

2018

ANNUAL REPORT



Department of Science and Technology
PHILIPPINE NUCLEAR RESEARCH INSTITUTE



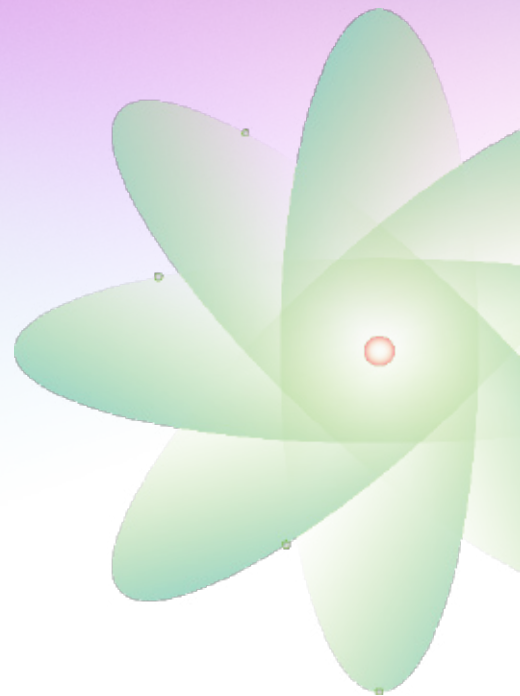
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PHILIPPINE NUCLEAR
RESEARCH INSTITUTE

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.

VISION

The PNRI is an institution of excellence - a provider of innovative and effective nuclear and radiation science and technology for national prosperity.

MISSION

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



DEPARTMENT OF SCIENCE AND TECHNOLOGY

Congratulations to the Philippine Nuclear Research Institute (PNRI) for another year of significant contribution in the sectors of food and agriculture, medicine, industry, natural resources management and environmental protection, bringing science closer to the people through its nuclear S&T projects and services.

This year has seen PNRI reap the harvest of its R&D. In agriculture, the Carrageenan Plant Growth Promoter has successfully completed its field trials, having increased the yield of rice in various regions nationwide. More importantly, this marvel of radiation processing is already commercialized, and will soon be available in the market for purchase.

With the general public's renewed interest in health and environmental concerns, PNRI's medical applications, such as the Technetium-99m generator and novel radiation-processed medical products are commendable. PNRI's analytical techniques also proved versatile in managing natural resources and in addressing environmental problems such as air and water pollution.

We also recognize PNRI's contributions to the industrial and commercial sectors through its nuclear and allied services. PNRI's tried and tested radiation processing facilities are set to be upgraded in the near future, thus improving the quality of Filipino products, especially those for export purposes.

I congratulate the scientists and researchers of PNRI for making these accomplishments possible. These brilliant civil servants have once again earned the highest number of publications among DOST agencies this year, with 19 publications under its belt garnering the DOST International Publication Awards.

Beyond R&D, PNRI is also set to break ground with regard to the national nuclear legal and regulatory framework. With the Comprehensive Nuclear Regulations Act moving forward in the House of Representatives and the Senate, the Philippines will soon see the establishment of a unified independent regulatory body for ionizing radiation sources. In the meantime, PNRI regulators remain faithful to their mandate to ensure the safe and peaceful uses of nuclear and radioactive materials.

With these accomplishments, I am confident that PNRI will keep paving the way towards more contributions to national development through nuclear R&D.

Congratulations and Mabuhay!


FORTUNATO T. DE LA PEÑA
Secretary



PHILIPPINE NUCLEAR RESEARCH INSTITUTE



It is my pleasure to bring you the Institute's achievements for 2018. PNRI has defined this year by expanding its nuclear and radiation applications, sustaining the gains of successful projects and reaching landmarks in the national nuclear legal and regulatory field.

In particular, PNRI looks forward to the establishment of an independent nuclear regulatory body as it continues to push for the passage of the Comprehensive Nuclear Regulations Act, which has passed third reading in the House of Representatives, and is in the second reading in the Senate. This is especially relevant given the renewed consideration given by the government towards a coherent nuclear policy.

Leading the pack among our research projects is our radiation-processed Carrageenan Plant Growth Promoter. Beyond its entry to the market for our rice farmers, its recent testing on other crops such as mungbean, peanut and corn also showed great potential. PNRI is also developing new mutant varieties and improving the efficiency of our farmers in terms of soil, nutrient and water use efficiency.

The need for nuclear medicine and other contributions to public health cannot be overstated. Our newly found partnership with ROSATOM in Russia allowed PNRI to restart its production of Technetium-99m, which is the most commonly used radioisotope for diagnostic purposes.

Another welcome development will be the impending upgrade of our Cobalt-60 Multipurpose Irradiation Facility, especially for our clients from the commercial and industrial sectors which yearly reap the benefits of radiation processing to improve the quality of their products.

We also aim to address problems such as dengue and red tide through applications such as the sterile insect technique and receptor binding assay, respectively, as well as to ensure the safety of food and other products through irradiation and isotope analytical techniques.

Faced with current water crisis, PNRI has also expanded its analytical applications for water, environment and natural resources. These include studies on air and water pollution, soil erosion, groundwater resources and disaster-borne water contamination.

We owe all of these to the men and women of PNRI, who serve as the backbone of our projects, services and regulations. Our scientists and researchers have again proven themselves in the DOST International Publication Awards, where PNRI earned 19 IPA awards, the most among its fellow agencies.

We are also expanding nuclear science and technology among the youth through various collaborations with the International Atomic Energy Agency, the Department of Education and the Philippine Science High School in educating secondary schools through the Nuclear Science and Technology Education Program (NSTEP).

These accomplishments and more are reflected in this 2018 Annual Report. We pledge to continue doing more to contribute to national progress.

Again, thank you very much, and Mabuhay!

C.A.A.
CARLO A. ARCILLA
Director

HIGHLIGHTS OF ACCOMPLISHMENTS

The Department of Science and Technology – Philippine Nuclear Research Institute (DOST-PNRI) once again spearheaded the development of nuclear science and technology in the country through its research and development projects, nuclear and radiation-related services, technology diffusion, and nuclear regulatory activities.



GENERATION OF NEW KNOWLEDGE AND TECHNOLOGIES

FOOD AND AGRICULTURE

- Three putative mutant lines of adlai, a possible substitute for rice, were selected for 7th generation planting.
- Smart-farming methods for sugarcane determined optimum amount of nutrients for higher sugar yields, at 120 kg of nitrogen, 240 kg of phosphorous and 600 kg of potassium per hectare.
- Seven putative mutant varieties of sugarcane showed 26% increase in cane diameter and 70% increase of tillers.
- Carrageenan Plant Growth Promoter (PGP) increased yield by as high as 345% in mungbean and 61% in peanut during field testing for these crops.
- Around 350,000 liters of Carrageenan PGP were distributed for multilocation trials, covering 35,000 hectares in seven regions.

HEALTH AND MEDICINE

- PNRI restarted production of Technetium-99m generators with ROSATOM assistance.
- Mass rearing of mosquitos was improved for sterile insect technique against the dengue vector mosquito *Aedes aegypti*.
- PNRI researchers developed alginate-based wound dressing from stingless bee honey.

- Results of irradiating beef burger patties passed FDA standards. Irradiation prolonged shelf life of burger patties up to seven months.
- Bureau of Fisheries and Aquatic Resources has begun the incorporation of PNRI-developed Receptor Binding Assay for red tide monitoring procedures.
- PNRI used nuclear analytical techniques to verify the authenticity of vinegar and other condiments. Results for vinegar will form the basis of a proposed Vinegar Standards of the Philippines.

ENVIRONMENT PROTECTION AND MANAGEMENT

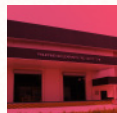
- Isotope analysis showed that the groundwater in Davao City is primarily recharged by rainwater and is not very vulnerable to contamination, while Pampanga River Basin showed rapid groundwater recharge in Angeles and Clark.
- Erosion studies in Pampanga River and Manila Bay were undertaken to mitigate soil erosion and reduce pollution.
- PNRI used nuclear techniques to analyze the contamination caused by Typhoon Yolanda in Tacloban City, Leyte.
- Real-time environmental radiation monitor stations were established in Samar, Aurora and Surigao Del Sur.

- Air pollution studies in Metro Manila and Boracay show that except for the fine air particulates in Boracay, the World Health Organization limit for coarse and fine air particulates has been exceeded in all stations.

HARNESSING EMERGING TECHNOLOGIES TO BOOST COMPETITIVENESS

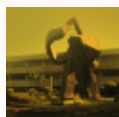
- PNRI researchers developed radiation-grafted materials to produce biodiesel.
- Radiation-grafted copolymers for recovering scandium, a rare-earth element, were developed.
- PNRI collaborated with Synchrotron Light Research Institute in Thailand in studies on radiation damage in allanite materials.
- The collaborative research project between DOST-PNRI and the University of the Philippines-Manila used a prototype system to study the sterilization effects of neutrons in *Escherichia coli* bacteria.
- The Institute developed radiation-processed super water absorbents for agricultural productivity.
- PNRI researchers developed and optimized the procedure for uranium extraction from phosphoric acid on a laboratory scale.
- Survey and characterization of heavy minerals (allanite and monazite), thorium, copper, molybdenum, rare earth elements, and other unconventional uranium resources were conducted.

- PNRI carried out activities in preparation for the re-operation of the Philippine Research Reactor-1 as a Subcritical Assembly for Training, Education and Research (SATER).



PROVISION OF QUALITY S & T SERVICES

- The customers served in the Cobalt-60 Multipurpose Irradiation Facility increased despite limitation in 24/7 operation.
- Around 427,500 liters of Carrageenan PGP were irradiated at the Electron Beam Irradiation Facility.
- PNRI-rendered radiation protection services to around 3,600 customers.
- The Institute maintained the operation of its Secondary Standards Dosimetry Laboratory and Radioactive Waste Management Center.
- The National Dose Registry for monitoring occupational exposure of radiation workers was developed.
- New facilities for radiation protection services such as the neutron dosimetry laboratory were completed.
- PNRI provided various nuclear-based analytical services to clients.
- The Institute analyzed samples from clients for microbiological testing and provided cytogenetic biodosimetry for monitoring radiation exposure of industrial radiographers.
- The cobalt-60 source for gamma column scanning service has been upgraded .
- Engineering services were provided for fabrication of nuclear equipment, instruments, and other materials.



ENSURING THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

- The Bill for the Comprehensive Nuclear Regulations Act was approved on third and final reading at the House of Representatives.
- PNRI updated Code of PNRI Regulations (CPR) Part 3 on radiation protection standards and CPR Part 5 for requirements for siting of nuclear installations.
- Consultative meetings for stakeholders for revisions of Code of PNRI Regulations were held.
- The Institute issued 423 licenses for radioactive materials.
- 187 regulatory inspections were conducted, and 14 Notices of Violation and 56 follow-up letters were issued to enforce nuclear regulations.
- IAEA conducted safeguards inspection of the Philippine Research Reactor - 1 and Bataan Nuclear Power Plant.
- Nuclear security collaborations were carried out with United States Department of Energy.
- The PNRI continued the maintenance of radiation portal monitors at Manila South Harbor.
- The Mobile Expert Support Team was deployed during the Feast of the Black Nazarene (Traslacion 2018).
- The Institute did assessment studies on occupational exposure doses of radiation workers.
- The National Radiological Emergency Preparedness and Response Plan (RADPLAN) was updated.



DIFFUSION OF KNOWLEDGE AND TECHNOLOGIES

- PNRI conducted 46 nuclear training courses for 843 participants.
- 113 students completed their on-the-job training at PNRI.
- 14 students were given assistance under the thesis/research advisorship program of the Institute.
- The PNRI conducted 34 nuclear awareness seminars and lectures to more than 1,000 individuals.
- PNRI developed 30 information, education and communication materials on nuclear technologies.
- The Institute prepared 45 press releases and coordinated/arranged 20 media interviews.
- The PNRI Facebook Page has garnered 32,062 likes, an increase of 232% from the previous year's number of likes.
- PNRI participated in 11 major S & T events, including the IAEA Ministerial Conference in Vienna, Austria.
- PNRI partnered with DepEd on teaching nuclear science to selected elementary and high school students in Quezon City through Project STRIVE (Science, Technology and Research for Innovative Ventures).
- The Institute negotiated 24 commercialization deals with private sector technology adopters.
- Several information systems and network/internet infrastructures were developed.



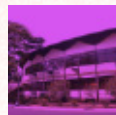
S & T LINKING

- International Atomic Energy Agency (IAEA) Director General Yukiya Amano visited the Philippines in February.
- PNRI received IAEA funding/ assistance for 10 Research Contracts and 30 Technical Cooperation Projects.
- There were 53 IAEA Experts/Mission delegates in 2018.
- The PNRI hosted seven regional meetings, seminars/ workshops and Regional Training Courses sponsored by the International Atomic Energy Agency.
- 101 PNRI staff and 92 non-PNRI personnel received training/ fellowship grants from foreign institutions/agencies.
- Senators and PNRI officials had a scientific visit to IAEA and European facilities; DOST and PNRI officials participated in the IAEA Ministerial Conference.
- Memoranda of Understanding were forged between (a) DOST-PNRI and the Department of Education and (b) DOST-PNRI and Philippine Science High School for IAEA Project on Nuclear Education in Secondary Schools.



FINANCIAL RESOURCES

- PNRI had a budget allotment of Php 344,897,000.00 by class and Php 143,525,000.00 by major final output.
- The Institute earned an annual income of Php 42,033,948.00.



HUMAN RESOURCE DEVELOPMENT

- There were 227 PNRI staff as of 2018.
- Four PNRI staff obtained their doctoral and masteral degrees in 2018 and eight staff pursued post graduate degrees through local/foreign scholarships.
- PNRI staff participated in 109 locally-sponsored trainings/seminars/ workshops in various fields.
- Scientists and technical staff of PNRI won three national awards for various achievements and three utility model awards for technologies and systems developed.
- PNRI garnered the highest number of DOST International Publication Awards, with 19 papers published in internationally-recognized journals.
- The PNRI Table Tennis Men's Division and Women's Division won 1st and 2nd Place respectively, at the Inter Government Agency Sports Festival.



SPECIAL S & T EVENTS

- A total of 170 participants attended the 4th Philippine Nuclear Youth Summit at PNRI.
- PNRI celebrated the 46th Atomic Energy Week with the theme "Science and Technology for the People: Innovation for Collective Prosperity"
- PNRI opened its 1st Nuclear Research and Development Conference with in-depth presentations by PNRI scientists and researchers on various fields.
- The 2018 Philippine Nuclear Science Quiz culminated with trophies and Php 150,000 cash prize to the finalists

GENERATION OF NEW KNOWLEDGE & TECHNOLOGIES

PNRI spearheads the development of nuclear and radiation applications, geared towards increasing agricultural and industrial productivity, improving healthcare, safeguarding the environment and ensuring nuclear safety.



NUCLEAR APPLICATIONS IN FOOD AND AGRICULTURE

ENHANCING AGRICULTURAL PRODUCTIVITY OF CROPS

To further develop new varieties and improve existing ones, the PNRI uses gamma radiation, mutation breeding and biotechnology on crops such as adlai (*Coix lacryma-jobi* L.) which may serve as a substitute for rice and corn.

This year, PNRI researchers selected three putative mutant lines of the adlai variety “Guinampay” for the seventh generation planting. The mutant lines were selected based on yield, number of tillers, earliness to maturity, and number of sterile seeds per panicle. Results of data analysis from the seventh generation planting will serve as basis for selecting the pure line of adlai for registration to the National Seed Industry Council.



Guinampay variety of adlai

ENHANCING AGRICULTURAL PRODUCTIVITY IN SMART FARMING

Improving Nutrient Use Efficiency Through Enhanced Soil and Water Resources Research

The Bureau of Soils and Water Management (BSWM), in cooperation with PNRI, undertakes this project to improve nutrient use efficiencies of various agronomic crops.

In 2018, field trials were started in selected sites at Binalonan, Pangasinan for cassava, and in Bogo, Cebu for corn. The collection and laboratory analysis of soil and plant tissue samples are ongoing.



Collection of field data in Malingin, Bogo, Cebu City for nutrient use efficiency study in corn



Sugarcane field trials conducted in Floridablanca, Pampanga



Seven-month-old canes of putative mutants (irradiated) showing increase in diameter as compared to the control (unirradiated)

Increasing Sugarcane Productivity Through Smart Farming-Based Efficient Nutrient Management

The PNRI is conducting a study to increase the utilization efficiency of crop nutrients, and reduce loss of soil nutrients and fertilizer application in sugarcane production using elemental tracer and related techniques.

Based on the crop agronomic response of new plant and ratooned sugarcane croppings, the optimal amount of the three major nutrients (nitrogen (N), phosphorous (P) and potassium (K)), that can achieve significantly higher sugar yield is around 120 kg N/ha, 240 kg P/ha and about 600 kg K/ha. In both croppings, about half of the applied fertilizer (N, P and K) were utilized by the crop.

Improving the Recommended Sugarcane Varieties Using Nuclear Technology and Biotechnology

With the increasing demand of sugarcane products for food and energy (bioethanol), the PNRI, in collaboration with the Sugar Regulatory Administration, is conducting mutation breeding studies on improving

selected varieties of the crop from different localities using gamma radiation.

This year, seven putative mutants were identified based on improved morphological characteristics of the irradiated crops as compared to the control (unirradiated) such as increased cane diameter up to 26% and increased number of tillers up to 70%. DNA markers are being designed for screening and confirmation of the observed traits.

