SECONDARY STANDARD DOSIMETRY LABORATORY PROFILE

RADIATION PROTECTION SERVICES SECTION
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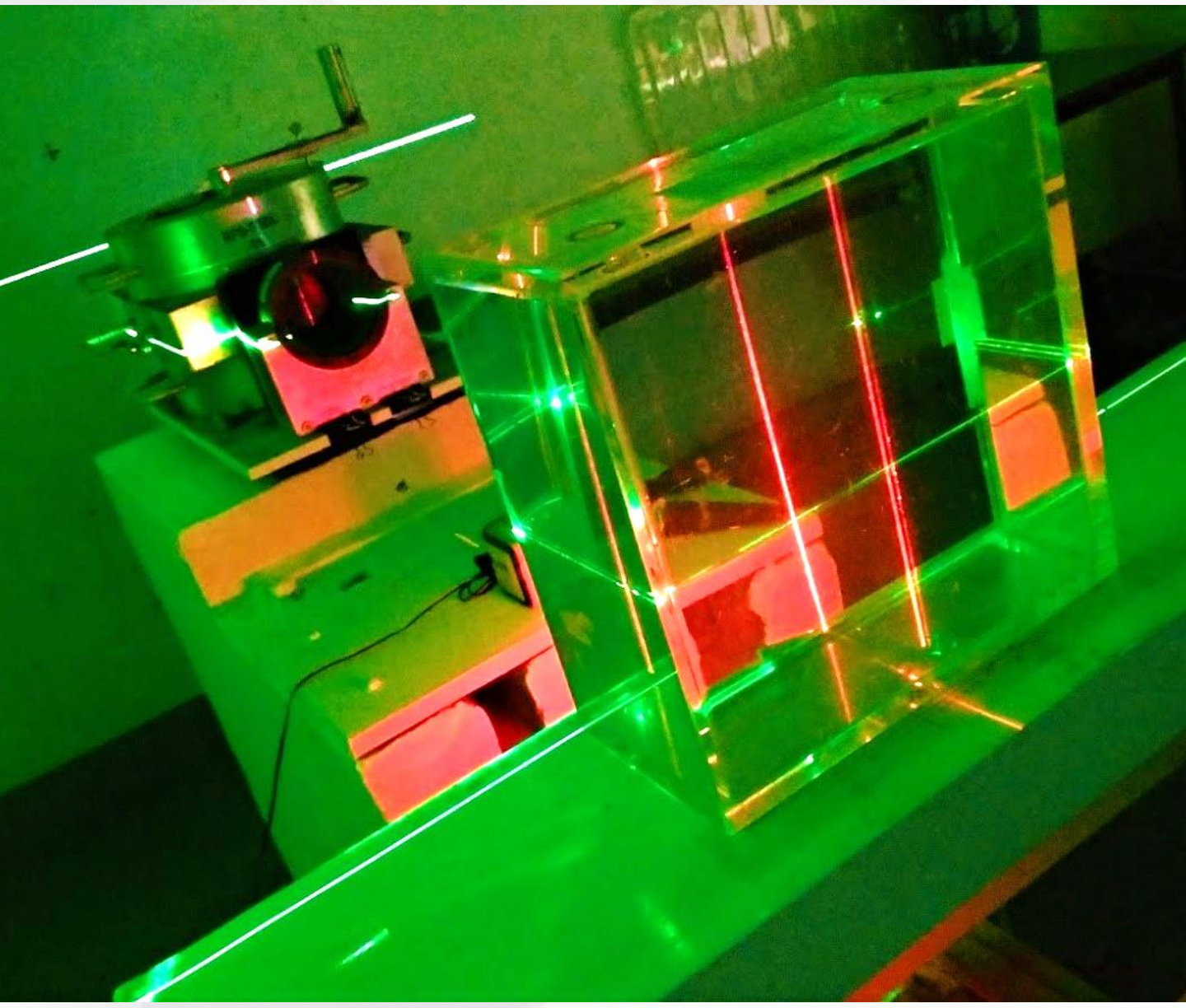


