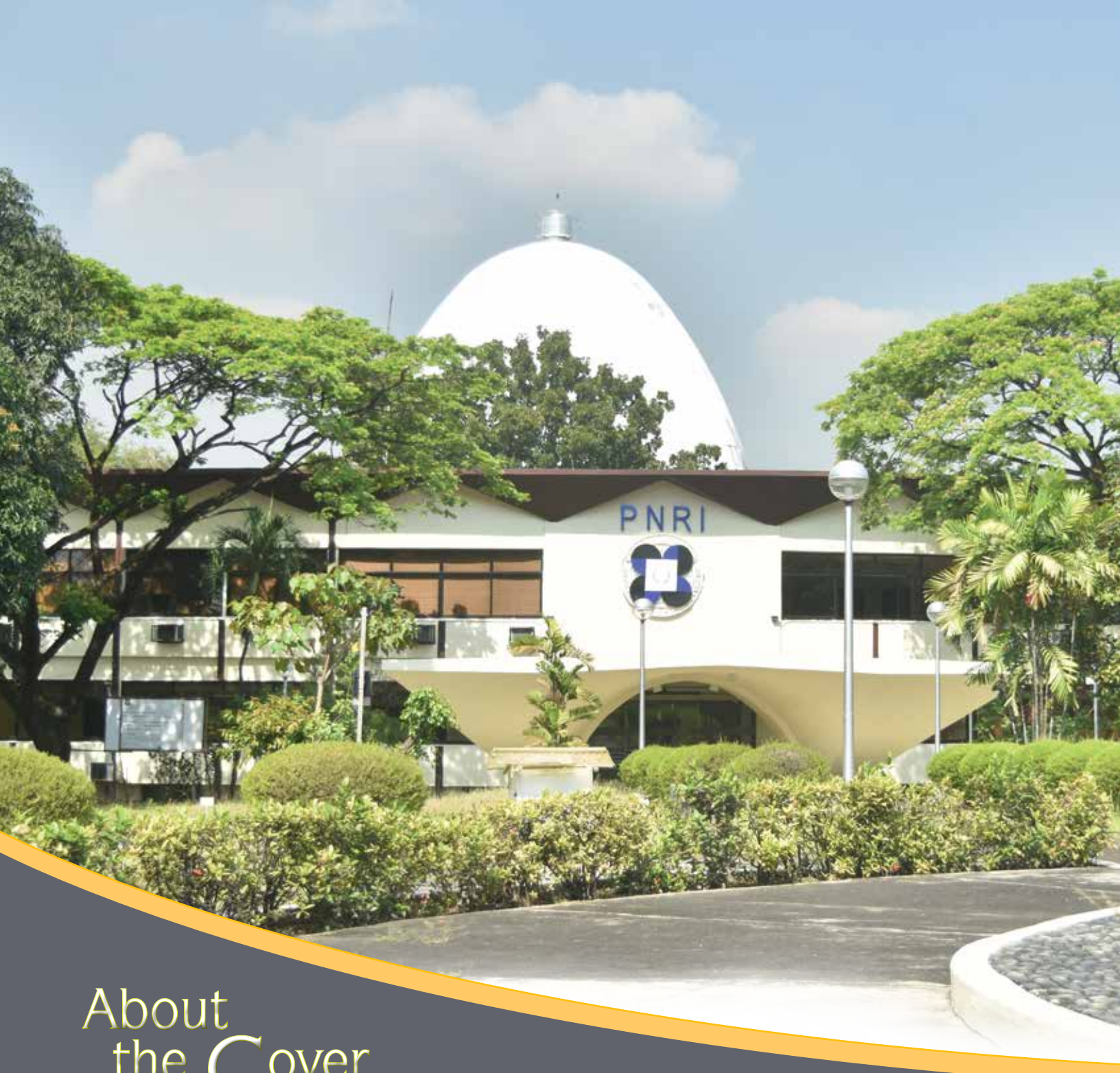


DEPARTMENT OF SCIENCE AND TECHNOLOGY
Philippine Nuclear Research Institute



2017
Annual Report

Nuclear Science & Technology
for the People



About the Cover



The orb, which symbolizes the dynamic reach of the Department of Science and Technology - Philippine Nuclear Research Institute (DOST-PNRI) in 2017 through research and development, state-of-the-art services, nuclear regulations, and technology diffusion, is carried through the gray, which fades into ever brighter shades into a prosperous future. The green and yellow themes symbolize the harmony between growth, renewal, intelligence, safety and energy, which reflect the dual mandate of the Institute to promote and regulate the safe and peaceful uses of nuclear science and technology.



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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.”



Message from the Secretary



Department of Science and Technology

I congratulate the Philippine Nuclear Research Institute (PNRI) as it chronicles its accomplishments for 2017. As a proud member of the DOST family, the PNRI has been doing its part along with other Research and Development Institutes (RDIs) in developing technologies that truly support the intentions of bringing Science for The People. The diversity of nuclear and radiation-related applications are very appropriate for meeting the requirements of the Harmonized National Research and Development Agenda for 2017 to 2022, be it in agriculture, health, industry, climate change and disaster preparedness. Indeed, beyond R&D, PNRI has also opened its doors to the industrial and commercial sectors as well as the general public in bringing the unique advantages of nuclear services and facilities in the processing of food and medical products, analysis of samples, and radiation protection, to name a few.

In addition to the country's indigenous talent and national support, the strong international linkages of PNRI with organizations such as the International Atomic Energy Agency (IAEA) help to ensure that the Philippines will have a helping hand, both in terms of technical and financial capabilities, in pushing nuclear technology applications. I commend the Institute as it continues to spread knowledge and awareness of its hard-earned research outputs for the benefit of the public through the adoption and utilization of technologies, promotion of nuclear and radiation applications, conduct of training courses, collaboration with various colleges and universities in nuclear and radiation-related research, and the more recent efforts to educate secondary school students and teachers on nuclear science and technology.

Last, but not least, PNRI's regulatory work over the safe and peaceful uses of nuclear and radioactive materials, as well as its efforts in ensuring nuclear security and emergency response should be recognized. I am very confident that the Institute will be able to sustain the legacy of these achievements, and more importantly, to exceed them as expected of every agency in the DOST family. Congratulations and *Mabuhay!*

FORTUNATO T. DELA PEÑA
Secretary

Message from the Director



Philippine Nuclear Research Institute

It is my privilege and honor to present the results of our labors in 2017: the achievements of the DOST-PNRI.

PNRI has achieved truly meaningful results in agricultural productivity and other endeavors but these milestones are still largely unheard of in the general populace. Our multi-awarded Plant Growth Promoter product could have immediate, significant impact on rice productivity of the country. We continue to help our agricultural sector and food supplement industry with our irradiation services, which could expand to many other sectors.

PNRI is at the forefront of monitoring the environment through its groundwater isotope facilities and pollution monitoring.

We are promoting the important role of nuclear science and medicine, with our nearly-operational Technetium facility and radiopharmaceutical research.

We are the cusp of helping private sector install irradiation facilities that will expand agricultural shelf life and promote agricultural exports with huge economic potential and benefits for our poorest segment of the population.

Rationalizing our role as both promoter and regulator of nuclear matters, PNRI has helped push the Comprehensive Nuclear Regulations Act in advanced stages in Congress, which will make us compliant with international best practices.

Our human resource development efforts continue – we have new PhD graduates and will encourage more, and our scientists have received the highest possible awards from government for their contributions. We are actively pursuing students and professionals within and outside PNRI willing to train in nuclear science and engineering.

We acknowledge our local and international partners, especially the International Atomic Energy Agency (IAEA) with whom we continue robust exchanges and are blessed with numerous assistance, and we have just chaired the nascent ASEANTOM nuclear regulatory cooperation efforts.

I commend the work, sacrifice and enthusiasm of our PNRI staff and officials. We are doing great service to the country, but we can do more. Let us not waver in our commitment to serve with competence and integrity.

Thank you, and *Mabuhay!*

DR. CARLO A. ARCILLA

Director

Highlights of Accomplishments

Consistent with its dual mandate to promote and regulate the safe and peaceful uses of nuclear science and technology, the Department of Science and Technology – Philippine Nuclear Research Institute (DOST-PNRI) once again contributed to the attainment of the nation's development goals in 2017. These year's accomplishments were due in large part to the hard work and technical expertise of its human resources, as well as the Institute's local and international linkages with other agencies and organizations.



GENERATION OF NEW KNOWLEDGE AND TECHNOLOGIES

Food and Agriculture

- Mutation breeding of *adlai* as an alternative staple food crop, with 6th generation of putative mutants showing shorter height, increased tillers and early maturity
- Development of computer-based nutrient management support tool for corn production
- Testing and evaluation of the effects of radiation-processed carrageenan plant growth promoter which increased yield by around 44 to 52% for mungbean and at least 20% for rice

Health and Medicine

- Improved rearing and trapping methods for Sterile Insect Technique against the dengue mosquito vector *Aedes aegypti*
- Capacity building for operation and maintenance of technetium-99m generator facility for diagnostic procedures
- Transfer of receptor binding assay technology for monitoring "red tide" to Department of Agriculture-Bureau of Fisheries and Aquatic Resources
- Development of radiation-processed propolis wound dressings for improved healing and longer shelf-life
- Formulation of a new vinegar standard of the Philippines, which includes isotopes and nuclear-based techniques as parameters

Environmental Protection and Management

- Nuclear and isotope analytical techniques for management of groundwater resources
- Air and water pollution studies using isotope analytical techniques in Metro Manila and Boracay
- Monitoring of environmental radiation and naturally-occurring radioactive materials (NORMs) in industries
- Establishment of real-time online environmental radiation monitoring stations in Cebu and Davao
- Radiation-induced grafting of adsorbents for toxic materials in various industries

Maximizing Nuclear Resources and Facilities

- Extraction of uranium, rare earth elements and other metals from phosphoric acid in fertilizers
- Geological survey of uranium, thorium and rare earth elements



PROVISION OF QUALITY S&T SERVICES

- 21% increase in clients of Cobalt-60 Multipurpose Irradiation Facility
- 16% increase in clients of PNRI Radiation Protection Services
- 220 customers availing nuclear-based analytical services
- 19 clients for microbiological and physico-chemical analysis
- Cytogenetic biodosimetry provided for monitoring radiation exposure of five industrial radiographers
- Gamma column scanning service and other sealed source applications for petrochemical refinery



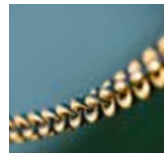
ENSURING THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

- Revision of Part 4 of the Code of PNRI Regulations on safe transport of radioactive materials
- Issuance of Administrative Orders on extending validity of licenses and revised license fees and charges
- 386 licenses issued for radioactive materials
- 186 regulatory inspections conducted
- Two PNRI enforcement orders, five notices of violations and 40 follow-up letters to enforce its regulations
- Maintenance of radiation portal monitors at Manila South Harbor
- Enhancing nuclear security systems of hospitals, medical centers and PNRI facilities
- Ensuring security during the Philippines' hosting of ASEAN events
- Revision of the National Radiological Emergency Preparedness and Response Plan (RADPLAN)
- Approval of the Substitute Bill for the Comprehensive Nuclear Law at the House of Representatives Joint Committee Meeting
- Philippines, through PNRI, chairs the 4th ASEANTOM Annual Meeting



DIFFUSION OF KNOWLEDGE AND TECHNOLOGIES

- Commercialization of plant food supplement, hydrogel wound dressing, hemostat and honey nutri-bar
- 42 nuclear training courses for 775 participants
- 182 students completing on-the-job training
- More than 1,300 clients for nuclear awareness seminars, more than 600 visitors for PNRI guided tours, and 540 researchers at PNRI library
- More than 46 press releases and 21 interviews, both in traditional and online media.
- PNRI participation in eight major S & T events
- DepEd-NCR collaboration to develop lesson exemplars integrating nuclear science in various subjects and educating students through DepEd-Quezon City Project Strive (Science, Technology, and Research for Innovative Ventures)
- Development of several information systems and network/internet infrastructures



S & T LINKING

- Signing of Country Program Framework between the Philippines and the International Atomic Energy Agency (IAEA) to facilitate transfer of nuclear technology and technical cooperation resources



HUMAN RESOURCES

- Two new PNRI scientists under the Scientific Career System
- Three researchers obtained post-graduate degrees (master's and doctorate degrees)
- PNRI scientists and researchers garnered several regional, national and international awards
- PNRI researchers win seven DOST International Publication Awards

Generation of New Knowledge and Technologies

PNRI leads the way in the development of nuclear and radiation applications in the Philippines. Its wide coverage in the fields of agriculture, health and medicine, industry and environmental protection is a testament to the contributions of nuclear science and technology to the national welfare.



Nuclear Technology Applications in Food and Agriculture

Crop Improvement

The PNRI continued to use gamma irradiation, coupled with mutation breeding and biotechnology, to develop and enhance crop varieties.

The Institute pursued the development of the putative mutants of adlai (*Coix lacryma-jobi L*), which can serve as a substitute for rice and corn. After being irradiated at 100 Gy, the data for the sixth generation of putative mutants showed shorter height with more tillers and matured earlier than the unirradiated adlai plants by 77 days.



Early maturing putative mutant line from 100 Gy dose irradiation of Adlai

Precision Farming to Enhance Agricultural Productivity

In collaboration with the Department of Agriculture (DA) and its regional offices, the Bureau of Soils and Water Management (BSWM) and the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), PNRI engages in different projects using nuclear and isotope-based analytical techniques to improve nutrient and water use efficiency in crop production.

Managing the Nutrient Use Efficiency of Coffee

Using nitrogen-15 isotope tracer and related elemental techniques, PNRI researchers re-evaluated the present practices of supplying the fertilizer requirement (nitrogen, phosphorus and potassium) and of reducing fertilizer input in



Non-destructive sampling of coffee-bearing trees for leaf biomass calculation



Liberica coffee beans (left)
Arabica coffee beans (right)

Liberica and Arabica coffee. Two sampling methods for leaf biomass were compared in the computation of nutrient uptake. The results showed that the non-destructive method (measuring the different tree parts) can provide similar data on nutrient uptake as that of the destructive method, which involved cutting and weighing the above ground tree.

Managing Nutrient Efficiency and Irrigation in Corn Production



Researchers developed a computer-based nutrient management and decision support tool for corn production which incorporates data on soil test calibrations and refined fertilizer recommendations. The tool was disseminated nationwide in September through a seminar-workshop hosted by DA-BSWM.

Assessing Nutrient Dynamics of Rice-Based Farming Systems

PNRI studied the use efficiency of nitrogen fertilizers for inorganic and organic rice-based farming systems. Results showed that crops absorbed around 40% of the nitrogen after one fertilizer application, with efficiency decreasing exponentially with increased application rates. The unutilized nitrogen can spread to the environment through leaching and other processes causing detrimental impacts. More nitrogen was absorbed by rice plants with split fertilizer application, resulting to increased rice biomass and grain yield.

Increasing Sugarcane Productivity through Nutrient Management

Nutrient monitoring for sugarcane production showed that nitrogen, phosphorus and potassium content generally decreases as the crop matures. This pattern can be used to update nutrient management programs optimizing nutrient supply and demand, which will improve nutrient use efficiency in sugarcane plantations. The studies on soils showed poor potassium supplying capacity and high structural fixation, with crops responding to very high levels of potassium application. Further data analysis is ongoing at PNRI.



Gathering of data on soil water availability using soil moisture neutron probe as part of studies on increasing sugarcane productivity



Mr. Roland Rallos, Science Research Specialist II, presents the findings on nutrient and water management for rice production through isotopic techniques during the IAEA 60th General Conference Side Event on "Climate Proofing Rice Production Systems" at the IAEA Headquarters in Vienna, Austria in September 2017.



The new isotope ratio mass spectrometer, coupled with flash combustion and high temperature elemental analyzers, at the PNRI Soil Science and Crop Nutrition Research Laboratory for agriculture and environmental research

Isotope Facility for Soil Science and Crop Nutrition Research Laboratory

To support on-going collaborations for agriculture and environmental research, DOST-PCAARRD funded the upgrading of PNRI's Soil Science and Crop Nutrition Research Laboratory through the acquisition of a new isotope ratio mass spectrometer (IRMS) for stable isotope analyses. The new facility will prove useful in providing alternative solution to problems still unaddressed by conventional methodologies.

Using Radiation-modified Carrageenan as Plant Growth Promoter for Rice and Mungbean

The Institute continuously tested the effects of radiation-modified carrageenan as plant growth promoter (PGP) for rice in Regions 2 (Cagayan Valley) and 3 (Central Luzon). The tests confirmed the previous results showing the increased yield of rice by at least 20%. The product has been registered with the Fertilizer and Pesticide Authority as Carrageenan PGP in August 2017.

Meanwhile, PNRI continues to evaluate the effects of Carrageenan PGP applications on mungbean. Preliminary results from field tests in Bukidnon showed that the yield of mungbean variety



Carrageenan PGP being tested on mutant lines of traditional rice variety.

increased by 44% when Carrageenan PGP was supplemented to farmer's practices. The yield further increased to 52.3% when the recommendatory fertilizer use was halved. Mass height and fresh biomass also increased. In addition, treated plants exhibited more resistance to pests and diseases. Stability testing showed that Carrageenan PGP remains stable and effective for at least one year.