Effects of Radiation-modified Carrageenan on the Growth and Yield of Mungbean and Peanut

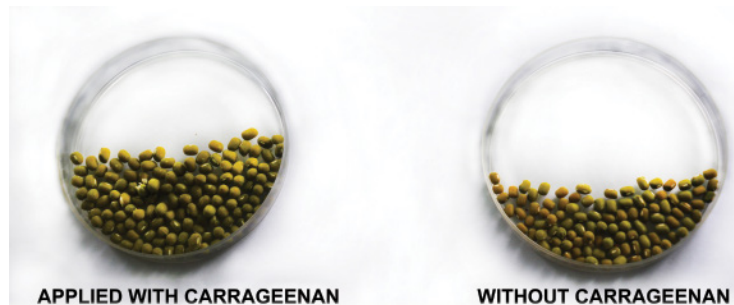
This project aims to increase yield and sustain the availability of quality seeds of mungbean (*Vigna radiata* [L.] R. Wilczek) and peanut (*Arachis hypogaea* [L.]) in major growing areas in Regions 2 (Cagayan Valley), 3 (Central Luzon), 7 (Central Visayas) and 10 (Northern Mindanao) using the PNRI-formulated plant growth promoter from radiation-modified carrageenan.

Results showed that the use of 100 ppm Carrageenan PGP as leaf spray for mungbean and peanut increased their yield by as high as 345% and 61%, respectively, especially when seeds were

treated with inoculants. These plants had an increase in herbage yield (biomass); number of effective nodules, roots and branches as well as an increase in size of leaves and change of color to darker green. Supplementing the farmer's practice with Carrageenan PGP increased the number of primings for mungbean from three to six times, thus prolonging the reproductive stage of the plants or harvest time. This is favorable to those who grow mungbean as a main crop.

Field Verification Testing of Carrageenan Plant Growth Promoter (PGP) for Enhanced Growth and Induced Pest and Disease Resistance

Through a joint project with DOST Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARD) and the Department of Agriculture, PNRI distributed 350,000 liters of Carrageenan PGP for the conduct of multi location trials in seven regions of the country, namely Regions 1 (Ilocos); 2 (Cagayan Valley);



Comparison of pods and seeds of mungbean with and without Carrageenan PGP treatment

3 (Central Luzon); 4A (CALABARZON); 6 (Western Visayas); 10 (Northern Mindanao); and 11 (Davao Region). The Carrageenan PGP is being applied in rice and corn for 2,500 hectares per region for enhanced growth and induced pest and disease resistance.



Participants of the Farmer's Field Day at the Department of Agriculture - Northern Mindanao Agricultural Crops and Livestock Research Complex visit the experimental site of peanut plants applied with Carrageenan PGP.

NUCLEAR APPLICATIONS IN HEALTH AND MEDICINE



Rearing of dengue mosquito vector (*Aedes aegypti*) in the PNRI entomology laboratory for development of sterile insect technique against this pest

STERILE INSECT TECHNIQUE FOR DENGUE MOSQUITO VECTOR USING GAMMA IRRADIATION

The ability to mass-rear quality and competitive dengue mosquitos in the laboratory is very important in the development of sterile insect technique (SIT) against this pest. Hence, the rearing protocol for enhanced quality and competitiveness of the dengue mosquito, *Aedes aegypti*, has been improved. The improvements include the development of locally available food for larvae, blood feed for adults, egg hatching optimization,

and maintenance of right temperature and humidity for rearing dengue mosquitos.

Population trends of dengue mosquito vector in two selected sites (one each for control and treated) in Quezon City has been continuously monitored including the fertility of the mosquito, proportion of each specie and adult male to female ratio.

DEVELOPING NOVEL BIO-BASED MATERIALS FOR MEDICAL APPLICATIONS

PNRI developed an alginate-based wound dressing containing stingless bee honey as its active ingredient. The stingless bee honey was chosen because of its superior physico-chemical and antimicrobial activity compared to other local honeys and with the New Zealand Manuka honey.

Preliminary results showed that a 25 kGy electron beam irradiation dose was sufficient to remove any traces of microbial contamination without any

significant effect on the antimicrobial property of the honey and the physical properties of the dressing.





Finished Tc-99m generator products ready for quality control testing

DEVELOPMENT OF TECHNETIUM-99M RADIOPHARMACEUTICALS

The Institute continued to establish the national capacity to manufacture radiopharmaceutical kits for technetium-99 (Tc-99m) labeling in support of the eventual distribution of this most widely used diagnostic radioisotope in the country.

As part of this project, PNRI researchers conducted two production runs of the

Tc-99m facility using molybdenum-99 (Mo-99) provided by ROSATOM, Russia. These were conducted to assess the quality of the Mo-99 source as raw starting material for the preparation of Mo-99/Tc-99m generators as well as to restart the production process and initiate distribution activities of this medical radioisotope.

FOOD IRRADIATION TECHNOLOGY FOR ENHANCING FOOD SAFETY

Reducing Microbial Load in Beef Burger Patties Using Electron Beam Irradiation

Exposure of frozen, vacuum-packed burger patties to 2 kGy dose significantly reduced microbial load to acceptable level, up to the seventh month of storage. Sensorial attributes of the patties were also maintained throughout the six months of storage. Exposure to 6 kGy resulted to total elimination of aerobic bacteria, fungal pathogens and coliforms.

The results obtained are comparable with the acceptable limit of aerobic plate count in heat-treated meat patties, which is 10^4 cfu/g, and coliform counts of 10 cfu/g, based on the Food and Drugs Circular 2013. The results are also within the

recommended dose limits of 1 to 7 kGy, based on the Philippine National Standard on Code of Hygienic Practice for Radiation Processing of Food.



Preparation of burger patties for electron-beam irradiation

Health Applications of Cytogenetic Biological Dosimetry

A study is being done to investigate the sensitivity of cancer patients to gamma radiation treatment using cytogenetic assays and gene characterization of small amount of blood samples. The assay involves sample collection from healthy individual donors, irradiation at 2 Gy dose and gene characterization of the irradiated

blood samples. The genetic difference determines the individual's reaction to the treatment.

The information obtained from the study may assist physicians in the delivery of a more suitable radiation dose that will efficiently kill cancer cells but with less adverse effects on the healthy cells. The results will also serve as baseline for comparison to the data obtained from cancer patients.

NUCLEAR ANALYTICAL TECHNIQUES IN HARMFUL ALGAL BLOOMS



A PNRI researcher performing receptor binding assay on several samples

Single Laboratory Validation of Receptor Binding Assay for Ciguatoxin

Researchers have validated the use of a standardized method of receptor binding assay (RBA) for quantification of different harmful algal toxins such as ciguatoxin and saxitoxin (STX). The validation procedure was based on the performance quality of the assay, precision, accuracy through recovery, sample toxicity and robustness.

As a result of the procedure, the use of RBA had been adapted for related marine research applications and seafood routine monitoring. Furthermore, the Bureau of Fisheries and Aquatic Resources (BFAR) had initiated the incorporation of STX-RBA in their monitoring program to ensure seafood safety.

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

This project aims to locally produce reference materials (RMs) for HAB to supply the needs of research laboratories and/or agencies in developing more sensitive, reliable and appropriate methods for marine toxin determinations.

As part of the study, researchers used optimized high-pressure liquid chromatography (HPLC) for paralytic shellfish toxin (PST) determination. Results showed that the method provided a good estimate for toxicity levels based on the saxitoxin peak, the most toxic form of “red tide” toxin. Future studies will deal with other forms of the red tide toxins.



The microplate liquid scintillation counter for receptor binding assay

RELATED NUCLEAR-BASED APPLICATIONS

Authentication of Condiments Using Nuclear Analytical Techniques

The PNRI uses isotope analytical techniques to verify the authenticity of condiments. Radiocarbon assay, more popularly known as carbon-14 liquid scintillation counting, detects petroleum-derived or synthetic acetic acid and is used to differentiate adulterated vinegar and ketchup with synthetic acid from natural samples (plant-derived). Researchers are also developing methods for authenticating soy sauce and fish sauce using isotope ratio mass spectrometry, particularly with the carbon-13 and nitrogen-15 values.

The data obtained will be useful for implementing future regulations to safeguard the quality of condiments. As of 2018, PNRI has tested more than 300 vinegar brands sampled from major supermarkets all over the Philippines. From these samples, seven out of ten brands showed adulteration and or misrepresentation with synthetic acid. Results of the study are being proposed as basis for formulation of the Vinegar Standards of the Philippines.



Preparation and analysis of vinegar samples using a liquid scintillation counter

Honey Adulteration Testing and Finger Printing Using Stable Isotope Analysis



(Left) Honey samples gathered for the study
(Right) Beehives where artisanal honey is collected

This study aims to: (1) investigate the extent of fraud in Philippine honey by comparing the isotopic ratio of carbon-13 to carbon-12 of the bulk honey with its protein and (2) to establish the various isotopic signatures of Philippine honey from different sources via isotope ratio mass spectrometry for origin identification. To date, 13 artisanal (pure) honey samples from several regions and 42 commercial honey samples have been gathered for the study. It is believed that Philippine honey has great potential to be competitive with honey from other countries, with appropriate safeguards from adulteration and mislabeling.

Shabu Profile Mapping Using Nuclear and Isotope-based Analysis

As part of the government's unrelenting war on drugs, the Philippine Drug Enforcement Agency (PDEA) is tapping the expertise of PNRI in nuclear and isotope-based analytical techniques to analyze samples for the profile mapping of the prohibited drug methamphetamine hydrochloride, colloquially known as shabu. The samples are to be subjected to stable isotope and multi-elemental profiling using isotope ratio mass spectrometry and X-ray fluorescence.

NUCLEAR ISOTOPE TECHNIQUES APPLICATIONS IN ENVIRONMENTAL PROTECTION AND MANAGEMENT

ISOTOPE AND RELATED TECHNIQUES FOR GROUNDWATER STUDY

Davao City is experiencing rapid urbanization and economic development which makes it one of the nine critical areas for water resource availability. A previous PNRI study on Davao City groundwater resources that applies

isotope and chemical techniques conducted from 1998 to 2002 showed that the groundwater in Davao City is recharged primarily from infiltration of precipitation. The groundwater has an age of more than 50 years and therefore is not very vulnerable to contamination.

In 2018, after nearly two decades, PNRI researchers conducted a resampling of groundwater samples for the Davao City basin which covered Talomo – Lipadas Sibulan System (TLSS) and the Davao – Bunawan – Lasang System (DBLS) by installing rain water collectors in selected sites in the city. Initial results showed that groundwater dynamics have not drastically changed; the groundwater system in the study area is still in steady state condition; and that any effects brought by climate change, land use change, population growth and industrialization are delayed.



Analysis of groundwater samples using isotope ratio mass spectrometry

NUCLEAR ANALYTICAL TECHNIQUES IN MARINE ENVIRONMENT

Assessing Soil Erosion in Selected Sub-Basin of Manila Bay Using Conventional and Isotope Techniques

PNRI researchers continued to use isotopic techniques (stable carbon and nitrogen isotopes) as soil erosion indicators in various land areas in Barangay Buted, Talutog in Nueva Ecija, a province with rivers that drain into the Pampanga River and later into the Manila Bay. The isotopic value (carbon and nitrogen) of cultivated soils differ

from grassland soils and such variations can help differentiate its respective origin and history.

The future findings of this study can help determine the sources of pollution so that the concerned government agencies, non-government organizations, land and water managers, environmental planners, and decision makers could develop/craft appropriate soil and water conservation measures, steps and technologies in mitigating soil erosion and reducing pollution from various sources.

Assessing Groundwater System in Pampanga River Basin, Central Luzon, Philippines

The cities of Angeles and Clark in the Pampanga River Basin are among the groundwater critical areas in the country identified by the National Water Resources Board (NWRB). For better management of these water resources, the PNRI carries out hydrological studies for quantitative water assessment using isotope techniques.

In 2018, PNRI completed all the water stable isotopes and tritium measurements for Angeles and Clark Field. Results showed that the combined data from water chemistry and stable isotopes suggest a relatively rapid groundwater recharge process. A semi-quantitative groundwater age-dating done on some parts of the watershed with measureable tritium indicated that the groundwater age with a tritium range of about 0.4 to 1.2 TU is between 4 to 25 years. PNRI is now working towards the modelling of groundwater recharge dynamics in the area.

Applying Nuclear Techniques in the Attenuation and Natural Disaster-Borne Contamination

PNRI, with the support from the International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations, helped assess the changes in circulation, dynamics and quality of groundwater in Tacloban City and to evaluate and monitor the natural attenuation of the pollution brought about by Typhoon Haiyan/Yolanda.

In Marine Environment - Increased levels of nutrients in the aquatic environment cause eutrophication of coastal waters. For the purpose of monitoring coastal waters, researchers used classical or traditional approaches in conjunction with isotope techniques to obtain information about the current status or condition of that particular area. Employing stable isotope techniques as an additional monitoring method expounded environmental data by giving possible pollution sources, which may be used for pollution source management.



PNRI researchers collect samples to assess quality of groundwater in Tacloban City

In Fresh Water Resources - A total of 32 monitoring stations were set up and used for both conventional and nuclear techniques in the characterization of these resources. Results of PNRI's studies showed that the city's groundwater, sodium chloride and nitrate did not exceed the limit set by the Philippine Standards for Drinking Water. Thus, seawater did not enter the aquifer and the biological/biomass contamination are being naturally decontaminated. These potential contaminants probably decayed before they could get to the groundwater.

It was also found that the isotopic composition of the water in the aquifer is close to that of today's rainwater – which means that the city's water supply was not in danger of disappearing. However, the wells in the relocation site of more than 2,000 people were unfit for drinking, with spikes of arsenic and other pollutants. A database for these hydrological data is now available.

Assessing the Levels, Distribution and Effects of Natural and Anthropogenic Radionuclides in the Philippine Marine Environment

This project aims to provide awareness on the status of the marine environment in the event of a nuclear emergency and to assess the potential impact of radioactive releases from nuclear facilities in the Asia-Pacific region.

This year, samples of surface seawater, sediment and biota were collected from three strategic coastal areas in Baler, Aurora Province, Batanes Island and Bohol Sea (Camiguin Island). The samples were analyzed for natural (potassium-40, radium-226 and thorium-232) and anthropogenic radionuclides (cesium-134 and cesium-137) by gamma spectrometry using a High-Purity Germanium detector.



A PNRI researcher using a High-Purity Germanium (HPGe) detector for analysis of marine samples

Data generated from these monitoring activities will serve as inputs to the regional and global assessment of radioactivity in the marine environment as well as in the development of the first marine radioactivity map of the concentrations of natural and artificial radionuclides in marine coastal waters in the Philippines.

MONITORING AND EVALUATION OF RADIATION DOSE RATE LEVELS IN THE PHILIPPINES

The Health Physics Research Section (HPRS) conducts regular monitoring of ambient gamma radiation levels in 28 monitoring sites in PNRI grounds and perimeter as well as in Metro Manila and other provinces to assess the levels of radioactivity for the protection of workers, the general public.

Results of the radiation measurements within PNRI grounds and perimeter is 47 ± 3 nanosieverts per hour (nSv h⁻¹) while on selected locations within Metro Manila is 41 ± 4 nSv h⁻¹. These values are within the background radiation level at 70 nSv h⁻¹ with values ranging from 24 – 85 nSv h⁻¹. The radioactivity data obtained from environmental monitoring will serve as baseline for future studies on anomalous increase of radioactivity in the environment as well as an essential tool in monitoring radioactive discharges resulting from nuclear accidents that could possibly affect the Philippines in the future.



Ambient gamma monitoring by PNRI researchers using (inset) portable gamma spectrometer

ESTABLISHING REAL-TIME RADIATION MONITORING SYSTEM

To help ensure the protection and safety of the public, PNRI is establishing the System for Online Monitoring of Environmental Radiation (SOMER) throughout the Philippines for real-time monitoring and detection of radiation emergencies.

To fill the gap and further expand the coverage for monitoring the eastern portion of the Philippines, three additional automated radiation monitoring stations were installed in the following locations: (1) Guiuan, Eastern Samar; (2) Baler, Aurora; and (3) Hinatuan, Surigao Del Sur. As of 2018, there are eight stations installed in the country. Five stations were previously installed in the following: (1) PNRI, Quezon City;

(2) Aparri, Cagayan; (3) Puerto Princesa City, Palawan; (4) Lapu-lapu City, Cebu; and (5) Davao City.



The real-time environmental monitoring system being established by PNRI in several regions (inset) Web-based software for accessing the real-time monitoring data

RADIOLOGICAL ASSESSMENT OF NORMS/TENORMS IN INDUSTRIAL FACILITIES IN THE PHILIPPINES

For the protection of workers, public and the environment, the PNRI Health Physics researchers conducted gamma



Collection of bottom ash sample at Sual Coal Plant for analysis of naturally-occurring radioactive materials

dose rate measurements of naturally occurring radioactive materials (NORM) and technologically-enhanced NORM in different samples (such as coal, bottom ash, fly ash, gypsum and sludge, soil) collected inside the Sual coal-fired Power Plant in Pangasinan. Results showed that the activity concentrations of natural radionuclides radium-226, thorium-232 and potassium-40 were below the limits set by the International Atomic Energy Agency Basic Safety Standards. Moreover, the dose rates were within the normal background of 24 to 125 nSv/h in the entire country.

Radiological surveillance was also conducted in San Vicente, Palawan which has a high natural radiation background due to the presence of rare earths and thorium-containing mineral allanite. Ambient gamma dose rates measured ranged from 60-810 nSv/h which shows higher dose rates than the normal background of 24 to 125 nSv/h (Philippine range). Further investigations will be done to assess its health impact to residents.

DETERMINING RADON LEVELS IN THE PHILIPPINES AND ITS IMPACT TO HUMAN HEALTH

This year, radon measurements were performed in samples of building materials with known elevated radon concentrations, including cement, sand and phosphogypsum - a naturally-occurring radioactive material (NORM). The measurements were done using a technique that involved exposure of the samples for about two to three weeks to a polyethylene bottle equipped with passive alpha track CR39 film.

The result obtained showed that radon exhalation rate of the cement and sand samples was very much below the values observed in phosphogypsum. Mixing/diluting samples of technologically-enhanced NORM and sand/cement were also analyzed. Results showed that the radon activity concentration and radon exhalation rate were lowered to about two to five times from their original radon activity concentration.