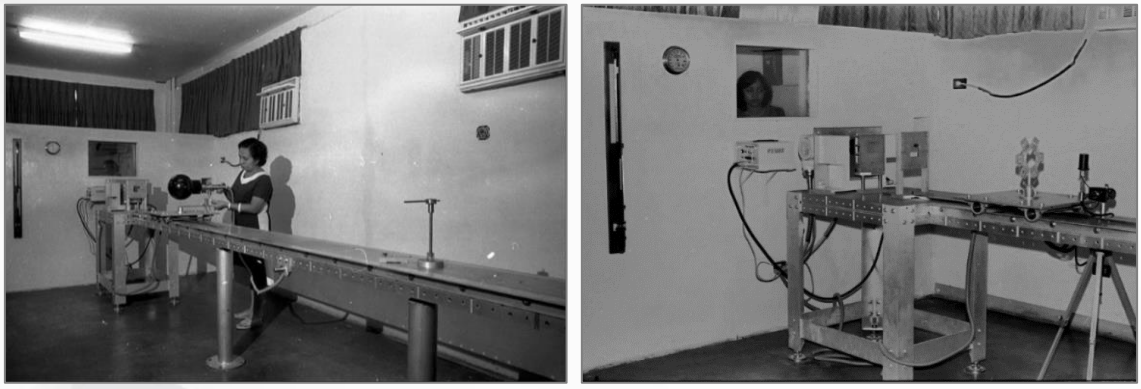
INTRODUCTION

The Secondary Standard Dosimetry Laboratory of the Philippine Nuclear Research Institute (PNRI-SSDL) establishes and maintains the metrological standards for protection level of ionizing radiation in the Philippines. The methods employed by the laboratory are according to international recommendations.

The laboratory currently holds the protection level standard for gamma and neutron radiation in the country; offers output measurement of brachytherapy well-type chambers traceable to primary standards; and harmonizes dose calibrator activity meters using reference sources traceable to primary standards.

HISTORICAL OVERVIEW

In 1977 when PNRI was still the Philippine Atomic Energy Commission, the SSDL was established to provide calibration services for users of radiation detection devices in the Philippines. The laboratory was established through the International Atomic Energy Agency (IAEA) Technical Assistance where the first equipment installed included a Picker 125 kVp, 200 mA X-ray machine setup for protection level measurements, as well as the NPL 2550 Secondary Standard protection level dose rate meter.



The SSDL showing (L) kerma measurements and (R) film badge irradiation of the Picker 125 kVp X-ray machine.

The SSDL is a member of the International Atomic Energy Agency – World Health Organization (IAEA-WHO) network of SSDLs that primarily provides dosimetry laboratory services for the calibration and standardization of units in radiation measurement in the country.

It aims to improve dosimetric accuracy in radiation protection; and promote the compatibility of methods applied for calibration and performance. This is to achieve uniformity of dosimetric measurements throughout the world. This also ensures the compliance of radiation protection and dosimetry practices of radiation facilities with international measurement standards and to protect the health, interest, and safety of every client and their environment from the harmful effects of inaccurate or false measurements.

HISTORICAL OVERVIEW

In the Philippines, the PNRI-SSDL provides the following services:

a) Calibration of radiation monitoring instruments and dosimeters

b) Output calibration of brachytherapy and dose calibrators; and

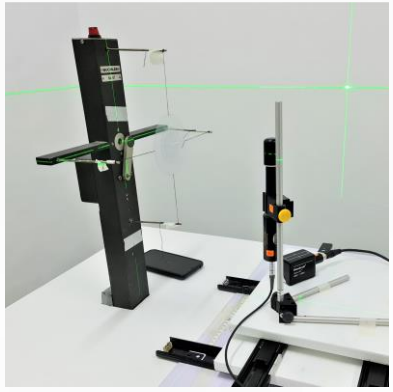
c) Radiation monitoring and dose quality audits of radiation facilities

Through the years, the laboratory has expanded its services to provide output measurements of medical devices such as brachytherapy sources and cross-calibration of well-type brachytherapy ionization chambers. The laboratory also calibrates dose calibrator activity meters using primary standard-traceable resin type sources to harmonize nuclear medicine equipment all over the country. In addition, several radiation qualities have been developed and established to calibrate different types of radiation monitoring instruments for protection of workers in the Philippines

Calibration of dose calibrator activity meters

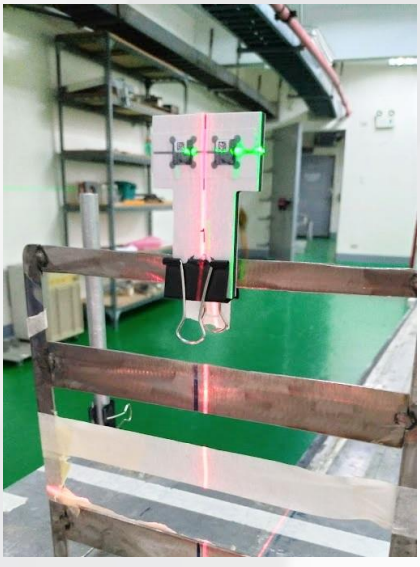
Calibration of radiation protection instruments

