture spearheaded the conduct of a Focus Group Discussion (FGD) together with the PNRI in preparation for undertaking a feasibility study for the establishment of a commercial irradiation facility in the country. The FGD serves as a platform to assess the market requirements, and to gather the necessary data from the potential users of the radiation technology. PNRI technical staff served as resource persons for the FGDs.
A series of FGDs were conducted with participants from spice, dehydrated vegetable and herbal product companies. These resulted in increased awareness, identification of potential clients' needs and commitment to use irradiation in commercial production.

Through S&T Linking and Networking

Local and international linkages form the backbone of growth in the nuclear community. They fuel the exchange of ideas, experiences and expertise that allows countries to apprise themselves of developments in the nuclear field, learn from the lessons of others and be informed of the best practices from other cultures and organizations.

PNRI, cognizant of the value of networking and outreach, harnesses domestic and international relations in order to spur capacity-building that is eventually reflected in better equipped facilities and an enhanced human resources pool. Moreover, the opportunity for cooperation nurtures amity in the nuclear community—an important factor in advancing the safe, secure and peaceful applications of nuclear technology.

Local S&T Networking

One of the key priorities of PNRI is strengthening linkages with both private and government institutions/ organizations. This year, the Institute forged memorandum of agreements for collaborative projects with four government institutions:

Sediment Quality Guidelines

Environmental Management Bureau-Department of Environment and Natural Resources for the research project entitled "Development of Sediment Quality Guidelines for the Philippines". This project aims to strengthen the Bureau's efforts in protecting and maintaining the quality of the country's fresh and marine water environments, with the use of nuclear and isotopic techniques, among others.

Radiation-Modified Polysaccharides

Philippine Council for Health Research and Development (PCHRD) for the research project on "Hemostatic Agents from Radiation-Modified Polysaccharides and Their Derivatives: Product Development and Efficacy/Safety Evaluation in Animal Model" . The project aims to develop a hemostatic material from radiation-modified polysaccharides and derivatives that is comparable or superior to the imported products currently available in the market.

Paralytic Shellfish Toxins-

Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development for the research project on "Transfer of AOAC Accredited Isotope-Based Receptor Assay for Paralytic Shellfish Toxins to Regulatory Setting". This project aims to transfer the Receptor Binding Assay for Paralytic Shellfish Poisoning (RBA-PSP) technology to end-users.

Radiation-Modified Carrageenan

Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development for the research project on "Plant Bio-Stimulants and Elicitor from Radiation-Modified Natural Polymers". This project generally aims to evaluate the effects of radiation-modified carrageenan and chitosan on the growth and yield of mungbean (*Vigna radiate* [L.] R. Wilczek) and peanut (*Arachis hypogaea L.*).and their reaction to common pests under screenhouse and field conditions.

FOREIGN S&T NETWORKING

The Philippines, through the PNRI, continues to nurture its collaborations with the following:

- International Atomic Energy Agency (IAEA), Vienna, Austria
- Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific (RCA), Vienna, Austria
- Ministry of Science, Technology, Education, Culture and Sports (MEXT) of Japan
- Forum for Nuclear Cooperation in Asia (FNCA), Japan
- Nuclear Safety Research Association (NSRA), Japan
- Japan Atomic Energy Agency (JAEA)
- United States Department of Energy (US-DOE)
- United States Department of Agriculture (US DA)
- Australian Nuclear Science and Technology Organization (ANSTO)
- Asian Nuclear Safety Network (ANSN)
- Asian Network for Education in Nuclear Technology
- Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Vienna, Austria
- European Commission (EU)

FOREIGN S&T NETWORKING

7 IAEA research contracts,

6 IAEA technical cooperation projects,

46 IAEA experts/mission delegates,

61 Fellowship/travel grants for PNRI and non-PNRI personnel

12 PNRI hosted meetings, seminars/workshops and regional training courses.

41ST ATOMIC ENERGY WEEK

Nuclear Science, Safety and Security: Road to Smarter Philippines

Philippine Nuclear Research Institute
December 9 - 13, 2013

As mandated under Presidential Proclamation No. 1211 in 1973, the annual Atomic Energy Week (AEW) is celebrated every second week of December to help generate awareness of the Filipinos on the beneficial uses of nuclear science and technology. The 41st AEW celebration featured the latest advances in nuclear science and technology in the fields of agriculture, industry, medicine and the environment.

Wreath Laying
At the monument of Brigadier General Florencio A. Medina, recognized as the "Father of Atomic Energy in the Philippines."

Thanksgiving Mass
Officiated by Rev. Father Jose Eliseo B. Buenviaje, Parochial Vicar – Our Lady of Peace and Good Voyage Parish

Opening Ceremonies
Hon. Jesus R. S. Domingo, Assistant Secretary, Office of the United Nations and Other International Organizations - Department of Foreign Affairs, was the keynote speaker during the AEW opening ceremonies on December 9.

Opening of AEW Exhibits
DFA Assistant Secretary Jesus R.S. Domingo, assisted by PNRI Director Dr. Alumanda M. Dela Rosa and AEW Executive Committee Chairperson Mr. Teofilo V. Leonin, Jr., cuts the ceremonial ribbon to formally open the 2013 AEW exhibits.

Opening of AEW Exhibits

Press Conference
27 media representatives attended the press conference on December 9. PNRI Director Alumanda M. dela Rosa presented highlights of PNRI activities and new projects for 2014.

Technical Sessions* *December 10 to 11*
Experts from PNRI and other institutions tackled the applications of nuclear science and technology in the areas of agriculture, medicine and the environment, nuclear safety and emergency planning:

- Nuclear Techniques as a Tool in Smart Farming in Agriculture
- Radioisotopes as Environmental Tracers
- Technetium-99m Radiopharmaceutical Production and Cyclotron and PET-CT
- Graded Approach in Radioactive Material Licensing
- National Contingency Planning Process During Emergencies

Guided Tours at PNRI Facilities and Laboratories
Students, teachers, members of the media, representatives from the medical sector and the public attended and visited the open-house exhibits and facilities of the PNRI.

Closing Ceremonies
Congressman Alfred D. Vargas, Representative of the 5th District of Quezon City and DOST Undersecretary Fortunato T. Dela Peña graced the celebration's closing ceremonies. Congressman Vargas congratulated the PNRI for the success of the 41st Atomic Energy Week, giving his support to the Institute's future activities and endorsing the importance of its work in government

Meanwhile, Undersecretary Dela Peña redefined the AEIOU vowels into the necessary virtues and factors the PNRI must sustain in the field of nuclear research and development – "A for Advancement, E for Excellence, I for Innovation, O for Outcome-based and U for Upward movement in the value chain."


41ST
ATOMIC ENERGY
WEEK
Technical Sessions*
Press Conference
Guided Tours at PNRI
Facilities and Laboratories
Road to Smarter Philippines
NUCLEAR RESEARCH INSTITUTE
MUTATION BREEDING
SOIL SCIENCE
NUCLEAR SCIENCE
THE EASY WAY!
Closing Ceremonies

PHILIPPINE NUCLEAR SCIENCE QUIZ

for High School Students

One of the highlights of the Atomic Energy Week celebration in December 2013 was the Philippine Nuclear Science Quiz (PNSQ) which aims to sustain awareness and understanding of high school students on nuclear science and technology and its beneficial applications. This year, the PNSQ was participated in by 35 public and private secondary schools in the country. The competition covered various topics on nuclear science and technology such as radiation and radioactivity, atomic/nuclear structure, radiation protection, nuclear regulations and other related topics.

WINNERS OF THE PNSQ

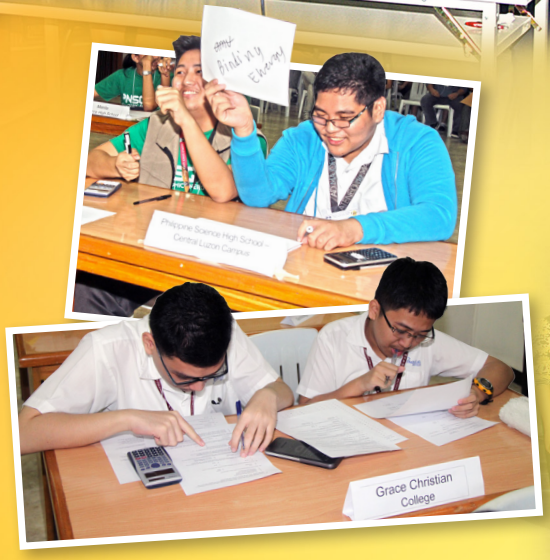
1st Place
Tabaco National High School, Tabaco City, Albay Region V
Joshua R. Carag and John D. Celestial
Coach: Analyn B. Borlasa

2nd Place
Manila Science High School,
Metro Manila in National Capital Region
Christlyn Faith H. Arias and Jasper S. Jamir
Coach: Ferdinand S. Bautista

3rd Place
Philippine Science High School (Central Luzon Campus) in Region IV-A
Carlin Drew S. Lapuz and Jose R. Rueda IV
Coach: Mark Xavier E. Bailon

PNSQ judges: (L – R) Ms. Lynette B. Cayabo, Dr. Vangeline K. Parami, Dr. Christina A. Petrache

The PNSQ winners pose with Congressman Alfred D. Vargas (seated, middle), Representative of the 5th District of Quezon City, PNRI Director Dr. Alumanda M. Dela Rosa (third from right), Nuclear Regulatory Division Chief and 2013 AEW Executive Committee Chairperson Mr. Teofilo V. Leonin, Jr. (second from left), and 2013 PNSQ Chairperson Thelma P. Artificio (extreme left) during the AEW Closing ceremonies at PNRI.



Other PNRI Activities

▲ PNRI at the DOST-Wide Sportsfest

▲ Christmas Presentations of PNRI Divisions

▼ Aerobics Day at PNRI

▼ Officers of the PNRI Employees Union with the PNRI Director

▲ Oathtaking of PNRI Employees Credit Cooperative officers for 2013 - 2015

Human Resources Development

11
PNRI staff obtained their doctorate and masteral degrees in 2013
(Appendices p.58)

23
PNRI staff pursued post graduate degrees on local/foreign scholarships

37
Nuclear training courses conducted by PNRI with 738 participants

112
Students from 31 schools were accommodated for on-the-job training at PNRI.

23
Students from five schools were accepted for thesis advisorship at PNRI

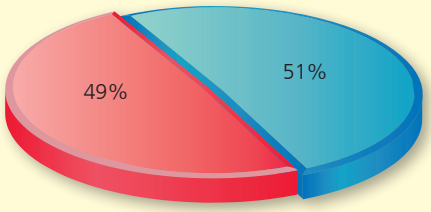
54
Locally-sponsored trainings/seminars/ workshops in various fields participated in by PNRI employees

123
Trainings/fellowship grants availed of by PNRI and non-PNRI personnel through linkages with foreign institutions/ agencies

In pursuit of the Institute's vision of a dynamic and competent workforce in the mainstream of national development, PNRI continues to prioritize manpower development in order to meet the standards of civil service and to facilitiate better productivity in research, delivery of nuclear services, promotion of nuclear technology and the enforcement of nuclear regulations, among others.

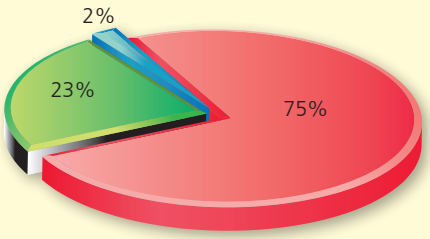
DISTRIBUTION OF PERSONNEL

BY GENDER



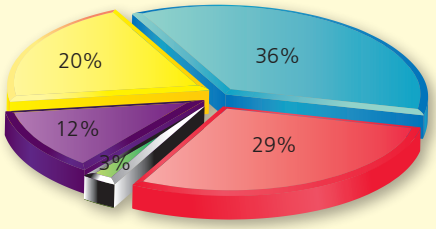
MALE
FEMALE
TOTAL 211

BY STAFF CATEGORY



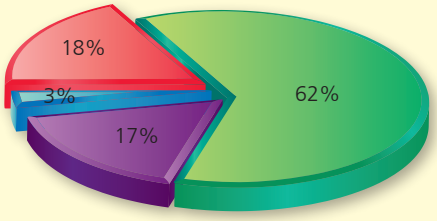
MANAGERIAL
TECHNICAL
ADMINISTRATIVE
TOTAL 211

BY STAFF ACTIVITY



R&D
S&T SERVICES
S&T EDUCATION
REGULATORY
ADMINISTRATIVE
TOTAL 211

BY EDUCATION



PH.D.
MS/MA
BS/BA
BELOW BS
TOTAL 211

PNRI RECOGNITION AWARDS

PNRI gave the following recognition awards to six of its staff and two teams during the 41st AEW Closing Ceremonies at PNRI:

MODEL EMPLOYEES

DIRECTOR'S CHOICE

Director's Choice Award based on the employee's contributions to the Institute and commitment to service

Electron Beam (EB) Facility Team

[3] Luvimina G. Lanuza *(Supervising Science Research Specialist)*; [4] Giuseppe Filam O. Dean, [2] Aurelio L. Maningas and [1] Haydee M. Solomon *(Senior Science Research Specialist)*

PRAISEWORTHY AWARD

The PRAISE (Program on Awards and Incentives for Service Excellence) Special Award for expertise shared to the Institute on matters relating to nuclear technology

Non-Destructive Testing (NDT) Team
Engineering Services, Nuclear Services Division

[2] Renato T. Bańaga *(Senior Science Research Specialist)*; [1] Andrew C. Barrida *(Science Research Analyst)*; [4] Arturo F. Salih *(Senior Science Research Specialist)*

Nuclear Training Center
Technology Diffusion Division

[9] Percedita T. Cansino *(Senior Science Research Specialist)*; [5] Ramoncito F. Sulit, [8] Alvie J. Asuncion *(Science Research Specialist II)*; [6] Inocencio A. Agron *(Science Research Specialist I)*; Angeles M. Marcelo *(Science Research Analyst)*; [7] Portia T. Villegas *(Science Research Assistant)*; and [3] Roel A. Loteriña *(Senior Science Research Specialist)*

DIVISION AWARDEES

Division Award for contributing greatly to the accomplishment of the division's functions and goals

Atomic Research Division
Jordan F. Madrid
Science Research Specialist I
Chemistry Research Section

Finance and Administrative Division
Ricky Gabinete
Administrative Assistant V
Property and Procurement Section

Nuclear Services Division
Janice P. Mallillin
Science Research Specialist I
Isotope Techniques Section

Pablito S. Maat
Administrative Aide III
General Services Section

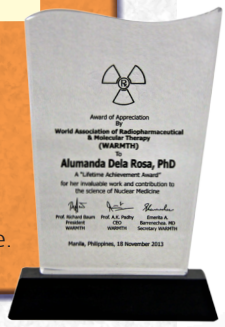
Nuclear Regulatory Division
Alan M. Borras
Senior Science Research Specialist
Licensing,5 Review and Evaluation Section

Technology Diffusion Division
Alvie J. Asuncion
Science Research Specialist II
Nuclear Training Center

RECOGNITION AWARD

WARMTH LIFETIME ACHIEVEMENT AWARD

The World Association of Radiopharmaceutical and Molecular Theraphy (WARMTH) presented PNRI Director Alumanda Dela Rosa with a lifetime achievement award during the 8th International Conference on Radiopharmaceutical Theraphy (ICRT) held in Manila last November 17-21, 2013. The award was given to her for invaluable work and contribution to the science of nuclear medicine.