ASSESSING TEMPORAL VARIATIONS OF AIR PARTICULATE RADIONUCLIDES THROUGH THE CTBTO MONITORING STATION

PNRI works on establishing the background radiation levels in the environment through its Radionuclide Monitoring Station (PHP52) of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) installed in Tanay, Rizal. This is aimed at generating baseline data for the analysis of atmospheric processes and evaluation of background radioactivity in the Philippines.

In 2018, the PHP52 monitoring station underwent major improvements which allowed PNRI to fulfill its roles and responsibilities in the detection of nuclear weapons testing as signatory of the Comprehensive Nuclear Test Ban Treaty (CTBT) and its commitment to ASEAN's Southeast Asia Nuclear Weapon-Free Zone (SEANWFZ), also known as the Bangkok Treaty. These improvements also enabled PNRI to continuously keep high quality station data available, through CTBTO's International Data Centre (IDC), for various civil and scientific applications.

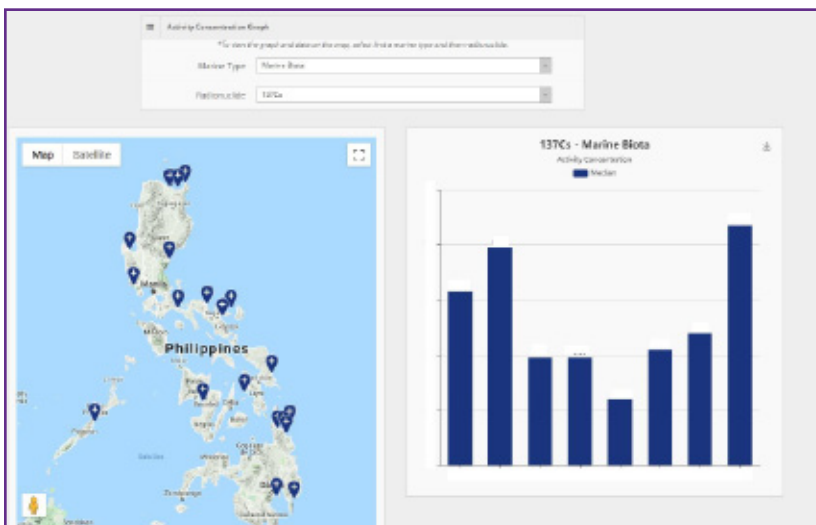


Improvement and maintenance of the CTBTO station for transmitting data to the CTBTO International Data Center

MANAGEMENT OF ASIA-PACIFIC MARINE RADIOACTIVITY DATABASE (ASPAMARD)

For the first time, the Philippine marine radioactivity data were uploaded in the ASPAMARD using the online data submission program developed by PNRI. Other participating countries were encouraged to submit data using the on-line submission.

Data on concentration of radionuclides such as cesium-134, cesium-137, potassium-40, thorium-230, and radium-226 in seawater, sediment and biota in the Philippines from 2016 are now available and can be viewed by registered users using the link: aspamard.pnri.dost.gov.ph.



Data on marine environmental radioactivity stored in the ASPAMARD program developed by PNRI

SCREENING FOR RADIONUCLIDE CONTAMINATION FROM THE FUKUSHIMA ACCIDENT BY IODINE-129 MEASUREMENT IN CORALS



(Top photo) Coral sampling using a hydraulic drill
(Middle) Actual image and (Bottom) X-ray image of collected coral cores from Baler, Aurora Province

Following the Fukushima Daiichi Nuclear Power Plant accident in 2011, PNRI researchers started a study on evaluating the transport of radionuclide contamination from Japan via the Kuroshio Recirculation Gyre by analyzing iodine-129 in coral cores from the Philippines. Coral cores are capable of recording radiological impact every year of the past 100 years or more.

This year, the research group has obtained *Porites* coral cores off the coast of Baler, Aurora Province - one of the project sites. PNRI also conducted initial briefings for the Baler Municipal and Aurora Provincial government regarding the project.

NUCLEAR ANALYTICAL TECHNIQUES FOR BETTER AIR QUALITY MANAGEMENT



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

PNRI researchers continued to study the composition and origin of air pollutants using nuclear and isotope-based analytical techniques. Two monitoring stations remained in Metro Manila, particularly in Valenzuela City and at the North Harbor area in Manila. Meanwhile, the newly-established station in Boracay Island last 2017 was supplemented by an additional station in Batan, Aklan, due to the closure of Boracay to tourists.

Results showed that the air in Valenzuela and Boracay mostly exceeded the World Health Organization (WHO) yearly limit for coarse particulates. Data in the Valenzuela station also exceeded the WHO limit for fine particulates, but the reading at Boracay showed that the fine particulates in the area have not yet reached the WHO limit.

HARNESSING EMERGING TECHNOLOGIES TO BOOST COMPETITIVENESS

PREPARATION OF RADIATION-GRAFTED MATERIALS FOR BIODIESEL PRODUCTION

PNRI researchers prepared radiation grafted materials, which could be utilized as catalyst in the production of biodiesel, through gamma radiation-induced graft polymerization. The grafted material has several merits over the traditional catalyst used in biodiesel production. It is less corrosive than homogeneous alkali catalysts, does not produce soap, and can be easily removed from the reaction mixture, thereby reducing the steps needed for neutralization and washing. With these advantages, the grafted catalyst may be able to simplify and streamline the biodiesel production process and reduce the waste product during production of biodiesel.



PNRI Chemistry Research Section researchers preparing the functionalization step of biodiesel heterogeneous catalyst synthesis

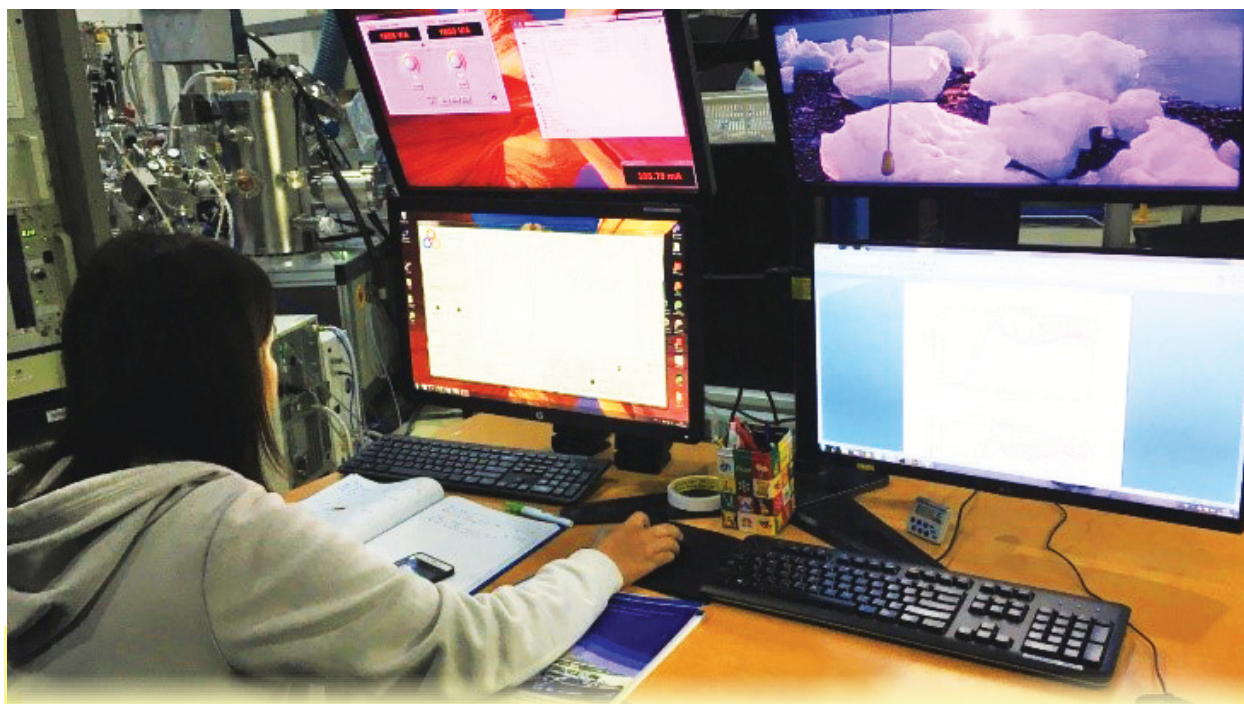
APPLICATIONS OF RADIATION-GRAFTED COPOLYMERS IN THE RECOVERY OF SCANDIUM

This project aims to develop adsorbents for recovery of scandium in nickel ores. Scandium is a valuable metal which is used in fuel cell, electronics, aerospace and lighting applications. The recovery process involves the use of polypropylene-based adsorbents modified through radiation grafting. Among the synthesized grafted adsorbents studied, PNRI researchers found that phosphorus containing graft copolymer has promising potential in scandium recovery.



PNRI chemist preparing the radiation-grafted adsorbent for recovery of scandium

CHARACTERIZATION OF RADIATION DAMAGE IN ALLANITE MINERAL USING NUCLEAR AND OTHER RELATED SPECTROSCOPIC TECHNIQUES



PNRI data on radiation damage of allanite mineral being analyzed at the BL5.2 SUT-NANOTEC XAS Beamline Control Area of the Synchrotron Light Research Institute in Nakhon Ratchasima, Thailand

To investigate the correlation of radiation damage with the oxidation states of iron present in allanite minerals, PNRI collaborated with the Synchrotron Light Research Institute in Thailand on a project for using the X-ray Absorption

Spectroscopy (XAS) technique. The first beamline experiment was conducted at the SUTNANOTEC XAS beamline in SLRI headed by Dr. Pinit Kidkhunthod.

CAPACITY BUILDING IN THE USE AND OPERATION OF SMALL NEUTRON SOURCES

The renewal of the Memorandum of Agreement (MOA) between DOST-PNRI and the University of the Philippines – Manila (UP-Manila) in 2018 has led to research collaboration between the PNRI Applied Physics Research Section and the Department of Physical Sciences and Mathematics of the College of Arts and Science in UP-Manila. The collaborative research involved the use of a prototype

irradiation system to investigate the sterilization effects of neutrons in *Escherichia coli* bacteria. The results showed that neutrons can kill or sterilize a certain percentage of the bacteria and that to reach a 99% sterilization, a stronger neutron source is needed to investigate the sterilization effects.

DEVELOPING RADIATION-PROCESSED SUPER WATER ABSORBENTS FOR AGRICULTURAL APPLICATIONS

Researchers used radiation to develop biodegradable super water absorbents (SWA) which are cross-linked polymers that can absorb and retain large amounts of water. This environment-friendly technology could help farmers increase their productivity by increasing water

holding capacity of soil, minimizing water use and enhancing plant growth. From the synthesis and physico-chemical characterization of the SWA based on cassava starch and acrylic acid, two formulations were found to be superior than the commercial Thai SWA.

ENHANCING OF RADIATION PROCESSED MATERIALS THROUGH BASIC RESEARCH

Carboxymethyl hyaluronic acid (CMHA) hydrogel crosslinked by radiation is an ideal biocompatible material that can be used in tissue regeneration and medicine. Radiation crosslinking of CMHA in a highly concentrated solution or paste-like state was found efficient at a

high degree of substitution (DS). In studying the optimization of CMHA synthesis, researchers obtained a medium substituted CMHA with a DS of 0.72. Future CMHA studies will include optimizing crosslinking parameters and biocompatibility.

RESEARCH AND DEVELOPMENT ON NUCLEAR MATERIALS

DEVELOPING URANIUM EXTRACTION TECHNOLOGY FROM WET PHOSPHORIC ACID

In phosphate fertilizer production, uranium from phosphate rock raw materials goes to the final fertilizer products. Laboratory analysis showed that produced nitrogen, phosphorous and potassium (NPK) fertilizers contain 26 to 228 ppm of uranium.

In 2018, PNRI researchers developed and optimized the operating procedure for the extraction of uranium from phosphoric acid on a laboratory scale. Results will be used to engineer an upscaled continuous extraction system leading to sustainable uranium production in the country.



Pretreatment of raw phosphoric acid for uranium extraction

CHARACTERIZATION AND SEPARATION OF HEAVY MINERALS IN THE ALLUVIAL AND BEACH SANDS

Allanite and monazite are naturally occurring radioactive minerals and are sources of rare earth elements (REE). These are the major contributors in increased background radiation in the beach and estuarine areas in Barangay Erawan and Barangay Ombo in San Vicente, Palawan. Laboratory results showed that the beach sands contain elevated concentrations of thorium (up to 345 ppm), and REE content of up to 5,889 ppm.

In a field survey, some areas in Erawan and Ombo were identified to have high background radiation which could result to radiation exposure exceeding the 1 mSv/year dose limit for the public. Through this project, the PNRI

demonstrated the removal of these minerals from the beach sand and advised the local government units in Palawan to avoid certain areas.



PNRI researchers presenting the results of the study on characterization and separation of heavy minerals in beach sands to local government units, DOST-Provincial Science and Technology Center and other sectors in Palawan.

EVALUATION AND CHARACTERIZATION OF URANIUM RESOURCES



Measurement of uranium concentration using an RS-330 gamma spectrometer (inset) for use in characterization of natural resources

The PNRI started a study on the characterization of unconventional uranium resources in the country, which include phosphates, heavy minerals, black sand deposits, industrial by-products, and mine tailings. This is aimed at generating basic data on the availability and characteristics of these minerals for which the information can be used by the mining and mineral resource sector to determine the added values in such resources. The study also aims to determine possible sources of nuclear fuel in case the Philippines decides to incorporate nuclear power in the energy mix.

GEOCHEMICAL AND RADIOMETRIC CHARACTERIZATION OF THE COPPER-MOLYBDENUM-URANIUM OCCURRENCES

The PNRI has confirmed a new radiometric anomaly in Barangay Nakalaya, Larap, Paracale in Camarines Norte about 100 meters south from the first anomaly having 5 to 283 ppm uranium (U) and 1.2 to 2.7 ppm thorium (Th) in soil. High concentrations of uranium in rocks and soil with a range of 103 –283 ppm also gave relatively high concentrations of copper (843 – 3,429 ppm) and molybdenum (122 – 1,245 ppm). Geochemical analysis of rocks and soil samples taken in Barangay Nakalaya showed relatively high concentrations

of total light rare earth elements (LREE – lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium) from 59 to 1066 ppm in soil and 22 to 829 ppm in rock.

Advanced exploratory work is needed to study possible extension of depth as well as to determine the nature of uranium mineralization. The data gathered from the project will enrich the world uranium and thorium deposits databases and provide valuable inputs for its sustainable development.

TRACING THE PATHWAYS OF MERCURY CONCENTRATION IN MINED-OUT AREAS

Due to reported mercury poisoning cases from two barangays in Puerto Princesa City in Palawan, a study tracking the mercury (Hg) concentration from an abandoned open-pit mercury mine is being undertaken by the PNRI Nuclear Materials Research Section. Researchers sampled sediments and analyzed surface water from the lake, nearby river systems

and the drainage bay using Manual Cold Vapor Atomic Absorption Spectroscopy (AAS). Partial results showed that two areas have high values of Hg relative to the accepted values for Hg as indicated in DAO 2016-08: leachate samples from Puerto Princesa City Sanitary Landfill and Honda Bay coastal water near the wharf.

RE-UTILIZATION OF NUCLEAR FACILITIES

PNRI is preparing to re-operate the Philippine Research Reactor-1 (PRR-1) as a Subcritical Assembly for Training, Education and Research (SATER). PRR-1 SATER will provide Filipinos with an access to an operating nuclear facility and will support the country's nuclear manpower development. In support of the SATER project, rehabilitation activities have commenced and safety analyses were conducted to demonstrate the safety of the planned re-operation of the facility. PNRI conducts ongoing research activities on neutron science and reactor physics to

support its mandate to conduct research and development activities in the field of nuclear science and technology.