Calibration of neutron survey meter



Beam profiling of a beta field

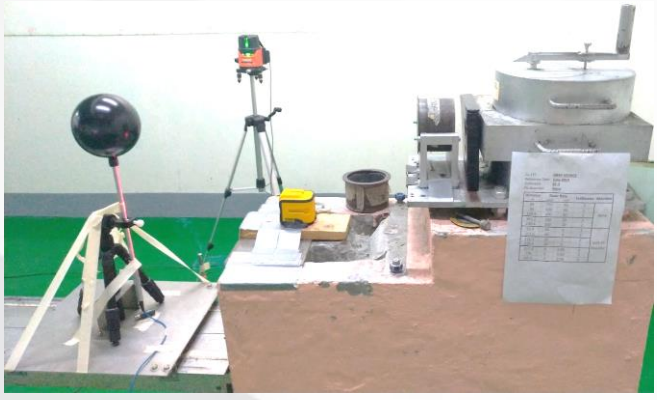
CURRENT SSDL ACTIVITIES



CALIBRATION OF PROTECTION LEVEL GAMMA AND NEUTRON RADIATION MONITORING INSTRUMENTS

One of the main activities of the SSDL is to provide protection level calibration services for gamma or neutron survey meters, contamination meters, rate alarms, electronic personal dosimeters, and pocket dosimeters.

The radiation field of a Cesium-137 radioactive source is measured with a reference 1-Liter spherical ionization chamber in terms of kerma rate, traceable to the International Bureau of Weights and Measures (BIPM) through the IAEA SSDL. The kerma rate is then converted to ambient dose equivalent H*(10) (μSv/hr) to determine the response of the radiation protection instruments in the Cs-137 field. Conversion coefficients are as according to international recommendations (IAEA Safety Reports Series No. 16). The radiation protection instrument is then placed in the radiation field where the ambient dose equivalent rate was established to determine the response of the instrument.

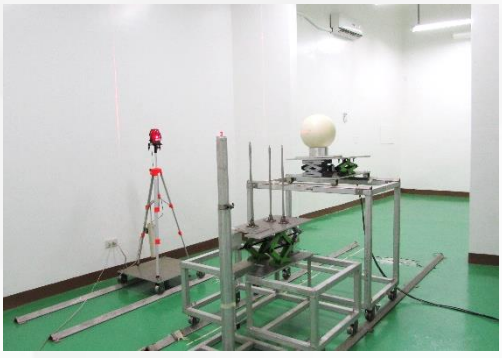


Reference 1-L spherical ionization chamber measuring kerma in the Cs-137 field.

SSDL staff positioning a survey meter in the Cs-137 field for response determination.

CALIBRATION OF PROTECTION LEVEL GAMMA AND NEUTRON RADIATION MONITORING INSTRUMENTS

The neutron fluence of a Californium-252 bare source is measured in total field and scattered field with a reference He-3 spherical proportional counter, traceable to the National Physical Laboratory (NPL), U.K., using the shadow cone technique as according to ISO 8529. The net fluence produces measurements in the primary field where the response of radiation protection instruments is obtained.



Reference He-3 spherical proportional counter in a 10" Bonner sphere measuring total field counts in a bare Cf-252 field.

Reference instrument measuring scattered field counts using the shadow cone.

Neutron survey meter in the total field of the bare Cf-252 for response determination

DEVELOPMENT AND ESTABLISHMENT OF NEW RADIATION FIELDS

The SSDL continuously endeavors to develop and establish new radiation fields to provide a wide range of protection level calibrations. The newest radiation fields being developed is focused on the lower energy range that focuses on the diagnostic level from 80 keV – 200 keV.

Through the new Beta Radiation Laboratory and X-ray Laboratory, the SSDL can provide accurate calibrations for protection level instruments used in these energy ranges, ensuring the safety of radiation workers all over the country.

BETA RADIATION LABORATORY

Beta radiation is considered as external hazards for extremities (e.g. hands, eyes, etc) due to the amount of energy it imparts in a very short distance. This type of radiation can penetrate the skin up to a depth of 0.07 mm, and the lens of the eye up to 3 mm. International regulations require the monitoring the skin dose $H_P(0.07)$ and the lens dose $H_P(3)$.