Multi-location trials of Carrageenan PGP for improved productivity of mungbean



Nuclear Applications in Health and Medicine

The Institute offers a plethora of state-of-the-art technologies that cater to the health and well-being of the general public through nuclear and radiation applications that contribute to the prevention, diagnosis and treatment of various diseases.

Control of Dengue Mosquito Vector Using Gamma Irradiation

Researchers continued to develop a sterile insect technique (SIT) for controlling the population of the dengue mosquito vector, *Aedes aegypti*.



Rearing of *Aedes aegypti* mosquitoes at the new PNRI laboratory for sterile insect technique studies

In support of this study, the Institute upgraded its laboratory to improve mosquito rearing procedures. Researchers also studied three trapping methods for the dengue mosquito vector. Results showed that Ovicidal/Larvicidal (OL) traps are more reliable for surveillance and long-term monitoring of mosquito population density in urban areas.

Development of ^{99m}Tc and ^{99m}Tc Radiopharmaceuticals

To help make nuclear medicine services more affordable and accessible to Filipinos, PNRI continues to develop the national capacity for distributing technetium-99m (Tc^{99m}) radiopharmaceuticals and the preparation of radiopharmaceutical kits for Tc^{99m} labeling. In support of this, researchers continued to engage in local and international training while developing quality control protocols and preparing for accreditation by the Food and Drug Administration.



PNRI researchers visit the National Centre for Nuclear Research Radioisotope Laboratory POLATOM in Poland as part of their on-the-job training on radiopharmaceutical production.



Propolis alginate patch for use as wound dressing

Development of Novel Biomedical Products Utilizing Gamma and Electron Beam Facilities

Researchers continued to improve the PNRI-developed honey alginate wound dressing while developing new radiation-processed products derived from honey bee materials such as propolis. This year, the honey dressing was stored for 21 months at room temperature for shelf-life extension studies. The newer propolis alginate patch, on the other hand was subjected to antimicrobial testing against *Staphylococcus aureus* and *Pseudomonas aeruginosa*.





The farm in Lobo, Batangas is one of the sources of honey and propolis samples. The other sources are apiaries in Laguna and Quezon.

Food Irradiation Technology for Enhancing Food Safety, Quality and Agricultural Trade

PNRI continued to assess the effect of gamma and electron beam irradiation on the quality of food to ensure its safety, quality and shelf-life extension.

Analysis of Radiation-treated Cereal Bar

The Institute continued to test the effect of gamma radiation on PNRI-developed honey cereal nutribars for calamity and other emergency situations. Results show that the irradiated nutribars maintained their nutritional content during nine months of storage. Shelf-life studies are ongoing to determine the applicability of irradiation in food safety while preserving its quality for two years.

Producing Safe and Quality Bee Products

PNRI engaged in a project with the Department of Agriculture-Bureau of Agricultural Research to use irradiation technology and organic production systems to ensure the safety and quality of honey bee products. As part of this project, PNRI researchers conducted microbial evaluation of honey and propolis samples. Results showed that the honey samples passed the acceptable limits for microbial content, and along with propolis samples, had also

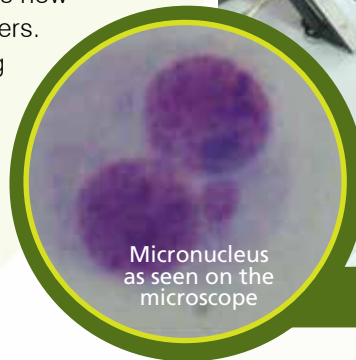


The ready-to eat radiation-treated honey nutribar is made from blends of natural ingredients such as pounded glutinous rice (*pinipig*), honey, dried fruits, rice crispies and pectin.

passed the acceptable limits for toxic heavy metals such as cadmium, nickel and lead. To disseminate information on good bee farming practices and on useful products which could be derived from honey, PNRI and experts from Bee Network Philippines Foundation, Inc. conducted training courses for local beekeepers in Region IV B - MIMAROPA (Mindoro and Marinduque) and Region V - Bicol region (Sorsogon).

Enhancing Cytogenetic Biological Dosimetry Capabilities for Nuclear Incident Preparedness

The Institute strengthens its capabilities in cytogenetic biodosimetry as an assessment tool for radiation exposure using the dicentric chromosome assay and micronucleus assay. This is now offered as a service to radiation workers. The micronucleus assay is also being utilized for radioprotective studies. Both assays have important roles during nuclear incidents in determining absorbed radiation dose in exposed persons.



Micronucleus as seen on the microscope



Microscopy for dicentric chromosome assay to monitor radiation exposure

Nuclear Analytical Techniques in Harmful Algal Bloom Studies

Serving as the IAEA Collaborating Center for Harmful Algal Blooms (HABs) since 2005, PNRI continues to develop the receptor binding assay (RBA) to complement the mouse bioassay in the early detection of harmful algal blooms or “red tide”.

Technology Transfer of Isotope-Based Receptor Binding Assay (RBA) for Paralytic Shellfish Toxins

PNRI has transferred the RBA technology to the Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR). The agency is now using RBA in addition to the existing mouse bioassay technology for toxicity analysis of paralytic shellfish poisoning in seafood as basis for imposing regulatory ban in shellfish harvest areas in the



DA-BFAR staff performs the receptor binding assay (RBA) in their newly established radio-assay facility

country. In support of the RBA technology transfer, PNRI published a learning module on HAB studies on the PNRI Website (www.pnri.dost.gov.ph) and YouTube channel. The links to the learning module are listed below.

Topics and YouTube Links for PNRI Harmful Algal Bloom Studies

What is Harmful Algal Bloom?
<https://www.youtube.com/watch?v=706kZXIHZRw>

Paralytic Shellfish Poisoning Toxin
<https://www.youtube.com/watch?v=Wj6KWosFZjE>

Available Methods for the Analysis of Algal Toxins
<https://www.youtube.com/watch?v=V1LsQ5uT3Bo&t=1s>

Receptor Binding Assay (RBA): Principles and Introduction to Radioactivity, <https://www.youtube.com/watch?v=js0L6Kdrs0c>

Membrane Preparation and Characterization for RBA
<https://www.youtube.com/watch?v=1xoXO14B4yk>

PSP Toxin Extraction and Sample Preparation
<https://www.youtube.com/watch?v=EX3O2gc20SY>

Receptor Binding Assay Protocol
 Part 1: <https://www.youtube.com/watch?v=anI3J3FJ6q8>
 Part 2: <https://www.youtube.com/watch?v=SGbBerfl8gE>

Capacity Building in Production of Marine Reference Materials for Harmful Algal Bloom (HABs) Management

PNRI researchers are working on the production of freeze-dried contaminated green-lipped mussel *Perna viridis* as a possible reference material for paralytic shellfish poisoning analysis. The processing of samples is ongoing.



Freeze-dried contaminated green-lipped mussel, *Perna viridis*, as starting material for the production of a reference material prototype

Single Laboratory Validation of Receptor Binding Assay for Ciguatoxin Project

Researchers validated the RBA for ciguatoxin analysis to fulfill the initial requirement as an official method of analysis based on the AOAC International criteria. The single laboratory validation of the method is the first step towards its accreditation.



Analysis of fish extracts for Ciguatoxin receptor binding assay

Related Nuclear-Based Applications

Gas-tightness Evaluation of Packaging Materials Using Radon Emanation Technique

Researchers developed a method using radon-222 and the liquid scintillation counter to test the air tightness of several polyethylene (PE), oriented polypropylene (OPP), polyphenylene sulfide (PPS), and polyethylene terephthalate (PET)-based packaging materials for food, pharmaceuticals and cosmetics, such as PET-1/PE 50, OPP 20-4 6.5-PE40, Plain PET 12 Foil 7 – PE 700 and PPS4. Results show that all packaging materials tested were airtight except for PPS4.

Authentication of Philippine Vinegar using Nuclear Analytical Techniques

The Institute uses nuclear and isotope-based techniques such as liquid scintillation counting and isotope ratio mass spectrometer to analyze the origin and synthetic acetic acid adulteration of samples purporting to be genuine Philippine vinegar. In support of this, researchers improved on the carbon-14 radiocarbon assay analytical procedures which lowered the cost four-fold without compromising the quality of analysis.

Formulation of the Vinegar Standard of the Philippines

PNRI participates in a Consultative Working Group to formulate a new vinegar standard of the Philippines which includes isotope and nuclear-based techniques as parameters. The updated standard for vinegar aims to eventually supplant DOH Administrative Order 134, which was issued in 1970 and has yet to be revised. If approved by the regulatory bodies (Food and Drug Administration and the DA-Bureau of Agriculture and Fisheries Standards) and the stakeholders, the standard will ensure the mechanism for the validation of botanical origin claims, detection of fake raw materials, authentication of geographical origin of foodstuffs, and methods of production.



PNRI studies the right amount of gamma radiation for microbial decontamination of cosmetics such as lipsticks and lotions without degrading the product and its container.



Analysis of synthetic acetic adulteration of vinegar samples using the liquid scintillation counter

Application of Isotopes of Carbon in Distinguishing between Plant-derived and Synthetic Waxes Used in Skin Care Cosmetics

The isotope ratio mass spectrometer and liquid scintillation counting technologies were used to trace the origin of various waxes and esters. Samples of jojoba ester, carnauba, beeswax, paraffin wax and silicone wax, lanolin, ethylhexyl palmitate, and behenyl dimethicone were analysed for carbon-14 activities and carbon-13 abundances. The abundances of these isotopes allow researchers to determine whether the samples are natural or synthetic.

Gamma Radiation to Decontaminate Cosmetics and Raw Materials

Decontaminating cosmetics and raw materials is another application of gamma radiation worldwide. PNRI researchers optimized a procedure to use gamma-rays from cobalt-60 to irradiate Philippine-made cosmetics (such as pressed powder, lipsticks, lotions, and raw materials) and assessed its effect to physico-chemical and microbiological properties of the products. Results show that physico-chemical changes occur at 7 kGy dose for lotions and emulsions, while colored cosmetics and pressed powders remain stable up to 50 kGy dose. Discoloration occurs at 100 kGy radiation dose.



Environmental Protection and Management

PNRI contributes to the protection of the environment through radioactivity monitoring and nuclear-and isotope-based analytical techniques for monitoring of air and water pollution, and for groundwater resource management, among others.

Isotope Techniques for Analysis of Groundwater Resources in Zambales

PNRI researchers utilized isotope techniques to analyze the groundwater resources in San Narciso, Zambales. The study aimed to contribute to water resource management policies and to establish baseline data relative to the Philippine National Standards for Drinking Water (PNSDW). Based on the results, at least 72% of the shallow wells in San Narciso were found to have total coliform plate counts of more than 1.1 MPN/100 mL. Wells in Siminublan showed iron (Fe) concentrations which exceeded the limits set forth by the PNSDW.

Stable isotope values of groundwater from shallow and deep wells in La Paz, Paite, Dalipawen, Siminublan, Grullo, and Manatakan showed that the majority of the aquifers were being recharged locally by rain water. Water samples from shallow wells in La Paz were relatively more isotopically enriched as compared to majority of the wells.

Tritium Enrichment Unit for Ultra-low Level Analysis

Through an International Atomic Energy Agency Technical Cooperation Project on the application of isotope techniques in water resource management, PNRI has acquired a new tritium enrichment unit capable of analyzing ultra-low concentrations of tritium, up to 0.03 tritium units, in environmental waters. With this new system, it is now possible to determine groundwater ages up to 100 (+/- 3) years depending on the average tritium concentration found in rain. Knowledge of groundwater age is very useful in addressing issues concerning sustainability and vulnerability of groundwater resources.



PNRI researcher uses the ultra low level tritium enrichment system for determining groundwater age

Sedimentation Rate Determination and Age Dates Calculation Using lead-210 Dating Method

Researchers used the lead-210 dating technique to study the accumulation of sediments in Manila Bay and to provide an age control on sediment layers. Results showed an enhanced deposition of materials at four cm per year in offshore Pampanga compared to one cm per year in the offshore areas of Parañaque and Bulacan. These results validated the earlier estimates done by PNRI and other researchers in these parts of the bay.

Monitoring and Evaluation of Dose Rate Levels in the Philippines—Phase I

This project aims to measure the ambient gamma radiation and evaluate the levels of radioactivity to ensure the safety of the public and the environment against the hazards of radiation.

Results from the routine ambient monitoring of Health Physics Research Section (HPRS) at the northern and southern parts of Metro Manila show that the radiation dose reached an average of

39 ± 8 nSv/hr, while the dose rates in PNRI and its perimeter were at around 47 ± 3 and 42 ± 3 nSv/hr, respectively. These values are within the normal background level of 42 to 61 ± 5 nSv/hr at PNRI, and do not pose any hazard to the public and the environment.



Measurement of lead-210 plated on silver disc (inset) using an alpha spectrometer



Monitoring in PNRI ground and its perimeter using a portable gamma dose rate meter (inset)





Establishment of real-time environmental radiation monitoring system in Luzon, Visayas and Mindanao

Real-time Environmental Radiation Monitoring System in the Philippines

The PNRI is establishing the System for On-line Monitoring of Environmental Radiation (SOMER) in strategic locations throughout the Philippines for the early detection of widespread radiation emergencies. As of 2017, five SOMER stations were installed and in full operation, which include two new stations located in Lapu-Lapu City, Cebu and in Davao City. The three previously installed stations (Quezon City, Aparri, and Puerto Princesa) recorded the following ambient gamma radiation dose rates: 27.3, 15.5, and 18.1 nSv/h respectively. These measurement were normal background radiation levels and within the range of background terrestrial gamma dose rate in the Philippines ranging from 5 to 74 nsv/hr.



PNRI researcher monitors and assesses radiation levels in the Philippines through the real-time environmental radiation monitoring system



Collection of seawater, sediment and fish samples in Surigao Province as part of the marine environmental radioactivity monitoring

Temporal Variation of Air Particulate Radionuclides Through CTBTO Monitoring Station

To study radionuclide concentrations in air particulates, PNRI used the radionuclide data from the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) Monitoring Station PHP52 in Tanay, Rizal. As in previous studies, the data showed that lead-212 concentrations increased from January to June and decreased towards the year's end, while beryllium-7 also decreased from April to June.

generate a database in support of regulations and radiological impact assessment. This year, PNRI obtained samples from Pilipinas Shell Petroleum Corporation in Batangas City and Petron Bataan Refinery in Bataan. The dose rates obtained were within the normal background of 24 to 125 nSv/h. Activity concentrations of radium-226, thorium-232 and potassium-40 are below the limits set by the IAEA Basic Safety Standards.

Assessment of the Potential Impact to the Philippine Marine Environment of Radioactive Releases from Nuclear Facilities

PNRI researchers completed Phase 1 of its collaborative project with Surigao del Sur State University. This includes the collections of marine samples (seawater, sediment and biota samples) in the coastal areas of Surigao del Sur and del Norte to determine the presence of artificial and natural radionuclides. The activity concentrations of cesium-137 in the marine samples were all found to be below the reference values reported in the Asia-Pacific Marine Radioactivity Database (ASPAMARD).

Radiological Assessment of NORMs/ TENORMs in Industrial Facilities in the Philippines

PNRI monitors the activity concentrations of naturally-occurring radioactive materials (NORM) and technologically-enhanced NORM (TENORM) to



Ambient gamma dose rate measurements at Petron Bataan Refinery (PBR) facility in Limay, Bataan

Determination of Radon Levels in the Philippines and Its Impact to Human Health

PNRI researchers also focused on technologically enhanced naturally-occurring radioactive materials (TENORM) phosphogypsum used as additives for manufacturing building materials (cement and hollow blocks) since these may be one of the source responsible for increasing indoor levels. Once inside an enclosed space such as homes, radon exhaled from concrete walls (maybe with phosphogypsum additive) can accumulate and may reach concentrations that may exceed the action limit of 100 becquerel per cubic meter (Bq/m³). Long-term exposure to radon has been associated with increased risk of lung cancer.

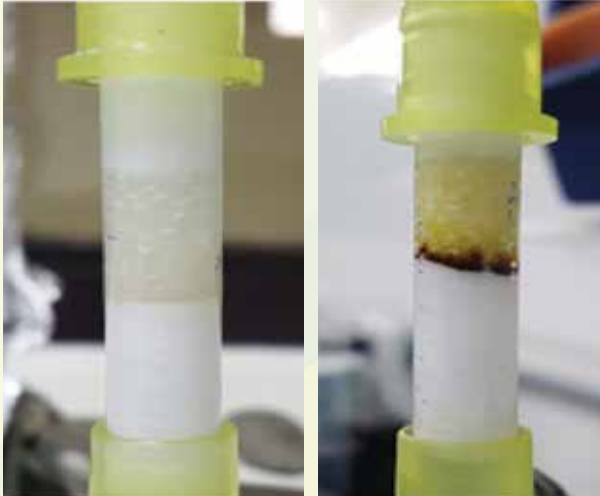
Initial results of the measurements showed that the building materials containing phosphogypsum have elevated radium-226 activity concentrations. Consequently, the radon exhalation rates were computed to be almost 100 times higher compared to ordinary building materials such as sand and cement samples.