The Philippine Research Reactor-1 building at the PNRI compound

LIST OF SCIENTIFIC PUBLICATIONS

PUBLICATIONS WHICH GARNERED THE 2018 INTERNATIONAL PUBLICATION AWARDS

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME/ TYPE OF JOURNAL	DATE PUBLISHED
Radiation-induced grafting of acrylic acid and glycidyl methacrylate onto abaca/polyester nonwoven fabric	Jordan F. Madrid, Patrick Jay E. Cabalar, Lucille V. Abad	Journal of Natural Fibers 15(5):625-638	October 2017
Hemostatic granules and dressing prepared from formulations of carboxymethyl cellulose, kappa-carrageenan and polyethylene oxide crosslinked by gamma radiation	Bin Jeremiah D. Barba, Charito T. Aranilla, Lorna S. Relleve, Veriza Rita C. Cruz, Jeanina Richelle M. Vista, Lucille V. Abad	Radiation Physics and Chemistry 144:180-188	August 2017
Semi-commercial scale production of Carrageenan Plant Growth Promoter by E-beam technology	Lucille V. Abad, Guiseppe Filam O. Dean, Gil L. Magsino, Rafael Miguel M. Dela Cruz, Mariel G. Tecson, Matt Ezekiel S. Abella, and Mark Gil S. Hizon	Radiation Physics and Chemistry 143:53-58	July 2017
Effects of chain transfer agent on the electron beam-induced graft polymerization of glycidyl methacrylate in emulsion phase	Jordan F. Madrid, Lucille V. Abad, Takeshi Yamanobe, Noriaki Seko	Colloid and Polymer Science 295(4):1007-1016	June 2017
RAFT-mediated graft polymerization of glycidyl methacrylate in emulsion from polyethylene/polypropylene initiated with γ -radiation	Jordan F. Madrid, Yuji Ueki, Lucille V. Abad, Takeshi Yamanobe, Noriaki Seko	Journal of Applied Polymer Science 134(36):45270	June 2017
Effect of gamma radiation on egg hatchability, adult survival and longevity of the mango pulp weevil, <i>Sternonchetus Frigidus</i> (Fabr.)	Glenda B. Obra, Sotero S. Resilva, Louella Rowena J. Lorenzana	Philippine Journal of Science 146(3): 299-303	September 2017
A coral $^{129}\text{I}/^{127}\text{I}$ measurement method using ICP-MS and AMS with carrier addition	Angel T. Bautista VII, Yasuto Miyake, Hiroyuki Matsuzaki, Fernando P. Siringan	Analytical Methods 9:5181-5188	August 2017
Data on preparation of psychrotolerant bacterium <i>Shewanella Olleyana</i> sp. Nov. cells for transmission electron microscopy	Chitho Feliciano and Windell Rivera	Data in Brief 9:710-175	December 2016
High dose irradiated food: Current progress, applications, and prospects	Chitho Feliciano	Radiation Physics and Chemistry 144:34-36	October 2017
Generating superimposed besell beams with a volume holographic axicon	Alvie J. Asuncion and Raphael A. Guerrero	Applied Optics 56(14):4206-4212	May 2017

LIST OF SCIENTIFIC PUBLICATIONS

PUBLICATIONS WHICH GARNERED THE 2018 INTERNATIONAL PUBLICATION AWARDS (Continuation)

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME/ TYPE OF JOURNAL	DATE PUBLISHED
Insecticidal activity of selected essential oil extract against common cutworm, <i>Spodoptera litura</i> Fabricus (Lepidoptera)	Abigaile Mia V. Javier, Virginia R. Ocampo, Flor A. Ceballo, Pio A. Javier	Philippine Journal of Science 146(3):247-256	September 2017
High-resolution ¹²⁹ I bomb peak profile in an ice core from SE-Dome site, Greenland	Angel T. Bautista VII, Yasuto Miyake, Hiroyuki Matsuzaki, Yoshinori Iizuka, Kazuho Horiuchi	Journal of Environmental Radioactivity 184-185:14-21	January 2018
Recovery of uranium from Philippine wet phosphoric acid using D2EH-PA-TOPO solvent extraction	Botvinnik L. Palattao, Jennyvi D. Ramirez, Estrellia U. Tabora, Editha A. Marcelo, Edmundo P. Vargas, Socorro P. Intoy, Reymar R. Diwa, Rolando Y. Reyes	Philippine Journal of Science 147(2):275-284	June 2018
Single step fabrication of polydimethylsiloxane microwell arrays with long-lasting hydrophilic inner surfaces	Bin Jeremiah D. Barba, Tomoko Gowa Oyama, Yuji Hosaka, Mitsumasa Taguchi	Applied Physics Letters 112(21):213704	May 2018
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	Arvin M. Jagonoy, Hirofumi Tsukada	Philippine Journal of Science 146(2):193-199	June 2017
Long-term bioavailability of redox nanoparticles effectively reduces organ dysfunctions and death in the whole-body irradiated mice	Chitho Feliciano, Yukio Nagasaki, Hiroyuki Kimura, Kenshi Suzuki, Koji Tsuboi	Biomaterials 129:68-82	March 2017
Oral nanotherapeutics: redox nanoparticles attenuate ultraviolet B radiation-induced skin inflammatory Disorders in <i>Kud: Hr</i> -Hairless Mice	Chitho Feliciano and Yukio Nagasaki	Biomaterials 142:162-170	July 2017
Development of a local Anesthetic of a local lidocaine-loaded redox-active injectable gel for post-operative pain management	Yukio Nagasaki, Yutaro Mizukoshi, Zenyu Gao, Chitho Feliciano, Kyungho Chang, Hiroshi Sekiyama, Hiroyuki Kimura	Acta Biomaterialia 57:127-135	April 2017
Shielding design of a target station and radiation dose level investigation of proton linac for a compact accelerator-driven neutron source applied at industrial sites	Baolong Ma, Yoshie Otake, Sheng Wang, Hideyuki Sunaga, Yutaka Yamagata, Atsushi Taketani, Huasi Hua, Qinggang Jia, Guang Hua and Unico Bautista	Applied Radiation and Isotopes 134:129-13	July 2018

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OTHER SCIENTIFIC PUBLICATIONS

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME/ TYPE OF JOURNAL	DATE PUBLISHED
On the sustainability and progress of energy neutral mineral processing	Reitsma F., Woods P., Fairclough M., Kim Y., Tulsidas H., Lopez L., Zheng Y., Hussein A., Brinkmann G., Haneklaus N., Kacham A.R., Sreenivas T., Sumaryanto A., Trinopiawan K., Al Khaledi N., Zahari A., El Yahyaoui A., Ahmad J., Reyes R., Kiegiel K., Abbes N., Mwalongo D., Greaves E.D.	Sustainability 10(1)	January 2018
Chemical constituents of <i>Hoya madulidii</i>	Borlagdan M., Aurigue F.B., Shen C.-C., Ragasa C.Y.	Chemistry of Natural Compounds 54(1):198-199	January 2018
The role of reactive iron in long-term carbon sequestration in mangrove sediments	Dicen, G.P., Navarrete, I.A., Rallos, R.V., Salmo, S.G., Garcia, M.C.A.	Journal of Soils and Sediments 19(1):501-510	June 2018
Insecticidal activities of essential oils from different plants against the cabbage worm, <i>Crociodolomia pavonana</i> Fabricius (Lepidoptera: Crambidae)	Javier, A.M.V., Ocampo, V.R., Ceballo, F.A., Javier, P.A.	Philippine Agricultural Scientist 101(2):158-166	June 2018
Life history and biological control potential of snellenius manilae ashmead (Hymenoptera: Braconidae), a parasitoid of <i>Spodoptera litura</i> Fabricius (Lepidoptera: Noctuidae)	Javier, A.M.V., Ceballo, F.A.	Philippine Agricultural Scientist 101(2):148-157	June 2018
Sedimentation tests of small scale gold mining wastewater	Samaniego, J.O., Tanchuling, M.A.N.	International Journal of Scientific and Technology Research 7(6):73-80	June 2018
Enhanced amination and adsorption performance of functional copolymer synthesized via RAFT-mediated radiation grafting in emulsion	Madrid, J.F., Ueki, Y., Abad, L.V., Yamanobe, T., Seko, N.	Journal of Polymer Research 25(2)	September 2018
Insecticidal activity of crude ethanolic extracts of five Philippine plants against cabbage worm, <i>Crociodolomia pavonana</i> Fabricius (Lepidoptera: Crambidae)	Javier, A.M.V., Ocampo, V.R., Ceballo, F.A., Javier, P.A.	Philippine Journal of Science 147(3):513-521	September 2018

LIST OF SCIENTIFIC PUBLICATIONS

OTHER SCIENTIFIC PUBLICATIONS (Continuation)

TITLE OF SCIENTIFIC PAPER	NAMES	PUBLICATION/NAME/ TYPE OF JOURNAL	DATE PUBLISHED
Physico-chemical characteristics of wastewater from a ball mill facility in small-scale gold mining area of Paracale, Camarines Norte, Philippines	Samaniego, J.O., Tanchuling, M.A.N.	Philippine Journal of Science 147(3):343-356	September 2018
Radiation crosslinking of carboxymethyl hyaluronic acid	Relleve, L.S., Gallardo, A.K.R., Abad, L.V.	Radiation Physics and Chemistry 151:211-216	October 2018
Synthesis and characterization of mordenite-type zeolites with varying Si/Al ratio	Gili, M.B.Z., Conato, M.T.	Materials Research Express 6(1)	October 2018
A radioligand receptor binding assay for ciguatoxin monitoring in environmental samples: method development and determination of quality control criteria	Díaz-Asencio, L., Clausing, R.J., Rañada, M.L., Alonso-Hernández, C.M., Dechraoui Bottein, M.-Y.	Journal of Environmental Radioactivity 192:289-294	December 2018
Effect of radiation-modified kappa-carrageenan as plant growth promoter on peanut (<i>Arachis hypogaea</i> L.)	Abad, L.V., Aurigue, F.B., Montefalcon, D.R.V., Mangiat, P.H., Carandang, F.F., Mabborang, S.A., Hizon, M.G.S., Abella, M.E.S.	Radiation Physics and Chemistry 153:239-244	December 2018
Organogenic Potential of <i>Dendrobium</i> Floral Tissues for Stable Transformation Applications	J.R. Sahagun, A. Kongbangkerd and K. Ratanasut	Philippine Journal of Science 147(4):667-676	December 2018



PROVISION OF QUALITY S & T SERVICES

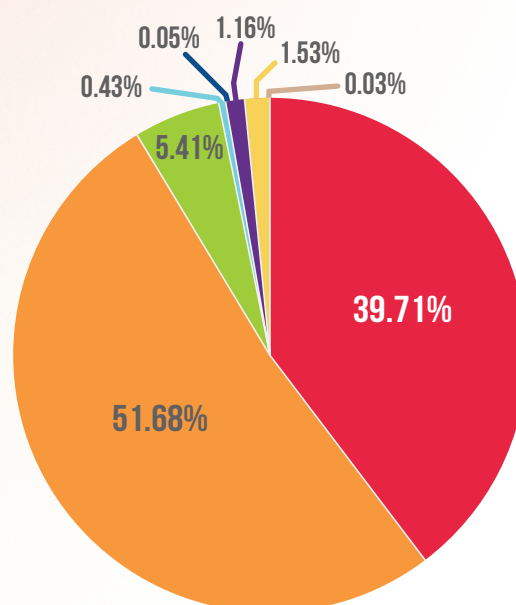
Maximizing the unique advantages of nuclear and radiation applications compared to conventional methods, PNRI offers its wide range of services to customers from various sectors, such as the processing of commercial and industrial products, sample analysis, and radiation protection, among others.

PHILIPPINE NUCLEAR RESEARCH INSTITUTE



IRRADIATION SERVICES

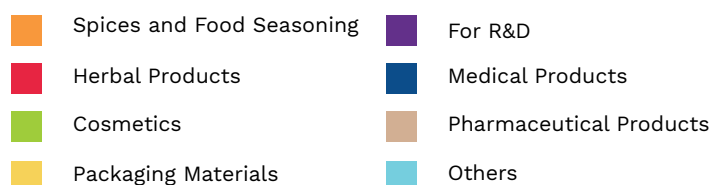
Clients from industry, academe and research sectors availed of PNRI's gamma and electron beam irradiation services for the following purposes: (1) to decontaminate or reduce microbial load of spices and food seasoning, herbal products, and cosmetic raw materials and accessories (2) to sterilize medical devices, pharmaceuticals, packaging materials, and tissue grafts (3) to eliminate pathogens in food (4) to extend shelf life and disinfest fruits and vegetables. PNRI's irradiation facilities were also used for the production of the PNRI-developed Carrageenan Plant Growth Promoter and for modification of other materials.



Multipurpose Irradiation Facility and Gammacell-220

For this year, 28,453 bags/boxes of samples from 94 clients were irradiated at the Multipurpose Irradiation Facility (MIF). The number of clients served in the MIF still increased by 3% (from 91 in 2017 to 94 in 2018) despite the limitation in the 24/7 operation and reduced activity of cobalt-60 source. The Gammacell-220 was also used for small volume irradiation of 270 samples from 18 clients.

PRODUCTS IRRADIATED AT THE MULTIPURPOSE IRRADIATED FACILITY • 2018



Preparation of commercial and industrial products for gamma irradiation at the Cobalt-60 Multipurpose Irradiation Facility

ELECTRON BEAM IRRADIATION FACILITY

PNRI's 2.5 MeV Electron Beam Irradiation Facility is the first of its kind in the country intended for full-scale research and development and semi-commercial services. The facility is also used in the production of Carrageenan Plant Growth

Promoter (PGP) developed by PNRI, which can increase the yield of crops and make these more resistant to blight and infestations. For this year, the E-Beam facility was used for the irradiation of 427,500 liters of the Carrageenan PGP.

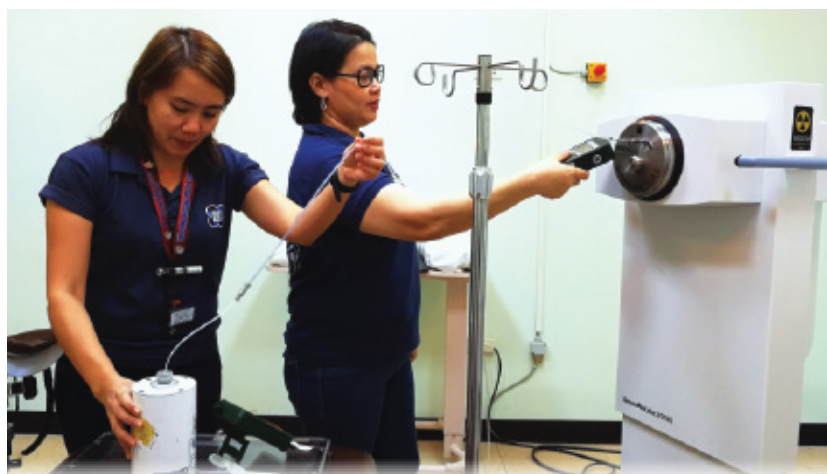


Irradiation of Carrageenan Plant Growth Promoter (PGP)
at the PNRI Electron Beam Irradiation Facility

PROVISION OF RADIATION PROTECTION SERVICES

The PNRI, through the Radiation Protection Services Section (RPSS), provides services to facilities working with radioactive materials and other sources of ionizing radiation such as X-ray machines to monitor, assess and control radiation levels and exposures to help ensure the safety of the workers and members of the public.

For 2018, the RPSS rendered 68,067 services to about 3,600 customers. In particular, a total of 65,500 personnel monitoring services were provided; 1632 instruments calibrated; 650 swipe samples analyzed; 62 sealed sources leak tested; and 15 disused sealed sources received for waste management.



Measurement of output of iridium-192 high dose rate brachytherapy seed used for cancer treatment



Processing of optically stimulated luminescence (OSL) dosimeters for personnel radiation monitoring

OPERATION AND MAINTENANCE OF THE SECONDARY STANDARDS DOSIMETRY LABORATORY (SSDL) AND RADIOACTIVE WASTE MANAGEMENT FACILITY

The RPSS operates the SSDL which establishes and maintains the relevant standards of measurement for ionizing radiation in the country. With these standards maintained, calibration of field instruments used by licensed users such as hospitals, mining and industries can be performed.

The Section also maintains and operates the only centralized Radioactive Waste Management Facility (RWMF) in the country. It provides radioactive waste management services for the wastes generated from use of radioactive materials from the different nuclear applications. For this year, work was

focused on the conditioning of disused sealed radioactive sources (DSRS). A total of 71 devices containing radioactive sources have been dismantled and 90 DSRS were recovered, 46 of which have been encapsulated.

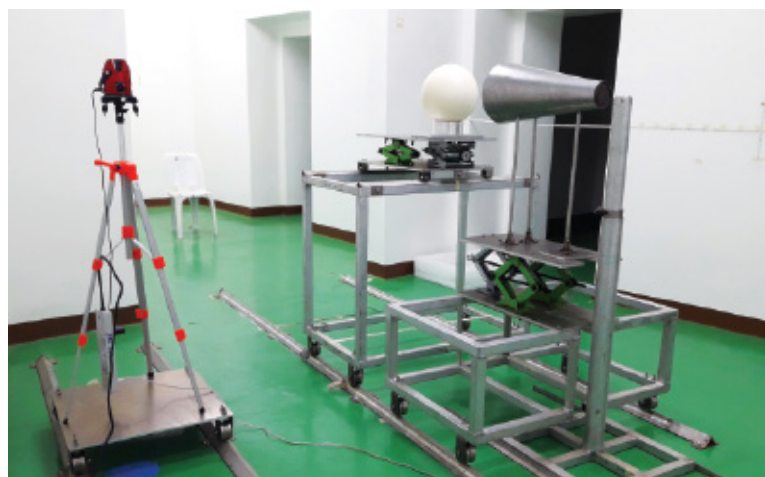
The PNRI also adopted the Radioactive Waste Management Registry (RWMR 3.2 Web) of the International Atomic Energy Agency. A total of 1,783 waste records starting from 1981 to 2018 have been successfully imported to the system. The RWMR will be used for better management and inventory of the various steps involving wastes until disposal.

DEVELOPMENT OF THE NATIONAL DOSE REGISTRY

The RPSS developed a system for the National Dose Registry (NDR) which is a centralized database for monitoring of the doses of occupationally exposed radiation workers in the Philippines. The current function of the NDR include the tracking

of dose history of radiation workers in the country, reporting of over exposures and providing means to assess and report levels of radiation exposures and evaluation of radiation risk.

RADIATION PROTECTION SERVICES FACILITIES



(Left) The new Radiation Protection Services (RPSS) building at PNRI (Right) The newly-completed neutron dosimetry laboratory which allows (a) calibration of neutron monitoring instruments, (b) monitoring of personnel for neutron exposures and (c) advanced research on neutron science

NUCLEAR-BASED ANALYTICAL SERVICES



Analysis of food samples by gamma spectrometry at the PNRI Atomic Research Center

Using nuclear and isotopic analytical techniques, the PNRI continued to provide clients with efficient and accurate analysis of samples for a broad range of purposes from research projects to regulatory certification of domestic and export products. Many of these techniques are capable of providing a wider range of more precise information on the sample without risking the sample to damage.

The nuclear-based analytical services provided by PNRI consisted of the following: gammametric analysis of 73 samples of food for 37 customers; liquid scintillation counting for total alpha and gross beta analysis of 314 water samples for 105 customers; and radon analysis of 319 water samples for 80 customers using liquid scintillation counting.

MICROBIOLOGICAL TESTING AND CYTOGENETIC ANALYSIS

The Institute performed microbiological tests of 83 samples from 20 customers. under various microbiological tests. Most of these samples were subjected to sterility testing, while other items were tested for aerobic plate count, molds and yeast count, and bioburden testing.

Seven industrial radiographers availed of PNRI's cytogenetics service to monitor any recent acute exposure to gamma radiation through analysis of blood samples. All of them obtained normal results and did not show evidence of acute gamma radiation exposure.