RECOGNITION AWARDS RECEIVED BY PNRI

Best Poster Paper - Paper Competition

"Efficacy of Gamma Sterilization Technique for Biofertilizer Carrier Production" by Roland V. Rallos and Faye G. Rivera, Agricultural Research Section, Atomic Research Division-PNRI together with Juliet A. Anarna, University of the Philippines Los Bańos- National Institute of Microbiology and Biotechnology, Marcelina J. Palis and Jacqueline S. Rojales, Department of Agriculture-Bureau of Soils and Water Management. The award was given during the 16th Annual Conference and Scientific Meeting of the Philippine Society of Soil Science and Technology held in Subic, Zambales on May 29-31, 2013.

Third Place - Best Poster Paper Competition

"Agronomic Applicability of Non-Destructive Soil Moisture-Density Measurements Using Gamma-Neutron Probe" by Roland V. Rallos, Wilfredo A. Gultiano and John Faustus C. Vidal. The award was given during the 16th Annual Conference and Scientific Meeting of the Philippine Society of Soil Science and Technology.

PNRI Garners Recognition in the NAST-DOST First International Publication Awards

PNRI awardees in the NAST-DOST International Publication Awards pose with PNRI Director Dr. Alumanda M. Dela Rosa (2nd from left); NRCP-DOST President and International Publication Committee Chairperson Dr. Lourdes Cruz (1st from left); DOST Undersecretary for Scientific and Technological Services Prof. Fortunato dela Peña (3rd from left) and NAST-DOST Secretary Dr. Evelyn Mae Tecson Mendoza (1st from right).

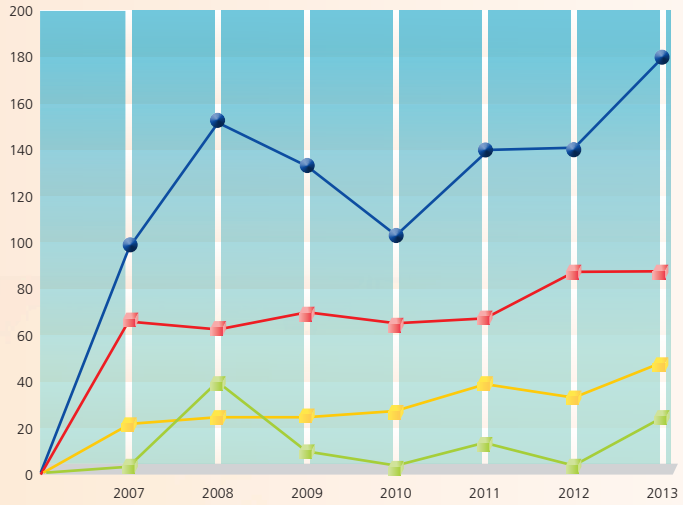
PNRI scientists garnered awards for 13 papers published in internationally – recognized journals. The awards were given by the National Academy of Science and Technology (NAST) during the first DOST-International Publication Awards ceremonies held on December 12 at the Trader's Hotel Manila.

Title of Paper	Principal Author	Name of Journal
Environmental Isotopes and major ions for tracing leachate contamination from a municipal landfill in Metro Manila, Philippines	Soledad Castañeda	Journal of Environmental Radioactivity
Receptor modeling studies for the characterization of air particulate lead pollution sources in Valenzuela sampling site (Philippines)	Preciosa Corazon Pabroa	Atmospheric Pollution Research Journal
Radiation inactivation of Paenibacillus larvae and sterilization of Americal Foul Brood (ADB) infected hives using Co-60 gamma rays	Zenaida De Guzman	Applied Radiation and Isotopes
Irradiation as a potential phytosanitary treatment of mango pulp weevil, *Sternochetus frigidus* (Fabr.) (*Coleoptera: Curculionidae*) in Philippine Super Mango	Glenda Obra	The Philippine Agricultural Scientist
Influence of Adult diet and exposure to methyl eugenol in the mating performance of *Bactrocera philippinensis*	Glenda Obra	Journal of Applied Entomology
Mass rearing technique for mango pulp weevil *Sternochetus frigidus* (Fabr.) ("*Coleoptera: Curculionidae*")	Louella Lorenzana (Senior author-Department of Agriculture Glenda Obra (co-author)	The Journal of the International Society for Southeast Asian Agricultural Sciences
NMR analysis of fractionated irradiated k-carrageenan oligomers as plant growth promoter	Lucille Abad	Radiation, Physics and Chemistry
Antioxidant Activity Potentail of Gamma-Irradiated Carrageenan	Lucille Abad	Applied Radiation and Isotopes
Effects of irradiation to morphological, physicochemical and biocompatibility properties of carrageenan	Jhalique Jane Fojas and Rizalinda De Leon (University of the Philippines) and Lucille Abad (co-author)	World Academy of Science, Engineering and Technology
Synthesis and characterization of carboxymethyl derivatives of kappa-carrageenan	Charito Aranilla	Carbohydrate Polymers
Tributylin in marine sediments and Philippine green mussels (Perna viridis) in Manila Bay	Ryan Olivares	Journal of Marine Science and Technology
Gamma radiation-induced grafting glycidyl methacrylate (GMA) onto water hyacinth fibers	Jordan Madrid	Radiation Physics and Chemsitry
Abaca/polyester nonwoven fabric functionalization for metal ion adsorbent synthesis via electron beam-induced emulsion grafting	Jordan Madrid	Radiation Physics and Chemistry

Financial Resources

This year, PNRI had a budget allotment of ₱188,559,000 by class and ₱188,559 by major final output. The Institute generated an annual income of ₱20,378,035.91 from licensing fees and from the Institute's nuclear and allied services, among others. Additional resources were also generated through local and foreign –funded projects on nuclear science and technology applications.

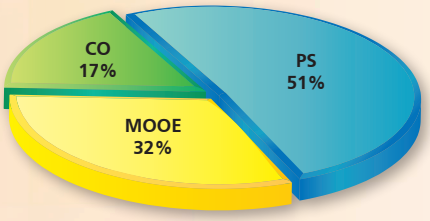
TREND OF ANNUAL PNRI BUDGET (2007-2013)



Legend:

- PS (Personal Services)
- MOOE (Maintenance & Other Operating Expenses)
- CO (Capital Outlay)
- TOTAL

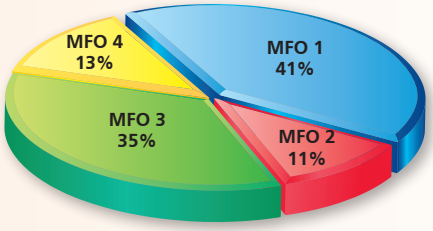
2013 PNRI BY ALLOTMENT CLASS



TOTAL ₱180,523,000.00

- PS ₱101,715,000.00
- MOOE ₱ 56,844,000.00
- CO ₱ 31,000,000.00

2013 PNRI EXPENDITURES BY MAJOR FINAL OUTPUT (MFO)



TOTAL 188,559,000.00

- MFO1 = ₱77,427,000.00
  Nuclear Research & Development
- MFO2 = ₱20,843,000.00
  Technology Transfer Services
- MFO3 = ₱65,791,000.00
  Nuclear S & T Services
- MFO4 = ₱24,498,000.00
  Nuclear Regulatory Services

APPENDICES

TABLE1. TECHNICAL TRAINING COURSES/SEMINARS CONDUCTED IN 2013

TITLE OF TRAINING	TRAINING VENUE/ LOCATION	NO. OF PARTICIPANTS	INCLUSIVE DATES CONDUCTED	FUNDING SCHEME
RADIOISOTOPE TECHNIQUES				
Radioisotope Techniques Training Course- Medical (RTTC) - 101st Session	PNRI, Diliman, Quezon City	34	3– 28 June '13	Company- sponsored
Radioisotope Techniques Training Course – General (RTTC) - 102nd Session	PNRI	8 (6*)	3– 28 June '13	Company- sponsored
Radioisotope Techniques Training Course- Medical (RTTC) – 103rd Session	PNRI	22 (1*)	16 Sept–11 Oct '13	Company- sponsored
NUCLEAR SCIENCE AND TECHNOLOGY				
Seminar on Nuclear Science for High School Science Teachers (SNSHSST) – 37th Session	PNRI	26	15 April–17 May '13	PNRI-sponsored
Nuclear Technology for University/College Faculty (NTUCF) – 46th Session	PNRI	1	15 April–17 May '13	PNRI-sponsored
RADIATION SAFETY				
Safety in the Use of Nuclear Equipment and Devices (SUNED) -62nd Session	PNRI	19 (2*)	18–22 Feb '13	Company- sponsored
Radiation Safety Course (2 days)	PNRI	14 (1*)	27–28 Feb '13	Company- sponsored
Radiation Safety Officer (RSO) Refresher Course	PNRI	20 (4*)	5–7 March '13	Company- sponsored
Safety in the Use of Nuclear Equipment and Devices (SUNED) – 63rd Session	PNRI	10	1–5 April '13	Company- sponsored
Safety in the Use of Nuclear Equipment and Devices (SUNED) – 64th Session	EEI Corporation, Quezon City	13	5 April–3 May '13	Company- sponsored
Safety in the Use of Nuclear Equipment and Devices (SUNED) – 65th Session	HPAL, Claver, Taganito, Surigao del Norte	18	22– 26 April '13	Company- sponsored
Safety in the Use of Nuclear Equipment and Devices (SUNED) – 66th Session)	PNRI	21 (2*)	20–24 May '13	Company- sponsored
Radiation Safety Course (2 days)	PNRI	11 (1*)	17–18 June '13	Company- sponsored
Radiation Safety Course for Medical and Radiophamaceutical Facilities	PNRI	8 (1*)	28 June–Aug 30	Company- sponsored
Safety in the Use of Nuclear Equipment and Devices (SUNED) – 67th Session)	PNRI	20 (1*)	22–26 June'13	Company- sponsored
Radiation Safety Course for Industrial Radiographers	PNRI	18	5–16 Aug '13	Company- sponsored
Radiation Safety Course for Commercial Sale and Distribution	PNRI	27	29–30 Oct '13	Company- sponsored
Safety in the Use of Nuclear Equipment and Devices (SUNED) – 67th Session)	PNRI	29	11–15 Nov '13	Company- sponsored
Radiation Safety Officer (RSO) Refresher Course	EEI Corporation, Quezon City	10	15 and 22–29 Nov '13	Company- sponsored
NUCLEAR POWER				
Special Educational Course on Nuclear Engineering for Installation, Operation and Regulation of Nuclear Power Plant	PNRI	41 (19*)	14–18 Jan '13	PNRI- sponsored
EMERGENCY PREPAREDNESS				
JAEA Follow-up Training Course on Nuclear and Radiological Emergency Preparedness and Response	PNRI	11 (11*)	11–15 Feb '13	PNRI- sponsored
ENVIRONMENTAL RADIOACTIVITY				
JAEA Follow-up Training Course on Environmental Radioactivity Monitoring	PNRI	13 (13*)	18–22 Feb '13	PNRI- sponsored
NON-DESTRUCTIVE TESTING (training courses are conducted in cooperation with the Philippine Society for Nondestructive Testing, Inc. (PSNT)				
Ultrasonic Testing – Level 2	PNRI	17	14–25 Jan '13	Individual fee- paying
Surface Methods – Level 2	PNRI	18 (*1)	11–22 Feb '13	Individual fee- paying
Radiographic Testing – Level 2	PNRI	33	11–22 March '13	Individual fee- paying
Eddy Current Testing – Level 2	PNRI	10	15–26 April '13	Individual fee- paying
Ultrasonic Testing – Level 2	PNRI	40 (*1)	20–31 March '13	Individual fee- paying
Surface Methods – Level 2	PNRI	19 (*1)	17–28 June '13	Individual fee- paying
Radiographic Testing – Level 2	PNRI	51	15–26 July '13	Individual fee- paying
Eddy Current Testing – Level 2	PNRI	6	12–16, 22–23, 27–29 Aug '13	Individual fee- paying
Ultrasonic Testing – Level 2	PNRI	36	9–23 Sept '13	Individual fee- paying
Surface Methods – Level 2	PNRI	23 (*1)	9–23 Sept '13	Individual fee- paying
Infrared Thermographic Testing – Level 1	PNRI	12	30 Sept–4 Oct '13	Company- sponsored
Ultrasonic Testing – Level 2	Tsuneishi Industrial Services, Inc.,Cebu	19	4–15 Nov '13	Company- sponsored
Radiographic Testing – Level 2	PNRI	33	2–13 Dec '13	Individual fee- paying
WELDING TECHNOLOGY (training courses are conducted in cooperation with the Philippine Society for Nondestructive Testing, Inc. (PSNT)				
Welding Inspectors	PNRI	12	8–12 July '13	Individual fee- paying
Welding Inspectors	PNRI	15	21–25 Oct '13	Individual fee- paying
TOTAL NO. OF COURSES: 37		**TOTAL : 738 (66*)**		