Electron Beam-induced Grafting of Abaca/Polyester Nonwoven Fabric and its Application as Toxic Metal Ion Adsorbent

PNRI utilized electron-beam induced grafting to modify an abaca-based fibrous material for metal ion uptake. The material has been successfully applied to treat water contaminated with highly-toxic cadmium ions. Results showed that the synthesized adsorbent can efficiently remove cadmium ions from flowing contaminated water, with faster metal ion uptake rates than commercially available resins.





Column-packed amino-type adsorbent before (left) and after (right) treatment of tanning waste water

Radiation-induced Grafting of Nonwoven Fabrics for Tanning Industry Waste Water Treatment

Another radiation-grafted adsorbent was used to successfully treat waste waters from two major leather tanning companies in Bulacan, enough to satisfy the limit set by the Department of Environment and Natural Resources Administrative Order No. 35. The reusable PNRI-developed adsorbents may also operate at flow rates 20 times higher than commercial counterparts, leading to faster treatment.

Nuclear Analytical Techniques for Better Air Quality Management

Air particulate matter (PM_{10}) fractionated into the coarse [$PM_{10-2.5}$] and fine [$PM_{2.5}$] samples have been collected using Gent air samplers at three sampling sites namely, Valenzuela, Pamantasan ng Lungsod ng Maynila (PLM) and Boracay starting June 2017.

Particulate mass was determined by gravimetry using a microbalance, black carbon by reflectometry and multi-element levels were determined by X-ray fluorescence spectrometry (XRF). Results show PM_{10} and $PM_{2.5}$ levels at the two Metro Manila sites, PLM and Valenzuela, to be non-compliant to the WHO one-year and 24-hr guideline values of 20 and $50 \mu\text{g m}^{-3}$ for PM_{10} and 10 and $25 \mu\text{g m}^{-3}$ for $PM_{2.5}$. The site in Boracay shows borderline average levels which may also become non-compliant.

Black carbon (BC) levels (average at $4.7 \mu\text{g m}^{-3}$) across the three sampling sites are at an average of four to 47% of the fine particulate mass. Black carbon composition are 28, 18 and 39% for Valenzuela, Boracay Island and PLM, respectively. BC is a fingerprint of incomplete combustion products, indicative of vehicular emissions at roads in proximity to the sampling sites. Vehicular emission predominates at the Metro Manila sites – Valenzuela and PLM. Boracay is better off in terms of BC emissions.



Analysis of air filter samples using the X-ray fluorescence spectrometer



Research and Development on Nuclear Materials

Characterization of Radiation Damage of Uranium/Thorium Bearing Heavy Minerals

Researchers investigated the internal structure and radiation damage in thorium- and uranium- bearing allanite minerals from northern Palawan, which may serve as natural analogues for radiation waste materials. With funding from the Swiss government, researchers conducted x-ray diffraction analysis of the Palawan samples at the Paul Scherrer Institute in Switzerland. Results proved that the allanite is in a crystalline state, while investigation of radiation effects in intra-grain structure of the mineral, along with tomographic reconstruction of the grain slices, are currently in progress.

Recovery of Uranium, REE and other Valuable Commodities from Phosphoric Acid

Another PNRI project involves the extraction of uranium, rare earth elements (REE) and other strategic metals from phosphoric acid in fertilizers. Beyond reducing contamination from fertilizers, the technology can help maximize the country's nuclear resources. Results showed that phosphate rocks contain 66 to 145 parts per million (ppm) of uranium, and 108 to 1085 ppm of REE, along with cobalt, cadmium, lead and chromium. The technology showed an extraction efficiency of 92% and stripping efficiency of ~99%. PNRI has also produced the first uranium yellowcake from phosphates in the country.



PNRI researchers perform sample-beam alignment and batch file processing for micro-XRF and micro-XRD analysis



PNRI researchers take measurements using gamma spectrometer (inset) along the beach at Erawan in San Vicente, Palawan

Characterization and Separation of Heavy Minerals in the Alluvial and Beach Sands

PNRI has identified and explored the beach of San Vicente, Palawan, particularly, Baranggay Erawan and Ombo as an area having significant amounts of the radioactive minerals allanite and monazite, which elevates the background radiation in the vicinity. To help mitigate the radiation health hazard, researchers engaged in characterization, mapping and demonstration of the separation of the minerals in the area.

Analysis of Tektites Using Wavelength-Dispersive XRF

PNRI researchers analyzed the elemental composition of tektites from meteorites using an X-ray fluorescence spectrometer, revealing information about glassy objects often found

in strewn fields across the earth's surface. Bulk analyses showed major element compositions such as calcium, aluminum, silicon, iron and magnesium. Statistical analyses strongly suggest possible presence of ejecta rays in the Philippines.

Resource Evaluation and Characterization of Uranium, Thorium, Rare Earth and Other Essential Elements

The Institute engaged in a techno-economic pre-feasibility study for the use of uranium and thorium from unconventional sources as future nuclear fuel in high-temperature gas-cooled reactors. These sources may include phosphates, and heavy minerals as well as existing mining and extraction or processing industries that the elements may be derived from. Additionally, a research collaboration with the University of the Philippines - National Institute of Geological Sciences (UP-NIGS) was made to explore and characterize black sand



PNRI geologist conducts gamma spectrometric measurements and sampling of possible uranium bearing rocks in Nakalaya Pit, Nakalaya, Jose Panganiban, Camarines Norte.

occurrences in the Philippines. Radiometric measurements of black sand in La Union and Leyte revealed 0.8 to 2 ppm of uranium and 1.4 up to 7.7 ppm of thorium in La Union and up to 4.7 ppm in Leyte.

Co-location of Near-Surface and Borehole Facilities for Radioactive Waste Disposal

The Philippines, through PNRI, currently engages in technical cooperation projects with the International Atomic Energy Agency (IAEA) on the establishment of near-surface and borehole facilities for long-term radioactive waste disposal consistent with the IAEA borehole disposal of disused sealed radioactive sources (BOSS) system. In line with this, researchers evaluated the condition of the boreholes in the facilities as well as the possible access for road construction. PNRI also entered into project discussions with the local government units concerned and DOST officials.



PNRI geologist scans core samples from Boyongan and Bayugo boreholes of Silangan Mindanao Mining Company, Inc. at Brgy. Timamana, Tubod, Surigao Del Norte for identification of elevated radioactivity in the layers of rock.

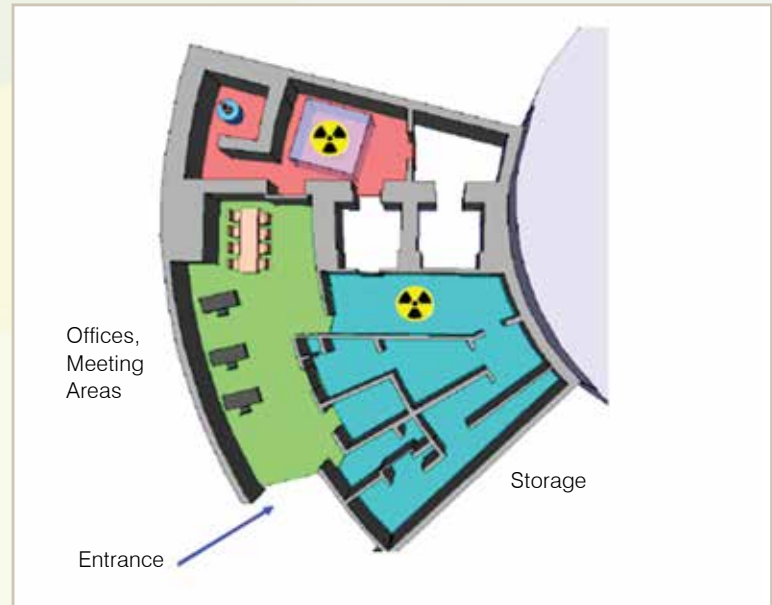
Geochemical and Radiometric Characterization of the Copper-Molybdenum-Uranium Occurrences

Researchers verified areas identified with anomalous radioactivity and rare earth element (REE) contents to enrich the uranium and thorium databases of the Philippines and the International Atomic Energy Agency. Verification done in Barangay Nakalaya, Larap, Paracale in Camarines Norte showed that the uranium and thorium in soils in this area ranged from 5 to 283 parts per million (ppm) and 1.2 to 2.7 ppm, respectively. The REEs in soil and rock samples ranged from 70 to 1093 ppm and 29 to 849 ppm. The increasing copper (Cu) and molybdenum contents in the samples showed an increasing trend in uranium content signifying its high concentration.



Establishment of Re-Utilization of Nuclear Facilities

To develop a new generation of workforce for future nuclear programs, PNRI prepares for the establishment of a Subcritical Assembly for Training, Education and Research (SATER) by re-using the TRIGA fuel elements of the Philippine Research Reactor-1. The facility will be used for research and education in nuclear science and engineering in order to strengthen nuclear research and expertise in the country, and in the capacity building on research reactor technologies. In support of the SATER project, a neutron laboratory for neutron science and dosimetry has been constructed at PNRI.



The recently constructed neutron laboratory at the PNRI compound.

List of Scientific Publications

Publications which garnered the 2017 International Publication Awards and Incentives of P60,000 per publication

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME /TYPE OF JOURNAL	DATE PUBLISHED
A Protocol Transport of Mango Pulp Weevil	Lorenzana, L. R. J.; Obra, G. B.	ISSN 0859-3132 Journal of International Society for Southeast Asian Agricultural Sciences (ISSAAS) 22(2):91-97	December 2016
Chemical Constituents of <i>Hoya cumingiana</i> Decne	Ragasa C.Y., Borlagdan M.S., Aurigue F.B., Brkljaca R., Urban S.	ISSN 0975-4873 International Journal of Pharmacognosy and Phytochemical Research 8(12): 2033-2038	December 2016
Enhancing Cytogenetic Biological Dosimetry Capabilities of the Philippines for Nuclear Incident Preparedness	Asaad, C.O., Caraos, G.L., Robles, G.J., Asa, A.D.D., Cobar, M.L.C., Asaad, A.	ISSN 2041-9414 Genome Integrity 7(4) : 1-5	December 2016
Secondary Metabolites from <i>Hoya publicalyx</i> Merr.	Bolinget, E., Panajon, N.M., Aurigue, F.B., Van Althena, I.A.	ISSN 0975-8585 Reseach Journal of Pharmaceutical, Biological and Chemical Sciences 8 (2): 678-681	March-April 2017
Chemical Constituents of <i>Hoya paziaae</i> Kloppenb	Perez, J.D.V., Borlagdan, M.S., Aurigue, F.B., Van Althena, I.A., Ragasa, C.Y.	ISSN 0975-8585 Reseach Journal of Pharmaceutical, Biological and Chemical Sciences 8(2) : 737-739	March-April 2017
Measurements of Rare Element and Other Element Mass Fractions in Environmental Reference Materials by INAA, ICP-AES and ICP-MS	Cao V.D., Sucgang R., Tran T.Q., Ho D.V., Shirai N., Ebihara M.	ISSN 1639-4488 Geostandards and Geoanalytical Research 41(2): 305-315	June 2017
Application of full-factorial design in the synthesis of polypropylene-g-poly (glycidyl methacrylate) functional material for metal ion adsorption	Madrid, J.F., Lopez, G.E.P., Abad, L.V.	ISSN 0626-806X Radiation Physics and Chemistry 136 : 54-63	July 2017

Other Scientific Publications

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME /TYPE OF JOURNAL	DATE PUBLISHED
Microbiological quality of brown rice, ready-to-eat pre-cut fresh fruits, and mixed vegetables irradiated for immuno-compromised patients	Feliciano C.P., de Guzman Z.M., Tolentino L.M.M., Asaad C.O., Cobar M.L.C., Abrera G.B., Baldos D.T., Diano G.T.	ISSN 0969-806X Radiation Physics and Chemistry 130 : 397-399	January 2017
Characterization of radiocesium levels and fractions of ¹³⁷ Cs in soil collected from Oguni, date using manual and instrument software calculation based on covell method	Jagonoy A.M., Tsukada H.	ISSN 0031-7683 Philippine Journal of Science 146 (2) : 193-199	January 2017

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME /TYPE OF JOURNAL	DATE PUBLISHED
Generating superimposed Bessel beams with a volume holographic axicon	Asuncion A.J., Guerrero R.A.	ISSN 2155-3165 Applied Optics 56 (14) : 4206-4212	May 2017
Chemical constituents of <i>Hoya cagayanensis</i> C. M. Burton	Ragasa C.Y., Borlagdan M.S., Aurigue F.B., Brkljaca R., Urban S.	ISSN 2231-3354 Journal of Applied Pharmaceutical Science 7(5) : 61-65	May 2017
Long-term bioavailability of redox nanoparticles effectively reduces organ dysfunctions and death in whole-body irradiated mice	Feliciano C.P., Tsuboi K., Suzuki K., Kimura H., Nagasaki Y.	ISSN 0142-9612 Biomaterials 129 : 68-82	June 2017
Effects of chain transfer agent on the electron beam-induced graft polymerization of glycidyl methacrylate in emulsion phase	Madrid J.F., Abad L.V., Yamanobe T., Seko N.	ISSN 0303-402X Colloid and Polymer Science 295 (6): 1007-1016	June 2017
Development of a local anesthetic lidocaine-loaded redox-active injectable gel for postoperative pain management	Nagasaki Y., Mizukoshi Y., Gao Z., Feliciano C.P., Chang K., Sekiyama H., Kimura H.	ISSN 1742-7061 Acta Biomaterialia 57 : 127-35	July 2017
A coral 129I/127I measurement method using ICP-MS and AMS with carrier addition	Bautista A.T., VII, Miyake Y., Matsuzaki H., Siringan F.P.	ISSN 1759-9660 Analytical Methods 9 (35): 5181-5188	August 2017
Toxicity and protein expression of alexandrium species collected in the philippine waters	Subong B.J.J., Benico G.A., Sulit A.K.L., Mendoza C.O., Cruz L.J., Azanza R.V., Jimenez E.C.	ISSN 0031-7683 Philippine Journal of Science 146 (4) : 425-436	August 2017
RAFT-mediated graft polymerization of glycidyl methacrylate in emulsion from polyethylene/polypropylene initiated with γ -radiation	Madrid J.F., Ueki Y., Abad L.V., Yamanobe T., Seko N.	ISSN 0021-8995 Journal of Applied Polymer Science 134 (36) : 1-11	September 2017
Radiation-induced graft polymerization of acrylic acid and glycidyl methacrylate onto abaca/polyester nonwoven fabric	Madrid J.F., Cabalar P.J.E., Abad L.V.	ISSN 1544-0478 Journal of Natural Fibers 1-14	October 2017
Oral nanotherapeutics: Redox nanoparticles attenuate ultraviolet B radiation-induced skin inflammatory disorders in Kud: Hr- hairless mice	Feliciano C.P., Nagasaki Y.	ISSN 0142-9612 Biomaterials 142 : 162-170	October 2017
Performance evaluation of a rectifier column using gamma column scanning	Aquino, D.D. Email Author, Mallillin, J.P., Sulit, R.F., Hila, F.C., Nuñez, I.A.A., Bulos, A.D.M.	ISSN 0029-5922 Nukleonika 62(4) : 285-287	December 2017

Provision of Quality S&T Services



PNRI strives to ensure that its services—radiation protection and monitoring, products and materials irradiation, and nuclear-based analytical services, among others—are of the highest quality and reliability.



Irradiation Services

Irradiation Services

The Institute provides gamma and electron beam irradiation services to research, academe and industry sectors for food safety and shelf-life extension, disinfestation of fruits and vegetables, radiation sterilization of medical devices and packaging materials, radiation decontamination or reduction of microbial load of cosmetic raw materials and accessories, and for modification of materials.

For 2017, the total number of clients in the Multipurpose Irradiation Facility (MIF) increased by 21% especially in the academe sector (with an increase of 112%). The number of services in the MIF also increased by seven percent. The results of the customer satisfaction measurement is outstanding for all quarters in 2017.



The multipurpose irradiation facility ready for operation

NAME OF TECHNICAL SERVICE	NUMBER OF TECHNICAL SERVICES	NUMBER OF CLIENTS SERVED
Gamma irradiation services (MIF)	668	91
Gamma irradiation services (Gammacell 220) for small volume of samples	34	28
Electron beam irradiation services	19	1



Irradiation Services Section personnel prepare samples for irradiation in the Electron Beam Facility



Radiation Protection Services

Radiation Protection Services

The PNRI, through its Radiation Protection Services Section (RPSS), provides services to users of ionizing radiation to monitor, assess and control radiation levels and exposures to help ensure the safety of the workers and the public. Among the services provided are (a) calibration of radiation instruments, (b) personnel dosimetry services, and (c) gross radioactivity measurements.

The PNRI also establishes the national standards for protection level of ionizing radiation through the Secondary Standards of Dosimetry Laboratory (SSDL). In addition, the Institute maintains and operates the only centralized Radioactive Waste Management Center in the country. It provides radioactive waste management services for the waste generated from use of radioactive materials

from the different nuclear applications in the industrial, medical, research and educational institutions.

In 2017, RPSS provided about 12,515 services to 10,833 clients. This represents a 16% increase in clients served. Other major accomplishments of the Section are (a) accreditation to ISO 17025:2005 of the RPSS-OSL Personnel Monitoring Service by the Philippine Accreditation Board, (b) repatriation of 44 units Am-241 sources and 849 foils of Am-241 from smoke detectors disused sealed radioactive sources and (c) management of existing depleted uranium used as shielding material for radioactive sources.