PNRI researcher performing microbiological testing

ENGINEERING AND INSTRUMENTATION SERVICES

The Engineering Services Section provided support in the fabrication, repair and maintenance of nuclear and non-nuclear equipment to PNRI research facilities as well as to customers from various sectors. This included assistance in the electrical setup of the laboratories in the different divisions and sections including

other modular laboratories, repair and maintenance of the liquid nitrogen plant; fabrication, repair and maintenance of equipment at the Cobalt-60 Multipurpose Irradiation Facility, and the Secondary Standards Dosimetry laboratory.

SEALED SOURCES APPLICATIONS

PNRI's gamma column scanning service has been upgraded with the acquisition of a new 100-milliCurie cobalt-60 radioactive source. This higher strength source would enable the Institute, through the Isotope Techniques Section (ITS), to perform

gamma column scanning in process columns and vessels in refineries and petrochemical plants with larger diameter column. The ITS also assembled a column scanning demonstration setup for training and presentation purposes.

ENSURING THE SAFETY AND SECURITY OF RADIOACTIVE SOURCES

PNRI serves as the national regulatory body for nuclear and radioactive materials and facilities by virtue of Republic Act 5207 or the Atomic Energy Regulatory and Liability Act of 1968, as amended, and Executive Order 128 of 1987. The Institute accomplishes this mandate through its Nuclear Regulatory Division (NRD).



REGULATIONS AND STANDARDS DEVELOPMENT

PNRI issues official directives such as regulations, administrative orders and requirements for the use of nuclear and radioactive materials in line with international standards and best practices. Through the DOST - Legislative Liaison Office, the Institute also coordinates with both houses of Congress as well as various local and international organizations to improve the national nuclear legal and regulatory framework.

Development of Code of PNRI Regulations and Other Regulatory Issuances

The NRD updated seven regulations corresponding to seven parts of the Code of PNRI Regulations (CPR) for 2018. CPR Part 3, which covers radiation protection standards, and CPR Part 5, which covers requirements for siting of nuclear installations, were already submitted for approval of the PNRI Director. Four CPR parts are undergoing internal and external review.



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

In addition to these requirements, PNRI issues Regulatory Guides, Information Notices and Regulatory Bulletins to inform the licensees on the recent developments regarding regulatory requirements and take appropriate actions, if necessary.

PNRI ADMINISTRATIVE ORDER	TITLE	DATE APPROVED
PNRI Administrative Order No. 01 Series of 2018 - Amendment to PNRI Administrative Order No. 002 Series of 2009	Authorization for Transfers of Nuclear-Related Dual-Use Equipment, Materials, Software and Related Technology	Approved June 21, 2018 Published in the Official Gazette on July 3, 2018
PNRI Administrative Order No. 02 Series of 2018 - Amendment of Administrative Order No. 1, Series of 2006	Establishing the Code of PNRI Regulations	Approved December 17, 2018
PNRI REGULATORY BULLETIN		
PNRI Regulatory Bulletin No. 18-01	Transitory Measures for the Designation of Medical Physicist in Nuclear Medicine Facilities	October 12, 2018
PNRI Regulatory Bulletin No. 18-02	Authorization to Transport Radioactive Materials	December 18, 2018
PNRI Regulatory Bulletin No. 18-03	Designation of Radiation Safety Officers (RSO) and Assistant Radiation Safety Officers (ARSO)	December 17, 2018

Development of Nuclear Legal and Regulatory Framework

PNRI collaborated with the IAEA as well as the Department of Energy (DOE) in several activities which aim to strengthen the national nuclear legal and regulatory framework. Among these were the hosting of a five-day National Workshop to Inform High-Level Officials about the Nuclear Law. Moreover, several PNRI personnel participated with the DOE in the preparation of the Self-Evaluation Report (SER) submitted to the IAEA as a requirement of the Integrated Nuclear Infrastructure Review (INIR) Mission.

Stakeholders Involvement

PNRI held two Consultative Meetings for stakeholders and interested parties in medical applications and radiographic testing. The participants' comments will be considered in revising CPR Parts 11 for industrial radiography and CPR Parts 12, 13 and 14, for medical practice. These were followed by two Regulatory Conferences for interested parties on CPR Part 3 and CPR Part 5.

Approval of Substitute Bill for the Comprehensive Nuclear Law

The Institute coordinated with lawmakers from both houses of Congress for the enactment of the Comprehensive Nuclear Regulation Act, which aims to create an independent regulatory body which will cover all activities and facilities involving ionizing radiation sources, consistent with international standards.

The House of Representatives' Ways and Means Committee, led by Representative Estrelita B. Suansing, approved the substitute bill on November 26, and the bill passed second reading on December 12. The bill was finally approved on third and final reading on January 18, 2019.

At the Senate, the counterpart bill is about to be endorsed for approval by the Senate Committee on Science and Technology, chaired by Senator Paolo Benigno Aquino. PNRI continues to coordinate with the legislative staff of Senator Aquino, as well as Senate President Vicente Sotto III and Senate Committee on Energy Chairperson Senator Sherwin Gatchalian regarding the bill.



(Left photo) DOST Secretary Fortunato De La Peña (right) and PNRI Director Dr. Carlo Arcilla (left) during the meeting of the House of Representatives on the Comprehensive Nuclear Regulations Act

LICENSING, REVIEW AND EVALUATION

In 2018, a total of 388 licenses were issued consisting of 319 licenses renewals, 45 amendments, and 24 new applications. Four licenses were terminated this year. NRD also performed four pre-licensing and verification inspections of medical and industrial facilities.

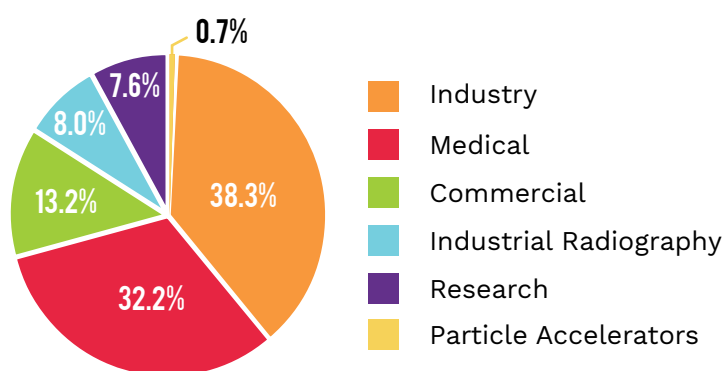
With a total of 423 current licensees, around 40% of the licensees use radioactive materials in industrial applications, mostly for quality assurance of level, density and thickness of process materials. More than 30% of the licensees

are engaged in medical applications, either for diagnosis or treatment of diseases. The rest of the licensees are engaged in commercial sale and services (13.2%), industrial radiography (8%) and research (7.6%). PNRI has licensed three particle accelerators in the country for the production of radiopharmaceuticals.

PNRI also implements an Internal Regulatory Control Program for its own facilities and laboratories for the use of nuclear and various radioactive materials.

GEOGRAPHICAL DISTRIBUTION OF LICENSEES FOR 2018			
REGION I	9	REGION IX	4
REGION II	5	REGION X	16
REGION III	43	REGION XI	11
REGION IV	65	REGION XII	4
REGION V	7	REGION XIII	4
REGION VI	13	CAR	4
REGION VII	14	NCR	222
REGION VIII	2	TOTAL	423

DISTRIBUTION OF LICENSEES BY USE



REGULATORY INSPECTION AND ENFORCEMENT

Inspection and Enforcement Activities

The Institute conducts regulatory inspections and audit of radioactive materials, facilities and activities to ensure licensees' compliance with the law, the Code of PNRI Regulations, and the conditions of the licenses issued.

For 2018, NRD conducted a total of 187 inspections, of which 163 are regular, five were unannounced, two are reactive, six are for follow-ups, and 11 are for facilities inspected under the PNRI Internal Regulatory Control Program. Results of



PNRI inspectors conducting visual examination of a licensed facility

the inspections showed that around 9% of the licensees were found to have no violations at the immediate time of the inspection. Corrective actions were required at follow up for the rest of the licensees, with most licensees implementing corrective actions.

Licensees violating the law and regulations are given sanctions in accordance with PNRI's regulatory enforcement policy. A construction company and two medical licensees were given Notice of Violation (NOV) for non-compliance to several safety regulation requirements. NOVs were also issued to 12 licensees whose licenses expired.

Safe Transport of Radioactive Materials

Radioactive materials have potential radiological hazards. Thus, PNRI monitors the transport of radioactive materials in the country by issuing permits to transport these materials. The Institute issued a total of 6,270 Permits to Transport Radioactive Materials to 63 PNRI licensees in compliance with the requirements for safe transport of radioactive materials in and out of the country.

NUCLEAR SAFEGUARDS AND SECURITY



IAEA safety inspectors visiting the Bataan Nuclear Power Plant in Morong, Bataan

PNRI implements the Philippines' commitments to the Non-Proliferation of Nuclear Weapons Treaty (NPT), the IAEA Safeguards Agreement and Additional Protocol, and other conventions and agreements. In collaboration with government agencies and international organizations, the Nuclear Safeguards and Security Section (NSSS) ensures that nuclear materials are not diverted to non-peaceful applications.

IAEA Safeguards Inspections

PNRI assisted the IAEA safeguards inspectors during the annual physical inventory verification of the Philippine Research Reactor-I (PRR-I) and three other facilities with depleted uranium. The inspectors also conducted a design information verification at the Bataan Nuclear Power Plant (BNPP) in Morong Bataan.



IAEA safety inspectors visiting the PRR-I at the PNRI compound

INTERNATIONAL COLLABORATION ON NUCLEAR SAFETY AND SECURITY

Office of Radiological Security (ORS)

Helping to ensure nuclear security across the globe, PNRI collaborates with the ORS (formerly the Global Threat Reduction Initiative) through continuous inspection and enhancement of security systems of medical and research facilities with radioactive materials. As part of this, PNRI joined the ORS team in site assessment of facilities with Category 1 radiation sources, followed by visits at PNRI and other medical facilities to ensure that the alarm systems are functional.

Nuclear Smuggling Detection and Deterrence (NSDD)

Formerly the Megaports Initiative, the NSDD is a project involving the operation of radiation portal monitors (RPMs) at the major ports of Manila and Cebu to prevent illicit trafficking of unauthorized nuclear and radioactive materials. This year, PNRI trained two batches of Bureau of Customs personnel in the operation of the Central Alarm System for the RPMs.

Collection of Radiation Detection Data for Alarming Containers

PNRI, through the Nuclear Safeguards and Security Section, engaged in an IAEA Coordinated Research Project (CRP) for the development of software tools with an alarming commodity catalogue for radiation characteristics of various materials, specifically those which are naturally-occurring radioactive materials (NORMs). The data were collected from alarming containers at the Cebu port, with 40 containers subjected to secondary inspection with handheld equipment after passing through RPMs. PNRI entered the data through the IAEA software (ICAD) and corresponding reports were prepared for submission.

Integrated Nuclear Security Support Plan (INSSP)

The Philippines, through PNRI, continues to receive support from the IAEA in terms of reviewing and sustaining its nuclear security regime through the INSSP. The Institute hosted a three-day review/update meeting in April followed by a visit to the Cebu Port Authority, as well as an IAEA mission regarding the Nuclear Security Support Centre (NSSC). The meetings aimed to further implement several nuclear security activities in the Philippines and to develop a national nuclear security support center with an effective network for training, as well as for technical and scientific support.



The PNRI Mobile Expert Support Team (MEST) at the Traslacion 2018



Deployment of Mobile Expert Support Team at Traslacion 2018

Contributing its expertise to ensure security during major events, PNRI deployed its Mobile Expert Support Team (MEST) before and during the *Traslacion* or the Feast of the Black Nazarene in

Quiapo Church, including the Pahalik of the image at the Quirino Grandstand, in January for the monitoring of nuclear and other radioactive materials in the vicinity. Aside from conventional route scanning, the PNRI MEST team conducted aerial monitoring with the Philippine Air Force (PAF) using the Spectral Advanced Radiological Computer System (SPARCS).

RADIOLOGICAL IMPACT ASSESSMENT



A RIAS personnel measuring the gamma and neutron dose rates coming from a californium-252 source rod.

In support of the Institute's regulatory functions, the PNRI Radiological Impact Assessment Section (RIAS) conducts studies to assess the impact of the use of radioactive materials and facilities on radiation workers and the general public.

In 2018, PNRI provided its expertise in validating the actual number of californium-252 (Cf-252) radiation sources piled inside a source rod disposed by a licensed facility, which alleviated fears that some of the radioactive materials were missing.

RIAS was also involved in the assessment of the occupational exposure dose of radiation workers in licensed facilities, particularly those in nuclear medicine, teletherapy, brachytherapy and industrial radiography over a five-year period. Results showed that almost all of the radiation workers received doses which were within the acceptable limits.

PNRI regulators have an ongoing study on the inhalation exposure of medical workers administering radioiodine. Iodine-131 is commonly used for treatment of the thyroid at hospitals and medical centers, although researches also consider the risk that the medical personnel may inhale the radioiodine, leading to occupational exposure.



Measurement of radioiodine concentration in thyroid of a nuclear medicine facility staff

EMERGENCY PREPAREDNESS AND RESPONSE

PNRI continued its effort towards the updating of the National Radiological Emergency Preparedness and Response Plan (RADPLAN) in order to better respond in the event of nuclear or radiological emergencies. In 2018, PNRI held a consultative meeting with various RADPLAN member agencies in close coordination with the National Disaster Risk Reduction and Management Council (NDRRMC), to expedite the approval of the current RADPLAN document.

The Institute also received support from international organizations such as the IAEA and the European Union (EU) in improving its emergency preparedness and response capabilities, facilities and equipment. PNRI participated in international exercises involving emergency scenarios such as the IAEA Convention Exercises (ConvEx). In particular, PNRI materials for the ConvEx 2a exercise of March 2018 were used as exemplars for other countries in responding to such incidents.



Radiation emergency exercises

DIFFUSION OF KNOWLEDGE AND TECHNOLOGIES

The Institute disseminates the benefits of nuclear science and technology to stakeholders through the conduct of information, education and communication activities; improves the capabilities of various sectors through nuclear training courses, seminars and workshops; and promotes/transfers technologies developed by PNRI for commercialization.

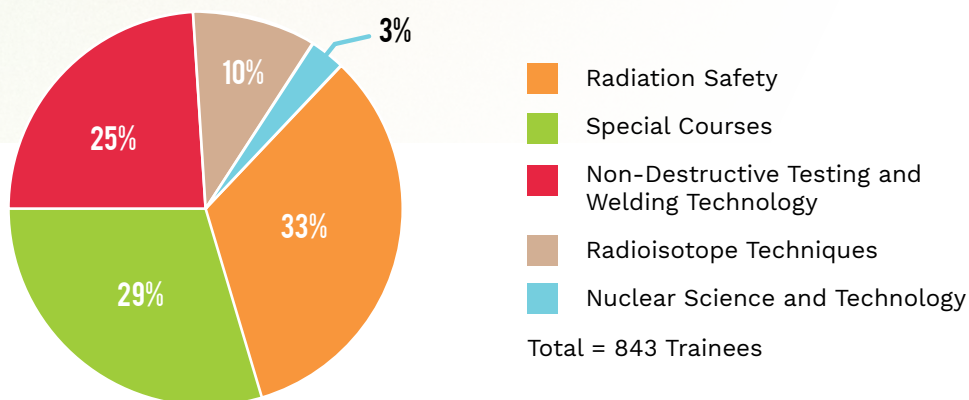


CAPACITY BUILDING ON NUCLEAR SCIENCE AND TECHNOLOGY

NUCLEAR TRAINING AND OTHER SPECIALIZED COURSES

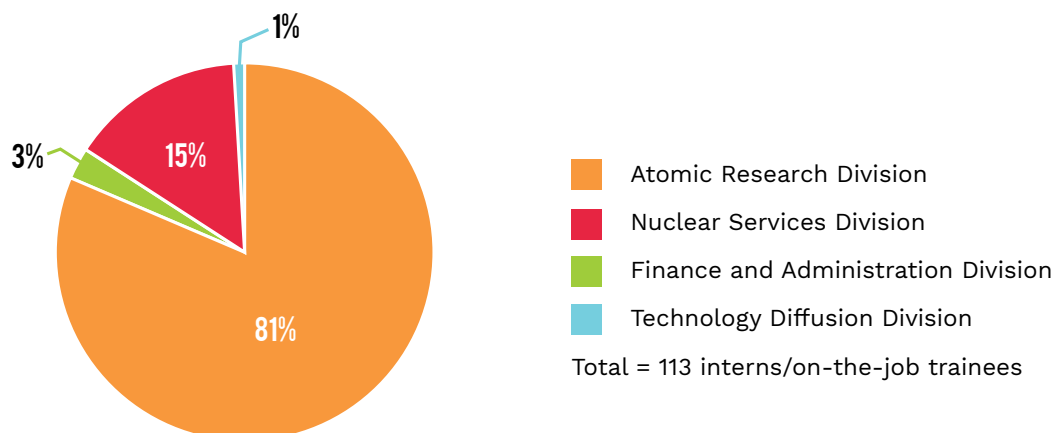
As part of the capacity building activities of PNRI on nuclear science and technology, the Institute's Nuclear Training Center (NTC) offers training courses for various sectors. In 2018, PNRI conducted 46 courses in radioisotope techniques, nuclear science and technology, radiation safety, nondestructive testing and other specialized topics.

These courses were participated in by 843 trainees. PNRI also conducted specialized courses in environmental monitoring, reactor engineering and emergency preparedness and response in cooperation with the Japan Atomic Energy Agency (JAEA).



INTERNSHIP/ON-THE-JOB TRAINING PROGRAM

Under this program, NTC arranged/coordinated the acceptance of 113 interns/on-the-job trainees, of which 62 are undergraduate students and 51 are high school students. The interns were deployed to various sections at PNRI.