*No. of PNRI participants

TABLE 2. NUCLEAR S & T ON-THE-JOB TRAINING FOR UNDERGRADUATES IN 2013

FIELD OF TRAINING	PNRI SECTION/ UNIT	SCHOOL	COURSE	NO. OF STUDENTS
ATOMIC RESEARCH DIVISION				
Biomedical research activities	Biomedical Research Section	St. Paul University, Quezon City	BS Biology	1
Assistance to project on "Capacity Building in the Use and Operation of Small Neutron Sources"; neutron flux measurements; Monte Carlo simulation; NAA at NIC and set up of NaI counting system; construction/ reparation/molding of borated paraffin wax bricks; activation of gold in Am-Be;	Applied Physics Research Section	Eulogio Amang Rodriguez Institute of Science and Technology (EARIST); University of Sto. Tomas; Polytechnic University of the Philippines (PUP); University of the Philippines-Los Baños; Ateneo de Manila University	BS Applied Science with Computer Science Emphasis; BS Applied Physics; BS Physics; BS Electrical Engineering	14

TABLE 2. NUCLEAR S & T ON-THE-JOB TRAINING FOR UNDERGRADUATES IN 2013 (continuation)

FIELD OF TRAINING	PNRI SECTION/ UNIT	SCHOOL	COURSE	NO. OF STUDENTS
Assistance in the rearing, collection and encoding of data and quality control studies in relation with the fruitfly, *Brontispa longissima* and mosquito dengue project; Tissue culture techniques, and soil and plant tissue sample preparation; plant propagation; research and grain quality assessment of grain cereals, rice and mungbean; molecular marker techniques; radio sensitivity study of a root crop; application of radiation modified natural polymers; orchid breeding and embryo culture	Agriculture Research Section	Philippine Normal University (PNU); Pamantasan ng Lungsod ng Maynila; Rizal Technological University; St. Paul University-Quezon City; Our Lady of Fatima University	BS Biology for Teachers; BS Chemistry; BS Biology	15
Environmental radioactivity measurements; preparation and analysis of marine samples (sediment, biota) using HPGe; gammametric analysis of environmental samples; handling and treatment of chemical wastes in a laboratory	Health Physics Research Section	Pamantasan ng Lungsod ng Maynila; University of the Philippines, Manila; PUP	BS Biology; BS Biochemistry; BS Chemistry	6
Laboratory works on cytogenetics; biodosimetry; irradiation of blood samples; sample analysis, processing, and microscopy; radiation processing of food and medical products	Biomedical Research Section	Pamantasan ng Lungsod ng Maynila (PLM); Batangas State University; St. Paul University-Quezon City	BS Biology; BS Food Engineering	3
Atomic Absorption Spectrometry (AAS) analysis, X-ray Fluorescence Spectrometry (XRF); research and engineering design; ion chromatography for water samples; radon monitoring along Marikina Valley Fault System; analyses of rare earth elements (REE), thorium (Th), uranium (U) samples; fluorometry analysis of water samples-ion chromatography; process design/ design of pilot plant on uranium extraction from WPA; analysis for uv-vis spectrophotometry,	Nuclear Materials Research Section	Mariano Marcos State University; University of Sto. Tomas; Mapua Institute of Technology	BS Chemical Engineering; BS Chemistry	4
Radiation processing activities; processing of ESR data; radiation induced grafting of GMA; harmful algal bloom research; bioaccumulation studies; alcoholic fractionation of irradiated carrageenan	Chemistry Research Section	PLM; University of the Philippines-Diliman; UP-Manila; PUP; PSHS-Main Campus; St. Paul University-Quezon City	BS Chemistry; BS Biochemistry; 4th year High School; BS Biology	11
NUCLEAR SERVICES DIVISION				
Brachytherapy calibration; use of survey meters	Radiation Protection Services Section	EARIST; De la Salle University – Manila	BS Applied Physics; BS Pre-Med Physics	8
Maintenance and trouble shooting of electronic devices and nuclear instruments	Engineering Services Section	AMA University; UP-Los Baños; Cavite State University; Bulacan State University	BSECE; BS Electrical Engineering; BS Industrial Technology	5
Assistance in the preparation and calibration of dosimeters; routine dose measurement; and preparation of R & D samples for irradiation	Irradiation Services Section	EARIST	BS Applied Physics	1
Radioactivity in food and environmental samples	Nuclear Analytical Techniques Applications Section	UP-Manila; UP-Diliman; PUP; PSHS-Main Campus; PSHS-Mindanao	BS Biochemistry; BS Chemistry; 3rd year High School; 4th year High School	8
TECHNOLOGY DIFFUSION DIVISION				
Assistance in the following (1) implementation of the Nuclear Training Center (NTC) Learning Management System; (2) laboratory experiments during seminar for high school science teachers; (3) program design to consolidate NTC databases for easier information access of NTC course participants and clients; (4) profiling of NTC clients; characterization of the neutron howitzer source consolidation of database	Nuclear Training Center	STI College, Novaliches; Technological University of the Philippines (TUP); PNU; Quezon City Polytechnic University; EARIST; Pamantasan ng Montalban	BS Computer Science; BS in Applied Science – Laboratory Technology; BS Biology for Teachers; BS Information Technology; BSBA (HRDM)	7
Maintenance and processing of hardware monitoring system biometrics and SQL Express DB; Assistance in the application programming, maintenance, HD formatting, installation of OS ; network installation, configuration and trouble shooting	Management Information System	Technological University of the Philippines (TUP); Asian Institute of Computer Studies; De la Salle College of St. Benilde	BS Information Technology; BS Computer Science	5
Assistance in the nuclear information, education and communication activities; assistance in data encoding, processing and other library work	Nuclear Information and Documentation Section	Bestlink College of the Philippines; Asian Institute of Computer Studies	BS in Office Administration; BS in Computer System and Design Program; BS Computer Science	4
FINANCE AND ADMINISTRATIVE DIVISION				
Office administrative procedures and document management	Office of the FAD Chief	New Era University	BSBA major in Management	2
Office administrative procedures/work regarding property and procurement processes such as inventory of incoming and existing supplies/materials/ instruments and equipment, updating of Purchase Order database	Property and Procurement Section	Quezon City Polytechnic University; Bestlink College of the Philippines; Pamantasan ng Montalban	BS Entrepreneural Management; BS in Office Administration; BSBA (HRDM)	5
Office administrative procedures and document management and human resource development	Human Resource Management & Records and Communication Section	St. Joseph College of Bulacan; Pamantasan ng Montalban; Bulacan State University	AB Psychology; BSBA (HRDM); BS Industrial Technology major in Computer Technology	4
Office administrative procedures and document management	Budget Section	Pamantasan ng Montalban	BSBA (HRDM)	1
Office administrative procedures and document management	General Services Section	AMA University	Computer System, Design & Programming	2
NUCLEAR REGULATORY DIVISION				
Office administrative procedures and document management	Licensing, Review & Evaluation Section	Pamantasan ng Montalban	BSBA	2
Office administrative procedures and document management	Regulations and Standards Development Section	Pamantasan ng Montalban	BSBA	1
Assistance in the preparation of the following, among others: (1) computer program for the inventory of equipment and other emergency supplies/ materials; and (2) radiological emergency brochures	Radiological Impact Assessment Section	Bulacan State University	BS Industrial Technology	1
OFFICE OF THE DIRECTOR				
Office administrative procedures and document management	Office of the Director	Bestlink College of the Philippines	BS in Office Administration	1
Office administrative procedures and document management	International Cooperation Section	Pamantasan ng Montalban	BSBA major in Human Resource	1
TOTAL NO. OF SCHOOLS SERVED: 31 NO. OF STUDENTS: 112				

APPENDICES

TABLE 3. THESIS/RESEARCH ADVISORSHIP IN 2013

FIELD OF TRAINING	PNRI SECTION	SCHOOL	COURSE	NO. OF STUDENTS
ATOMIC RESEARCH DIVISION				
Extraction of quercetin; acquisition treatment and irradiation of blood samples; and cytogenetic analysis of human lymphocytes	Biomedical Research Section	Philippine Science High School – Main Campus	High School	3
Neutron flux measurements; gamma spectrometry; and MCNP Code Simulation	Applied Physics Research Section	Eulogio Amang Rodriguez Institute of Science and Technology (EARIST)	BS Applied Physics	3
Preparation of chitosan solution: coating of fruits; Carboxymethylation (starch) gamma irradiation; Materials preparation prior to irradiation; work-up of samples after reaction; analysis of polymer grafted materials; and study of absorption of metal ions.	Chemistry Research Section	Caloocan City Science High School; Quezon City Science High School; PLM	BS Chemistry; High School	12
Method development by comparative analysis (OC/EC); determination of ^{137}Cs; ^{40}K,				
TECHNOLOGY DIFFUSION DIVISION				
Development and Evaluation of Radiation Measuring Instruments	Nuclear Training Center	EARIST	BS Applied Physics	5
TOTAL NO. OF SCHOOLS SERVED: 5 NO. OF STUDENTS: 23				

TABLE 4. IAEA RESEARCH CONTRACTS* IMPLEMENTED IN 2013

TITLE/DESCRIPTION OF RESEARCH	PROJECT DURATION		NAME OF RESPONSIBLE AGENCY/STAFF
	START	END	
Enhancing Cytogenetic Biological Dosimetry Capabilities of the Philippines for Nuclear Incidence Preparedness	2 Feb '12	2 Feb '13	Celia O. Asaad PNRI
Completion and Release of the Philippine I-Wave Pilot Study Gap report and Implementation of Specific Remedies for Identified Gaps in Hydrological Understanding	10 Feb '12	14 Feb '13	Susan Abano National Water Resources Board
Mutation Breeding and Molecular Genetics of Adaptation to High Temperature in Rice	15 Feb '12	14 Feb '13	Thelma Padolina Philippine Rice Research Institute
Application of Isotope Hydrology Techniques by the Philippine Nuclear Research Institute in Water Resources- Regions 2 and 10 in Support of the Groundwater Resource and Vulnerability Assessment Project in the Department of Environment and Natural Resources	30 April '12	29 April '13	Soledad S. Castañeda PNRI
Use of Sentinel Lymph Node in Breast, Melanoma, Head and Neck and Pelvic Cancers	30 Nov '12	12 Oct '13	Jonas Santiago St. Luke's Medical Center
Development of Safe, Quality and Shelf-Stable Foods for Immunocompromised Patients and Calamity Victims	11 Dec '12	12 Nov '13	Zenaida M. De Guzman PNRI
Improving Capability in Detecting Early Breast Cancer Using Diagnostic Imaging Modalities	14 Dec '12	11 Dec'13	Orestes Monzon Philippine Heart Center

- IAEA Research Contracts are grants under the IAEA Contract Research Programme whose funding is sourced from the IAEA Regular Budget and also from the extrabudgetary contributions to the IAEA. Through this program, minor equipment and miscellaneous local purchases are provided. The grant to a project is of the average US dollar 5,000 per year.

TABLE 5. IAEA TECHNICAL COOPERATION PROJECTS* IMPLEMENTED IN 2013

NAME OF PNRI CONTACT PERSON	TITLE/DESCRIPTION OF RESEARCH	PROJECT DURATION		PROJECT COST (IN PESOS)
		START	END	
Alumanda M. Dela Rosa, Ph.D.	Assessing the Development of a Nuclear Power Programme	2012	2013	4,260,637.00
Lucille V. Abad, Ph.D.	Using E-beam Technology for Industrial, Environmental and Agricultural Applications	2012	2013	7,776,019.00
Adelina DM. Bulos	Building Capacity for the Preparation and Quality Control of Radiopharmaceuticals for Enhanced Nuclear Medicine Applications	2012	2013	11,827,777.00
Pablo Saligan	Preparing Plans for an Ion Beam Accelerator Facility for Research, Training, Education and Applications in Nuclear Science and Technology	2012	2013	3,618,909.00
Teofilo San Luis, Jr.	Establishing a Cyclotron/Positron Emission Tomography (PET) Facility	2012	2013	2,789,411.00
Teofilo V. Leonin, Jr.	Upgrading the National Infrastructure and Strengthening Capabilities for an Independent Regulatory Authority	2012	2013	3,412,009.00

* Technical Cooperation (LTC) Projects are under the IAEA Technical Cooperation Program and funded by the Technical Assistance Committee Fund (TACF) and extra budgetary contributions to the IAEA. Financial support is provided into their components, namely, expert assistance, equipment donation and overseas training.

TABLE 6. IAEA EXPERTS/OTHER MISSIONS

FIELD/PURPOSE	NAME OF EXPERT	DATE OF VISIT
Conducting a Study and Evaluation of the Co-location of a Borehole Disposal Concept with a Proposed Near-Surface Radioactive Waste Repository	Paul Degnan	28 Jan '13
Memorandum of Agreement with the Korean Atomic Energy Research Institute	Dr. Young Chang Dr. Jong Seok Park	2 April '13
Korean Atomic Energy Research Institute	Mr. Whan Sam Chung	8 April '13
Documentation of SHARS Conditioning	Mr. Vilmos Friedrich Ms. Christina Geoge Ms. Louise Patterson	
Conduct Radiological Source Physical Protection Site Assessment at Licensed Facilities	Mr. Keith Freier Mr. Drue Collins Mr. Peter Hoag Mr. Jake Burns	10 April '13
Radiation Processing	Prof. Olgun Guven	10–14 June '13
SA Provision of Guidance and Assistance in the Identification of Human Resources Needs and Competency Areas of the Regulatory Body	Mr. Pierre Mignot	10–14 June '13
Assist in the HRD Plan Preparation for the Regulatory Body	Pierre Mignot	10 – 14 June' 13
Technical Cooperation (TC) Project on Preparing Plans for an Ion Beam Accelerator Facility for Research, Training, Education and Applications in Nuclear S & T	Dr. Luka Snoj	17–21 June '13

TABLE 6. IAEA EXPERTS/OTHER MISSIONS (continuation)