Calibration of radioactivity meters in nuclear medicine facilities

SERVICE PROVIDED	NUMBER OF UNITS	NUMBER OF CLIENTS
Personnel dosimetry to measure personnel exposures <ul style="list-style-type: none"> Optically stimulated luminescence (OSL) Thermoluminescence dosimeters (TLD) 	47,200 16,628	7,991 1,604
Calibration of radiation detection instruments to ensure accuracy of measurements	1,426	793
Swipe sample analysis to check presence of residual activity and contamination in sealed sources and surfaces	604	273
Leak testing of sources	116	22
Radioactive waste management	18	8



Nuclear-Based Analytical Services

The PNRI utilizes nuclear and isotope-based analysis to provide efficient and accurate analysis for research applications, and regulatory certification of local and export products, among others.

The analyses involved the following: (1) gross alpha beta analysis of bottled water and well water samples by liquid scintillation counting; (2) gammametric analysis of food product and environmental samples by gamma spectrometry; (3) synthetic acetic acid adulteration in local vinegar by radiocarbon-14 assay using liquid scintillation counting ; (4) multi-elemental analysis of samples using energy dispersive x-ray fluorescence spectrometry; (5) radon-22 analysis of water by liquid scintillation counting, and (6) stable isotope and tritium analysis for dating of ground water samples and analysis of food product.

PNRI offers these services for determination of radioactivity of food products for water, and for non-radioactivity certification of products prior to trading and export.

NUCLEAR-BASED ANALYTICAL SERVICES		
SERVICE PROVIDED	NUMBER OF SAMPLES	NUMBER OF CLIENTS
Gross alpha-beta analysis in water	209	101
Gammametric analysis	118	67
Vinegar authentication	2	1
Multi-elemental analysis	4	3
Radon analysis	147	45
Stable isotope analysis	16	2
Tritium analysis	2	1

Instruments used for nuclear-based analysis

Liquid scintillation counter



Isotope-ratio mass spectrometer



Gamma spectrometer



X-ray fluorescence spectrometer





Microbiological Test and Cytogenetic Analysis

Microbiological Analysis

A total of 19 clients availed of this service for aerobic plate count of 19 water samples; molds and yeast count for 10 samples consisting of chili powder, pure honey, sterilized talc powder, and cosmetic raw materials. Sterility testing was done on 56 samples consisting of various medical products such as contact lens solution, surgical gowns, and surgical kits from eight clients. Bioburden testing was conducted on medical supplies like forceps and catheters from two clients.

Physico-chemical analysis was availed by two clients for total soluble solids and pH on honey samples.



Cytogenetic Analysis

To check whether they had any recent acute exposure to gamma radiation, five industrial radiographers working abroad availed of the

dicentric chromosome analysis or cytogenetic analysis. All of them obtained normal results and did not show evidence of acute gamma radiation exposure based on the absence of abnormal dicentric chromosomes.



Engineering and Instrumentation Services

The Engineering Services Section (ESS) plays an active role in the fabrication of nuclear and non-nuclear equipment for various customers and in keeping the PNRI's research facilities and laboratories functional through its regular repair and maintenance services.

Among the instruments fabricated this year included a radioactive source holder for gamma column scanning; reactor fuel examination gauge; collimator and lead absorber for instrument calibration purposes. Some of the repair and preventive maintenance work done were on liquid nitrogen plant for research; sampler set up for air pollution studies, and shaker for agricultural sample preparation.



Machining of various components and parts needed by clients for nuclear and non-nuclear applications

Sealed Source Applications

The PNRI provides cost-effective and cost-efficient means for on-line investigation of operational conditions of process columns in refineries and petrochemical plants using gamma column scanning.

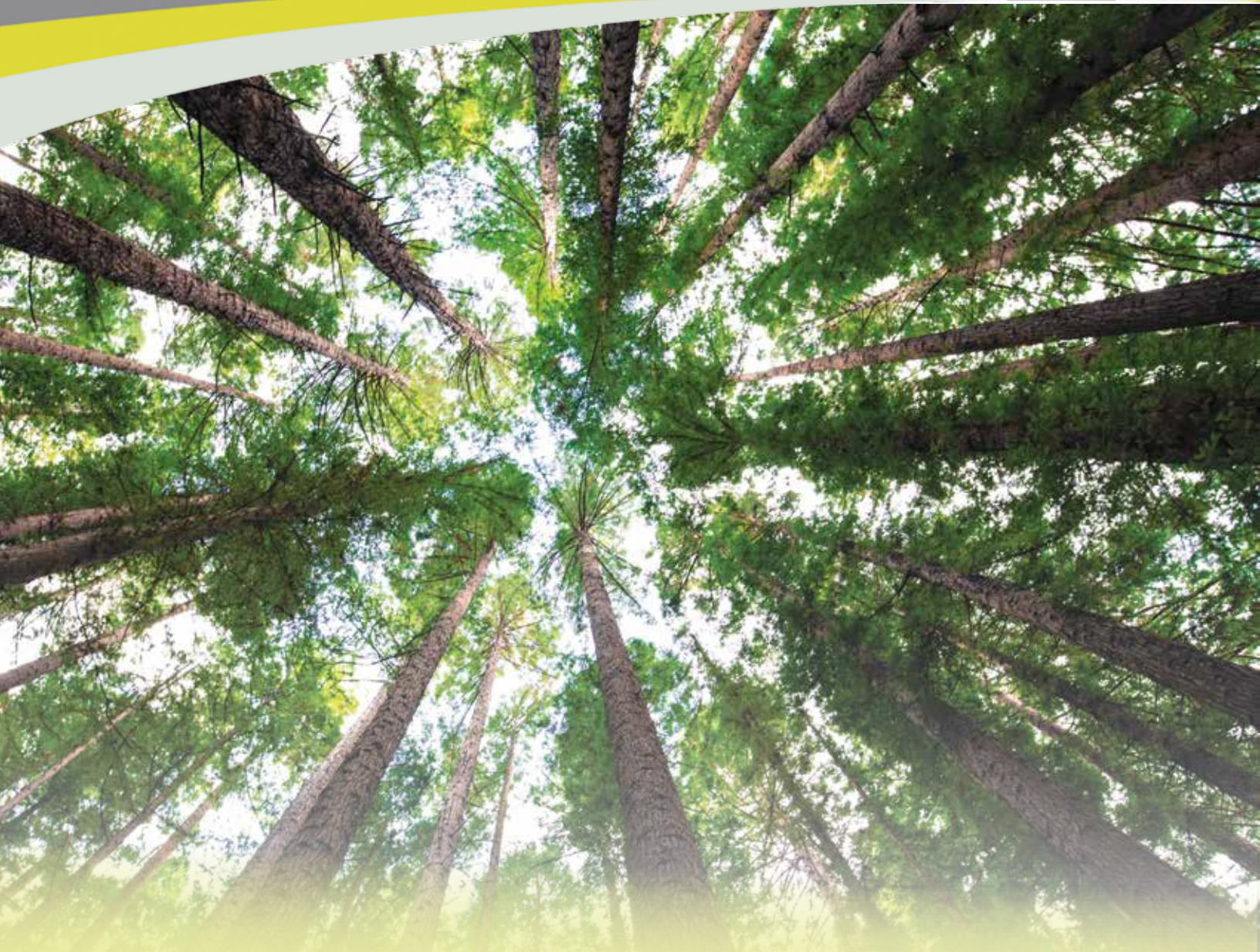
In 2017, operators and engineers from a refinery employed the services of PNRI to investigate the

cause of anomaly in one of the distillation columns. The scanning technology identified the problem and revealed the exact location inside the column that helped the engineers address and solve the issue. This paved the way for further requests of the refinery for PNRI to perform gamma column scanning on several other process columns.



PNRI performs gamma column scanning to test the operating conditions of a distillation column in a refinery.

Ensuring the Safety & Security of Radioactive Sources



As mandated under Republic Act 5207 and Executive Order 128, PNRI serves as the regulatory body for the safe and secure utilization of nuclear and radioactive materials and facilities, as well as fulfilling international commitments on nuclear safety, safeguards and security. The Institute performs this task through its Nuclear Regulatory Division.



Regulations and Standards Development

PNRI issues statutory requirements for the safe, secure, and peaceful utilization of nuclear and radioactive materials, including regulations and administrative orders in keeping with internationally acceptable standards and best practices. The Institute also coordinates with both House of Representatives as well as various international organizations through the DOST-Legislative Liaison Office to improve the national nuclear legal and regulatory framework.

Code of PNRI Regulations (CPR), Regulatory Guides and Administrative Orders

The revised Part 4 of the Code of PNRI Regulations (CPR) entitled, "Regulations on the Safe Transport of Radioactive Materials in the Philippines", was published in the Official Gazette on March 27. Two Administrative Orders (AO) entitled, "Extending the Validity Period of Radioactive Material License" and "New Schedule of Fees for Radioactive Material License with Extended Validity Period and Licenses Incorporating Authorization to Transport Radioactive Materials, Amending for the Purpose Section 6 of CPR Part 22 Rev. 2", were also published in the Official Gazette on May 15 and September 4, respectively. PNRI organized a



The revised Part 4 of the Code of PNRI regulations was published in the Official Gazette on March 27.

regulatory conference on May 23 to discuss the two AOs with the licensees and other stakeholders. Another major accomplishment is the approval of a Regulatory Guide for CPR Part 21 entitled, "Guide for the Preparation of an Application for a License of Particle Accelerator Facility for the Production of Radionuclides."

Approval of Substitute Bill for the Comprehensive Nuclear Law

The creation of a substitute bill consolidating the seven previous bills on the Comprehensive Nuclear Law was approved during the joint meeting of the



Representatives Xavier Jesus Romualdo and Francis Gerald Abaya (seated, 3rd and 4th from left, respectively), DOST Secretary Fortunato Dela Peña (seated, 2nd from left), DOE Assistant Secretary Atty. Gerardo Erquiza Jr. (seated, extreme left), DOE Consultant Dr. Alumanda M. dela Rosa (seated, 2nd from right) and PNRI Director Dr. Carlo Arcilla (seated extreme right) with other DOST and DOE officials and committee secretariat during the joint committee meeting of the House Committees on Government Reorganization and Science and Technology.



The nuclear regulatory staff with European Union experts at the final meeting of the EU-funded technical assistance project for the national regulator framework on March 23, 2017.

Committee on Government Reorganization and the Committee on Science and Technology of the House of Representatives on November 21. The bill aims to create an effectively independent regulatory body consistent with international standards for the regulation of all activities and facilities involving sources of ionizing radiation.

In the Senate, PNRI also coordinated a briefing with the legislative staff of Senate Majority Floor Leader Senator Vicente Sotto III and Senate Committee on Science and Technology Chairperson Senator Paolo Benigno Aquino, leading to the filing of the counterpart Senate Bill 1352 by Senator Sotto on February 28.

Technical Assistance for the National Regulatory Framework

In March, PNRI has formally concluded its participation in the PH-RA01 European Union (EU)-funded project entitled “Technical Assistance for Improving the Legal Framework for Nuclear Safety and Strengthening the Capabilities of the Regulatory Authority of the Philippines and its TSO (PNRI)”. The EU-funded project, the first of its kind, enhanced the regulatory capabilities of PNRI, particularly in their technical background on legal and regulatory infrastructure for nuclear power plants. The project was also instrumental in the drafting of Code of PNRI Regulations (CPR) Part 5 on Site Evaluation Criteria and CPR Part 7 on Licensing of Nuclear Installations.

Licensing, Review and Evaluation

This year, the Institute issued 386 licenses for authorization to use, possess, produce, store, sell or import radioactive materials. Of these licenses, 282 were for license renewals, 19 were for new, and 52 were amended licenses, with a notable increase in the number of licensees for brachytherapy.

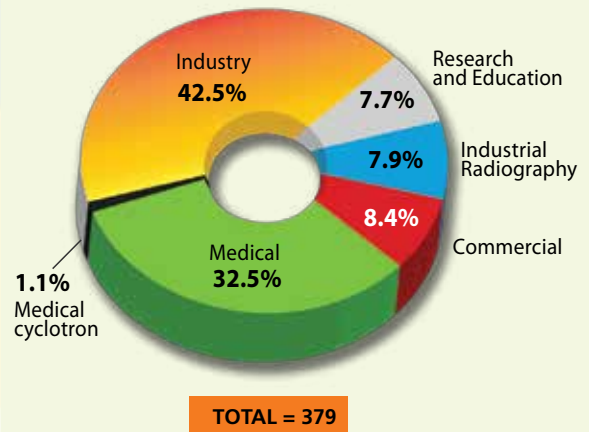
The Licensing, Review and Evaluation Section (LRES) produced 384 safety evaluation reports, issued 549 Release Certificates for imported radioactive materials to be released from the custody of the Bureau of Customs, and 24 license exemption certificates for materials entering the country that did not contain any radioactive material or the activity of radioactive material/s were of exempt levels. Six licenses were

terminated.

PNRI also implements an Internal Regulatory Control Program through the Nuclear Regulatory Division for its own facilities and laboratories for use of nuclear and various radioactive materials. The LRES prepared the renewal and amendment of five authorizations of PNRI facilities and laboratories for 2017.

Two facility license applications were made for the establishment of two more cyclotrons in the country which will be used for radioisotope production. The first is the Neo-Isotope World cyclotron facility at the University of Perpetual Help Medical Center compound in Las Piñas City, which was granted a license to operate on October 23. This new cyclotron facility is expected to serve current and prospective positron emission tomography (PET) facilities in the south of Metro Manila. A provisional permit for preparatory construction work was issued for the proposed cyclotron facility of Chong Hua Hospital Mandaue in Cebu. The cyclotron is the first such facility outside of Metro Manila.

Distribution of Radioactive Material Licensed Users under PNRI



Distribution of Licensed Users According to Geographical Location and Classification

Region I	7
Region II	5
Region III	38
Region IV	61
Region V	4
Region VI	11
Region VII	13
Region VIII	2
Region IX	3
Region X	15
Region XI	10
Region XII	3
CARAGA	4
CAR	4
NCR	199
TOTAL	379



PNRI regulatory staff conducts pre-licensing and verification inspection during the construction of a cyclotron facility

Regulatory Inspection and Enforcement

Inspection Activities

The PNRI conducted a total of 186 (164 announced, four unannounced, one reactive and follow-up) regulatory inspections and audit of radioactive materials, facilities and activities to verify licensee's compliance with the law, safety and security regulations and standards contained in the Code of PNRI regulations, and PNRI license conditions. As part of the implementation of the PNRI Regulatory Control program, a total of 12 authorized facilities and laboratories were inspected to ensure if they operate under safe and secure environment. Evaluations of licensee's response to PNRI inspection reports were performed and a total of 195 evaluation reports were issued to licensees.

Regulatory inspections conducted showed that licensees and PNRI facilities follow standards and adhere to regulations, and no incident/accident that would involve radioactive materials occurred.

Evaluation of Licensee's Corrective Actions

PNRI issued two PNRI Orders, five Notices of Violation, two warning letters and 40 follow-up letters as enforcement actions based on PNRI regulatory enforcement policy and criteria on severity of violations. Identified licensees provided corrective actions that were evaluated, thus safety and security concerns identified were resolved and reinstated.

Safe transport of radioactive materials

Transport of radioactive materials involve potential radiological hazards. PNRI monitors the transport of radioactive materials in the country by issuing 5,931 Permits to Transport Radioactive Materials to 58 PNRI licensees, including in-house authorized facilities.



PNRI inspectors perform visual examination of installed nuclear gauges at a licensed mining plant



Nuclear Safeguards and Security

The Philippines, through PNRI, upholds its commitments in implementing the country's obligations under the Non-Proliferation of Nuclear Weapons Treaty, the International Atomic Energy Agency (IAEA) Safeguards Agreement and Additional Protocol, and other international conventions and agreements.

IAEA Nuclear Safeguards Inspections and Nuclear Materials Accounting

As part of PNRI's safeguards agreement with the IAEA, safeguard inspectors from the IAEA carried out a Complementary Access at PNRI in November for laboratory inspection and discussions on studies for extracting uranium and rare earth elements from phosphoric acid.

Establishment of Safeguards and Security Laboratory

In collaboration with the United States Department of Energy (USDOE), the PNRI engaged in a joint project for the establishment of a Safeguards and Security Laboratory. In preparation for this, PNRI hosted a three-day workshop with experts from the United States facilitating discussion on the analysis of the laboratory's purpose, scope, potential applications, and requirements for equipment and staffing.

Nuclear Smuggling Detection and Deterrence (NSDD)

Formerly the Megaports Initiative, the NSDD is a project with the USDOE intended to prevent the illicit trafficking of unauthorized nuclear and radioactive materials through major ports such as Manila and Cebu. This year, PNRI regulatory staff met with their United States counterparts to discuss the Maritime Vectors Program as part of measures to account for materials beyond regulatory control. The Nuclear Safeguards and Security Section (NSSS) also continued the maintenance and troubleshooting of the radiation portal monitors at the South Harbor in Manila.