PNRI NUCLEAR TRAINING COURSES • 2018

NUCLEAR TRAINING	NO. OF PARTICIPANTS	NUCLEAR TRAINING	NO. OF PARTICIPANTS
RADIOISOTOPE TECHNIQUES		SPECIAL COURSES <i>(continuation)</i>	
Course on Medical Use of Radioisotopes (CMR) – Three Sessions	72	Follow-up Training Course (FTC) on Reactor Engineering Level 1 – Two Sessions	39
Course on Radioisotope Technology (CRT)	7	FTC on Nuclear and Radiation Emergency Preparedness and Response – Two Sessions	51
NUCLEAR SCIENCE AND TECHNOLOGY		FTC on Environmental Radioactivity Monitoring	18
Seminar on Nuclear Science for Teachers (SNST)	24	NON-DESTRUCTIVE TESTING (NDT)* AND WELDING TECHNOLOGY <i>Conducted in cooperation with the Philippine Society for Nondestructive Testing, Inc. (PSNT)</i>	
RADIATION SAFETY		Surface Methods (Level 2) – Three Sessions	53
Radiation Safety Course- Sealed Sources in Industrial Devices (RSC-ID) – Seven Sessions	127	Radiographic Testing (Level 2) – Three Sessions	48
Radiation Safety Course -Commercial Sale Involving Radioactive Materials and Low Activity Sources (RSC-CL) – Two Sessions	34	Ultrasonic Testing (Level 2) – Three Sessions	47
Radiation Safety Refresher Course (RSRC) – Four Sessions	109	Infrared Thermographic Testing – Two Sessions	28
Radiation Safety Course Industrial Radiography (RSC-IR)	10	Eddy Current Testing (Level 2) – Two Sessions	29
SPECIAL COURSES		Welding Inspector Course – Two Sessions	8
OJT Orientation and Radiation Safety Seminar – Four Sessions	89	TOTAL NO. OF COURSES: 46	
RSC-Security Personnel – Two Sessions	18	TOTAL NO. OF PARTICIPANTS: 843	
Course on Fundamentals of Nuclear Science and Technology and Basic Principles of Radiation Protection (CNSRP)	32		



INFORMATION, EDUCATION AND COMMUNICATION OF NUCLEAR S & T



PNRI Director Dr. Carlo A. Arcilla briefs President Rodrigo Roa Duterte and DOST Secretary Fortunato De La Peña on products developed by the Institute during the NSTW celebration in Davao City.

SPECIAL EVENTS AND NUCLEAR AWARENESS SEMINARS

The Nuclear Information and Documentation Section in cooperation with the PNRI technical staff conducted five Nuclear 101 Awareness Seminars in Region 1 (Laoag City, Ilocos Norte), Region 7 (Cebu City), and National Capital Region (PNRI, Quezon City). These seminars were attended by around 600 participants composed of college students, high school science supervisors/teachers, university/college instructors, and young professionals from the government and private sectors. A total of 29 lecture sessions for around 500 clients were

also conducted at PNRI in cooperation with the Nuclear Training Center and other PNRI technical staff.

PNRI technologies and services were promoted in the following events: nine national and regional science and technology events organized by the Department of Science and Technology, international event organized by the International Atomic Energy Agency, and the PNRI organized annual Atomic Energy Week celebration.

S & T EVENTS • 2018

EVENT	VENUE
A. National S & T Events	
DOST-NCR Hazards and Disaster Awareness for Kids (HANDA)	Muntinlupa Sports Complex, Muntinlupa City
DOST-National Science and Technology Week (NSTW) in Mindanao	SMX Convention Center, Lanang, Davao City
DOST-NSTW Celebration	World Trade Center, Pasay City
DOST-Regional Science and Technology Week (RSTW) Celebration – Region 5	Bicol University, Legazpi City, Albay
DOST-RSTW Celebration – Region 6	Robinsons Place, Roxas City, Capiz
DOST-RSTW Celebration – Region 10	Bukidnon State University, Malaybalay City, Bukidnon
DOST-RSTW Celebration – NCR	Unibersidad de Manila, City of Manila
National Biotechnology Week	World Trade Center, Pasay City
DOST-RSTW Celebration – Region 7	Island City Mall, Tagbilaran City, Bohol
Atomic Energy Week	PNRI, Diliman, Quezon City
B. International S & T Event	
IAEA Ministerial Conference and Exhibit	Vienna International Centre, Vienna, Austria



The Philippine exhibit at the 2018 IAEA Ministerial Conference in Vienna, Austria



(Left Photo) The PNRI exhibit during the Regional Science and Technology Week celebration in Roxas City, Capiz
(Right) PNRI exhibit at the Science, Technology and Innovation in School cluster during the National Science and Technology Week Celebration at World Trade Center, Pasay City

MEDIA PUBLICITY



PNRI Deputy Director Soledad Castañeda during a television interview notifying the public about a missing moisture density gauge allegedly stolen from one of PNRI's licensees.

To increase public visibility through various media channels, the PNRI carried out the following: (1) preparation of 45 press releases, all of which were posted on the PNRI website and some were featured and published in daily broadsheets, news/ media agencies, and government

agencies, including their online versions; (2) coordination of 20 interviews for television, radio and print media with PNRI officials and technical staff; and (3) conduct of a press conference for 35 media representatives during the 46th Atomic Energy week celebration.

DEVELOPMENT OF INFORMATION MATERIALS ON NUCLEAR S & T

PNRI developed 30 information, education and communication (IEC) materials on nuclear technologies in various formats such as flyers; exhibit banners, posters and other display materials; and video presentations. The printed materials were distributed during special events

and educational tours of visitors in PNRI facilities and laboratories while the videos are posted at the official DOST – PNRI Facebook page. The exhibit and display materials were displayed during the national, regional and international S & T celebrations and in other events.

LIBRARY SERVICES, WEBSITE AND SOCIAL MEDIA

Library services were provided to around 350 clients, composed mostly of students and researchers. PNRI also continued to provide inputs to the International Nuclear Information System (INIS) through the submission of 96 new inputs of nuclear-related literature published in the Philippines.

PNRI reaches out to various groups through its official website (<http://www.pnri.dost.gov.ph>) and Facebook page

(<https://www.facebook.com/PNRIDOST>). As of December 2018, the PNRI Facebook Page has garnered 32,062 likes, an increase of 232% from the previous year's number of likes.



*Scan with a QR Code application on your phone to visit the official website and Facebook page

EDUCATING SECONDARY STUDENTS AND SCIENCE TEACHERS ON NUCLEAR S & T

PNRI signed a Memorandum of Understanding (MOU) with the Department of Education (DepEd) in implementing the IAEA Regional Technical Cooperation Project on Educating Secondary Students and Science Teachers on Nuclear Science and Technology. The project aims to help increase the interest of students in Science, Technology, Engineering and Mathematics (STEM) and to provide a more accurate perspective of nuclear concepts among secondary school students. The MOU signing was held during the PNRI's hosting of the IAEA Regional Workshop on Curriculum Development and Launching of the Nuclear S & T for Secondary Schools at Crowne Plaza Galleria, Pasig City in February 2018.

As part of the project, PNRI launched the Nuclear Science and Technology Education

Program (nSTeP+) for K-12 teachers and students which aims for the integration or addition of nuclear science and technology concepts into the present K-12 curriculum. A total of six teachers from DepEd, Philippine Science High School (PSHS) and DOST-Science Education Institute - Project STAR were sent for training abroad and a total of 78 teachers were trained locally.

The program was also introduced to six DepEd regional and division science supervisors and 11 PSHS campus directors and head teachers in anticipation of its roll out to various regions in the Philippines. As a result, another MOU between PNRI and PSHS was signed in November 2018.



IAEA officials and experts with leading educators, communicators and government representatives from 23 IAEA Member States during the Regional Workshop on Curriculum Development and Launching of Nuclear Science and Technology for Secondary Schools held in the Philippines in February



The Nuclear Amazing Race during the Project STRIVE Culminating Activity in December at the PNRI compound

PROJECT STRIVE

The PNRI participated in the DepEd Schools Division Office Quezon City Project STRIVE (Science, Technology and Research for Innovative Ventures) involving selected Grade 5 and 8 learners in Quezon City. The project aims to acquire the current trends in learning Science, Technology and Research through an atmosphere of independent and collaborative learning. A total of

120 students from different schools in Quezon City participated in 20 Saturdays of training-workshops in nuclear science, robotics, science investigatory projects and science improvisation. The culminating activity was held at PNRI in December, and consisted of guided tours of PNRI facilities, lectures and fun activities.

TECHNOLOGY TRANSFER AND COMMERCIALIZATION OF PRODUCTS AND TECHNOLOGIES

TECHNOLOGY TRANSFER

The PNRI, through the Business Development Section (BDS), negotiated 24 commercialization deals with technology adopters from private sector. Twenty-one of these had been assessed by the Fairness Opinion Board, as 'fair to the licensor' while the remaining three are expected to be decided upon in 2019. The board is an independent body of competent industry leaders tasked to evaluate commercialization deals for technologies developed from R&D projects. Also, two commercialization deals on Carrageenan Plant Growth Promoter (PGP) technology had been translated into memoranda of agreements paving the way for the mass production

and national distribution of PGP to rice farmers nationwide. To show that PGP technology works for other crops other than rice, eight memoranda of agreements had been made and executed by and between PNRI and the private sectors for field test trials on other crop categories. These partnerships will provide more commercialization opportunities once tests are completed and approved by the Fertilizer and Pesticide Authority for label expansion of the product. Several international patents for PGP had also been filed to pave the way for overseas commercialization of the technology by private sector adopters.

TECHNOLOGY MANAGEMENT AND PROMOTION

Intellectual Property Management

PNRI received two intellectual property awards in recognition of utility models developed for the locking system in the PNRI Multipurpose Irradiation Facility. A utility model certificate was also granted to the Institute for the improvements done by its researchers to the alumina column in the Isotope Techniques Section.

Technology Promotion

Several activities were conducted and linkages with prospective adopters were carried out for the promotion of the following PNRI- developed technologies: (1) hemostatic technology to reduce or stop bleeding in wounds; (2) gamma irradiator for use in commercial treatment service facilities to support the enhancement of the competitiveness of our local industries; and (3) commercialization of the Technetium-99m generator facility for national distribution and export to neighboring countries.



DOST-Technology Application and Promotion Director Edgar I. Garcia (left) awards the Fairness Opinion Board Certificate to PNRI for commercialization deals with private sector adopters on technologies developed by the Institute.

INFORMATION TECHNOLOGY AND NETWORK SYSTEMS

DEVELOPMENT OF INFORMATION SYSTEMS AND SOFTWARE

This year, the Management Information Systems Section (MISS) developed, upgraded and maintained 13 information systems and software to provide digitized and more efficient office processes and services. Six of these systems/software were deployed and optimized in 2018:

Radiation Protection Services Management Information System

This system adapts and automates the processes of different services provided by the Radiation Protection Services Section.

Property Procurement Information System

The system handles the preparation and approval of Purchase Request up to the generation of Purchase Order and printing of Inventory and Custodian Slip, among others.

Enhanced Nuclear Knowledge Management System

This serves as a database repository of the knowledge and information gained in the training attended by PNRI employees. It is used to monitor the conduct of echo seminars and submission of official travel reports and training materials by the employees.

Asia Pacific Marine Radioactivity Database (ASPAMARD) Software

This software was continuously customized and optimized to provide data on key anthropogenic and natural radionuclides.

New Web-based Payroll System with Allowance Module and Annualization

This aims to help in the management of payroll, salaries, deductions and allowances. This is integrated with the InfoSys system where employees can view their own pay slips and Daily Time Record.

Regulatory Authority Information System (RAIS)

RAIS was optimized to support the management of the regulatory control program in accordance with IAEA Safety Standards and guides.



Maintenance of servers and development of information systems
by PNRI MISS staff

S & T LINKING AND NETWORKING

The Institute's strong linkages and networks are vital in furthering its mandate, as most of its projects receive support from various local and international organizations, particularly the International Atomic Energy Agency (IAEA). PNRI also closely coordinates with various government agencies, academic and scientific institutions, and the private sectors to mutually enhance their capabilities in nuclear science and technology.



LOCAL AND INTERNATIONAL S & T NETWORKING

The institute established new local linkages and maintained existing ones with other government agencies, private sector, the academe, medical institutions, and scientific organizations, through its research and development projects, specialized services, technology diffusion program and through its nuclear regulatory activities. This year, PNRI forged linkages with various institutions through ten Memorandum of Agreements, three Memorandum of Understanding, and three bilateral and confidentiality undertaking agreements.

On an international level, the Philippines is a Member State of the International

Atomic Energy Agency (IAEA), an autonomous United Nations agency mandated to promote scientific and technical cooperation in the field of the peaceful uses of atomic energy. The PNRI, as the lead agency in atomic energy matters in the country, serves as a link between IAEA and government and private entities using atomic energy in the country. The Institute also has cooperative agreements in nuclear technology with other IAEA Member States and in other scientific institutions/organizations in Australia, Canada, European Commission, Japan, Korea, Russia, United States, among others.

VISIT OF IAEA DIRECTOR GENERAL AMANO TO THE PHILIPPINES



10

IAEA Research Contracts

30

IAEA Technical Cooperation Projects

53

IAEA Experts/Mission Delegates

7

PNRI Hosting of Regional Meetings, Seminars/Workshops and Regional Training Courses

101

PNRI and 92 non-PNRI

personnel received training/ fellowship grants from foreign institutions/agencies

The visit of IAEA Director General Yukiya Amano to the Philippines early in February highlighted the Philippines' strong engagement in the IAEA's thrust towards Atoms for Peace and Development. Director General Amano met with DOST and DOE officials as well as members of the academe to discuss the ongoing and future IAEA technical cooperation projects with the Philippines, as well as the possibility of including nuclear power in the energy mix.

SENATORS AND PNRI OFFICIALS ON A SCIENTIFIC VISIT TO IAEA AND EUROPEAN FACILITIES



Senate President Aquilino “Koko” Pimentel III, Senate Energy Committee Chairperson Senator Sherwin “Win” Gatchalian (7th and 8th from right), DOE Undersecretary Donato Marcos (extreme right) and PNRI Director Dr. Carlo Arcilla (5th from right) and members of the Philippine delegation at the IAEA headquarters in Vienna, Austria on May 2. (Photo by Dean Calma, IAEA)

DOST & PNRI AT THE 2018 IAEA MINISTERIAL CONFERENCE



Left Photo: DOST Secretary Fortunato T. De La Peña (seated right) and PNRI Director Dr. Carlo Arcilla (seated left) during the 2018 IAEA Ministerial Conference on Nuclear Science and Technology, with Charge d’Affaires, a.i. Minister Ms. Leilani S. Feliciano (standing, 3rd from right) and other officials. Photo from DFA - Vienna Philippine Embassy



Right Photo: Secretary De La Peña delivers the Philippine Statement at the 2018 IAEA Ministerial Conference. Photo from DFA - Vienna Philippine Embassy

SIGNING OF MOU BETWEEN DepEd AND DOST-PNRI



Officials from the IAEA, DOST and DepEd pose for a group photo after the Memorandum of Understanding signing ceremony for the implementation of an IAEA regional technical cooperation project for nuclear science education on February 8, 2018. IAEA Director General Amano (5th from left), DOST Secretary Fortunato De La Peña (4th from left), DepEd Undersecretary Tonisito Umali (5th from right), Ambassador Maria Cleofe Natividad (3rd from right) and PNRI Director Dr. Carlo Arcilla (4th from right).

IAEA RESEARCH CONTRACTS IMPLEMENTED IN 2018

TITLE/DESCRIPTION OF RESEARCH	NAME OF RESPONSIBLE AGENCY STAFF
PHILIPPINE NUCLEAR RESEARCH INSTITUTE	
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
Assessment of the Levels, Distribution and Effects of Natural and Anthropogenic Radionuclides in the Philippine Marine Environment	Eliza Enriquez
Application of Cytogenetic Biodosimetry in Determining Radiosensitivity of Cancer Patients	Celia Asaad
Assessing the Impact of Industrial Activities on Air Quality and Its Surrounding Environment in Mining and Industrial Areas in the Philippine Using Nuclear and Related Analytical Techniques	Preciosa Corazon Pabroa
FOOD AND NUTRITION RESEARCH INSTITUTE (FNRI)	
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 V. Capanzana
NATIONAL WATER RESOURCES BOARD	
Integrated and Sustainable Groundwater Resources Management in Water Resources Regions 2 and 10 and Nine (9) Cities with Water Stressed Aquifer Systems	Susan Abaño
ST. LUKE'S MEDICAL CENTER	
Evaluation of Multimodality Imaging in the Assessment and Diagnosis of Post-Operative Spinal Infection	Dr. Vincent Peter Magboo

IAEA TECHNICAL COOPERATION PROJECTS IMPLEMENTED IN 2018

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
Strengthening National Capacity in the Manufacture of Radiopharmaceuticals for Health Care Applications	Adelina Bulos PNRI
Applying Nuclear Techniques in the Attenuation of Floods and Natural Disaster-Borne Contamination	Raymund Sucgang PNRI
Bench-scale Simulation for the Development of Continuous Extraction Technology of Uranium and Other Valuable Elements from Phosphates - Phase II	Rolando Reyes PNRI
Enhancing the Utilization of the Fully Automated Philippine Nuclear Research Institute Gamma Irradiation Facility	Luvimina Lanuza PNRI
Assessing the Development of a Nuclear Power Programme	Marietta Quejada Department of Energy
Regional Agreement Projects	
Facilitating Activities Implemented under the RCA Framework	Carlo Arcilla PNRI
Developing Bioenergy Crops to Optimize Marginal Land Productivity through Mutation Breeding and Related Techniques and Related Biotechnologies for the Development of Green Crop Varieties	Jorge Sahagun PNRI
Enhancing Food Safety and Supporting Regional Authentication of Foodstuffs through Implementation of Nuclear Techniques	Raymund Sucgang PNRI
Assessing and Improving Soil and Water Quality to Minimize Land Crop Productivity using Nuclear Techniques	Efren Sta. Maria PNRI
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
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 St. Luke's Medical Center
Strengthening Cancer Management Programmes in RCA States Parties through Collaboration with National and Regional Societies (RCA)	Miriam Calaguas Jose Reyes Memorial Medical Center
Enhancing Medical Physics Services in Developing Standards, Education and Training through Regional Cooperation	Jonathan Corpuz Southern Philippines Medical Center