FIELD/PURPOSE	NAME OF EXPERT	DATE OF VISIT
Regulatory Framework and Regulatory Functions	Mr. Ugur Bezdeguemeli Mr. Geoff Vaughan Mr. Naveed Maqbul Mr. Suk-Ho Lee	1–5 July '13
EU Mission on Emergency Preparedness and Response	Mr. Jose Mota Neale Kelly Mr. Henk Van Rij Mr. O. Sestokas Mr. Robert Frank Mr. Marc de Cort Mr. Peter Zombori	30 July '13
Conduct of Sampling for Noble Gas in Groundwater in Regions 2 and 10	Dr. Takuya Matsumoto	19–25 Aug '13
QUANUM Mission to Elevate the level of Practice of Nuclear Medicine	Dr. Thomas Neil Pascual Ms. Einat Even-Sapir Weizer Ms. Sylviene Prevot Mr. Eyal Yosef Mishan Mr. S. Na Somanesan	2–6 Sept '13
Discussion on Status of Collaborating Center for Harmful Alagal Blooms	Mr. Michel Warnau	25–26 Sept '13
Visiting Professor from Tokyo University	Prof. M. Uesaka	24 Oct '13
Monitoring and Evaluation Tools for Technical Cooperation (TC) Project to Strengthen the Capacity Skills of National Stakeholders in Logical Framework Approach, Monitoring of TC Projects and Pilot and Validate the Field Monitoring Missions Methodology	Galya Dimitrova Frank Campbell	11 –15 Nov '13
Review and Finalization of the Energy Development Scenarios	Mr. Hans-Holger Rogner	2–6 Dec '13
ITG Support Group (ANSN)	Sameer Kunjeer M. Sumbarjo	2–6 Dec '13
Monitoring of Progress of Activities Under the IWAVE Project	Mr. Pradeep Aggarwal	3–4 Dec '13
Provision of Assistance in the Identification of Activities Needed for Hydrogeological Assessment, Mapping, Groundwater Modelling and Water Use Data Processing	Mr. Thomas Himmelback Mr. Roland Bauemle	3–5 Dec '13
Safeguards Inspector	Mr. Mazibur Rahman Mr. Faisal Ajjeh	10–13 Dec '13
4th Steering Committee Meeting Between PNRI and Japan Atomic Energy Agency (JAEA)	K. Shigemoto N. Nakamura Y. Yabuuchi M. Sawada	17–-19 Dec '13

TABLE 7. PNRI HOSTINGS IN 2013

FIELD	PHILIPPINE PARTICIPANT	AGENCY / INSTITUTE	ORGANIZER/S	VENUE	DATE
Workshop on Effective Border Control Coordination for Asia and the Pacific and Middle East Countries	Julietta Seguis, Sylvia Busine, Nelson Badinas Angeline Agustine Michelle Jayag, Jhoanna Jarasa Armando Razon Nicomedes Enad	PNRI Office of the Exec. Secretary United Nation and Other International Organizations, DFA Philippine Ports Authority Bureau of Customs	IAEA	Manila Diamond Hotel	20-22 Feb. 2013
IAEA/RCA Regional Training Course On Basic Radiation Processing Of Polymer Focusing On Radiation Grafting	Annie Day Asa, Veriza Rita Cruz, Davison Baldos, Wendy Lim Jeannie Lynn Cabansag, Zailla Flores,	PNRI Philippine Textile Research Institute	IAEA/RCA	Crowne Plaza Galleria Manila	15-19 April 2013
IAEA-ANSN Regional Workshop on Communication Plan, Strategies and Tools	Rhodora Leonin, Justina Cerbolles, Ma. Celerina Ramiro, Joan Tugo Mona Carina Montevirgen, Framelia Anonas Christopher Manalo, Diana Gabito	PNRI STII-DOST Department of Energy	IAEA/ANSN	Bayview Park Hotel, Manila	28-31 May 13
IAEA First Coordination & Steering Meeting RAS5065 " Supporting Climate-Proofing Rice Production Systems(CRIPS) Based on Nuclear Applications"	Corazon Bernido, Victoria Fe Medina, Christina Petrache, Glenda Obra	PNRI	IAEA	Crowne Plaza Galleria Manila	25-29 June 2013
Regional Training Course on GxE Testing, Seed Storage and Farmer Participation	Mark Ian Calayugan Martha Chico Teodora Mananghaya Ronalyn Miranda Lenie Pautin	Philippine Rice Reserach Institute (PhilRice)	IAEA	IRRI Los Banos, Laguna	1-12 July 2013
Regional Workshop On Integrated DSA and PSA for Risk Management Of Nuclear Power Plants	Raymund Beredo, Guisepe.F. Dean, John Richard Fernandez, Carl Nohay, Alfonso Singayan	PNRI	IAEA/ANSN	Crowne Plaza Galleria Manila, Quezon City Philippines	22 – 26 July 2013
Regional Training Course On Use of Nuclear & Isotopic Techniques In Assessment of Fertilizer and Water Use Efficiency	Perla Estabillo & Angelita Marcia Filomena Grospe Roland Rallos and Wilfredo Gultiano	Bureau of Soils and Water Management PhilRice / PNRI	IAEA	Crowne Plaza Galleria Manila, Quezon City	23 – 27 Sep. 2013
Training Course on Radioactive Waste Management: Stakeholder Considerations as Inputs into the Strategic Planning for Radioactive Waste Management	Edmundo Vargas Francis Richard Rabulan and Diana Christine Gabito Lucila Fuentes and Jose Manalo	PNRI Dept of Energy National Power Corporation	IAEA	Crowne Plaza Galleria Manila, Quezon City	21 – 25 Oct. 2013
Second Regional Workshop on the Implementation of IAEA General Safety Requirements Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards	Vangeline K. Parami, Thelma P. Artificio, Ana Elena L. Conjares, Estrella Caseria, Luzviminda Vineda, Lorna Jean H. Palad, Romelda Azores, M.L. Grande, Edgar Racho, Carl M. Nohay, Roel Loteriña, Dennis Aquino F. Gregorio Maica Tiongio Jeff Puyo Bayani San Juan, Augusto Morales, Gloria Vargas	PNRI AUFMC ACTI Center for Device Regulation, Radiation Health and Research-DOH	IAEA	Crowne Plaza Galleria Quezon City	28 Oct. – Nov. 01, 2013

APPENDICES

TABLE 7. PNRI HOSTINGS IN 2013 (continuation)

FIELD	PHILIPPINE PARTICIPANT	AGENCY / INSTITUTE	ORGANIZER/S	VENUE	DATE
	Ella S. Deocadiz Quenette Magbitang Michael Paul Kindica Pearl Kathleen Tumlos, Mary Ann Pacho Remigio Salvador Ariel P. Moleño Margareth A. Tavas, Kathleen Jane U. Cortez Janet Martinez Bonifacio Magtibay	EMB GMS PSH PCHRD PGH SLMC-GC SLMC-Q.C. WHO			
FNCA Workshop on Biofertilizer	Juliet Anarna	Biotech, UPLB	FNCA	UP Los Baños, Laguna	18-21 Nov. 2013
RCA/UNDP Project Annual Review Meeting on Electron Beam Applications for Value Addition to Food and Industrial Products and Degradation of Environmental Pollutants in the Asia Pacific Region,	Alumanda dela Rosa, Zenaida de Guzman, Nydia C. Medina	PNRI	RCARO/PNRI	Marriot Hotel, Cebu	21-22 Nov. 2013
Mid-Term Review Meeting Supporting Sustainable Air Pollution Monitoring Using Nuclear Analytical Technology	Preciosa Corazon Pabroa Jeam Rosete	PNRI DENR		Crowne Plaza, Quezon City,	25-29 Nov. 2013

TABLE 8. NON-PNRI HUMAN RESOURCES DEVELOPMENT (FOREIGN) IN 2013

FIELD	NAME	AGENCY	TRAINING VENUE	DATE	SPONSOR
GROUP FELLOWSHIP TRAINING					
Model of Energy Supply Strategy Alternatives and their General Environmental Impacts (MESSAGE) Software for Developing Long-Term Energy Supply Scenario for the Country	Marietta Quejada, Francis Richard Rabulan, Norman Vincent Martirez and Sherwin Adeva	Department of Energy	Vienna, Austria	5 – 30 Aug '13	IAEA
REGIONAL TRAINING COURSE					
Multi-Modality Approaches in the Diagnosis of Cardiovascular Diseases	Angelin Apostol	Philippine Heart Center	Gunma, Japan	8 – 12 April '13	IAEA/RCA
Image Based Radiotherapy and QA for Lung and Gastrointestinal Cancer	Dan Joseph Manlapaz Maria Teresa Julieta Benedicto	St. Luke's Medical Center Philippine General Hospital	Bangkok, Thailand	6 – 10 May '13	IAEA/RCA
Risk Analysis for Transboundary Animal Diseases	Emelinda Lopez	Bureau of Animal Industry	Bogor, Indonesia	10 – 14 June '13	IAEA/RCA
Promoting and Accelerating Nuclear SPECT/PET Imaging Technologies in the Region	Juanito Olpindo, Jr. Eddie Lim	Northern Luzon Nuclear Medicine Center Asian Hospital & Medical Center	Seoul, Korea	17 June – 5 July '13	RCA/UNDP
Providing Decision Support for Nuclear Power Planning & Development	Mauro Marcelo	National Power Corporation	Tokyo, Japan	8 – 19 July'13	IAEA/RCA
Nuclear Oncology for Nuclear Medicine Specialists	Maria Lourdes Mania-Taylan	University of Sto Tomas Hospital	Amman, Jordan	2 – 6 Sept'13	IAEA/RCA
Rapid and Confirmatory Diagnosis of Avian Influenza H7N9	Edna Felipe	Philippine Animal Health Center –Bureau of Animal Industry (PAHC-BAI)I	Seibersdorf, Austria	9 – 20 Sept'13	IAEA/RCA
Basic Concepts of 3D Image-Guided Brachytherapy for Cervical Cancer	Ana Maria Fineza Dela Cruz Janet Martinez	Jose R. Reyes Memorial Medical Center St. Luke's Medical Center	Chiang Mai, Thailand	7 – 11 Oct'13	IAEA/RCA
Advances in Hybrid Imaging in Oncology	Jamila Cecilia Gomez Jonas Francisco Santiago	St. Luke's Medical Center	Mumbai, India	7 – 11 Oct'13	IAEA/RCA
Training Course on First Response to a Radiation Emergency: Procedures for Ports and Customs Offices	Nicomedes Enad	Bureau of Customs	LV, Nevada, USA	28 Oct – 1 Nov '13	IAEA
Overview of 3D-CRT and Site Specific Radiotherapy	Ramil Cabaluna Johana Patricia Canal	CGHMC Philippine General Hospital	Kuala Lumpur, Malaysia	4 – 8 Nov	IAEA/RCA
International Training Course on Isotope Hydrology	Luis Rongavilla Joey Castro	National Water Resources Board	Vienna, Austria	4 – 15 Nov'13	IAEA
Introduction to Nuclear Forensics	Jade Roselle Ham	Philippine National Police	Kuala Lumpur, Malaysia	12 – 14 Nov'13	IAEA
Training Course on Clinical Application of Stereotactic Body Radiation Therapy (SBRT)	Kathleen Jane Cortez Nonette Cupino	St. Luke's Medical Center University of the Philippines- Philippine General Hospital	Seoul, Korea	2 – 6 Dec'13	IAEA/RCA
Functional Radionuclide Imaging in the Management of Cardiovascular Diseases	Carlos Jose San Juan	CSMC	Mumbai, India	9 – 13 Dec'13	IAEA/RCA
WORKSHOP/SEMINAR					
Workshop on Best Practices for Food Safety and Quality Applications of Food Irradiation	Karen Kristine Roscom	BAFPS-Department of Agriculture	Shanghai, China	6 – 11 May'13	IAEA/RCA
Regional Workshop on the Demonstration of Safety of Radioactive Waste Disposal Activities	Roy Anthony Luna Augustus Resurreccion	University of the Philippines Civil Engineering	Kuala Lumpur, Malaysia	17 – 21 June'13	IAEA/ANSN
Regional Workshop on Essential Knowledge of Site Evaluation Report for Nuclear Power Plant	Mario Juan Aurelio	University of the Philippines-National Institute for Geological Sciences	Kuala Lumpur, Malaysia	26 – 30 Aug'13	IAEA/ANSN
Regional Workshop on Observing a Nuclear Emergency Response Exercise of a Local Government	Edwin Sadang	Office of Civil Defense	Hokkaido, Japan	7 – 10 Oct'13	IAEA
FNCA Workshop on Radiation Oncology	Miriam Joy Calaguas	Jose R. Reyes Memorial Medical Center	Seoul, Korea	19 – 22 Nov'13	Japan Government
Workshop on Quality Management Audits in Nuclear Medicine Practices (QUANUM) for Europe, Asia and the Pacific	Gerard Francis Goco and Nathaniel De Vera	RMC St. Luke's Medical Center	Singapore	16 – 20 Dec'13	IAEA
MEETING					
Technical Consultation Meeting for the Project Design of a National Project on Water Resources Management	David Sevilla, Jr.	Mines and Geosciences Bureau	Vienna, Austria	4 – 6 Feb	IAEA

TABLE 8. NON-PNRI HUMAN RESOURCES DEVELOPMENT (FOREIGN) IN 2013 (continuation)

FIELD	NAME	AGENCY	TRAINING VENUE	DATE	SPONSOR
Regional Meeting of RCA Proposed Concepts	Miriam Calaguas Agnette Peralta	Jose R. Reyes Memorial Medical Center CDRRHR-FDA	Vienna, Austria	18 – 22 Feb	IAEA
Technical Meeting on Training and Demonstration of Waste Disposal Technologies within the Framework of the International Low Level Waste Disposal Network (DISPONET)	Roy Anthony Luna	University of the Philippines Civil Engineering & AMH	Budapest, Hungary	28 – 30 May	IAEA
Consultancy Meeting on Finalizing the Three Interactive Modules on CT Lymph Node Schematic Approach – A Practical Guide for Hybrid Imaging Analysis	Irene Bandong	Philippine Heart Center	Vienna, Austria	3 – 14 June	IAEA
First Research Coordination Meeting to Investigate the Relationship between End to End Accuracy and Quality Assurance Extent and Depth in Radiotherapy	Lilian Rodriguez	St. Luke's Medical Center – Global	Vienna, Austria	26 – 30 Aug '13	IAEA
Technical Meeting on the Design and Construction of Very Low, Low and Intermediate Level Waste Repositories	Roy Anthony Luna	University of the Philippines Civil Engineering	Vienna, Austria	30 Sept – 4 Oct '13	IAEA
Annual Meeting and Regional Workshop on Tsunami Hazards Assessment and Hydrology Related to Nuclear Power Plant Siting Activities and Requirements	Teresito Bacolcol	PHIVOLCS	Phuket, Thailand	4 – 8 Nov '13	IAEA-ANSN
Technical Meeting of the International Project on Human Intrusion in the Context of Disposal of Radioactive Waste	Roy Anthony Luna	University of the Philippines- Civil Engineering	Vienna, Austria	4 – 8 Nov '13	IAEA
Regional Executive Meeting for End-User and Policy Makers on Radiation Grafting	Raul Sabularse	PCIEERD	Jeongeup, Korea	11 – 15 Nov '13	IAEA/RCA
Technical Meeting to Evaluate Agronomics Performances	Thelma Padolina	Philippine Rice Research Institute (PHILRICE)	Penang, Malaysia	12 – 15 Nov '13	IAEA
Technical Meeting on Network of Training and Demonstration of Waste Disposal Technologies in Underground Research Facilities (URF Network)	Carlo C. Arcilla	University of the Philippines-National Institute for Geological Sciences	Vienna, Austria	26 – 29 Nov '13	IAEA
Technical Meeting on Harmonizing Quality Audit in Radiotherapy and Promoting he Concept of Audit in Member States	Miriam Joy Calaguas Nieva Lingatong	Jose R. Reyes Memorial Medical Center CDRRHR-Food and Drug Administration	Vienna, Austria	16 – 18 Dec '13	IAEA/RCA
INTERNATIONAL CONFERENCE					
Nuclear Security: Enhancing Global Efforts	Amelia Guevarra	Department of Science and Technology	Vienna, Austria	1 – 5 July '13	IAEA