Inspection of the PNRI Nuclear Materials Research Section laboratory by IAEA inspectors



Troubleshooting of radiation portal monitors at the South Harbor in Manila



PNRI testing and commissioning of the physical protection systems in the Philippine Research Reactor-1 with Canadian project leader and program officer



the alarms of various radiation detectors. In support of the project, the NSSS collected data from several alarming containers at the Cebu Port in May and September of this year. Twenty alarms categorized as Naturally Occurring Radioactive Materials (NORM) were found in containerized cargo. These were subjected to secondary inspection after passing through the Radiation Portal Monitors (RPMs) and additional radiation measurements using handheld equipment.

Global Partnership on WMDs with Canadian Government

Under the G-8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction (WMDs), PNRI collaborates with the Canadian Department of Foreign Affairs, Trade and Development to prevent the diversion of nuclear and radioactive materials into weapons of mass destruction. This year, Canadian officials and PNRI regulators tested and commissioned the physical protection systems installed at the Philippine Research Reactor – 1 (PRR-1).

IAEA Coordinated Research Project on Radiation Detection Data

The Institute participates in the IAEA Coordinated Research Project on Improved Assessment of Initial Alarm from Radiation Detection Instruments. The project involves the development of software tools and an alarming commodity catalogue for radiation characteristics to determine the nature of various radioactive materials, as applied when triggering



PNRI regulators conduct data collection of alarming containers at the Cebu Port



PNRI members of MEST teams deployed in Clark and Manila for ASEAN events

Office of Radiological Security (ORS)

The ORS (formerly the Global Threat Reduction Initiative) of the United States Department of Energy is a collaborative effort with PNRI on global nuclear security and threat of nuclear terrorism. PNRI participates in the program by ensuring enhancements to security systems and continuous inspection of hospitals, medical centers and PNRI facilities. This year, the ORS team inspected seven hospitals and three PNRI facilities with upgraded security systems.

Nuclear Security and Safeguards during the ASEAN Summit

To ensure the safety and security of world leaders and other participants from possible nuclear or radiological incidents, the PNRI deployed its Mobile Expert Support Teams (MEST) as the Philippines hosted the Association of Southeast Asian Nations (ASEAN) 2017, in time for the intergovernmental organization's 50th anniversary.

PNRI MEST teams provided assistance to members of the Philippine National Police and the Armed Forces of the Philippines in carrying out security measures to prevent the unauthorized presence of nuclear and other radioactive materials during



A PNRI member of MEST team works with the Philippine Army in conducting area monitoring during the 31st ASEAN Summit and related events using the Spectral Advanced Radiation Computer System (SPARCS).

major meetings and activities. These included the four-day 30th ASEAN Leaders' Summit held in April; the Grand Commemorative Celebration of ASEAN's 50th Anniversary; the 50th ASEAN Annual Ministerial Meeting and other important general ASEAN events from August 2 to 8; and the 31st ASEAN Summit, Special Celebration of ASEAN's 50th Anniversary with the leaders and other related meetings from November 10 to 14.

Capacity Building Activities

The PNRI provided technical support and equipment to a five-day Interagency Field Training Exercise in July held at the Ports of Manila, Cebu and Palawan. The training exercise is aimed at enhancing the Philippines' capability and capacity in conducting maritime surveillance and operation in line with the National Coast Watch Center (NCWC) program in

cooperation with the United States Defense Threat Reduction Agency.

The Institute, together with the United States Department of Energy, also hosted/conducted the following: a Mobile Detection System (MDS) Operator Refresher Training from 10-14 July 2017, Train-the-Trainers from 17-21 July 2017, and the PNP lead MDS Operator Training.



Radiological Impact Assessment Study

PNRI, through its Radiological Impact Assessment Section (RIAS), conducted two assessment studies on the impact of the use of radioactive materials and facilities on radiation workers as well as the public.

For the first study, PNRI researchers analyzed more than 90,000 records of processed dosimeters from 94 licensed facilities in 2012 to 2016 to assess the occupational exposure dose received by radiation workers. Results showed that the doses received by nuclear medicine and radiotherapy workers were comparatively lower than those received by industrial radiography workers. The highest exposure dose that exceeds the occupational dose limit of 50 mSv in any single year as provided in CPR Part 3 "Standards for Protection against Radiation" were observed in four radiography facilities involving six incidents.



PNRI researcher conducts an assessment of the fume hood operation in a nuclear medicine facility

For the second study, the RIAS gathered data from 60 nuclear medicine facilities, and administered survey questionnaires to identify the roles and responsibilities of the workers which were in turn used as a basis for sufficient recommendation in complying with CPR Part 13 “Licenses for Medical Use of Unsealed Radioactive Material”.

National Emergency Preparedness and Response

The Institute led the efforts for a third revision of the National Radiological Emergency Preparedness and Response Plan (RADPLAN) in coordination with the National Disaster Risk Reduction and Management Council (NDRRMC) and other agencies serving as first responders or support in operations. In line with this, PNRI hosted two consultative meetings on the review and approval of the RADPLAN Revision 3. The outcomes of the discussion will be used in updating the fourth draft of the RADPLAN.

Supporting the National Disaster Preparedness Plan

PNRI participated in the national effort to prepare the public during natural disasters, particularly earthquakes. In June and July, the Institute facilitated the earthquake and evacuation drills at its compound



The National Radiological Emergency Preparedness and Response Plan (RADPLAN) Consultative Meeting held on June 30 at PNRI



PNRI emergency manager briefs the employees during the Institute's participation in the National Shake Drill

as part of the simultaneous national earthquake drill by the National Disaster Risk Reduction Management Council (NDRRMC) and of the Third Metro Manila Shake Drill to prepare the residents for the “Big One”, a possible 7.2-magnitude movement of the West Valley Fault.

Refresher Course for REMCON Teams

To retrain the Institute’s emergency responders in performing their operational procedures, PNRI conducted a four-day Refresher Course on Nuclear and Radiological Emergency Preparedness and Response for members of its Radiological Emergency Monitoring and Control (REMCN) Teams in October. The Teams are on-duty 24/7 within 15-day cycles in case of radiation-related emergencies.



The PNRI REMCON team members discuss response action during their practical training exercise

Participation in the IAEA ConvEx Exercises

PNRI actively participates in the IAEA Convention Exercises (ConvEx), to help IAEA Member States gain practical experience on the execution of nuclear and radiological emergency preparedness and response and the procedures for providing and/or requesting assistance, if necessary.

The PNRI participated in four ConvEx exercises which tested the following: (1) emergency communication channels for reporting domestic emergencies; (2) receipt of notifications by national warning points; (3) continuous availability and prompt response by the Institute; and (4) coordination and communication of information, advice and assistance in a hypothetical scenario such as a terrorist threat involving highly dangerous radioactive materials.

4th ASEANTOM Annual Meeting and Technical Session on Nuclear Security



Representatives from the various nuclear regulatory bodies of the Association of Southeast Asian Nations (ASEAN) met in the Philippines as it hosted the 4th Annual ASEANTOM Meeting and Technical Session on Nuclear Security on December 7 to 8, 2017 at the Crowne Plaza Manila Galleria in Quezon City.

The ASEANTOM, or ASEAN Network of Regulatory Bodies on Atomic Energy, was established in 2013 to strengthen nuclear safety, security, and safeguards by enhancing cooperation and complementing the work among the ASEAN countries with the existing mechanisms at the national, regional, and international levels. The countries participating in the ASEANTOM are Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.



The various heads and representatives of nuclear regulatory bodies in Southeast Asia during the 4th Annual Meeting of the ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) and Technical Session on Nuclear Security on December 7 to 8 at the Crowne Plaza Manila Galleria in Quezon City

Diffusion of Knowledge and Technologies



The cascading of nuclear science and technology through promotion, training and commercialization is necessary for its successful acceptance by the general public as well as the members of the private sector, among others.



Capacity Building on Nuclear Science and Technology

Nuclear Training Courses

The PNRI offers training courses and seminars on nuclear science and technology through the expertise of its own research specialists as well as resource persons from other institutions. This year, a total of 42 courses were conducted with 775 participants from various sectors. Among the areas covered by the courses are radioisotope techniques; nuclear science and technology; radiation safety; environmental radioactivity; and nondestructive testing.

Follow-up Training Course (FTC) on Environmental Radioactivity

In cooperation with Japan Atomic Energy Agency (JAEA), PNRI also conducted an FTC on environmental radioactivity monitoring with 21 participants from PNRI, the government and academe. Instructors of the course were those that had undergone the Instructor Training Courses and other seminars hosted and organized by JAEA as part of its human resource development efforts in disseminating the peaceful uses of nuclear technology to several Asian countries.



Participants perform radioactivity measurement exercises as part of the Courses on Medical Use of Radioisotopes and on Radiological Technology



Participants to the 6th Follow-up Training Course on Environmental Radioactivity Monitoring

Nondestructive Testing

In partnership with the Philippine Society for Non-destructive Testing (PSNT), the Institute also offered non-destructive testing (NDT) courses. Around 179 participants were trained in radiographic, ultrasonic and eddy current testing, infrared thermography and surface methods, while 38 trainees participated in the welding inspector's course.

Train the Trainers (T3) Workshop

The NTC conducted special training courses such as the T3 workshop for 23 PNRI lecturers and facilitators as a refresher for best practices in teaching techniques in nuclear science and technology as well as to review and improve the existing course syllabi for training courses.

PNRI Undergraduate Programs

A total of 182 high school and college students from 32 schools had their on-the-job training at PNRI, while 21 college students engaged in these advisorships with PNRI science research specialists from different sections.



Some of the participants to the Non-destructive Testing training courses conducted by PNRI, in partnership with Philippine Society for Nondestructive Testing, Inc.



On-the-job trainees undertaking their internship at PNRI

PNRI NUCLEAR TRAINING COURSES • 2017

TITLE OF TRAINING	NO. OF PARTICIPANTS	TITLE OF TRAINING	NO. OF PARTICIPANTS
RADIOISOTOPE TECHNIQUES		ENVIRONMENTAL RADIOACTIVITY (Conducted in cooperation with the Japan Atomic Energy Agency)	
Course on Medical Use of Radioisotopes (CMR)- Three Sessions	121	JAEA Follow-up Training Course on Environmental Radioactivity Monitoring	21
Course on Radioisotope Technology (CRT)	14	NON-DESTRUCTIVE TESTING (NDT)* (Conducted in cooperation with the Philippine Society for Nondestructive Testing, Inc. (PSNT))	
NUCLEAR SCIENCE AND TECHNOLOGY		Surface Methods (Level 2)	10
Seminar on Nuclear Science for Teachers (SNST)	36	Radiographic Testing (Level 2)- Two Sessions	15
Course on Nuclear Technology (CNT)	4	Ultrasonic Testing (Levels 2 and 3) – Three Sessions	57
RADIATION SAFETY		Infrared Thermographic Testing-L1	14
Radiation Safety Course-Sealed Sources in Industrial Devices (RSC-ID)-Nine Sessions	169	Eddy Current Testing (Levels 2 and 3) –Two Sessions	31
Radiation Safety Refresher Course (RSC-RC)-Four Sessions	93	Surface Methods (Levels 2 and 3)- Two Sessions	29
Radiation Safety Course- Commercial Sale Involving Radioactive Materials and Low Activity Sources (RSC-CL)- Four Sessions	45	Radiographic Testing (Levels 2 and 3)	13
SPECIAL COURSES		Radiograph Interpretation Course	10
Train The Trainers (T3)	23	WELDING TECHNOLOGY (Conducted in cooperation with the PSNT)	
Introductory Seminar on Radiation Safety for Administrative Staff	8	Welding Inspector Course – Two Sessions	38
Basic Neutron Science	24	Total No. of COURSES: 42	
		Total No. of PARTICIPANTS: 775	

*PNRI, through the Nuclear Training Center (NTC), has been accredited for the third year by Lufthansa Technik Philippines as nondestructive testing (NDT) training provider per European Standard EN4179 (Aerospace series - qualification and approval of personnel for NDT)

Graduate Student Research Grant Program (GSRGP)

The PNRI, with funding from Philippine Council for Industry, Energy and Emerging Technology Research and Development, implements the GSRGP which provides for a research grant of Php 25,000.00 for each graduate student from reputable academic institution who is conducting thesis/dissertation related to nuclear science and technology or need to apply nuclear techniques in securing proof of concept. The project provides for the use of PNRI equipment, facilities, laboratory supplies and materials. An adviser is also assigned for each grantee to provide guidance during the conduct of the research work.

This year, ten graduate students (nine M.S. and one Ph.D.) from four universities, namely, University of the Philippines (UP)- Diliman; University of Santo Tomas (UST), Ateneo de Manila University (ADMU), and UP-Los Baños, were accepted in the program. Two of the grantees have completed and successfully defended their thesis, namely,



PNRI GSRGP grantee, Mr. Gerald Dicen, won the 1st Place Best Paper Award in the Senior Category during the 20th Philippine Society for Soil Science and Technology, Inc. (PSSST) Annual Meeting and Scientific Conference held from May 10–12, 2017 in Cebu City. PNRI science research specialist Mr. Roland Rallos (2nd from left) served as one of Mr. Dicen's advisers and co-authors.

Photo credit: ADMU School of Science and Engineering

Gerald P. Dicen on “Preservation of Organic Matter in Mangrove Sediments by Reactive Iron” and Gloriamaris L. Caraos on “Quercetin regulation of BCL-2 and TRX in gamma-irradiated human lymphocyte”. Mr. Dicen is an MS Environmental Science student from ADMU while Ms. Caraos of PNRI, is an MS Biological Science student from UST.



Nuclear Information, Education and Communication of Nuclear S & T

Development of Information Materials

In support of the nuclear promotion and dissemination activities, the Institute produced 18 information materials for the public, including the 2016 PNRI Annual Report and a PNRI institutional video, exhibit banners, posters, and flyers on nuclear science and technology.

Nuclear Awareness Seminars and Guided Tours

Coordinating with PNRI researchers and lecturers, the NIDS facilitated 24 nuclear awareness seminars for 1,300 clients and 27 guided tours for more than 660 visitors of PNRI facilities and laboratories throughout the year. Of those availing the guided tours, around 540 were high school and college students while another 120 were professionals from various sectors and postgraduate students.

Participation in Special Science & Technology Events

PNRI showcased its nuclear and radiation applications to the general public by participating in eight national and regional science and technology events. These include the 2017 National Science and Technology Week (NSTW) on July 11 to 15, the Atomic Energy Week (AEW) from December 4 to 7; five Regional Science and Technology (RSTW) celebrations; and the National Biotechnology Week on November 20 to 24.

Regional Science and Technology Week

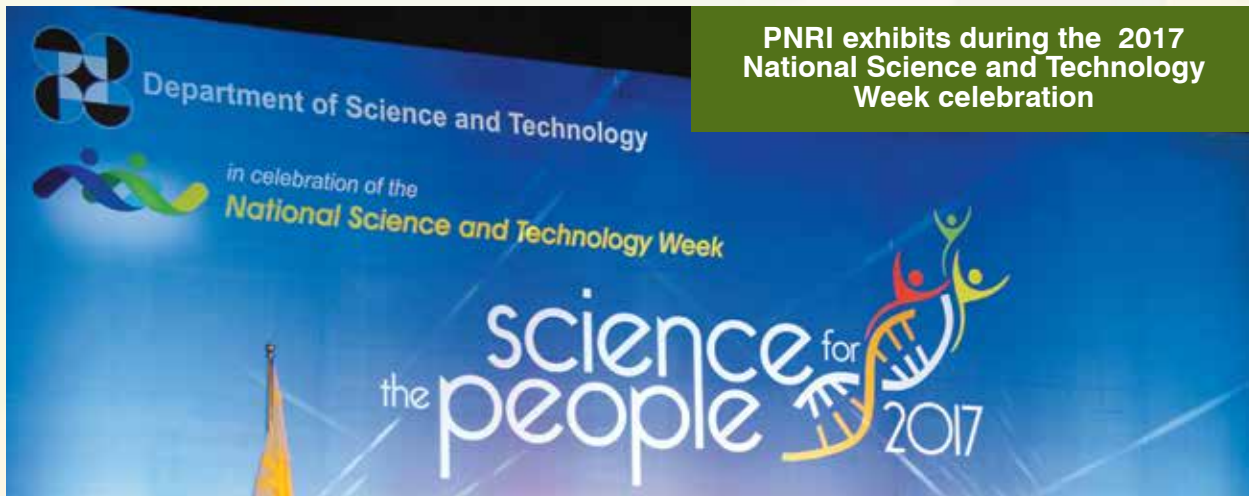
Region 2 - FL Dy Coliseum, Cauayan City, Isabela

Region 6 - SM City, Iloilo

Region 7 - Waterfront Cebu City Hotel and Casino, Lahug, Cebu City

MIMAROPA - Virginia Centurione Bracelli School, Odiongan, Romblon

CAR - PGLU Kalinga Astrodome, Tabuk City, Kalinga



PNRI exhibits during the 2017 National Science and Technology Week celebration



Media Publicity

To increase visibility of nuclear technologies, services and other nuclear-related matters, the NIDS prepared 46 press releases, many of which were published in major daily broadsheets and their online versions. In addition, NIDS arranged and coordinated the conduct of 21 interviews for television, radio and print media with PNRI officials and technical staff. PNRI also held a press briefing for 35 media representatives after the opening ceremonies of the 45th Atomic Energy Week in December.



Website and Social Media

To meet the needs of netizens interested in nuclear research and services, PNRI reaches out in the digital frontier through its official website (<http://www.pnri.dost.gov.ph/>) and Facebook page (<https://www.facebook.com/PNRIDOST/>).