IAEA TECHNICAL COOPERATION PROJECTS IMPLEMENTED IN 2018

TITLE/DESCRIPTION OF RESEARCH	NAME OF CONTACT PERSON
Regional Non-Agreement Projects	
Networking for Nuclear Education, Training, and Outreach Programmes in Nuclear Science and Technology in the Framework of Asian Network for Education in Nuclear Technology (ANENT)	Ana Elena Conjares PNRI
Educating Secondary Students and Science Teachers on Nuclear Science and Technology	Jasmine Angelie V. Albelda PNRI
Conducting the Comprehensive Management and Recovery of Radioactive and Associated Mineral Resources	Rolando Reyes PNRI
Supporting Climate-Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications-Phase II	Roland Rallos PNRI
Supporting the Applications of Emerging Targeted Therapeutic Radiopharmaceuticals for Radionuclide Therapy	Adelina Bulos PNRI
Supporting Regional Nuclear Emergency Preparedness and 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
Supporting Decision Making for Nuclear Power Planning and Development - Phase III	Mauro Marcelo National Power Corporation
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
Enhancing Safety and Effectiveness in Diagnostic Radiology through Training of Medical Imaging Professionals in Quality Practices	Emerita Barrenechea St. Luke's Medical Center
Enhancing the Management of Non-Communicable and Communicable Diseases through Capacity Building under the IAEA Curricula for Nuclear Medicine Professionals	Eduardo Ongkeko St. Luke's Medical Center

**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 • 2018

FIELD	PHILIPPINE PARTICIPANT	AGENCY/INSTITUTE	ORGANIZER/ VENUE/DATE
IAEA Regional Workshop on Curriculum Development and Launching of Nuclear S&T for Secondary Schools	Lilia Habacon Virginia Andres	DOST-PSHS	IAEA Crowne Plaza Manila Galleria 5 – 9 February
	Reynaldo Garnace Hillary Diane Andales	PSHS (Eastern Visayas Campus)	
	Cynthia Gayya	DOST-Science Education Institute	
	Denis Dyvee Erabo Maripaz Mendoza Manolo Davantes Roxanne Villanueva	Department of Education	
	Jasmine Angelie Albelda	PNRI	
Regional Training Course on Licensing and Inspection of Radioactive Materials	Maria Teresa Salabit Raymund Beredo Romelda Azores Vinz Michael Calija	PNRI	IAEA Novotel Manila Cubao, Quezon City, 9 – 13 April
First Coordination Meeting of RAS9089 “Strengthening Radiation Safety Infrastructure”	Alan Borrás Vangelina Parami Lorna Jean Palad	PNRI	IAEA Novotel Manila Cubao, Quezon City, 16 – 20 April
Regional Workshop on Challenges and Lessons Learned to Support the Decision Making for Nuclear Power Planning and Development	Roger Teves Mauro Marcelo, Jr. Manuel Luis Plofino	NAPOCOR	IAEA Pan Pacific Hotel, Manila 04 – 08 June
	Teresito Bacolcol	PHIVOLCS	
	Mario Marasigan Mary Grace Gabis Donato Marcos Araceli Soluta Danilo Vivar Angeline Manga Herminio Ariola Danilo Javier Kathleen Regala Gerardo Erguiza, Jr. Arthur Tenazas Carmencita Bariso	Department of Energy	
Regional Workshop on Self-Assessment of Emergency Preparedness and Response Arrangements	Mary Rose Mundo Lorna Jean Palad Paolo Tristan Cruz Joan Tugo	PNRI	IAEA Citadines Millenium Ortigas, Manila 15 – 19 October
Regional Training Course on Development and Validation of Analytical Method for Veterinary Drugs and Pesticide Residues in Animal Products	Christine Mae Arcebal Amorlina Ronato Arciaga Danica Angeline Dimaya Arneli Bueno Ignacio Jasmin Alday Loria Jonathan Sabiniano Hernando Tipa	Department of Agriculture	IAEA Novotel Manila Cubao, Quezon City, 12 – 23 November
RAS5073 Regional Training Course on Nitrogen-15 Isotope Tracer	Andrea Luz Nery Lenonard Labides Gerald Dicen Joseph Dayap	PNRI	IAEA Novotel Manila Cubao, Quezon City, 3 – 14 December
	Filomena Gorospe	PHILRICE	

PNRI HOSTINGS • 2018



Various PNRI hostings in 2018 with international and local participants

PNRI SPECIAL & T EVENTS



4TH PHILIPPINE NUCLEAR YOUTH SUMMIT



Participants, nuclear science and technology experts, PNYS organizers and officials of the International Youth Nuclear Congress (front row 4th to 7th from left) during the 4th Philippine Nuclear Youth Summit on December 4

More than 170 student leaders and young professionals from across the country gathered for the 4th Philippine Nuclear Youth Summit (PNYS) held on 4 December at the PNRI compound. The summit was organized by the Philippine Young Generation in Nuclear (PYGN), in partnership with the PNRI. This event aims to provide a forum for the youth to share information and scientific knowledge as potential future leaders and scientists. The officials of the International Youth Nuclear Congress (IYNC)

from Australia, Italy, United Arab Emirates and the United States also graced the event.

The PNYS activities were as follows: oathtaking of the PYGN officers - Philippines, Nuclear 101 Awareness Seminar, research proposal writeshop, technical sessions on nuclear science and technology, video making contest and the nuclear amazing race.

PNYS VIDEO MAKING CONTEST

1ST PLACE

(PRIZE: PHP 15,000)

Video Title: Nuclear Science and Technology: Empowering the Future
Team Quillsthetics
Calbayog City National High School (Region VIII)

2ND PLACE

Video Title: Nuclear Science and Albert
Team Albert
Mindanao State University - Iligan Institute of Technology and
Xavier University - Ateneo de Cagayan (Region X)

3RD PLACE

Video Title: Innovating Agriculture for the Future: Applications of Nuclear Science
Team Kalimutaw
University of the Philippines High School - Cebu (Region VII)



▶ SCAN ME!

1ST PLACE



▶ SCAN ME!

2ND PLACE



▶ SCAN ME!

3RD PLACE

*Scan with a QR Code application on your phone to view videos



Oathtaking of the Philippine Young Generation in Nuclear officers

OPENING CEREMONIES



The honored guests during the 46th Atomic Energy Week (AEW) Opening Ceremonies: DOST Secretary Fortunato De La Peña (3rd from left), DOST Undersecretary Dr. Rowena Cristina Guevara (2nd from left), Quezon City Councilor Precious Hipolito - Castelo (4th from right) and Atty. Teresa Ira Maris P. Guanzon, representing Senator Sherwin "Win" Gatchalian (2nd from right). They are joined by PNRI Director Dr. Carlo Arcilla (3rd from right), PNRI Deputy Director Dr. Soledad Castañeda (extreme right) and PNRI Technology Diffusion Division Chief and AEW Chairperson Ms. Ana Elena Conjares (extreme left).

WREATH LAYING AT THE MONUMENT OF GEN. FLORENCIO A. MEDINA



OPENING OF EXHIBITS



GUIDED TOUR AT PNRI FACILITIES



1ST NUCLEAR RESEARCH & DEVELOPMENT CONFERENCE



PRESS CONFERENCE



PHILIPPINE NUCLEAR SCIENCE QUIZ



CLOSING CEREMONIES





Atomic Energy Week
AEW46

1ST NUCLEAR RESEARCH AND DEVELOPMENT CONFERENCE



As part of the 46th AEW celebration, PNRI opened its 1st Nuclear Research and Development Conference on December 10 and 11, with in-depth presentations by PNRI scientists and researchers on various nuclear and radiation applications in agriculture, food, health and medicine, industry, and the environment.





Awarding of the top five PNSQ finalists together with PNRI officials and panel of judges during the PNSQ National Level in December.

A total of 34 teams of high school students from across the country competed in a test of knowledge on nuclear and radiation science in the national level of the 2018 Philippine Nuclear Science Quiz (PNSQ) on

December 13. The activity aims to provide an avenue to enhance Filipino students' awareness and appreciation of the nuclear science and technology field and its potential role in uplifting the quality of living in the country.

2018 PNSQ WINNERS (NATIONAL-LEVEL COMPETITION)

1ST PLACE (PHP 50,000.00 + TROPHY)

Philippine Science High School – Central Visayas Campus

Joseph P. Hortezuela (Coach)

George Von H. Dolalas, Seanuel Joash P. Uyangoren

2ND PLACE (PHP 40,000.00 + TROPHY)

Davao City National High School

Joel A. Calledo (Coach)

Jonoel Noah D. Grande, Glenn Jay C. Paglanson

3RD PLACE (PHP 30,000.00 + TROPHY)

Philippine Science High School – Cordillera Administrative Region Campus

Gineth Grace C. Calis (Coach)

Robert Nelson R. Leung, Juan Miguel Sebastian E. Orille

CONSOLATION PRIZE (PHP 15,000 EACH)

Negros Occidental High School

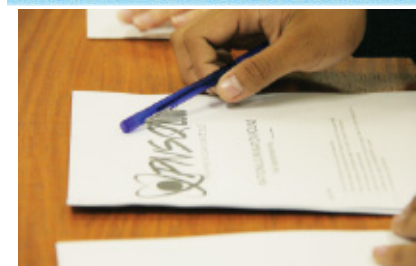
Eunice A. Malala (Coach)

Vohn Archie V. Edjan, Chrislyn Ann M. Mañero

Philippine Science High School – Eastern Visayas Campus

Herma Z. Morales (Coach)

Angie Lou C. Bajado, Eirene Jude P. Gomez



HUMAN RESOURCES DEVELOPMENT

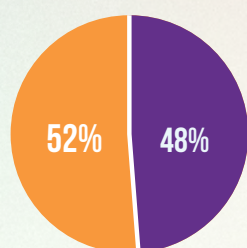
From the greatest accomplishments to the smallest details, behind it all are the officials, scientists, researchers, regulators, operators and staff of the Institute, whose expertise in their fields are only matched by their diligence and dedication to their respective endeavors. The men and women of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



DISTRIBUTION OF PERSONNEL

MANPOWER PROFILE • 2018

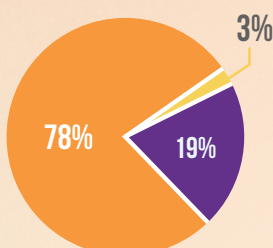
BY GENDER



Male
Female

Total 227

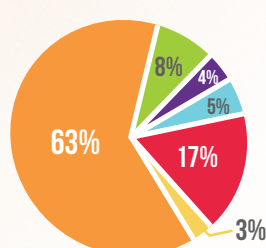
BY STAFF CATEGORY



Technical
Administrative
Managerial

Total 227

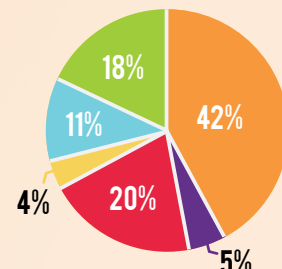
BY EDUCATION



Doctorate
MS/MA
Post BS/BA
BS/BA
Post High School
High School & Below

Total 227

BY PNRI STAFF ACTIVITY



R&D
Technology Delivery
S&T Services
Information Services
Technical Services
S&T Education
Regulatory
Administrative

Total 227

4

PNRI staff who obtained their doctoral and masteral degrees in 2018

Jordan F. Madrid

Senior Science Research Specialist
Chemistry Research Section,
Atomic Research Division
PhD in Science and Technology
Gunma University, Japan

Charles Darwin T. Racadio

Science Research Specialist II
Nuclear Analytical Techniques Application Section,
Nuclear Services Division
MS in Environmental Science
University of the Philippines, Diliman

Gloriamaris L. Caraos

Science Research Specialist II
Biomedical Research Section,
Atomic Research Division
MS in Biological Sciences
University of Santo Tomas, Philippines

Aileen B. Cezar

Administrative Officer II
Human Resources Management and Records Section,
Finance and Administrative Division
MA in Public Administration
Manuel L. Quezon University, Philippines

8

PNRI staff pursued post graduate degrees through local/foreign scholarships

46

Nuclear training courses conducted by PNRI with 843 participants

14

Students from 4 schools were accepted for thesis advisorship at PNRI

113

Students from 21 schools were accommodated for on-the-job training at PNRI

109

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

101

PNRI personnel & 92 non-PNRI

personnel received training/fellowship grants from foreign institutions/agencies



NATIONAL AWARDS

Conferment of Scientist II Rank



Dr. Lucille V. Abad, has been conferred the rank of Scientist II under the Scientific Career System of the Civil Service Commission

2018 NAST Talent Search for Young Scientists



Dr. Chitho Feliciano (center) received the First Prize Award for the 2018 National Academy of Science and Technology (NAST) Talent Search for Young Scientists

1st BANTOG – The Science for the People Media Awards – DOST Information Officers Category



PNRI Information Officer Mr. Hans Joshua V. Dantes (2nd from left) won 2nd place in the 1st BANTOG – the Science for the People Media Awards – DOST Information Officers Category.

Utility Model Award



Staff of the PNRI Isotope Techniques Section were awarded the Utility Model Award on the “Method for Pretreating Alumina for Chromatographic Separation in Radionuclide Generators” with the IP Certificate

2018 DOST Utility Model Registration Awards

1

“A process for Making an Electro-Mechanical System for Regulating the Opening and Closing of Doors”

by Aurelio L. Maningas and
Geofrey O. Tranquilan

2

“Electro-Mechanical System for Regulating the Opening and Closing of Doors”

by Aurelio L. Maningas and
Geofrey O. Tranquilan

2018 DOST International Publication Awardees



PNRI science research specialists garnered awards for 19 papers published in internationally recognized journals. The awards were given by the National Academy of Science and Technology during the 2018 DOST International Publication Award ceremonies held on December 18, 2018 at the Philippine International Convention Center.

Philippine Sports Commission Inter Government Agency Sports Festival Award



Table Tennis Men's Division

(Dante Q. Bajet, Davision T. Baldos, Rollie B. Ilao, Sofronio B. Enriquez, Gerardo Jose P. Robles, Christopher O. Mendoz, Angel T. Bautista VII, Raymund P. Beredo, Joseph R. Tugo, Efrén J. Sta. Maria, Dan Benneth C. Mangulabnan and Carl M. Nohay)

1st Place in the Philippine Sports Commission Inter Government Agency Sports Festival as the Representative of the Department of Science and Technology

Table Tennis Women's Division

(Kristine Marie D. Romallosa, Mary Jane C. Manrique, Ivy Angelica A. Nuñez and Genie Belle M. Bulaong)

2nd Place in the Philippine Sports Commission Inter Government Agency Sports Festival as the Representative of the Department of Science and Technology

PNRI RECOGNITION AWARDS

The Program and 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.

2018 GAWAD KAGALINGAN AWARD



Irradiation Services Team

(From left to right) Franklin A. Pares, James Harold M. Guillermo, Geoffrey O. Tranquilan, Arnaldo R. Valenzuela, Haydee M. Solomon, Crisol P. Villanueva, Andrea G. Baule, Aurelio L. Maningas, Giuseppe Filam O. Dean, Eduardo M. Moog and Francis Cyril C. Valdez

Gawad Kagalingan Award

In recognition of the team's outstanding contribution in the troubleshooting and maintenance of the Multipurpose Irradiation Facility which resulted to more satisfied customers and savings for the Institute

Gawad Kagalingan Award – 1st Runner Up

In recognition of the team's contribution in the development of the National Dose Registry and an information system for paperless monitoring of client records



Radiation Protection Services Section Laboratory Team

(From left to right) Ave Anne Nikolle M. Garalde, Lenlen S. Desoloc, Marianna Lourdes Marie L. Grande, Kristine Marie D. Romallosa, Abelardo A. Inovero, Ronald E. Piquero, and Jhenize Carvina A. Fernandez (not in photo)

PNRI DIVISION AWARDEES

For contributing greatly to the accomplishment of the division's functions and goals



Atomic Research Division (ARD)

Outstanding Senior Technical Staff

Abigaile Mia V. Javier
Science Research Specialist II
Agriculture Research Section



Outstanding Junior Technical Staff

Jorge R. Sahagun
Science Research Specialist I
Agriculture Research Section



Nuclear Services Division (NSD)

Outstanding Senior Technical Staff

Editha A. Marcelo
Senior Science Research Specialist
Radiation Protection Services Section



Nuclear Regulatory Division (NRD)

Outstanding Senior Technical Staff

Luzviminda L. Venida
Senior Science Research Specialist
Inspection & Enforcement Section



Technology Diffusion Division (TDD)

Outstanding Senior Technical Staff

Justina S. Cerbolles
Information Officer III
Nuclear Information & Documentation Section



Outstanding Junior Technical Staff

Sunrise B. Galan
Science Research Specialist I
Management Information System Section



Finance and Administrative Division (FAD)

Outstanding Senior Administrative Staff

Hershy Lou C. Santos
Administrative Officer V
Property and Procurement Section



Outstanding Junior Administrative Staff

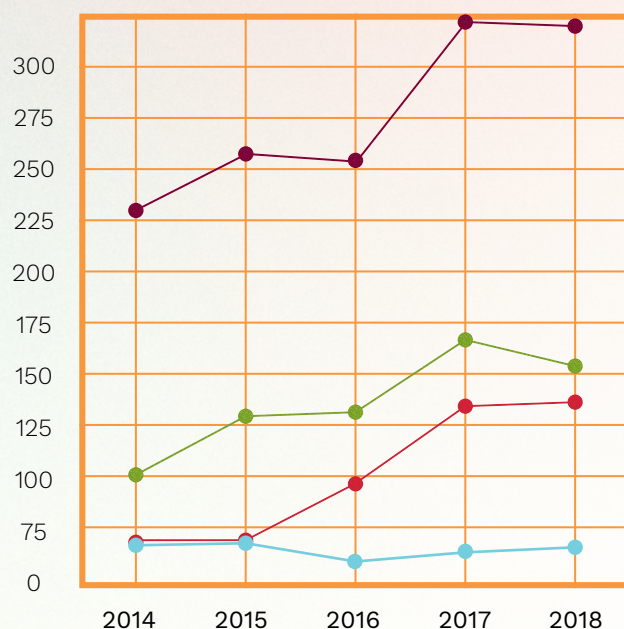
Desiree V. Ayo
Administrative Assistant I
Finance and Administrative Division