TABLE 9. PNRI HUMAN RESOURCES DEVELOPMENT (FOREIGN) IN 2013

FIELD	NAME	COUNTRY	DURATION	SPONSOR
ON-THE-JOB TRAINING (OJT)				
Stable Isotope Analysis of Fish and Fish Parasites	Norman DS. Mendoza	Kyoto, Japan	27 Jan– 9 Feb '13	Kyoto University
Radiation Processing Facilities and Applications	Adrian D. Cruz	Ho Chi Minh City, Vietnam	1 April – 31 May '13	IAEA
Radiation Processing Facilities and Applications	Anie Day DC. Asa	Quebec, Canada	1 May – 31 July '13	IAEA
Production of Isotopes	Teresita G. De Jesus	Miranda, Australia	13 May – 14 June '13	IAEA
Radiation Processing Facilities and Applications	Dan Benneth C. Mangulabnan	Daejon, Korea	1 July– 31 Aug '13	IAEA
Radiation Processing Facilities and Applications	Charito T. Aranilla	Lodz, Poland	23 Sept – 23 Dec '13	IAEA
TRAINING COURSE				
Site Location of Reactor Facility Course	Rolando Y. Reyes	Tokai, Japan	21– 25 Jan '13	JAEA
RTC on the Application of Stable Isotope & Trace Elements Analyses for Food Traceability	Raymund J. Sucgang Angel T. Bautista Vii	Penang, Malaysia	29 Jan– 8 Feb '13	IAEA
Practical Training Course in Naturally-Occurring Radioactive Materials (NORM) Waste Management	Abelardo A. Inovero	Muscat, Oman	2– 6 Feb '13	IAEA
Interregional Training Course on Performance Optimization in Uranium and Rare Earth Elements Production from Phosphate Rocks	Rolando Y. Reyes	Tunisia	11 -1 5 Feb'13	IAEA
RTC on Cradle to Grave Management of Radioactive Sources	Jose N. Calaycay	Kajang, Malaysia	18 – 22 Feb '13	IAEA
Research Cruise: Tropical Ocean Climate Studies	Rhett Simon Dc. Tabbada	Australia/Japan	18 Feb - 27 Mar '13	Japan Agency for Marine-Earth Science and Technology
11th ESARDA Course on Nuclear Safeguards and Non-Proliferation	Ramoncito F. Sulit Paolo Tristan F. Cruz	Kuala Lumpur, Malaysia	25 Feb – 3 March '13	European Commission
Training Course for Non-Destructive Testing (NDT) Instructors	Renato T. Bańaga	Tokyo, Japan	2 – 6 March '13	JSNDI
Training Course on Safety Assessment II (PSA)	Carl M. Nohay	Cologne, Germany	4 –8 March	ENSTTI
RTC on Industrial Process Single Photon Emission Computed Tomography (IP-SPECT)	Adelina DM. Bulos and Janice P. Mallillin	Dalat, Vietnam	11 – 15 March '13	IAEA
Interregional Training Course on Uranium Exploration Strategy, Mining and Processing Techniques	Edmundo P. Vargas	Jamshedpur, India	8 – 12 April '13	IAEA
RTC on the Analysis of Marine Radioactivity with Application of Radio-Analytical Procedures on Environmental Marine Samples	Ryan Joseph Aniago	Xiamen, China	15 – 25 April '13	IAEA
ENSTTI Course on Introduction to Nuclear Safety	Neil Raymund D. Guillermo	Garching, Germany	3 – 28 June '13	ENSTTI and EEIG
ENSTTI Course on Decommissioning	John M. Marquez Alan M. Borras	Fontenay-aux-Roses, France	24 – 28 June '13	ENSTTI
RTC on Use of High Energy Radiation Sources and Advance Supplementary Techniques for Nondestructive (NDT) Applications	Renato T. Banaga Arturo F. Salih	Tiruchchirappalli, India	1 – 5 July '13	IAEA
Nuclear and Radiological Emergency Preparedness Course	Haydee M. Solomon Joseph R. Tugo	Tokai-mura, Japan	11 July – 21 Aug '13	JAEA
Environmental Radioactivity Monitoring	Veriza Rita C. Cruz	Tokai-mura, Japan	11 July – 21 Aug '13	JAEA

TABLE 9. PNRI HUMAN RESOURCES DEVELOPMENT (FOREIGN) IN 2013 (continuation)

FIELD	NAME	COUNTRY	DURATION	SPONSOR
Instructor Training Course on Nuclear and Radiological Emergency Preparedness	Mary Rose Q. Mundo	Japan	28 July – 1 Aug '13	JAEA
RTC on Security of Radioactive Sources	Ma. Teresa A. Salabit	Beijing, China	29 July – 2 Aug '13	IAEA
RTC on Electron Beam Applications for Value Addition to Industrial Products	Jordan Madrid	Joengeup, Korea	9– 23 Aug '13	RCARO
RTC on Interpretation and Statistical Analysis of Nuclear and Isotopic Data in Addressing Climate Change Issues	Efren J. Sta. Maria Jennyvi D. Ramirez	Kuala Lumpur, Malaysia	26 – 30 Aug '13	IAEA
RTC on the Implementation of Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities	Luzviminda L. Venida	Tokai, Japan	26– 30 Aug'13	IAEA
RTC on QA Source Apportionments to Complete Data for Fingerprint Database	Preciosa Corazon B. Pabroa and Joseph Michael D. Racho	Beijing, China	26 – 30 Aug '13	IAEA
Training Course on Safety Evaluation of SAR and Oversight for Research Reactors	John M. Marquez	Ljubljana, Slovenia	2 – 6 Sept '13	EC
Tutoring Module N.3 on Safety and Oversight of Research Reactors	John M. Marquez	Ljubljana, Slovenia	9 Sept – 1 Nov '13	EC
Course on Nuclear Fuel Cycle Safety	Vangeline K. Parami	Marcoule, France	9– 20 Sept '13	EU
RTC on Modular Design of Processing & Storage Facilities for Small Volumes of Low & Intermediate Level Radioactive Wastes including Disused Sealed Sources	Jose N. Calaycay and Abelardo A. Inovero	Tangerang Selatan, Indonesia	30 Sept – 4 Oct '13	IAEA
RTC on Measurement Protocols for National Radon Strategies	Angelito F. Ramos Fe M. Dela Cruz	Bangkok, Thailand	9 – 13 Sept'13	IAEA
RTC on Use of Advanced NDE Techniques	Renato T. Bañaga Rollie Ilao	Shanghai, China	9 – 13 Sept '13	IAEA
Training Course on IMS and Developing Safety Culture	Alan M. Borras	Illinois, USA	23 Sept – 4 Oct '13	IAEA/US Government
RCARO RTC on Electron Beam Applications for Environmental Remediation	Preciosa Corazon B. Pabroa	Jeongeup, Republic of Korea	7 – 11 Oct '13	RCARO
Nuclear Energy Administration Course	Mylene M. Espinal	Tsuruga, Japan	21 Oct – 8 Nov '13	WERC
RTC on Compliance Assurance Training Aligned to the Regulation for the Safe Transport of Radioactive Material	Lynette B. Cayabo Albert M. Llagas	Beijing, China	4– 8 Nov '13	IAEA
Basic Liquid Chromatography Training Course	Rommel D. Mascariñas, Maria Dalia Philline T. Latido and Bin Jeremiah D. Barba	Singapore	06 – 08 Nov '13	PerkinElmer Instruments Philippines Corporation
DEVCO 1 Training Course on Instrumentation and Control and Electric Systems	Roberto N. Fontanilla	Rome, Italy	11 – 15 Nov '13	ENSTTI
Introduction to Nuclear Forensics Training Course	Estrellita U. Tabora	Kuala Lumpur, Malaysia	12–14 Nov '13	IAEA
RTC for those with Limited QMS Experience	Eliza B. Enriquez	Colombo, Sri Lanka	9 – 13 Dec '13	IAEA
RTC on Information and Computer Security for Nuclear Security Practitioners	Julietta E. Seguis John M. Marquez	Beijing, China	16 – 20 Dec '13	IAEA
MEETING				
INSC Regulatory Cooperation Forum Meeting	Alumanda M. Dela Rosa and Teofilo V. Leonin, Jr.	Brussels, Belgium	22 – 24 Jan '13	EU
Regional Meeting on Project Design of RCA Proposed Concepts for TCP 2014-2015	Zenaida M. De Guzman and Mary Jayne C. Manrique	Vienna, Austria	18 – 22 Feb'13	IAEA
Global Initiative to Combat Nuclear Terrorism (GICNT) Implementation and Assessment Group (IAG) Meeting	Teofilo V. Leonin, Jr.	Madrid, Spain	19– 22 Feb '13	US GICNT
Third Open-Ended Meeting of Technical and Legal Experts to Develop a Non-binding Instrument on the Transboundary Movement of Scrap Metal that May Inadvertently Contain Radioactive Material	Maria Visitacion B. Palattao	Vienna, Austria	25 Feb–1 March '13	IAEA
First Meeting of Project Coordinators of RAS9061 Project	Alumanda M. Dela Rosa	Vienna, Austria	26– 28 Feb '13	IAEA
Forum for Nuclear Cooperation in Asia (FNCA) Meeting	Adelaida Barrida	Kajang, malaysia	26 Feb – 1 March '13	MEXT of Japan
RAS/2016 Regional Project Coordination Meeting	Christina A. Petrache	Vienna, Austria	18– 22 March '13	IAEA
Technical Meeting on the Draft General Safety Guide on Communication and Consultation with Interested Parties (DS460)	Teresita G. De Jesus	Vienna, Austria	18– 22 March '13	IAEA
17th ANSN Screening Committee Meeting	Corazon C. Bernido	Vienna, Austria	24 – 26 April '13	IAEA
Kick Off Meeting on Electron Beam Applications for Value Addition to Food and Industrial Products and Degradation of Environmental Pollutants	Neil Raymund D. Guillermo	Phuket, Thailand	2-3 May'13	RCARO
3rd Meeting of the Nuclear Security Guidance Committee (NSGC)	Julietta E. Seguis	Vienna, Austria	13 – 17 May '13	IAEA
2nd Meeting of the Working Group on Radioactive Source Security (WGRSS)	Julietta E. Seguis	Vienna, Austria	27– 31 May '13	IAEA
Technical Meeting on Training and Demonstration of Waste Disposal Technologies in the International Low Level Waste Disposal Network (DISPONET)	Maria Visitacion B. Palattao	Budapest, Hungary	27 –- 30 May '13	IAEA
Regional Meeting on Developing the Legal and Regulatory Framework	Teofilo V. Leonin, Jr.	Vienna, Austria	3– 7 June '13	IAEA
Consultancy Meeting on the Implementation of the Borehole Disposal of Disused Sealed Radioactive Sources	Maria Visitacion B. Palattao, Alfonso A. Singayan, Edmundo Vargas	Accra, Ghana	10 – 14 June '13	IAEA
2nd Meeting of the Working Groups on IAEA Fukushima Report	Alumanda M. Dela Rosa	Vienna, Austria	12– 14 June '13	IAEA
Technical Meeting on the International Regulatory Network (RegNet)	Thelma P. Artificio	Vienna, Austria	17– 19 June'13	IAEA
Technical Meeting on Metasomatite Uranium Occurrences and Deposits	Rolando Y. Reyes	Vienna, Austria	17 – 19 June '13	IAEA
Annual Meeting and Regional Workshop on Optimization of Radiation Emergency Preparedness and Response	Teofilo V. Leonin, Jr. Estrella S. Caseria	Hanoi, Vietnam	17– 21 June'13	IAEA
Technical Meeting on Regional Networks For Education in Nuclear Technology	Corazon C. Bernido	Vienna, Austria	18– 21 June '13	IAEA

TABLE 9. PNRI HUMAN RESOURCES DEVELOPMENT (FOREIGN) IN 2013 (continuation)