PNRI facebook page: [f DOST-Philippine Nuclear Research Institute](https://www.facebook.com/PNRIDOST/)

Library Services

More than 540 researchers were able to avail of the PNRI Library's collection of nuclear-related journals, books and other reference materials, with around 160 new titles for acquisitions. PNRI also participated in the IAEA International Nuclear Information System (INIS) through the submission of 83 new inputs of nuclear-related literature published in the Philippines.





Educating Secondary Students and Science Teachers on Nuclear S & T

Building on the successful pilot implementation for the International Atomic Energy Agency (IAEA) Technical Cooperation Project on Supporting Sustainability and Networking of National Nuclear Institutions in Asia and the Pacific Region, the Philippines, through PNRI and the Department of Education (DepEd), expanded the outreach program for secondary schools to cover the National Capital Region.

Development of Lesson Exemplars Integrating Nuclear Science

In collaboration with the DepEd – National Capital Region (DepEd-NCR), PNRI pushed for the

development of lesson exemplars integrating nuclear and radiation concepts in high school subjects such as chemistry, earth and space, biology, and physics.

Around 30 exemplars for teaching nuclear science in classrooms were developed by the science teachers under the guidance of division science supervisors and PNRI technical consultants during a seminar and two writeshops conducted by PNRI in partnership with DepEd-NCR. The exemplars, which were validated through teaching demonstrations of science teachers, will be pilot tested in 2018.



Project STRIVE

PNRI participates in the DepEd Schools Division Office Quezon City Project STRIVE (Science, Technology, Research in Innovative Ventures) involving selected Grades 5 and 8 learners in Quezon City at the Quezon City Science Interactive Center.

The project aims to prepare elementary students for entry to science high schools, and to prepare high

school students for eventual entry into the Science, Technology, Engineering and Mathematics (STEM) track.

Four groups composed of 30 students each were selected to participate in 20 Saturdays of workshops in nuclear science, robotics, science investigatory project and improvisation. The project started in September 2017 and will continue until March 2018.



The nuclear science group composed of students from various elementary and secondary schools in Quezon City at the closing ceremony of the DepEd-QC Project STRIVE



Technology Transfer and Commercialization of Products and Technologies

Technology Transfer

PNRI successfully obtained signed licensing term sheets from three adopters of the Carrageenan Plant Growth Promoter. The licensing deals were subsequently adjudged as 'fair to the licensor' by the Fairness Opinion Board headed by DOST Secretary Fortunato dela Peña.

Technology Promotion

PNRI promoted its products and technologies through presentations, product sampling, and site visits of potential adopters and business partners. The technologies were promoted in at



Promoting PNRI technologies through technology transfer events

least six events: Technology Transfer Day events in San Jose, Antique, in Cebu City for Region VII; in Iloilo and Antique for Region VI; in Santiago City for Region II; in Clark, Pampanga for Region III; at the Seaweed Industry Forum in Cebu; and at the 43rd Philippine Business Conference and Expo in Manila Hotel.

Intellectual Property Management

The PNRI received two new intellectual property protection in the form of Utility Models (UMs) issued by the Intellectual Property Office of the Philippines (IPO). The UMs are entitled (a) A Process for Making an Electro-Mechanical System for Regulating the Opening and Closing of Doors (2-2016-000324) and (b) Electro-Mechanical System for Regulating the Opening and Closing of Doors (2-2016-000325).

Three intellectual property applications have been filed through IPO Philippines for seaweed-based plant biostimulant (2 applications) and Tc-99m generation (1 application).

Policy Development

The BDS also actively participated as contributor to Department of Trade and Industry-Board of Investment's Technical Working Group in drafting and finalization of the 2017 Investment Priority Plans Implementing Guidelines, which was signed by President Rodrigo Duterte in March 2017. The IPP 2017 contains various incentives and benefits for adopters of PNRI technologies and investors in commercial sterilization facilities.

The PNRI – developed technologies/products promoted to various business groups in the private sector for commercialization



Carrageenan Plant Growth Promoter



PVP-Carrageenan Hydrogel Wound Dressing



Honey NutriBar



Hemostat



Tc-99m Generator and complementary radiopharmaceuticals

Facilities that can be used for commercialization purposes



Gamma Irradiator Facility



Electron Beam Facility



Information Technology and Network Systems

PNRI's Management Information System Section (MISS) ensures that the research, services and administrative functions of the Institute continue to run smoothly through the development and maintenance of its information, communication and technology (ICT) infrastructure.

Information Technology and Network Systems

This year, the Management Information System Section (MISS) developed, upgraded and maintained 13 information systems and other applications. Three of these systems were already operationalized, four are subject to user testing and the rest are in the development stage.

Information Systems Operationalized in 2017

- Irradiation Services Management Information System which handles client management, measurement and computation of density of each sample and dosimetry results, among others.
- Competency Assessment Application Tool, a web-based application, based on SARCON tool by IAEA which is useful in determining the trainings needed to improve the competence of employees.

- Biometrics Attendance Module for Personnel Infosys which captures and records the log-in and log-out of PNRI employees in the biometric devices for attendance monitoring and recording.

The MISS has also developed the Asia-Pacific Marine Radioactivity Database (ASPAMARD) information system for online submission of member countries of their marine radiological data (seawater, sediment and biota) and is continuously customizing and modifying the Regulatory Authority Information System (RAIS), which supports the management of the Regulatory Control Program in accordance with IAEA safety standards and guides.

Enhancement of Network and Internet Infrastructure and Services

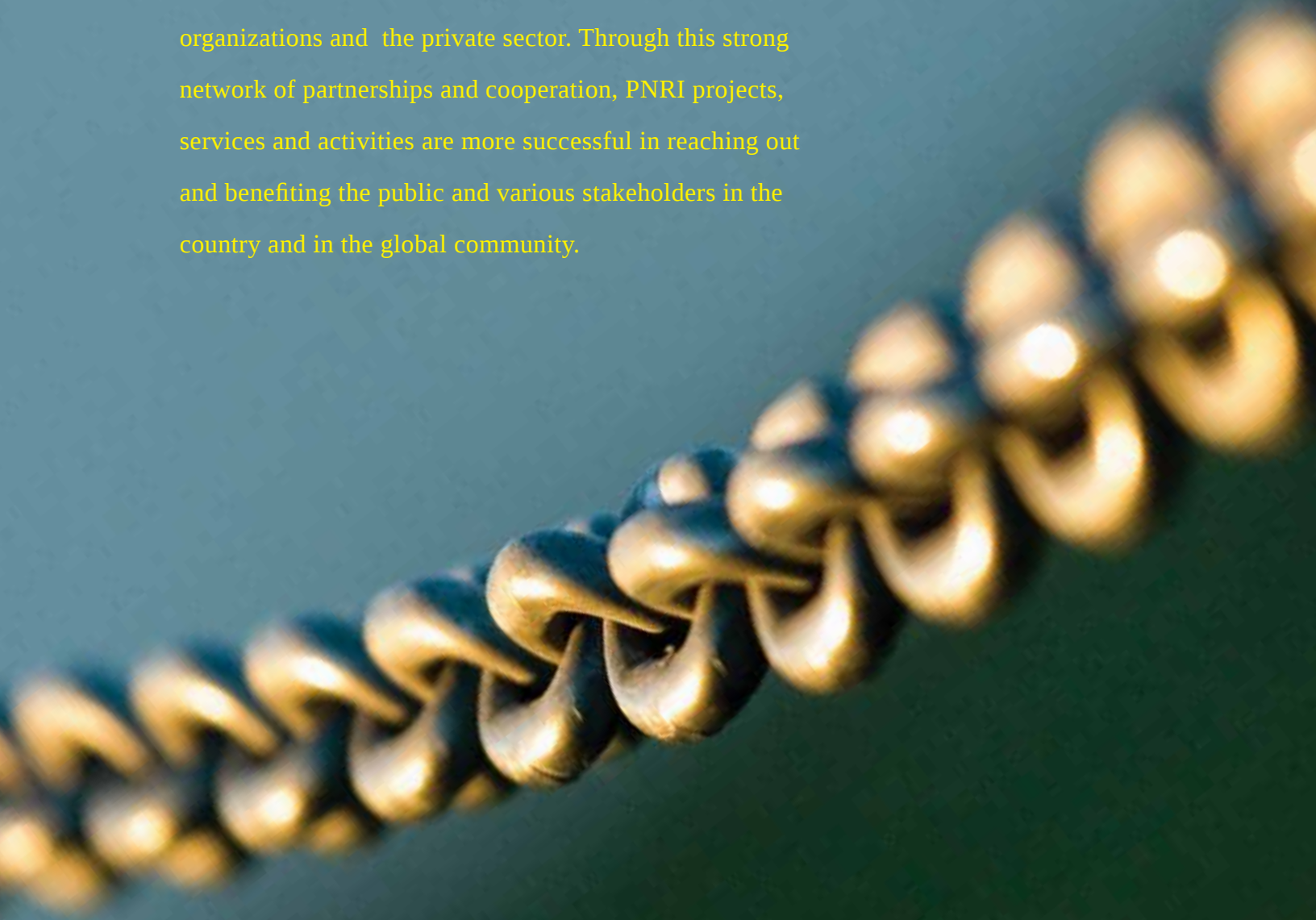
MISS also continued to enhance/upgrade its local area network (LAN), Internet access and Intranet system. The Institute has also recently adopted the use of biometrics devices to replace its antiquated daily time card system. A captive portal system was also installed and configured to provide PNRI guests with voucher type limited access to PNRI WiFi facility.



IT staff of the MISS at the PNRI server room

S & T Linking and Networking

The Institute continues to strengthen its linkages with organizations from various sectors. These partners include other government agencies as well as international organizations and the private sector. Through this strong network of partnerships and cooperation, PNRI projects, services and activities are more successful in reaching out and benefiting the public and various stakeholders in the country and in the global community.



LOCAL S&T NETWORKING

- Ateneo De Manila University
- Bureau of Customs
- Civil Aviation Authority of the Philippines
- Coca Cola Philippines
- De La Salle University
- Department of Agriculture
 - Bureau of Fisheries and Aquatic Resources
 - Bureau of Soils and Water Management
 - Philippine Center for Postharvest Development and Mechanization
- Department of Energy
- Department of Environment and Natural Resources – Environmental Management Bureau
- Department of Health
- Department of Science and Technology and DOST Councils, Research and Service Institutes
- Department of Education, Division of City Schools, National Capital Region
- FEATI University
- Heart Center of the Philippines
- International Rice Research Institute
- Katy's Farm, Cavite City
- Jose Reyes Memorial Medical Center
- Luzon Agricultural Research and Extension Center in Floridablanca, Pampanga
- Manila Observatory
- National Fisheries Research and Development Institute
- National Disaster Risk Reduction Management Coordinating Council and member agencies of the National Radiological Emergency Preparedness and Response Plan

- National Kidney and Transplant Institute
- National Power Corporation
- NutriAsia
- Partnership for Clean Air, Inc.
- Philippine Rice Research Institute
- Philippine Society for Nondestructive Testing, Inc.
- Quezon City Science Community
- St. Luke's Medical Center
- Sugar Regulatory Administration
- Surigao Del Sur State University – Cantilan Campus
- United Nations Development Programme – Philippines

7 IAEA research contracts

38 IAEA technical cooperation projects

41 IAEA experts/mission delegates

8 PNRI hosting of regional meetings, seminars/workshops and regional training courses

108 PNRI and **76** non-PNRI personnel received training/fellowship grants from foreign institutions/agencies



Participants and PNRI lecturers of the Training Course on Environmental Radioactivity Monitoring in Surigao del Sur State University. The training is part of PNRI and SDSSU collaborative project.

FOREIGN S&T NETWORKING

- Asian Network for Education in Nuclear Technology
- Asian Nuclear Safety Network
- Australian Nuclear Science and Technology Organization
- Comprehensive Nuclear Test Ban Treaty Organization
- Department of Foreign Affairs, Trade and Development of Canada
- European Commission
- Forum for Nuclear Cooperation in Asia, Japan Hirosaki University, Japan
- Japan Atomic Energy Agency
- Korea Advance Institute of Science and Technology
- Korea Advance Radiation Technology
- Korea Atomic Energy Research Institute
- Korea Institute of Nuclear Safety
- Ministry of Education, Culture, Sports, Science and Technology of Japan
- Nuclear Safety Research Association, Japan
- Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology for Asia and the Pacific
- RCA Regional Office in Korea
- Rosatom State Atomic Energy Corporation
- United States Department of Agriculture
- United States Department of Energy
- United States National Nuclear Security Administration

The Philippines Signs a Country Programme Framework (CPF) with the International Atomic Energy Agency (IAEA) for 2016-2021



DOST Undersecretary for Scientific and Technical Services Dr. Carol M. Yorobe (5th from left) and IAEA Deputy Director General and Head of the Department of Technical Cooperation – Mr. Dazhu Yang (6th from left), signed the Philippines' Country Programme Framework (CPF) for the period 2016-2021 on 31 May 2017 at the IAEA

Headquarters in Vienna, Austria. A CPF is the frame of reference for the medium-term planning of technical cooperation between a Member State and the IAEA and identifies priority areas where the transfer of nuclear technology and technical cooperation resources will be directed to support national development goals.



Bilateral Meeting between IAEA Director General Yukiya Amano (2nd from left) and Philippine delegates to the 61st IAEA General Conference in Vienna, Austria

IAEA RESEARCH CONTRACTS* IMPLEMENTED IN 2017

TITLE/DESCRIPTION OF RESEARCH	NAME OF RESPONSIBLE AGENCY STAFF
Philippine Nuclear Research Institute	
Development of New Applications of Machine Generated Food Irradiation Technology	Zenaida De Guzman
Uranium/Thorium Fuelled High Temperature Gas Cooled Reactor Applications for Energy Neutral and Sustainable Comprehensive Extraction and Mineral Product Development Processes	Rolando Reyes
Geochemical and Mineralogical Characterization of Uranium and Thorium Deposits	Edmundo Vargas
Development of Handling, Transport, Release and Trapping Methods of Dengue Mosquito Vector <i>Aedes aegypti</i> in the Philippines	Sotero Resilva
Collection and Analysis of Radiation Detection Data for Alarming Containers	Julietta Seguis
Food and Nutrition Research Institute	
Measurement of Breast Milk Intake Among Filipino Urban Children Aged 12-18 Months to Estimate Vitamin A Intake Amidst Multiple Large Scale Vitamin A Programs	Mario Capanzana
St. Luke's Medical Center	
Evaluation of Multimodality Imaging in the Assessment and Diagnosis of Post-Operative Spinal Infection	Dr. Vincent Peter Magboo

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

IAEA TECHNICAL COOPERATION PROJECTS IMPLEMENTED IN 2017

TITLE/DESCRIPTION OF RESEARCH	NAME OF CONTACT PERSON
National Technical Cooperation Projects	
Building Capacity in Nuclear Science and Technology by Re-establishing the Research Reactor-I as a Triga Fuel Subcritical Assembly	Kristine Marie Romallosa PNRI
Assessing the Development of a Nuclear Power Programme	Jesus Tamang Department of Energy
Building Capacity in Using the Sterile Insect Technique Against Dengue and Chikungunya Vectors	Glenda Obra PNRI
Enhancing Capacity for Synthesis and Characterization of Medical Diagnostic Kits for Nuclear Pharmacy Applications	Adelina Bulos PNRI
Establishing Quality Management Systems in Nuclear Medicine and Radiotherapy	Dan Joseph Manlapaz National Kidney & Transplant Institute
Building Capacity for the Detection, Quantification and Monitoring of Emerging Harmful Algal Bloom (HAB) Toxins	Rhett Simon Tabbada PNRI
Supporting Safety Assessment and Safety Case for the Near Surface and Borehole Disposal Facilities	Alfonso Singayan PNRI
Regional Agreement Projects	
Enhancing the Management of the RCA Agreement and Its Programme	Soledad Castañeda PNRI
Building Capacity for Applications of Advanced Non-Destructive Evaluation Technologies for Enhancing Industrial Productivity	Renato Bañaga PNRI
Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques	Mary Jane Manrique PNRI
Strengthening Adaptive Climate Change Strategies for Food Security through the Use of Food Irradiation	Zenaida De Guzman PNRI
Promoting the Application of Mutation Techniques and Related Biotechnologies for the Development of Green Crop Varieties	Mary Jane Manrique PNRI
Strengthening Radionuclide Therapy for High Impact Cancer Treatment Strategy in Member States of the Regional Cooperative Agreement	Emerita Barrenechea St. Luke's Medical Center
Strengthening Intensity Modulated Radiation Therapy Capability in the Region	Miriam Calaguas Jose Reyes Memorial Medical Center
Improving Cancer Management Through Strengthening the Computed Tomography Cancer Staging Process	Rhia Sauler-Gomez De La Salle University Medical Center
Strengthening the Effectiveness and Extent of Medical Physics Education and Training	Bayani San Juan Center for Device Regulation, Radiation Health and Research
Improving Patient Care and Enhancing Government Parties Capacity in Nuclear Medicine Programmes in RCA Region	Teofilo San Luis, Jr. St. Luke's Medical Center
Enhancing Stereotactic Body Radiation Therapy for Frequent Cancers in the RCA Region	Nonette Cupino Philippine General Hospital
Enhancing Regional Capabilities for Marine Radioactivity Monitoring and Assessment of the Potential Impact of Radioactive Releases from Nuclear Facilities in Asia-Pacific Marine Ecosystems	Eliza Enriquez, PNRI
Assessing the Impact of Urban Air Particulate Matter on Air Quality	Preciosa Corazon Pabroa PNRI
Assessing Deep Groundwater Resources for Sustainable Management Through the Utilization of Isotopic Techniques	Norman Mendoza PNRI