FINANCIAL RESOURCES

This year, PNRI had a budget allotment of Php344,897,000.00 by class and Php143,525,000.00 by major final output. The Institute generated an annual income of Php2,033,948.00 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



Legend:

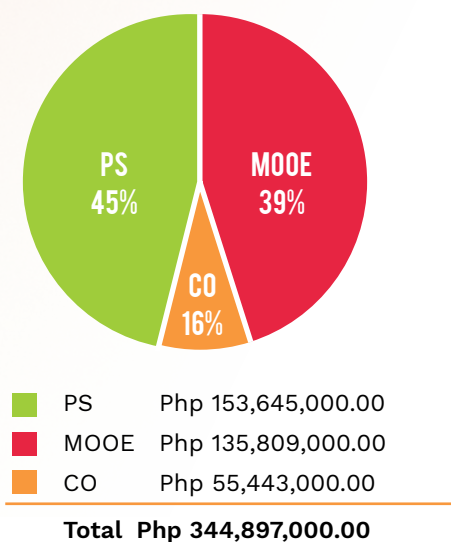
- PS (Personal Services)
- MOOE (Maintenance & Other Operating Services)
- CO (Capital Outlay)
- Total

YEAR	PS	MOOE	CO	TOTAL
2014	101,931,000	65,065,000	62,933,000	229,929,000
2015	129,813,000	65,194,000	63,000,000	258,007,000
2016	131,949,000	93,839,000	30,865,000	256,653,000
2017	163,348,000	132,858,000	49,872,000	346,078,000
2018	153,645,000	135,809,000	55,443,000	344,897,000

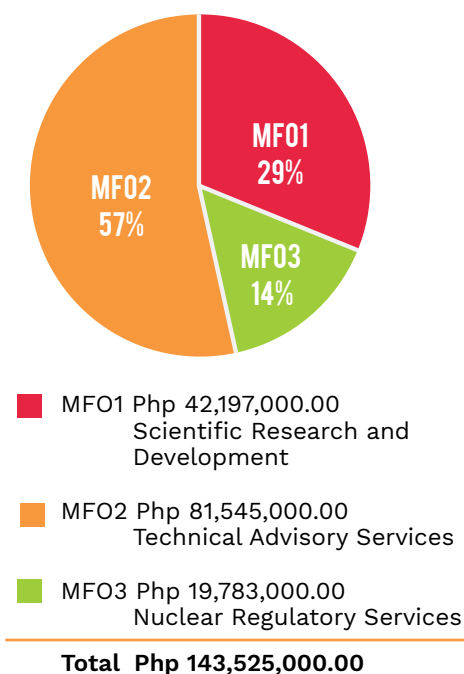
ADDITIONAL RESOURCES GENERATED FROM EXTERNAL SOURCES 2018

GRANT	AMOUNT
Local Grants-in-Aid	85,090,607
Foreign Grants	5,219,075
TOTAL	90,309,682

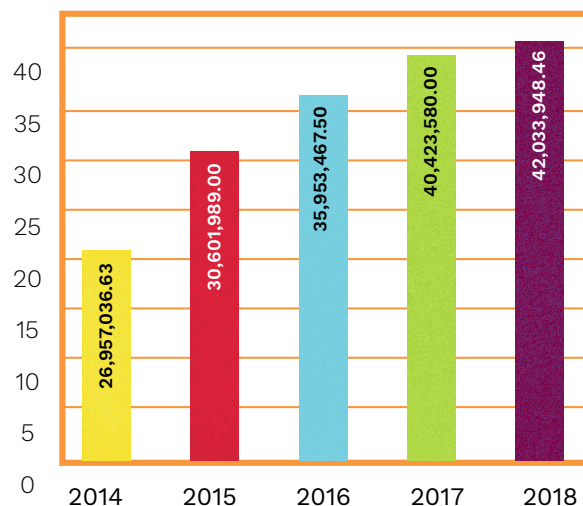
2018 ALLOTMENT BY EXPENSE CLASS



2018 EXPENDITURES BY MAJOR FINAL OUTPUT (MFO)



INCOME FROM PNRI SERVICES • 2018



SOURCE OF INCOME	INCOME GENERATED (IN PESOS)	SOURCE OF INCOME	INCOME GENERATED (IN PESOS)
A. NUCLEAR PERMITS AND LICENSES	6,150,725.00	B. SERVICE INCOME - Other Service Income (Continuation)	
Licensing Fees	2,711,625.00	Radioactivity Analysis	3,805,660.00
Permit Fees	3,439,100.00	• Gammametric Analysis	330,360.00
Transport Certificate	3,158,500.00	• Gross Alpha-beta Analysis	3,475,300.00
Release Certificate	273,600.00	Biological Test	54,350.00
Certificate of Exemption	7,000.00	• Cytogenetic Analysis	12,250.00
B. SERVICE INCOME	35,866,423.46	• Sterility Test	32,600.00
Inspection Fees	1,136,250.00	• Bioburden Test	7,000.00
Fines & Penalties	491,671.76	• Aerobic Plate Count	750.00
Other Service Income	34,238,501.70	• Mold and Yeast Count	1,750.00
Radiation Protection Services	23,883,981.70	Radioanalytical and Related Tests	827,150.00
• Monitoring Films/OSL/TLD and Cassettes	19,757,446.70	• Vinegar Adulteration	24,000.00
• Calibration	2,413,835.70	• Radon Analysis	801,800.00
• Leak Test/Spent-Sealed Sources	230,900.00	• Elemental Analysis	1,350.00
• Swipe Test	762,950.00	Tracer Technique Services (Column Scanning)	180,000.00
• Radiation Monitoring Hazards Evaluation	48,500.00	C. BUSINESS INCOME	16,800.00
• Rental of Survey Meter	582,300.00	Sale of CPR Compilation (Specific Part)/Infopac	1,200.00
• Repair of Survey Meter	20,800.00	Use of Dose Calibrator	3,200.00
• Radioactive Waste Management (Waste Storage/Disposal/Temporary Storage)	67,250.00	Use of Diagnostic Instrument/ Rotary Evaporator	2,400.00
Gamma Irradiation Services (Use of Cobalt-60 Facility)	5,487,360.00	Miscellaneous	10,000.00
		TOTAL INCOME	42,033,948.46

ADDITIONAL RESOURCES GENERATED FROM EXTERNAL SOURCES • 2018

PROJECT TITLE	AMOUNT		PNRI PROJECT LEADER	FUNDING AGENCY*
	LOCAL	FOREIGN		
US DOE/BATTELLE and PNRI in Support of the Global Threat Reduction Initiative Project		231,973	Julieta Seguis	US-DOE
Strengthening Adaptive Climate Change Strategies for Food Security through the Use of Food Irradiation		91,500	Zenaida De Guzman	CRP-IAEA
Development and Characterization of Packaging Materials for Irradiated Food Products		144,512	Lucille Abad	CRP-IAEA
Assessment of the Levels, Distribution and Effects of Natural and Anthropogenic Radionuclides in the Philippine Marine Environment		240,933	Eliza Enriquez	CRP-IAEA
Assessing the Impact of Mining and Industrial Activities on Air Quality and Surrounding Environment in Areas in Mindanao and Luzon, Philippines		410,881	Preciosa Corazon Pabroa	CRP-IAEA
Physical Protection Security Upgrades for PNRI		457,627	John Marquez	DFATD-Canada
Comprehensive Nuclear-Test Ban Treaty Organization (CTBTO)		3,641,650	Paolo Tristan Cruz	CTBTO
Tracing the Pathways of Mercury Concentration in Mined-Out Area	9,802,926		Jessie Samaniego	DOST
Enhancing OneLab for Global Competitiveness - RDIs Component (PNRI)	6,377,434		Preciosa Corazon Pabroa	DOST
Upgrading of the PNRI Cytogenetic Biological Dosimetry Capability for Nuclear Incident Preparedness and Other Related Services	354,570		Celia Asaad	PCHRD
Detection of Adulteration in Philippine Honey using Carbon-13 Isotope Analysis	270,091		Angel Bautista VII	PCIEERD
Upgrading of the PNRI Nuclear Training Center Laboratory Facility	4,000,000		Daisy Badilla	PCIEERD
Air Particulate Matter: Characterization by Elemental and Isotopic Fingerprinting of Organic and Inorganic Pollution Sources and Possible Mitigation Measures by Electron Beam Technology	335,018		Preciosa Corazon Pabroa	NRCP
Assessing the Naturally Occurring Radioactive Materials (NORM) of Soils in the Rice Fields of Aliaga and Bongabon in Nueva Ecija	622,485		Arvin Jagonoy	PCAARRD

ADDITIONAL RESOURCES GENERATED FROM EXTERNAL SOURCES • 2018

(continuation)

PROJECT TITLE	AMOUNT		PNRI PROJECT LEADER	FUNDING AGENCY*
	LOCAL	FOREIGN		
Screening for Radionuclide Contamination from the Fukushima Accident by Iodine-129 Measurement in Corals from the Philippines	2,613,921		Angel Bautista VII	PCAARRD
Multi-location Trials of Oligo-Carrageenan for Improved Productivity of Mungbean and Peanut in Region II, III, VII and X	265,058		Fernando Aurigue	PCAARRD
Radiation-induced Grafting of Nonwoven Fabrics for Tanning Industry Waste Water Treatment to Meet Class C Effluent Heavy Metal Standards	157,785		Jordan Madrid	PCAARRD
Field Verification Testing on Carrageenan Plant Growth Promoter for Enhance Growth and Induced Pest and Disease Resistance in Rice and Corn	12,000,000		Lucille Abad	PCAARRD
Development of Unit Dose Dispensing Capability of Tc ^{99m} Radiopharmaceutical Kit Facility	2,708,542		Adelina Bulos	PCHRD
Development of an Animal Model for Use in Radiation Research and Establishment of the Radiation Biology Research Center: Core Facility for Radiobiological Research	2,205,080		Chitho Feliciano	PCHRD
Development of Novel Nanomedicine (Redox Nanoparticles) for the Protection of Radiotherapy Patients and Nuclear Workers	19,454,226		Chitho Feliciano	PCHRD
Development of a GMP Compliant Laboratory for the Manufacture of Radiopharmaceutical Cold Kits	3,245,677		Maria Teresa Borrás	PCHRD
Shabu Profile Mapping Using Nuclear and Isotopic-based Analytical Techniques	953,982		Preciosa Corazon Pabroa	PCHRD
Development of a Passive Neutron Spectrometry System	4,099,584		Alvie Astronomo	PCIEERD
The Use of Radon Technique in Mapping Geological Faults in the Philippines	2,376,536		Angelito Ramos	PCIEERD
National Training Course in Nuclear Medicine Applications in Neurology	250,000		Nydia Medina	PCIEERD

ADDITIONAL RESOURCES GENERATED FROM EXTERNAL SOURCES • 2018

(continuation)

PROJECT TITLE	AMOUNT		PNRI PROJECT LEADER	FUNDING AGENCY*
	LOCAL	FOREIGN		
Development and Application of Isotope-Based Methodologies for Authenticity of Major Condiments (Vinegar, Soy Sauce and Catsup) in the Philippines	4,560,327		Raymund Sucgang	PCIEERD
Characterization and Separation of Heavy Minerals in the Alluvial and Beach Sands in San Vicente, Northwestern Palawan: Phase I	488,200		Rolando Reyes	PCIEERD
Extraction of Radionuclides, Rare Earths, and Other Valuable Industrial Elements from Philippine Phosphogypsum Tailings	2,839,933		Rolando Reyes	PCIEERD
Improvement of the Recommended Sugarcane Varieties Using Nuclear Technology and Biotechnology	1,710,358		Jorge Sahagun	SRA
2018 National Science and Technology Week Celebration	200,000		Rhodora Leonin	TAPI
Strategic Communication Approaches to Boost the Philippine Nuclear Research Institute Promotions: Year 1	3,198,874		Rhodora Leonin	PCIEERD
TOTAL	85,090,607	5,219,075		

*Funding Agency	
US-DOE - United States Department of Energy	PCIEERD - Philippine Council for Industry, Energy, & Emerging Technology Research and Development
CRP-IAEA - Coordinated Research Project - International Atomic Energy Agency	NRCP - National Research Council of the Philippines
DFATD-Canada - Department of Foreign Affairs, Trade and Development Canada	PCAARRD - Philippine Council for Agriculture, Aquatic and Natural Resources Research & Development
CTBTO - Comprehensive Nuclear Test Ban Treaty Organization	SRA - Sugar Regulatory Administration
DOST - Department of Science and Technology	TAPI - Technology Application and Promotion Institute
PCHRD - Philippine Council for Health Research & Development	

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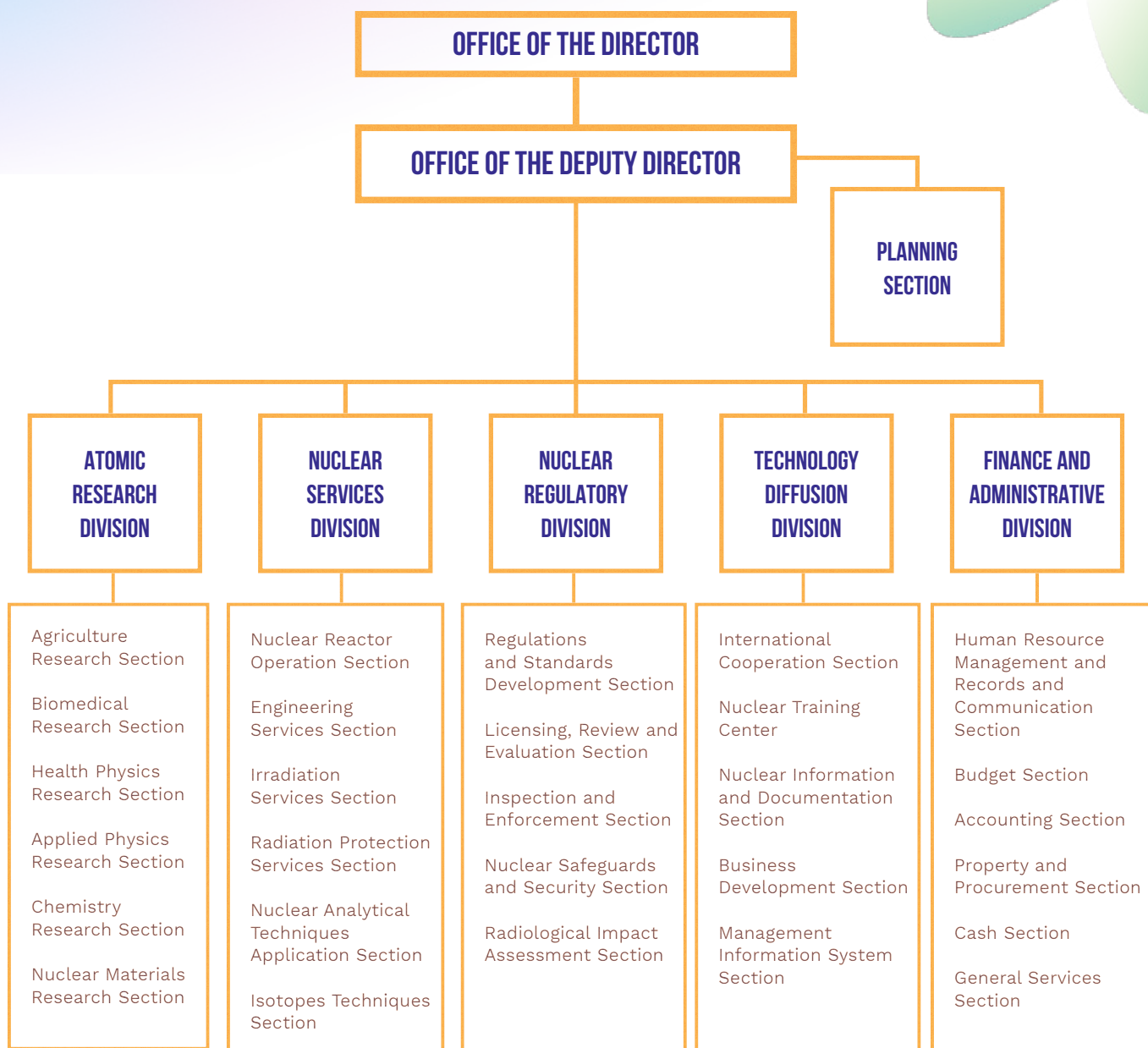
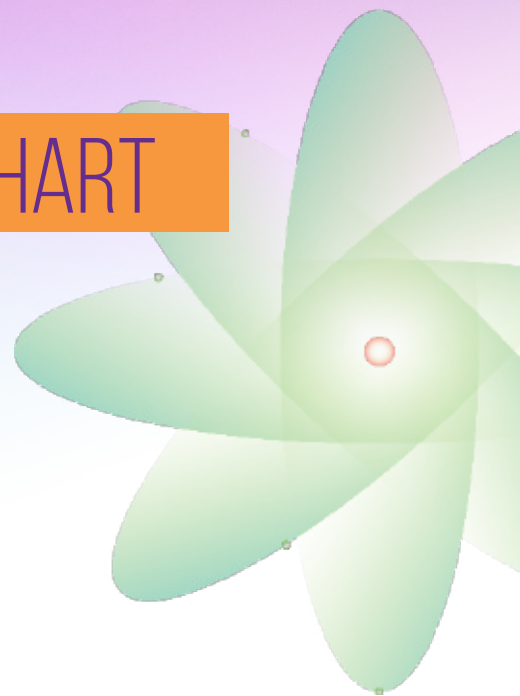
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