FIELD	NAME	COUNTRY	DURATION	SPONSOR
Kick Off Meeting of the UNICRI Project 4 on Inter-Agency Chemical, Biological, Radiological, Nuclear (CBRN) Response Programme (ICP)	Cecilia M. De Vera	Phnom Penh, Cambodia	2 – 3 July '13	ICP Consortium
Technical Meeting on Radiation Processed Materials in Products from Polymers for Agricultural Applications	Lucille V. Abad	Vienna, Austria	8–12 July'13	IAEA
3RD Program Committee Mtg for the International Conference on Security & Safety of Radioactive Sources	Alan M. Borras	Vienna, Austria	23–26 July '13	IAEA
High Level Regional Meeting on Regulatory infrastructure for the Control of Radiation Sources	Teofilo V. Leonin, Jr. Alan M. Borras	Kathmandu, Nepal	12– 15 Aug '13	IAEA
Technical Meeting to Exchange Expertise in Mutation Breeding and Best Fit Soil and Water Management Practices	Adelaida Barrida	Ulaanbaatar, Mongolia	13– 16 Aug '13	-----
2nd Annual Project Review Meeting of RAS7021	Eliza B. Enriquez	Koror, Palau	12 – 16 Aug '13	IAEA
Topical Meeting on the Implementation of the International Network for Nuclear Security Training and Support Centres (NSSC)	Julietta E. Seguis	Vienna, Austria	19 – 21 Aug '13	IAEA
Regional Meeting on RTD-CFD for Radiotracer Applications in Multiphase Reactors (RAS1012), China	Adelina Dm. Bulos Janice P. Mallillin	Xian, China	19– 23 Aug '13	IAEA
5th Meeting of the Study Panel on Approaches toward Infrastructure Development for Nuclear Power	Alumanda M. Dela Rosa Christina A. Petrache	Tokyo, Japan	21– 23 Aug'13	Government of Japan
Technical Meeting on the Implementing Guide on Preventive Measures for Nuclear and Other Radioactive Material Out of Regulatory Control	Julietta E. Seguis	Viena, Austria	2 – 6 Sept '13	IAEA
First Meeting of the ASEAN Network of Regulatory Bodies on Atomic Energy	Teofilo V. Leonin, Jr. Maria Visitacion B. Palattao	Bangkok, Thailand	2– 5 Sept '13	OAP
Third Research Coordination Meeting on the Development of Irradiated Foods for Immuno-compromised Patients and Other Potential Target Groups	Zenaida M. De Guzman	Joengeup, Korea	9– 13 Sept'13	IAEA
Technical Meeting on Thorium Resources and Provinces	Rolando Y. Reyes	Vienna, Austria	24– 27 Sept '13	IAEA
Annual Meeting of the Topical Group on Communication & Consultation with Interested Parties and Regional Workshop on Emergency Communication	Rhodora R. Leonin Justina S. Cerbolles	Jakarta, Indonesia	30 Sept. – 4 Oct '13	IAEA
Meeting with the Advanced Radiation Technology Institute (ARTI)	Soledad S. Castañeda	Jeongeup, Korea	21 – 25 Oct '13	Korea Research Council of Fundamental Science and Technology
4th Meeting of the Nuclear Security Guidance Committee (NSGC)	Julietta E. Seguis	Vienna, Austria	28–31 Oct '13	IAEA
Technical Meeting on the Draft Implementing Guide entitled "Implementing the Legislative and Regulatory Framework for Nuclear Security"	Nelson P. Badinas	Vienna, Austria	28 Oct – 1 Nov '13	IAEA
Meeting on Processing, Analysis and Interpretation of Isotopic and Hydrogeochemical Data for Groundwater Dynam	Soledad S. Castañeda	Beijing, China	4 – 8 Nov	IAEA
50th Meeting of the Joint OECD/NEA-AIEA Uranium Group	Rolando Y. Reyes	Paris, France	6 –8 Nov '13	IAEA
Meeting on Establishment of a Process Based Management System	Christina A. Petrache	Yogyakarta, Indonesia	2 – 6 Dec '13	IAEA
Annual Plenary Meeting on the Data Analysis and Collection for Costing of Research Reactor Decommissioning Project	John M. Marquez	Vienna, Austria	9–13 Dec'13	IAEA
RAS/9071 Mid-Term Project Coordination Meeting	Editha A. Marcelo	Thailand	9 – 13 Dec '13	IAEA
REGIONAL WORKSHOP				
Regional Workshop on Establishment of a Regional Advisory Safety Committee for Research Reactor Operating Organizations	John M. Marquez	Vienna, Austria	11 – 15 March '13	IAEA
RWS on Basic Professional Training on Nuclear Safety	Nelson P. Badinas Joseph R. Tugo John Richard A. Fernandez	Daejon, Korea	8– 19 April '13	IAEA/KINS
ARF Workshop on United Nations Security Council Resolution 1540 Implementation	Teofilo V. Leonin, Jr.	Bangkok, Thailand	14– 15 May '13	United States Government
Regional Workshop on Leadership, Management for Safety and Safety Culture	Alan M. Borras	Bangkok, Thailand	20– 23 May '13	IAEA
Regional Workshop on Leadership, Management for Safety and Safety Culture	Ma. Celerina M. Ramiro	Bangkok, Thailand	20– 23 May '13	IAEA
Regional Workshop on the Best Estimation Plus Uncertainty (BEPU) Method Applicable to Safety Analysis	Giuseppe Filam O. Dean Joseph R. Tugo	Beijing, China	27– 31 May '13	IAEA
Regional Workshop on Regulatory Control of Nuclear Power Plants	Luzviminda L. Venida	Daejeon, Korea	27 – 31 May '13	IAEA
ASEAN Regional Forum (ARF) UNSCR 1540 Implementation Workshop	Teofilo V. Leonin, Jr.	Bangkok, Thailand	14– 15 May '13	US
Workshop to Sensitize Member States to the Integrated Nuclear Security Support Plan (INSSP) Concept	Sylvia S. Busine	Kuala Lumpur, Malaysia	11– 13 June '13	IAEA
International Workshop on Additional Protocol: Experiences in the Southeast Asia	Julietta E. Seguis	Jakarta, Indonesia	17 – 19 June '13	US DOE - NNSA
Regional Workshop on the Demonstration of Safety of Radioactive Waste Disposal Facilities	Editha Marcelo, Edmundo Vargas	Kuala Lumpur, Malaysia	17 – 21 June '13	IAEA
International IAEA-CYTED-UNECE Workshop on United Nations Framework Classification	Rolando Santiago	Chile	9 – 12 July 13	IAEA
Workshop on Regional Cooperation on Emergency Preparedness and Response in SEA	Teofilo V. Leonin, Jr.	Kuala Lumpur, Malaysia	2 Aug '13	European Union
Workshop on Strengthening the RCA/RCARO Activities and Its Efficiency	Alumanda M. Dela Rosa	Seoul, Korea	7 – 9 Aug '13	RCARO
Regional Workshop on Essential Knowledge of Site Evaluation Report for Nuclear Power Plants	Rolando Y. Reyes	Kuala Lumpur, Malaysia	26 – 30 Aug '13	IAEA
Regional Workshop on Management of Nuclear Knowledge & Safety Competence	Graceta Dl. Cuevas Ma. Celerina M. Ramiro Ana Elena L. Conjares	Wuhan, China	2– 6 Sept. '13	IAEA

TABLE 9. PNRI HUMAN RESOURCES DEVELOPMENT (FOREIGN) IN 2013 (continuation)

FIELD	NAME	COUNTRY	DURATION	SPONSOR
Regional Workshop on Safety Review and Assessment for Regulators	Thelma P. Artificio Romelda P. Azores	Daejeon, Korea	9–13 Sept'13	IAEA/KINS
Forum for Nuclear Cooperation in Asia (FNCA) 2013 Workshop on Radiation Safety and Radioactive Waste Management	Maria Visitacion B. Palattao	Mongolia	10–13 Sept '13	Japanese Government
Workshop on Human Resource Development	Percedita T. Cansino	Tsuruga, Japan	17– 19 Sept'13	NSRA
Regional Workshop on the Application of the Code of Conduct on the Safety of Research Reactors for Core Management and Safety of Experiments	Jan Aldrich A. Agustin	Yogyakarta, Indonesia	23 – 27 Sept '13	IAEA
FNCA Workshop on Research Reactor Network & 9th International Conference on Nuclear and Radiation Physics	Neil Raymund Guillermo	Almaty, Kazakhstan	24– 27 Sept '13	Govt of Japan
CSCAP Nuclear Energy Experts Group (NEEG) Workshop	Teofilo V. Leonin, Jr	Da Lat, Vietnam	11–12 Nov '13	CSCAP
9th International Workshop on Ionizing Radiation Monitoring and Technical Tour at the Fukushima Daiichi Nuclear Power Plant	Teofilo Y. Garcia	Oara/Ibaraki, Japan	30 Nov – 2 Dec '13	International Organizing Committee
Regional Workshop on Complementary Safety Assessment of Research Reactors following the Lessons Learned from the Fukushima Daiichi Accident	Alfonso A.Singayan, Romelda P. Azores	Illinois, USA	9 – 13 Dec '13	IAEA
Regional Workshop on Continuous Improvement of Safety in the Light of Lessons Learned from the Accident at the Fukushima Daiichi Nuclear Power Plant	Ma. Visitacion B. Palattao, Rhodora R. Leonin, Rolando Y. Reyes, Ana Elena L. Conjares, Grace M. Carlos, Joan L. Tugo	Tokyo, Japan	10 – 13 Dec '13	IAEA
CONFERENCE/SYMPOSIUM				
International Conference on the Humanitarian Impact of Nuclear Weapons	Alumanda M. Dela Rosa	Oslo, Norway	4– 5 March '13	UNDP
International Conference on Molluscan Shellfish Safety	Aileen L. De Leon	Sydney, Australia	18 – 22 March '13	IAEA
International Conference on Effective Nuclear Regulatory Systems	Alan M. Borras Carl M. Nohay	Ottawa, Canada	8 – 12 April '13	IAEA
CTBT Science and Technology Conference	Ana Elena L. Conjares	Vienna, Austria	17 – 21 June'13	PTS - CTBTO
International Conference on Nuclear Security: Enhancing Global Efforts	Alumanda M. Dela Rosa and Julietta E. Seguis	Vienna, Austria	1– 5 July '13	IAEA
9th International Flora Malesiana Symposium (FM 2013)	Fernando B. Aurigue	Bogor, Indonesia	27 – 31 Aug '13	Philippine Horticultural Society Incorporated
57th International Atomic Energy Agency General Conference	Alumanda M. Dela Rosa	Vienna, Austria	13–20 Sept '13	Philippine Government
New Nuclear International Conference and the Special VIP Site Tour of the Emirates Nuclear Energy Corporation's Barakah Nuclear Power Plant (BNPP)	Maria Celerina M. Ramiro	Abu Dhabi, United Arab Emirates	10 – 14 Nov '13	Goodnight Consulting
CONSULTATION				
Technical Consultation For the Project Design of a National Project on Water Resources Management	Soledad Castañeda	Vienna, Austria	26-28 Feb '13	IAEA
SCIENTIFIC VISIT				
IAEA Scientific Visit to Draka Cable Wuppertal GmbH	Neil Raymund D. Guillermo	Wuppertal, Germany	8– 19 April '13	IAEA
IAEA Scientific visit for Technical Cooperation (TC) Project (PHI/130009V) in the Facility of EB Tech. Co., Ltd.	Giuseppe Filam O. Dean	EB Tech, Korea	1– July '13	IAEA
Scientific Visit for IAEA/TC Project on "Establishing Electron Beam Technology" (Food Irradiation)	Zenaida M. De Guzman	Hanoi, Vietnam	8–– 9 July '13	IAEA

TABLE 10. PNRI HUMAN RESOURCES DEVELOPMENT (LOCAL) IN 2013

FIELD	NAME	DATE	VENUE
TRAINING COURSE			
Training Workshop on Preparing Chemical Safety Manual	Davison T. Baldos	11 - 12 Feb '13	Makati City
Protocol and Social Graces	Christina A. Petrache	6 – 8 Mar '13	DOST
Counter-Proliferation Awareness at the Philippine National Police	Carl M. Nohay Mary Rose Q. Mundo	3 – 7 June '13	Camp Crame, Quezon City
Automated Production Systems for Increasing Agricultural Productivity	Roland V. Rallos	23 – 28 June '13	Batangas State University
Training-Seminar on Legal Writing and Human Rights Based Approach to Science Legislative Policy Advocacy Program	Teresita G. De Jesus	4 – 5 July '13	Subic, Zambales
Training Program on Project Management Training	Ana Elena L. Conjares, Cecilia M. De Vera, Brenda L. Pineda, Wendy G. Lim, Joseph Michael D. Racho,Christine P. Singayan	9 – 12 July '13	Technology Application Promotion Institute- DOST
Commodity Identification Training (CIT) Joint Pilot Course Coaching	Teresita G. De Jesus, Alvie J. Asuncion	5 – 6 Aug '13	Philippine National Police, Camp Crame
Content Training Program for Teachers	Alvie J. Asuncion	9 – 13 Sept '13	Pearl Orient Hotel
In-House Training on Curriculum Design for DOST-RDI Trainers	Roel A. Loteriña, Ramoncito F. Sulit, Joan L. Tugo	25 – 27 Sept '13	Metals Industry Research and Development Center
Training on the Use of Isotope/Nuclear Techniques for Soil and Water Management	Glenda B. Obra, Adelaida C. Barrida, Faye G. Rivera, Lynette B. Cayabo, Roland V. Rallos, Mary Jayne C. Manrique, Hilarion E. Mamaril	14 – 17 Oct '13	PNRI
Training for Young and Middle Managers of R&D and S&T	Kristine Marie D. Romallosa	16 – 18 Oct '13	Food and Nutrition Research Institute
Training on Technology Needs Assessment (TNA)	Celia O. Asaad, Gregory R. Ciocson	17 – 18 Oct '13	Kimberly Hotel
In-House Training for Video Conference Administrators for DOST Personnel	Christopher G. Halnin Arminda V. Espineda	11 – 14 Nov '13	Advanced Science and Technology Institute
Training Workshop on Prior Art / Patent Search	Lorna S. Relleve Ma. Allis U. Uriarte Arvin O. Dimaano	18 – 19 Nov '13	Philippine Council for Industry, Energy and Emerging Resarch and Development (PCIEERD)
Migration to Government Website Template Training	Christopher G. Halnin	25 – 29 Nov '13	Information and Communications Technology Office

TABLE 10. PNRI HUMAN RESOURCES DEVELOPMENT (LOCAL) IN 2013 (continuation)