IAEA TECHNICAL COOPERATION PROJECTS IMPLEMENTED IN 2017

TITLE/DESCRIPTION OF RESEARCH	NAME OF CONTACT PERSON
Regional Non-Agreement Projects	
Educating Secondary Students and Science Teachers on Nuclear Science and Technology	Rhodora Leonin PNRI
Supporting Decision Making for Nuclear Power Planning and Development – Phase III	Mauro Marcelo National Power Corporation
Conducting the Comprehensive Management and Recovery of Radioactive and Associated Mineral Resources	Rolando Reyes PNRI
Supporting Early Warning Response and Control of Transboundary Animal Diseases	Cristina Legaspi Bureau of Animal Industry
Promoting the Sharing of Expertise and Infrastructure for Dengue Vector Surveillance Towards Integration of the SIT with Conventional Control Methods Among South and Southeast Asian Countries	Glenda Obra PNRI
Integrating Sterile Insect Technique for Better Cost-Effectiveness of Area Wide Fruit Fly Pest Management Programme	Glenda Obra PNRI
Complementing Conventional Approaches with Nuclear Techniques Towards Flood Risk Mitigation	Raymond Sugcang PNRI
Supporting Climate-Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications-Phase II	Roland Rallos PNRI
Enhancing Food Safety Laboratory Capabilities and Establishing a Network in Asia to Control Veterinary Drug Residues and Related Chemical Contaminants	Danica Dimaya National Meat Inspection
Using Stable Isotope Techniques to Monitor Situations & Interventions for Promoting Infant and Young Child Nutrition	Leah Perlas Food and Nutrition Research Institute
Optimizing the Role of Nuclear Medicine Techniques in the Diagnosis and Clinical Management of Childhood Cancer and Inborn Diseases	Teofilo San Luis, Jr. St. Luke's Medical Center
Enhancing Safety and Effectiveness in Diagnostic Radiology Through Training of Medical Imaging Professionals in Quality Practices	Emerita Barrenechea St. Luke's Medical Center
Supporting the Applications of Emerging Targeted Therapeutic Radiopharmaceuticals for Radionuclide Therapy	Adelina Bulos PNRI
Supporting Regional Nuclear Emergency Preparedness & Response in the Member States of ASEAN Region	Teofilo Leonin, Jr. PNRI
Strengthening Public and Environmental Radiological Protection in the Asia-Pacific Region	Lorna Jean Palad PNRI
Enhancing National Capabilities on Occupational Radiation Protection in Compliance with Requirements of the New International Basic Safety Standards	Kristine Marie Romallosa PNRI
Enhancing the Radioactive Waste Management Infrastructure in the Asia-Pacific Region	Ronald Piquero PNRI

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

PNRI HOSTINGS

FIELD	PHILIPPINE PARTICIPANT	AGENCY / INSTITUTE	ORGANIZER/S VENUE/ DATE
IAEA Workshop on the Formulation and Implementation of National Policy and Strategy for the Management of Radioactive Wastes and Disused Sealed Radioactive Sources	Vince Calija	PNRI	IAEA Hotel Novotel, Quezon City 6 -10 March
Workshop on National Strategic Education and Training of Radiation Safety RAS 9081	Maria Pilar Capalongan Jane Rausan Sarmiento	Department of Education- NCR	IAEA Hotel Novotel, . Quezon City 15 - 17 March
	Roel Loterifa	PNRI	
Regional Workshop on Receptor Binding Assay Method Verification and Measurement Results Uncertainty Estimation According to International Standards RAS7026	Marc Lawrence Romero Alvin Gutierrez Awatin	Bureau of Fisheries and Aquatic and Resources	IAEA Hotel Novotel, Quezon City 24 - 28 April
	Ma. Llorina Ranada	PNRI	
IAEA/RCA Regional Training Course on Principles and Practice on the Use of Radiopharmaceuticals for Bone Pain Palliation and Treatment of Other Malignancies (RAS6071)	Angelica Barrenechea Jefferson Pagsisihan	St. Lukes Medical Center	IAEA Hotel Novotel, Quezon City 24 - 28 April
	Henry Canizares Richard Heredia	Vicento Sotto Memorial Medical Center	
	Adrew Dominic Soriano Kalaw	UST Hospital	
IAEA /RCA Regional Coordination Meeting RAS 5071 “Strengthening Adoptive Climate Change Strategies for Food Security Through the Use of Food Irradiation”	Zenaida M. de Guzman	PNRI	IAEA Crowne Plaza Manila Galleria 2 – 6 October
	Alicia Ilaga	Department of Agriculture	
Forum for Nuclear Cooperation in Asia Workshop on Radiation Oncology	Miriam Joy Calaguas	St. Luke’s Medical Center	FNCA Hotel Novotel, Quezon City 25 – 28 October
	Rey Delos Reyes	Far Eastern University - Nicanor Reyes Medical Foundation	
	Jaemelyn Marie Fernandez	Jose Reyes Memorial Medical Center	
Regional Workshop on Radioactive Waste Management Registry	Alfonso Singayan Edmundo Vargas Ronald Piquero	PNRI	IAEA Crowne Plaza Manila Galleria 6 – 10 November
	Jason Jude Villegas	Department of Energy	
4 th ASEANTOM Meeting	Teofilo Leonin Jr. Julietta Seguis	PNRI	IAEA Crowne Plaza Manila Galleria 7 – 8 December



Various PNRI hostings in 2017 with international and local participants



aeW45 Atomic Energy Week

As mandated under Presidential Proclamation No 1211 in 1973, the DOST-PNRI celebrated the 45th AEW to help generate awareness of the Filipinos on the beneficial uses of nuclear science and technology in food, agriculture, industry, medicine and the environment.

WREATH-LAYING

DOST Secretary Fortunato T. dela Peña joined PNRI officials and staff during the flag ceremony and wreathlaying at the monument of General Florencio A. Medina. Secretary dela Peña also delivered an inspirational speech for the AEW celebration.



OPENING CEREMONIES

The 45th AEW Opening Ceremonies Keynote Speaker Congressman Ron Salo with PNRI Director Dr. Carlo Arcilla, PNRI Deputy Director Dr. Soledad S. Castañeda (extreme left) and AEW Executive Committee Chairperson Ms. Ana Elena Conjares



OPEN HOUSE: Guided tour of PNRI facilities and laboratories





TECHNICAL SESSIONS



PHILIPPINE NUCLEAR SCIENCE QUIZ

PHILIPPINE NUCLEAR YOUTH SUMMIT



PRESS CONFERENCE

CLOSING CEREMONY





The PNSQ panel of judges with the top five finalists during the PNSQ National Level on December 6, 2017

One of the highlights of the AEW celebration was the conduct of the Philippine Nuclear Science Quiz (PNSQ). The PNSQ aims to provide an avenue to develop Filipino students' awareness and appreciation of nuclear science and technology and its potential role in uplifting the quality of living in the country. It also aims to sustain

awareness and understanding of the participants on nuclear science and technology and its beneficial applications.

A total of 62 teams from schools all over the country participated in the Regional Level competition, from which 34 teams advanced to the National Level.



2017 PNSQ Winners (National Level Competition)

1ST PLACE (PhP 50,000.00)

Saint Jude Catholic School

Russel Glenn C. Odi (Coach); Stefan Marcus A. Ong and Steven T. Reyes

2ND PLACE (PhP 40,000.00)

Cagayan National High School

Eric B. Pasion (Coach); Andrew Jerome O. Antonio and Lin Andre Jan T. Vitin

3RD PLACE (PhP 30,000.00)

Davao City National High School

Joel A. Called (Coach); John Marrselle W. Lamerina and Jan C. Lambojon

Consolation Prize (PhP 15,000.00)

Philippine Science High School - Central Visayas Campus

Joseph R. Hortezueta (Coach); Claire S. Mahusay and Estenard Jhay D. Tuazon

Commonwealth High School

John Niel T. Masong (Coach); Paula Mariz M. Bernal and Niño S. Ibuna



Philippine Nuclear Youth Summit 2017

To provide a forum for the youth to share information and scientific knowledge on nuclear science and technology, PNRI hosted the 3rd Philippine Nuclear Youth Summit (PNYS) on December 5, 2017. About 230 senior high school and college students, teachers and young professionals attended the event.



PNYS Activities

Sharing of on-going activities about Nuclear Science and Technology for the Youth

NucleaART: Digital Poster Making Contest Theme "Nuclear Science and Technology Working for You"

Nuclear Amazing Race

Youth Statement Crafting

Inauguration of the Philippine Young Generation in Nuclear (PYGN)



1ST PLACE:
Alladin M. Melico and Mrs. Angela DC Pereda
Signal Village National High School, NCR
Title: Radiating Nuclear Science and Technology's Benefits

NucleaART: Digital Poster Making Contest Winners

A total of 51 entries were submitted by senior high school students from 12 regions in the country.



PEOPLE'S CHOICE:
Micah Alexandra L. Domingo and Lex Vernon G. Anzano
San Miguel National High School, Region 3
Title: Embracing the World of Nuclear Science



Participants of the 3rd Philippine Nuclear Youth Summit held at PNRI on December 5, 2017

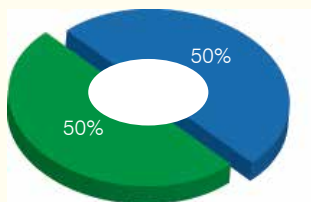
Human Resources Development



From the greatest accomplishments to the smallest details, behind it all are the officials, scientists, researchers, regulators, operators and staff of the Institute, whose expertise in their fields are only matched by their diligence and dedication to their respective endeavors. The men and women of PNRI continue to keep the nuclear fire burning brightly, lighting the way to a science-driven future.

DISTRIBUTION OF PERSONNEL

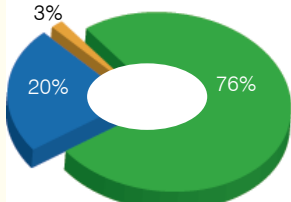
By Gender



MALE
FEMALE

TOTAL 220

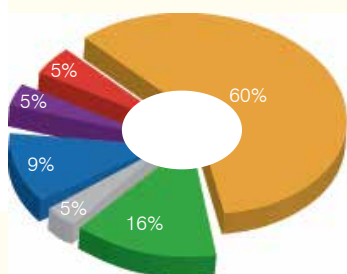
By Staff Category



ADMINISTRATIVE
MANAGERIAL
TECHNICAL

TOTAL 220

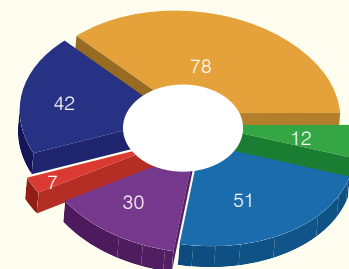
By Education



BS/BA
Post BS/BA
MS/MA
Post High School
High School and below

TOTAL 220

By PNRI Staff Activity



Research & Development
Administrative
Technology Delivery
Regulatory
S & T Education
S & T Services

TOTAL 220

2 New Scientists from PNRI Agriculture Research Section



Honorable Alicia dela Rosa-Bala, Civil Service Commission Chairperson (extreme left) administers the oath-taking of PNRI Agriculture Research Section Head Glenda Obra (2nd from right) and Fernando Aurigue from the PNRI Agricultural Research Section (extreme right) as they joined the new batch of Scientists under the Scientific Career System on June 19 at the Luxent Hotel in Quezon City.

20 PNRI staff pursued post graduate degrees through local/foreign scholarships

42 Nuclear training courses conducted by PNRI with 776 participants

21 Students from 5 schools were accepted for thesis advisorship at PNRI

3 PNRI staff who obtained their doctoral/masteral degrees in 2017

Chitho P. Feliciano
Senior Science Research Specialist
Biomedical Research Section, Atomic Research Division
PhD in Engineering Major in Materials Science
University of Tsukuba, Japan

Alvie A. Astronomo
Senior Science Research Specialist
Applied Physics Research Section, Atomic Research Division
PhD in Physics
Ateneo de Manila University, Philippines

Efren J. Sta. Maria
Senior Science Research Specialist
Chemistry Research Section, Atomic Research Division
MS in Development Management
Development Academy of the Philippines

182 Students from 32 schools were accommodated for on-the-job training at PNRI

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

108 PNRI personnel and **76** non-PNRI personnel received training/fellowship grants from foreign institutions/agencies

MODEL EMPLOYEES

P.R.A.I.S.E. Special Award

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

Mobile Expert Support Team

For having consistently provided valuable assistance and hard work as technical support to the Committee of Security, Peace and Order and Emergency Preparedness and Response and as one of the work forces of the Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) and Joint Task Group of Emergency Response that has contributed to the overall success of the ASEAN Summit 2017.



*From Left: Raymund P. Beredo, Paolo Tristan F. Cruz, Carl M. Nohay, Marianna Lourdes Marie L. Grande, Rosario R. Encabo, Eileen Beth A. Hernandez, Franklin A. Pares, Eugene S. Gregorio, Joseph R. Tugo, Jayson V. Godoy
Not in photo: Maria Teresa A. Salabit, Ramoncito F. Sulit, Dan Benneth C. Mangulabnan, Davison T. Baldos, Albert M. Llagas, Ryan A. Miot, Alfonso A. Maderazo and Edilberto C. Dumantay*



PNRI Table Tennis Players

For bringing honor, recognition, and prestige to the DOST System as Champions in the 6th Inter Government Agency Sports Festival.

*From left: Angel T. Bautista VII, Sofronio B. Enriquez, Christopher O. Mendoza, Ivy Angelica A. Nuñez, Kristine Marie D. Romallosa, Mary Jayne C. Manrique, Dante Q. Bajet, Carl M. Nohay, Davison T. Baldos, Rollie B. Ilaog, Gerardo Jose M. Robles, Efren J. Sta. Maria.
Not in photo: Raymund P. Beredo, Joseph R. Tugo, Rizalina G. Osorio, Genie Belle M. Bolaong, Lorna S. Relleve and Ana Maria S. Veluz*



PNRI Recognition Awards

Division Awardees

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



Nuclear Services Division • Column Scanning Team

Denis D. Aquino¹, Allan DM. Bulos², Mary Gold N. Dela Cruz³, Rollie B. Ilao⁴,
Janice P. Mallillin⁵, Ramoncito F. Sulit⁶ and Zaldy B. Costimiano⁷



Atomic Research Division

Ryan Joseph Aniago
Science Research Specialist II
Health Physics Research Section



Technology Diffusion Division

Hans Joshua V. Dantes
Information Officer I
Nuclear Information & Documentation Section



Finance and Administrative Division

Susan S. Pascual
Administrative Officer V
Cash Section



Nuclear Regulatory Division

Raymund P. Beredo
Science Research Specialist II
Nuclear Safeguards and Security Section



Cecilia M. De Vera
Senior Science Research Specialist
Radiological Impact Assessment Section



National and Regional Awards

Mango Weevil Research Team Wins The National Award for the Presidential Lingkod Bayan Group Category

Researchers under the Mango Weevil Research Team from DOST-PNRI and the Department of Agriculture (DA) were honored in Malacañang as the national awardees of the 2017 Presidential Lingkod

Bayan Award for the group category by President Rodrigo Roa Duterte at the Rizal Hall of Malacañan Palace on September 20, 2017.



Photo courtesy of the Civil Service Commission. Published in Manila Bulletin, October 3, 2017.

The PNRI Presidential Lingkod Bayan awardees pose with President Rodrigo Roa Duterte, CSC Chairperson Alicia dela Rosa-Bala, and CSC Commissioner Robert S. Martinez (1st row, middle), and committee members, among them Scientist I, Mango Weevil Research Team Leader and PNRI Agriculture Research Section Head Ms. Glenda Obra (1st row, 5th from left), PNRI Irradiation Services Section Head Ms. Luvimina Lanuza (1st row, 4th from left) and PNRI Science Research Specialist Mr. Sotero Resilva (2nd row, rightmost). They were joined by Mango Weevil Research Team Leader Dr. Louella Rowena Lorenzana of the Department of Agriculture (1st row, 6th from left).



Ms. Glenda Obra, Scientist I and head of the PNRI Agriculture Research Section (3rd from left), along with Mr. Sotero Resilva, Senior Science Research Specialist (extreme left), and Ms. Luvimina Lanuza, head of the PNRI Irradiation Services Section (2nd from left). Also among the awardees were their collaborators from the Department of Agriculture, namely Dr. Louella Lorenzana (3rd from right), Mr. Edison Bauzon (extreme right) and Ms. Elvira Litan (2nd from right).

PNRI Scientist Receives Outstanding R&D Award for Applied Research



PNRI Scientist Dr. Lucille Abad receives the Julian A. Banzon Award from DOST Secretary Fortunato De La Peña and DBM Secretary Benjamin Diokno during the 2017 National Science and Technology Week opening ceremonies at the World Trade Center.