FIELD	NAME	DATE	VENUE
Training on Foundation of IP and Prior Art Search; Training on Intellectual Property (IP) Valuation; and Training on Intellectual Property (IP) Management	Celia O. Asaad	26 – 29 Nov '13	Technological Institute of the Philippines, Quezon City
19th Executive Course on National Security	Ma. Celerina M. Ramiro	9 – 13 Dec '13	Camp Aguinaldo
SEMINAR/WORKSHOP			
Philippine Financial Reporting Standard Updates Seminar	Hershy Lou C. Santos	4 Mar '13	Philippine Institute of Certified Public Accountants
Seminar-Workshop on the Resource Description and Access (RDA) Compliant Library System	Isabel M. Amiscaray	15 – 17 May '13	Kimberly Hotel
Workshop on Documenting ISO 9001:2008 Requirements Based on ISO 9001:2008 under PNRI Project on Establishment and Implementation of PNRI-wide QMS Based on ISO 9001:2008	Christina A. Petrache, Lucille V. Abad, Glenda B. Obra, Ana Elena L. Conjares, Adelina DM. Bulos, Grace M. Carlos, Brenda L. Pineda, Ana Maria S. Veluz, Neil Raymund D. Guillermo, Cheri Anne M. Dingle, Maria Lucia B. Cobar, Veriza Rita C. Cruz, Rosario B. Encabo, Edmundo P. Vargas, Ana N. Villanueva, Hershy Lou C. Santos, Marife R. Roa, Israel D. Vinoya, Guilzam Z. Besa, Camille Grace B. Beredo, Luzviminda B. Muyco, Joan Rose N. Villanueva, Jeana Lee P. Sablay, Janice P. Mallillin John M. Marquez, Arturo F. Salih, Eileen Beth A. Hernandez, Arnold R. Valenzuela, Christine P. Singayan, Gregory R. Ciocson, Isabel M. Amiscaray, Alvie J. Asuncion, Jennylyn C, Minglana	28 – 29 May '13	PNRI Auditorium
Seminar on Basics and Applications of Monte Carlo Neutron Transport	Christina A. Petrache, Vangeline K. Parami, Maria Visitacion B. Palattao, Lopito A. Caluag, Carl M. Nohay, Alfonso A. Singayan, Alvie J. Asuncion Angel T. Bautista VII, Unico A. Bautista, Jan Aldrich A. Agustin, Lorna Jean H. Palad, Jeana Lee P. Sablay, Janice P. Mallillin, Ma. Elina Salvacion Kristina V. Ramo, Cheri Anne M. Dingle	18 – 20 June '13	PNRI
Food and Drug Administration Seminar on Good Manufacturing	Ma. Teresa L. Borras, Rizalina G. Osorio	3 July '13	
Workshop on Contingency Planning	Teofilo V. Leonin, Jr., Graceta DL. Cuevas, Julietta E. Seguis, Teofilo Y. Garcia, Estrella S. Caseria, Sylvia S. Busine, Cecilia M. De Vera, Ma. Teresa A. Salabit	5 – 8 Aug '13	PNRI
Seminar on Laws & Rules on Government Expenditures	Camille Grace B. Beredo	10 – 13 Sept '13	Commission on Audit, Quezon City
Seminar-Workshop on Control Charting	Anie Day DC. Asa Gina B. Abrera	17 Oct '13	Ateneo de Manila University, Quezon City
Patent Drafting Workshop	Lorna S. Relleve Gregory R. Ciocson	23 – 24 Oct '13	Department of Trade and Industry
Seminar on Basic Customer Service Skills	Joanrose N . Villanueva	24 – 25 Oct '13	Civil Service Commission, Quezon City
ARF Workshop on Countering Illicit Trafficking of Chemical, Biological, Radiological and Nuclear Materials	Julietta E. Seguis	20 – 21 Nov '13	Fairmont Hotel
WIPO-IPO Philippines Regional Workshop on Patent Analytics	Gregory R. Ciocson	4 – 6 Dec '13	Dusit Hotel
Seminar on Leave Administration Course for Effectiveness	Aileen B. Cezar	5 – 6 Dec '13	CSC, QC
MEETING			
Technical Working Group Meeting on the Strategic Trade Mgt. Act of 2012 and Chemical Weapons Act Ban 2012 at the Anti-Terrorism Council Program Management Center	Cecilia M. De Vera Teresita G. De Jesus	11 – 12 Feb '13	Malacañang Manila
5th Meeting of the Technical Working Group on Commodity Identification Training – National Curriculum Development (TWGCIT-NCD) and National Curriculum Development and Instructor Training Part 1	Mary Rose Q. Mundo Alvie J. Asuncion	15 – 17 May '13	Philippine National Police Training Center
5th ASEAN Regional Forum on Inter-Sessional Meeting on Non-Proliferation and Disarmament (ARFISM on NPD)	Julietta E. Seguis	4 – 5 June '13	Manila Peninsula Hotel
MITHI Clusters Plenary Meeting	Ana Elena L. Conjares Thelma P. Artificio	6 Nov '13	Department of Budget and Management
Climate Change and Disaster Risk Reduction and Management Cluster Meeting	Ana Elena L. Conjares, Cecilia M. De Vera, Nelson P. Badinas	28 Nov '13	Department of Budget and Management
OTHERS			
80th Council of the Philippines General Membership Assembly	Chitho P. Feliciano	13 Mar '13	Manila Hotel
80th NRCP General Membership Assembly	Corazon C. Bernido, Graceta DL. Cuevas, Soledad S. Castañeda, Christina A. Petrache, Glenda B. Obra, Ana Maria S. Veluz, Adelaida C. Barrida, Fernando B. Aurigue	13 Mar '13	DOST
Roundtable Discussion on Marine Aquatic Biofactories in the Philippines	Efren J. Sta. Maria	15 Mar '13	Traders Hotel
Roundtable Discussion on Human, Machine and Energy Resources for Manufacturing	Christina A. Petrache Soledad S. Castañeda	24 April '13	Hyatt Hotel Manila
Roundtable Discussion on Philippine Coconut Industry's Cocochemical Sector: Quo Vadis	Christina A. Petrache	28 May '13	Hyatt Hotel, Manila
2013 HR Symposium Performance Management Strategies and Breakthroughs	Alicia F. Lagunzad	16 – 19 July '13	Waterfront Hotel
Focus Group Discussion on Does Energy Efficiency Pay? A Closer Look at Energy Efficient Technologies	Christina A. Petrache	19 July '13	Hyatt Hotel, Manila
62th Annual Convention of Philippine Association for Advancement of Science (PHILAAS)	Levelyn Mitos M. Tolentino Gina B. Abrera	l12 – 13 Sept '13	Pearl Manila Hote
Scientific Forum on Emerging Sensors for Water Quality Monitoring	Joseph Michael D. Racho, Charles Darwin T. Racadio, Arvin Jagonoy	9 Oct '13	DOST
Symposium on Emerging Technologies for a Greener Earth	Preciosa Corazon B. Pabroa, Glenda B. Obra	22 – 24 Oct '13	Manila Hotel

TABLE 10. PNRI HUMAN RESOURCES DEVELOPMENT (LOCAL) IN 2013 (continuation)

FIELD	NAME	DATE	VENUE
PAN 2nd Forum of Updates	Levelyn Mitos M. Tolentino, Gina B. Abrera	15 Nov '13	Food and Nutrition research Institute
8th International Conference on Radiopharmaceutical Therapy	Adelina DM. Bulos, Ma. Teresa L. Borras Gregory R. Ciocson	18 – 21 Nov '13	St. Luke's Medical Center
HADR SMEE 13-3 Final Planning Conference (HAZMAT Response Awareness)	Cecilia M. De Vera	19 Nov '13	Camp General Aguinaldo
National Conference on Soil Fertility Management Researches and Organic Fertilizer Production and Regulation	Faye G. Rivera Wilfredo A. Gultiano	19 Nov '13	Bureau of Soils and Water Management
Agency Orientation of PhPay Adoption-Invite	Susan S. Pascual, Denia A. Dato-on Christine P. Singayan	28 Nov '13	Information and Communications Technology Office
National Privacy Consultative Conference	Ana Elena L. Conjares	2 Dec '13	Information and Communications Technology Office
National Export Congress (NEC)	Zenaida M. De Guzman Luvimina G. Lanuza	3 Dec '13	Philippine International Convention Center
RDA Compliant Cataloguing Policy for the DOST SciNET-Phil	Elizabeth C. Vidal	5 – 6 Dec '13	Science and Technology Information Institute
Roundtable Discussion on the Present State of Philippine ICT Infrastructure	Ana Elena L. Conjares	6 Dec '13	Traders Hotel

TABLE 11. PNRI GRADUATE PROGRAM IN 2013

NAME	LEVEL FIELD OF STUDY	NAME OF RECEIVING HIGHER EDUCATIONAL INSTITUTION	STATUS
WITH SCHOLARSHIP			
Preciosa Corazon B. Pabroa	Ph.D. in Environmental Science	University of the Philippines (UP) - Diliman	Graduated
Angel T. Bautista VII	M.S. in Environmental Science	University of the Philippines (UP) - Diliman	Graduated
Alfonso A. Singayan	M.S. in Public Management	Ateneo School of Government	Graduated
Ma. Teresa A.Salabit	M.S. in Public Management	Ateneo School of Government	Graduated
Lynette B. Cayabo	M.S. in Radiation and Nuclear Safety	Universiti Kebangsaan - Malaysia	Graduated
Roel A. Loteriña	M.S. in Radiation and Nuclear Safety	Universiti Kebangsaan - Malaysia	Graduated
Grace M. Carlos	M.S. in Public Management	Ateneo School of Government	Graduated
Gerald DG. Conise	M.S. in Public Administration	Polytechnic University of the Philippines	Graduated
Hidie S. Gocuyo	M.S. in Public Administration	Polytechnic University of the Philippines	Graduated
Michael P. Hernandez	M.S. in Public Administration	Polytechnic University of the Philippines	Graduated
Chitho P. Feliciano	Ph.D. in Material Science	University of Tsukuba - Japan	Ongoing/Gov't of Japan
Ryan U. Olivares	Ph.D. in Environmental Science	The University of Tokyo	Ongoing/DOST
Angel T. Bautista VII	Ph.D. in Nuclear Engineering for Systems Innovation	The University of Tokyo	Ongoing/Gov't of Japan
Ana Elena L. Conjares	Ph.D. in Information Technology	Technological Institute of the Philippines	Ongoing/DOST-HRDP
Ryan P. Morco	M.S. in Chemistry	University of Western Ontario,Canada	Ongoing
Neil Raymund D. Guillermo	M.S. Programmer in Nuclear Technology	Bangkok, Thailand	Ongoing/ENCONET Consulting GmbH
Unico A. Bautista	M.S. in Nuclear Engineering and Management	The University of Tokyo	On-going/Gov't of Japan
Norman DS. Mendoza	M.S. in Chemistry	University of Santo Tomas	Ongoing/DOST-HRDP
Gloriamaris L. Caraos	M.S. in Chemistry	University of Santo Tomas	Ongoing/DOST-HRDP
Gregory R. Ciocson	M.S. in Technology Management	UP-Diliman	Ongoing/SEI
SELF-FINANCED STUDIES			
Ma. Elina Salvacion Kristina V. Ramo	M.S. in Medical Physics	University of Santo Tomas	Graduated
Thelma P. Artificio	Ph.D. in Technology Management	Technological University of the Philippines – Manila	Ongoing
Alvie J. Asuncion	Ph.D. in Physics	UP – Diliman	Ongoing
Wendy G. Lim	Ph.D. in Chemistry	Mapua Institute of Technology	Ongoing
Ryan Joseph Aniago	M.S. in Chemistry	UP – Diliman	Ongoing
Anie Day DC. Asa	M.S. in Biochemistry	UP – Manila	Ongoing
Adrian D. Cruz	M.S. in Chemical Engineering	UP - Diliman	Ongoing
Paolo Tristan F. Cruz	M.S. in Pharmacology	UP – Manila	Ongoing
Jennyvi D. Ramirez	M.S. in Environmental Science	UP – Diliman	Ongoing
Cheri Anne M. Dingle	M.S. in Energy Engineering	UP – Diliman	Ongoing
Lorna Jean H. Palad	M.S. in Environmental Science	UP - Diliman	Ongoing
Charles Darwin T. Racadio	M.S. in Environmental Science	UP - Diliman	Ongoing
Ma. Llorina O. Rañada	M.S. in Chemistry	University of Santo Tomas	Ongoing
Rhett Simon DC. Tabbada	M.S. in Marine Science	UP - Diliman	On-going

TABLE 12. ADDITIONAL RESOURCES GENERATED THROUGH LOCAL AND FOREIGN-FUNDED PROJECTS IN 2013

DONOR NAME OF INSTITUTION	PROJECT TITLE	PROJECT LEADER	VALUE OF ASSISTANCE (in Philippine Pesos)
A. LOCAL GRANTS-IN-AID			
Department of Science and Technology (DOST)	Smart Farming - based and Water Management for Rice and Corn Production Project 2: Application of Nuclear Analytical Techniques in Improving Nutrient and Irrigation Management in Corn	Roland V. Rallos	2,934,115.33
DOST	Smart Farming - based and Water Management for Rice and Corn Production Project 2: Application of Nuclear Analytical Techniques in Improving Nutrient and Irrigation Management in Corn	Roland V. Rallos	424,680.00
DOST	Smart Farming - based and Water Management for Rice and Corn Production Project 3. Water Balance and Loss Assessment of the Upper Pampanga River Integrated Irrigation System	Roland V. Rallos	400,000.00
Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD)	Smart Farming - based and Water Management for Rice and Corn Production Project 2. Application of Nuclear Analytical Techniques in Improving Nutrient and Irrigation Management in Corn	Roland V. Rallos	311,555.00
PCAARRD	Smart Farming - based and Water Management for Rice and Corn Production Project 3. Water Balance and Loss Assessment of the Upper Pampanga River Integrated Irrigation System	Roland V. Rallos	38,700.00
PCAARRD	Application of Nuclear Techniques For Efficient Nutrient and Irrigation Management in Corn Production Activity 2	Roland V. Rallos	311,554.00
PCAARRD	Smart Farming - based and Water Management for Rice and Corn Production Project 3: Water Balance and Loss Assessment of the UPRIIS & MARNS Activity 2	Roland V. Rallos	38,700.00
PCAARRD	Smart Farming - based and Water Management for Rice and Corn Production Project 2: Application of Nuclear Analytical Techniques for Efficient Nutrient and Irrigation Mgt. in Corn Production	Roland V. Rallos	252,583.00
DOST	Smart Farming - based and Water Management for Rice and Corn Production Project 3: Water Balance and Loss Assessment of the UPRIIS and MARNS	Norman DS. Mendoza	118,250.00
DOST	Development of an Integrated Pest Management Strategy Against Brontispa longissima (Gestro) an invasive Pest of Coconut and Other Palm Species	Glenda B. Obra	196,225.90
DOST	Development of an Integrated Pest Management Strategy Against Brontispa longissima (Gestro)) an invasive Pest of Coconut and Other Palm Species	Glenda B. Obra	337,925.00
Department of Agriculture Bureau of Agriculture Research	Upgrading of the Entomology Research Laboratory of the PNRI	Glenda B. Obra	1,000,000.00
PCAARRD	Evaluation of the Effects of Radiation-Modified Carrageenan	Lucille V. Abad	4,383,150.00
Philippine Council for Health Research and Development (PCHRD)	Hemostative Agents from Radiation Modified Polyssacharide and their Derivative	Charito T. Aranilla	4,141,422.00
DOST-Office of the Secretary	Field Detection for Saxitoxin: a Novel Approach Using the Receptor Binding Assay Technology for In Situ Monitoring of Paralytic Shellfish Toxins	Aileen D. Mendoza	526,323.96
Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD)	Monitoring of the Philippine Fault and Valley Fault System	Angelito F. Ramos	2,598,490.00
PCIEERD	Use of Radon in the Monitoring of Philippine Fault and the Valley Fault System and its Implication as an Earthquake Precursor	Angelito F. Ramos	1,384,900.00
Davao City Water District	Research Contract 2nd Installment -Determination of Gross Alpha and Beta Activities in Water	Preciosa Corazon B. Pabroa	165,000.00
Environmental Management Bureau (EMB)	Research Contract – Multi Element and Black Carbon Determination of Air Particulate Samples from Caloocan City	Preciosa Corazon B. Pabroa	237,000.00
Davao City Water District	3rd Installment- Determination of Gross Alpha & Beta Activities in Water	Preciosa Corazon B. Pabroa	165,000.00
DOST	Application Of Isotopic and Geochemical Techniques to Uncover Point And Nonpoint Sources of Organic Nutrient Contamination in the Neritic Zone of Boracay Island	Raymund J. Sucgang	196,547.66
COCA-Cola Bottles Phils. Inc.	Research Contract	Raymund J. Sucgang	234,190.00
Splash Corp./Barrio Fiesta Manufacturing Corp.	Vinegar Adulteration	Raymund J. Sucgang	32,000.00
DOST	Developing PNRI Capability for Electron Beam Technology Applications	Luvimina G. Lanuza	30,620,615.38
DOST	Upgrading the National Personnel Monitoring Services Thesis on the Establishment of OSL System	Estrella S. Caseria	1,250,000.00
DOST	Ratiopharmaceuticals Preparation and Quality Control for Nuclear Medicine Application	Adelina DM. Bulos	3,705,152.00
DOST	Continuing R&D Initiatives: Enhancing Capacity for Industrial Applications of Gamma Column Scanning Technology	Denis D. Aquino	286,157.77
PCHRD	2nd Regional Workshop- IAEA-General Safety Requirements	Thelma P. Artificio	250,000.00
		Sub-Total	**59,040,237.00**
B. FOREIGN GRANTS			
International Atomic Energy Agency (IAEA)	Development of Irradiated Foods for Immunocompromised Patients and other Specific Target Groups	Zenaida M. De Guzman	350,341.00
IAEA	Development and Characterization of Packaging Materials for Irradiated Food Products	Zenaida M. De Guzman	884,508.00
IAEA	Application of Radiotracer and Radioassay Technologies in Paralytic Shellfish Poisoning	Adelina DM. Bulos	190,660.00
IAEA	Enhancing Cytogenetic Biological Dosimetry Capabilities of the Philippines for Nuclear Preparedness	Celia O. Asaad	209,630.00
Comprehensive Nuclear Test Ban Treaty Organization (CTBTO)	Post Certification Activities for the IMS Radionuclide Station RN52, Tanay, Rizal, Philippines	Teofilo Y. Garcia	752,723.00
CTBTO	Post Certification Activities for the IMS Radionuclide Station RN52, Tanay, Rizal, Philippines	Teofilo Y. Garcia	827,255.00

APPENDICES

TABLE 12. ADDITIONAL RESOURCES GENERATED THROUGH LOCAL AND FOREIGN-FUNDED PROJECTS IN 2013 (continuation)

DONOR NAME OF INSTITUTION	PROJECT TITLE	PROJECT LEADER	VALUE OF ASSISTANCE (in Philippine Pesos)
Global Threat Reduction Initiative (GTRI)	US DOE/Batelle and PNRI in Support of the Global Threat Reduction Initiative (GTRI) in the Philippines	Julietta E. Seguis	490,779.00
		Sub-Total	**3,705,896.00**
		GRAND TOTAL	**62,746,133.00**

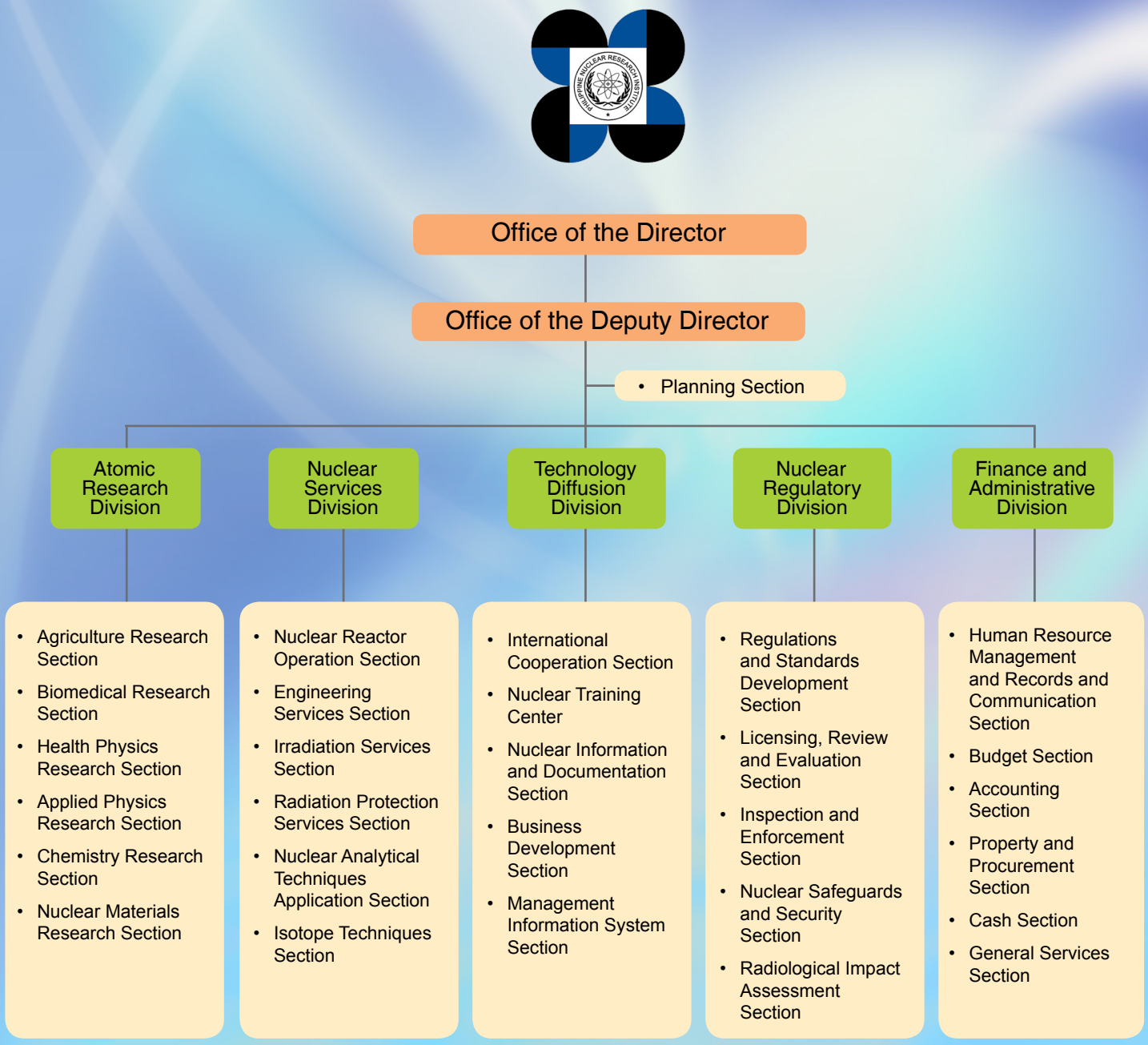
TABLE 13. LIST OF SCIENTIFIC PUBLICATIONS IN 2013

TITLE OF SCIENTIFIC PAPER	NAME/E-MAIL OF MAIN AUTHORS	PUBLICATION/NAME/TYPE OF JOURNAL	DATE PUBLISHED
Gamma radiation-induced grafting glycidyl methacrylate (GMA) onto water hyacinth fibers	Jordan F. Madrid (jfmadrid@pnri.dost.gov.ph) Guillermo M. Nuesca (UPD) Lucille V. Abad (PNRI)	Radiation Physics and Chemistry 85:182-188 2013.	April 2013
Agronomic applicability on non-destructive soil moisture-density measurements using gamma-neutron probe	Roland V. Rallos (rvrallos@pnri.dost.gov.ph) Wilfredo A. Gultiano John Faustus C. Vidal	Proceedings of the 16th Philippine Society of Soil Science and Technology, Inc. (PSSST) Annual Meeting & Scientific Conference, pages 83-84	May 2013
Efficacy of gamma sterilization technique for biofertilizer carrier production	Roland V. Rallos (rvrallos@pnri.dost.gov.ph) Faye G. Rivera, Juliet A. Anarna, Marcelina J. Palis, Jacqueline S. Rojales	Proceedings of the 16th Philippine Society of Soil Science and Technology, Inc. (PSSST) Annual Meeting & Scientific Conference, pages 85-86	May 2013
Irradiation as a potential phytosanitary treatment of mango pulp weevil, Sternochetus frigidus (Fabr.) (Coleoptera: Curculionidae) in Philippine Super Mango	Glenda B. Obra (gbobra@pnri.dost.gov.ph) Sotero S. Resilva, Louella DJ. Lorenzana	The Philippine Agricultural Scientist 96(2):172-178 2013.	June 2013
Influence of adult diet and exposure to methyl eugenol in the mating performance of Bactrocera philippinensis	Glenda B. Obra gbobra@pnri.dost.gov.ph	Journal of Applied Entomology	June 2013
Abaca/polyester nonwoven fabric functionalization for metal ion adsorbent synthesis via electron bean-induced emulsion grafting	Jordan F. Madrid (jfmadrid@pnri.dost.gov.ph) Yuji Uueki,Noriaki Seko -Japan Atomic Energy Agency	Radiation Physics and Chemistry 90:104-110 2013.	September 2013
Mass rearing technique for mango pulp weevil Sternochetus frigidus (Fabr.) (Coleoptera: Curculionidae)"	Glenda B. Obra (gbobra@pnri.dost.gov.ph) Louella Lorenzana (Department of Agriculture)	Journal of the International Society for Southeast Asian Agricultural Sciences.	December 2013
Antioxidant activity potential of gamma-irradiated carrageenan	Lucille V. Abad (lvabad@pnri.dost.gov.ph) Lorna S. Relleve, Charles Darwin T. Racadio Charito T. Aranilla, Alumanda M. Dela Rosa	Journal of Applied Radiation and Isotopes, v. 79, 73-79	2013
Effects of irradiation to morphological, physicochemical and biocompatibility properties of carrageenan	Lucille V. Abad (lvabad@pnri.dost.gov.ph) Jhalique Jane Fojas and Rizalinda De Leon	World Academy of Science, Engineering and Technology, v. 77, 502-505	2013
Radiological assessment for possible potential health implications owing to radiation exposure of the population living in the vicinity of PHILPHOS fertilizer plant	Teofilo Y. Garcia (tygarcia@pnri.dost.gov.ph) Eliza B. Enriquez, Fe M. dela Cruz, Lorna Jean H. Palad, Socrates Cañete, Teresa Y. Nazarea, Emma L. Cancino, and Jose Ramoncito Navarro	2013 Philippine Nuclear Journal	2013
Preliminary characterization of uranium and rare earth from phosphates and wet phosphoric acid fertilizer plant	Wendy G. Lim (wglim@pnri.dost.gov.ph) Estrellita U. Tabora, Edmundo P. Vargas, Jan Aldrich Agustin, Socorro P. Intoy and Rolando Y. Reyes	2013 Philippine Nuclear Journal	2013
Synthesis of kappa-carrageenan oligomers via synergistic action of gamma radiation and hydrogen peroxide	Charito T. Aranilla ctaranilla@pnri.dost.gov.ph) Irina Diane V. Castaños, Leni L. Quirit, Lorna S. Relleve and Lucille V. Abad	2013 Philippine Nuclear Journal	2013
A Collection of Philippine hoyas and their culture	Fernando B. Aurigue (fbaurigue@pnri.dost.gov.ph	Philippine Council for Agriculture, Aquatic and Natural Resources, Research & Development (PCAARD), Book Series No. 2/2013	2013
Determination of in-situ strength of selected bridge element concrete girder and slab of Nagtahan bridge using rebound hammer test	Bernadette Betsy B. Uy Renato T. Bañaga (PNRI)	The Evaluator, v. 28, pages 20-30	November 2013

ABBREVIATIONS

ANSN	Asian Nuclear Safety Network
ANSTO	Australian Nuclear Science and Technology Organization
CSCAP	Council for Security Cooperation in the Asia-Pacific
CTBTO	Comprehensive Nuclear-Test- Ban Treaty Organization
DEVCO	Development Cooperation- Europe
DOST	Department of Science and Technology
ENSTTI	European Nuclear Safety Training and Tutoring Institute
EEIG	European Economic Interest Grouping
EU	European Union
IAEA	International Atomic Energy Agency
IAEA/ANSN	International Atomic Energy Agency/Asian Nuclear Safety Network
ICP	Inter-Agency Chemical, Biological, Radiological, Nuclear (CBRN) Response Programme
FNCA	Forum for Nuclear Cooperation in Asia
JSNDI	Japanese Society for Non-Destructive Testing
KINS	Korea Institute of Nuclear Safety
NNSA	National Nuclear Security Administration
NSRA	MEXT Nuclear Safety Research Association of Japan
OAP	Office of Atoms for Peace, Thailand
PTS –CTBTO	Provisional Technical Secretariat-Comprehensive Nuclear Test-Ban Treaty Organization
RCA	RCA Regional Office in Korea
RCARO	Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific
UNDP	United Nations Development Programme
US DOE	United States Department of Energy
WERC	Wan Energy Research Center

PNRI ORGANIZATIONAL CHART



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