Dr. Lucille Abad, Scientist I and head of the PNRI Chemistry Research Section receives the Outstanding Research and Development Award for Applied Research (Julian A. Banzon medal) for her outstanding research on “Radiation Modified Carrageenan as Plant Food Supplement (CPFS)” that proved to be effective as plant growth promoter. The award was given during the opening ceremonies of the 2017 National Science and Technology Week on July 11, 2017 at the World Trade Center in Pasay City.

PNRI Researchers Win the Presidential Lingkod Bayan Regional Award

For their pioneering work in enhancing the quality of Filipino mango exports, agriculture specialists from the DOST-PNRI and DA were awarded with the 2017 Presidential Lingkod Bayan Regional

Award by the Civil Service Commission (CSC). The research team utilized irradiation as a quarantine treatment against the mango pulp weevil *Sternochetus frigidus* (Fabr.).



Ms. Glenda Obra, Scientist I and head of the PNRI Agriculture Research Section (5th from left), Mr. Sotero Resilva, Senior Science Research Specialist (6th from left), and Ms. Luvimina Lanuza, head of the PNRI Irradiation Services Section (4th from left) with PNRI Atomic Research Division Chief Dr. Soledad Castañeda (3rd from left) and PNRI researchers during the awarding of the 2017 Presidential Lingkod Bayan Regional Award at the Luxent Hotel in Quezon City.

DOST International Publication Awards

For demonstrating their technical capacity through their prolific authorship of research outputs, PNRI researchers won seven DOST International Publication Awards given by the National Academy of Science & Technology Philippines (NAST PHL). The winners were acknowledged for the publication of their articles in internationally recognized research journals.

- 1** **A Protocol for Transport of Mango Pulp Weevil, *Sternochetus frigidus* (Fabr. Coleoptera: Curculionidae in Philippines)**
 Louell Rowena J. Lorenzana and Glenda B. Obra
- 2** **Secondary Metabolites from *Hoya publicalyx* Merr.**
 Elvira Bolinget, Nelson M. Panajon, Fernando B. Aurigue, Ian Altena and Consolacion Y. Ragasa
- 3** **Chemical Constituents of *Hoya cumingiana* Decne**
 Consolacion Y. Ragasa, Nelson M. Panajon, Fernando B. Aurigue, Robert Brkljaca, and Sylvia Urban
- 4** **Application of full-factorial design in the sythesis of polypropylene-g-poly (glycidyl methacrylate) functional material for metal ion adsoption**
 Jordan F. Madrid, Girlie Eunice P. Lopez, and Lucille V. Abad
- 5** **Enhancing Cytogenic Biological Dosimetry Capabilities of the Philippines for Nuclear Incident Preparedness**
 Celia O. Asaad, Gloriamaris L. Caraos, Gerardo Jose M. Robles, Anie Day D. C. Asa, Maria Lucia C. Cobar and Al-Ahmadgaid Asaad
- 6** **Measurements of Rare Element and Other Element Mass Fractions in Environmental Reference Materials by INAA, ICP-AES and ICP-MS)**
 Vu Dong Cao, Raymond Suggang, Thien Quang Tran, Doanh Van Ho, Naoki Shirai and Mitsuru Ebihara
- 7** **Chemical Constituents of *Hoya paziaae* Kloppenb**
 Judy D.V. Perez, Melissa S. Borlagdan, Fernando B. Aurigue, Ian A. Van Altena and Consolacion Y. Ragasa

1st Best Research Paper "Nutrient Dynamics Assessment of Inorganic Rice-based Farming Systems Using Isotopic Techniques"

This was given during the DA-BSWM 66th Anniversary and In-House Review of Ongoing and Completed Projects on June 5, 2017 at the Department of Agriculture - Bureau of Soils and Water Management in Quezon City. Roland V. Rallos, PNRI Science Research Specialist II is one of the authors of the research paper.



PNRI Research Team Wins The 2017 FNCA Excellence Awards



Dr. Lucile Abad, who headed the Plant Food Supplement (PFS) project, demonstrated the E-beam applications for radiation processing to FNCA experts and seminar participants

The Japanese government, through the Forum for Nuclear Cooperation in Asia (FNCA), has awarded the project team behind the Plant Food Supplement (PFS) of the DOST-PNRI with the 2017 FNCA Excellent Research Team of the Year Award for its success in radiation technology applications, particularly in increasing the yield of rice, mungbean and other crops. The award was given on October 11, 2017 during the 18th FNCA Ministerial Level Meeting in Astana, Kazakhstan. The FNCA is a Japan-led cooperation framework for the peaceful applications of nuclear technology.

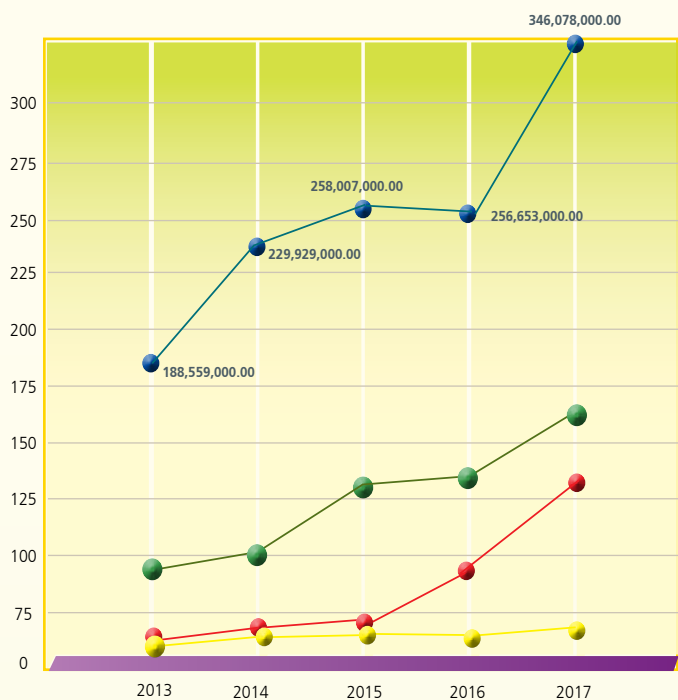


Financial Resources



This year, PNRI had a budget allotment of Php346,078,000.00 by class and Php152,608,432.00 by major final output. The Institute generated an annual income of Php40,423,580.00 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.

ANNUAL PNRI BUDGET (2013-2017)



YEAR	PS	MOOE	CO
2013	92,679,000	56,844,000	31,000,000
2014	101,931,000	65,065,000	62,933,000
2015	129,813,000	65,194,000	63,000,000
2016	131,949,000	93,839,000	30,865,000
2017	163,348,000	132,858,000	49,872,000

Legend:

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

ADDITIONAL RESOURCES GENERATED From External Sources 2017

GRANT	AMOUNT
Local Grants-in-Aid	Php 21,300,381.00
Foreign Grants	Php 5,350,212.00
TOTAL	Php 26,650,593.00

2017 EXPENDITURES By Major Final Output (MFO)



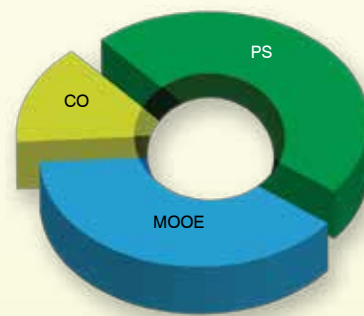
MFO1 Php 44,990,379.25
Scientific Research
and Development

MFO2 Php 83,601,165.12
Technical Advisory
Services

MFO3 Php 24,016,888.07
Nuclear Regulatory
Services

Total Php 152,608,432.44

2017 ALLOTMENT By Expense Class



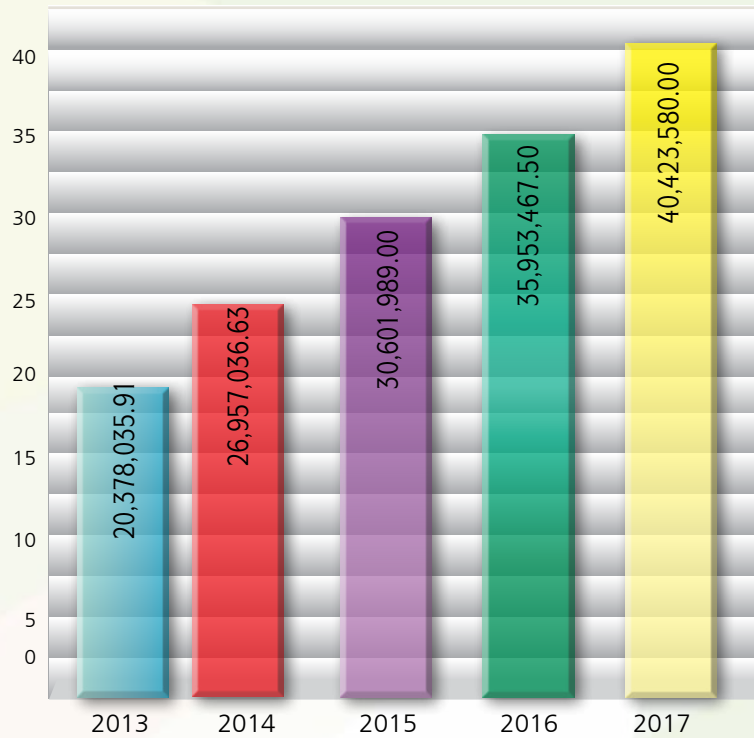
PS Php 163,348,000.00

MOOE Php 132,858,000.00

CO Php 49,872,000.00

Total Php 346,078,000.00

ANNUAL INCOME (2013-2017)



INCOME FROM PNRI SERVICES • 2017

SOURCE OF INCOME	INCOME GENERATED (IN PESOS)
A. NUCLEAR PERMITS AND LICENSES	5,650,312.50
Licensing Fees	2,309,962.50
Licensing Fees	466,300.00
Surcharge	31,700.00
Licensing Renewal	1,436,312.50
Licensing Amendment	375,650.00
Permit Fees	3,340,350.00
Transport Certificate	3,025,850.00
Release Certificate	299,000.00
Certificate of Exemption	15,500.00
B. SERVICE INCOME	34,632,507.60
Inspection and Audit Fees	1,111,500.00
Fines & Penalties - Service Income	638,158.00
Other Service Income	
Radiation Protection Services	32,822,849.60
Monitoring films/OSLs/TLDs and Cassettes	19,545,515.60
Calibration	2,126,000.00
Leak Test/Spent-Sealed Sources	114,600.00
Swipe Test	714,950.00
Radiation Monitoring/Hazards Evaluation	47,500.00
Rental of Survey Meter	438,400.00
Rental of Moisture Density Gauge	165,000.00
Repair of Survey Meter	14,000.00

SOURCE OF INCOME	INCOME GENERATED (IN PESOS)
Radioactive Waste Management (Waste Storage/Disposal/Temperature Storage)	102,900.00
Gamma Irradiation Services (Use of Cobalt-60 Facility)	6,431,060.00
Radioactivity Analysis	1,982,042.00
Gammametric Analysis	673,430.00
Cross Alpha-beta Analysis	1,308,612.00
Biological Tests	49,950.00
Cytogenetic Analysis	8,750.00
Sterility Test	30,800.00
Bioburden Count	7,000.00
Aerobic Plate Count	3,000.00
Chemical Analysis	400.00
RadioAnalytical and Related Tests	49,950.00
Radon Analysis	962,632.00
Elemental Analysis	25,500.00
Tritium Analysis	162,800.00
B. BUSINESS INCOME	140,759.90
Other Business Income	140,759.90
Sale of CPR	800.00
Use of Dose Calibrator	55,500.00
Use of Diagnostic Instrument/Rotary Evaporator	8,000.00
Miscellaneous	76,459.90
TOTAL INCOME	40,423,589.00

ADDITIONAL RESOURCES GENERATED FROM EXTERNAL SOURCES • 2017

PROJECT TITLE	AMOUNT		PNRI PROJECT LEADER	FUNDING AGENCY*
	LOCAL	FOREIGN		
Enhancing Onelab for global competitiveness- RDIs component	2,219,123		Ana Elena Conjares	DOST
Air Particulate Matter: Characterization by elemental and isotopic pollution sources and possible mitigation measures by electron beam technology	1,589,413		Preciosa Corazon Pabroa	NRCP
Multi-location on oligo carrageenan for improved productivity of mungbean and peanut in regions 2, 3,7 and 10	1,841,298		Fernando Aurigue	PCAARRD
Field verification of carrageenan plant food supplement for enhanced growth and induced pests and disease resistance in rice in regions 2 and 3.	610,460		Lucille Abad	PCAARRD
Smart-farming based efficient nutrient management to increase sugarcane productivity through elemental tracer and related techniques	1,680,706		Roland Rallos	PCAARRD
The use of radon technique in mapping geological faults in the Philippines	361,724		Angelito Ramos	PCIEERRD
Characterization and separation of heavy minerals in the alluvial and beach sands in San Vicente, northwestern Palawan: Phase 1	3,876,647		Rolando Reyes	PCIEERRD
National training course in nuclear medicine application in neurology	385,000		Nydia Medina	PCIEERRD
PNRI Graduate Student Research Grant Program (GSRGP)	4,999,216		Ana Elena Conjares	PCIEERRD
4 th Annual Meeting of ASEAN Network Regulatory Bodies on Atomic Energy (ASEANTOM)	200,000		Thelma Artificio	PCIEERRD
2017 National Science and Technology Week Celebration	200,000		Rhodora Leonin	TAPI
Promotion and utilization of organic production system and irradiation technology in the production of safe and quality bee products	1,490,592		Zenaida De Guzman	DA-BAR
ASEAN Summit 2017	710,000		Juliette Seguis	DOE
Improvement of the recommended sugarcane varieties using nuclear technology and biotechnology	1,136,202		Mary Jane Manrique	SRA
Development of handling, transport, release and trapping methods of dengue mosquito vector <i>Aedes aegypti</i> in the Philippines.		477,787	Sotero Resilva	CRP-IAEA
Organization and Conduct of IAEA Group Fellowship on Isotope Hydrology in Manila, Philippines, 7 November - 2 December 2016.		254,004	Soledad Castañeda	CRP-IAEA
Resource evaluation and characterization of uranium, thorium and rare earth and other essential elements from commercial phosphate fertilizer processing industry in the Philippines		283,628	Rolando Reyes	CRP-IAEA
Geochemical radiometric characterization of the Cu-Mo-U occurrences in the Larap-Paracale mineralized district, Camarines Norte, Philippines		283,276	Edmundo Vargas	CRP-IAEA
Collection and analysis of radiation detection data for alarming containers		496,643	Julietta Seguis	CRP-IAEA
Comprehensive Nuclear-test ban Treaty Organization (CTBTO)		3,479,918	Teofilo Garcia Paolo Tristan Cruz	CTBTO
USDOE/BATELLE and PNRI in support of the Office of Radiological Security (Global Threat Reduction Initiative) projects		74,956	Julietta Seguis	US-DOE
TOTAL	21,300,381	5,350,212		

*Funding Agency

CRP-IAEA – Coordinated Research Project - International Atomic Energy Agency	PCAARRD - Philippine Council for Agriculture, Aquatic and Natural Resources Research & Development
CTBTO – Comprehensive Nuclear Test Ban Treaty Organization	PCIEERRD - Philippine Council for Industry, Energy, and Emerging Technology Research & Development
DA-BAR – Department of Agriculture- Bureau of Agricultural Research	SRA- Sugar Regulatory Administration
DOE – Department of Energy	TAPI- Technology Application and Promotion Institute
DOST – Department of Science and Technology	US-DOE- United States Department of Energy
NRCP – National Research Council of the Philippines	



PNRI OFFICIALS

1 Carlo A. Arcilla, PhD
Director

2 Soledad S. Castañeda, PhD
Deputy Director

3 Lucille V. Abad, PhD
Chief, Atomic Research Division

4 Preciosa Corazon B. Pabroa, PhD
Chief, Nuclear Services Division

5 Teofilo V. Leonin, Jr., MSc
Chief, Nuclear Regulatory Division

6 Ana Elena L. Conjares, MSc
Chief, Technology Diffusion Division

7 Graceta DL. Cuevas, DPA
Chief, Finance & Administrative Division

PNRI ORGANIZATIONAL CHART



Office of the Director

Office of the Deputy Director

• Planning Section

Atomic
Research
Division

- Agriculture Research Section
- Biomedical Research Section
- Health Physics Research Section
- Applied Physics Research Section
- Chemistry Research Section
- Nuclear Materials Research Section

Nuclear
Services
Division

- Nuclear Reactor Operation Section
- Engineering Services Section
- Irradiation Services Section
- Radiation Protection Services Section
- Nuclear Analytical Techniques Application Section
- Isotope Techniques Section

Nuclear
Regulatory
Division

- Regulations and Standards Development Section
- Licensing, Review and Evaluation Section
- Inspection and Enforcement Section
- Nuclear Safeguards and Security Section
- Radiological Impact Assessment Section

Technology
Diffusion
Division

- International Cooperation Section
- Nuclear Training Center
- Nuclear Information and Documentation Section
- Business Development Section
- Management Information System Section

Finance and
Administrative
Division

- Human Resource Management and Records and Communication Section
- Budget Section
- Accounting Section
- Property and Procurement Section
- Cash Section
- General Services Section





**2017 PNRI ANNUAL REPORT
EDITORIAL AND
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