Standardizing the beta radiation field for ambient dose equivalent H(0.07)*

Reference beta survey meter traceable to a primary standard laboratory (AIST)

The Beta Radiation Laboratory aims to provide absorbed dose rate calibration for workplace monitoring instruments and personal skin dose equivalent $H_P(0.07)$ calibration for whole-body and extremity dosimeters. The reference radiation field used is Strontium 90 in accordance with ISO 6980 *Nuclear energy – Reference beta-particle radiation.* A reference beta survey meter traceable to the National Institute of Advanced Industrial Science and Technology (AIST).

SSDL Staff removing the build up cap of the reference instrument for beta radiation field measurements.

X-RAY LABORATORY

The X-ray Dosimetry Laboratory under the SSDL Photon Laboratory aims to provide calibration services for protection-level dosimeters and rate dosimeters to determine their response as a function of photon energy range from 65 keV to 160 keV. It is important to calibrate protection level instruments at these energies because majority of occupational hazards from medical facilities are in the conventional diagnostic energy range.

SSDL Staff positioning copper filters along the x-ray beam for field HVL measurements according to ISO 4037:1996 Narrow Spectrum Series.

The SSDL x-ray facility houses a 225 kVp continuous potential x-ray machine manufactured by Willick Engineering X-ray Systems. The x-ray field is established according to ISO 4037:1996 *X and gamma reference radiation for calibrating dosimeters and doserate meters and for determining their response as a function of photon energy*. The reference instrument is a PTW 1L spherical ionization chamber (LS-01 32002) traceable to the BIPM through the IAEA SSDL.

The x-ray field

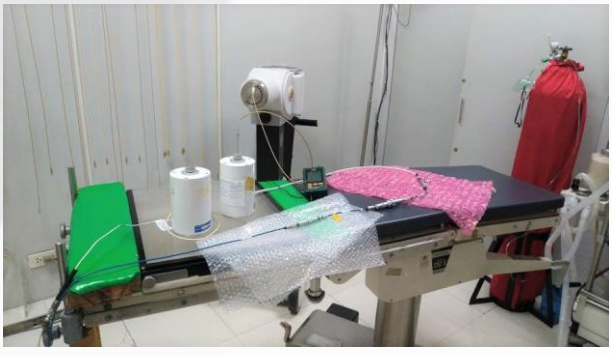
CONTINUOUS IMPROVEMENT OF CURRENT SSDL SERVICES

The SSDL continues to improve the services provided to radiation facilities all over the country. The laboratory further develops the existing radiation facilities and human resource capabilities of the SSDL staff, and ensure accuracy of measurements through regional and international intercomparison activities and audits.

OUTPUT MEASUREMENT AND CALIBRATION OF RADIOTHERAPY EQUIPMENT

Radiotherapy facilities use radioactive sources using brachytherapy techniques where the source is placed inside or near the tumor site to deliver a dose to kill the cancer cells. The SSDL provides output measurement of brachytherapy sources and cross-calibration of well-type brachytherapy chambers with the Standard Imaging HDR 1000 Plus secondary standard traceable to the primary standard laboratory Psysikalish-Technische Bundesanstalt (PTB) in Germany. The SSDL reference chamber is calibrated for Iridium 192 and Cobalt 60.

SSDL staff positioning the reference brachytherapy chamber for source output measurement



Cross-calibration of a hospital brachytherapy ionization chamber (L) against the SSDL reference chamber

HIGH INTENSITY CESIUM-137 IRRADIATION FACILITY UPGRADE

Due to the decay of the Cs-137 source for calibration of instruments, the Cs-137 Facility is currently undergoing an upgrade to install a new source for faster and easier calibrations to address the increasing volume of protection level instruments being calibrated by the laboratory. The new irradiator can be controlled in automatic mode by the operator, and a higher activity source ensures faster irradiation of personal dosimeters for calibration.

SSDL IRRADIATION AND TESTING SERVICES

The SSDL has widened its capability of irradiation and testing services in the existing reference photon, neutron, and beta radiation fields. The SSDL now offers irradiation of dosimeters, doserate meters, detectors, and materials for various tests and traceability services. These services support personnel monitoring services, industrial facilities, and research students.

Personal dosimeters being irradiated for blind testing of personal dosimetry systems (Left: Optically-stimulated luminescent dosimeters; Right: Thermoluminescent dosimeters)

Samples placed in front of the Cs-137 irradiator for shielding effectivity testing. A doserate meter placed at a fixed distance from the source to measure the effectivity of the samples.

ENSURING ACCURATE MEASUREMENTS

The SSDL is part of the IAEA SSDL Dosimetry Network and participates in dosimeter postal audits conducted every three years. The objective of the audit is to harmonize the output measurement of SSDL calibration fields. The data table below shows the output response of dosimeters irradiated in the SSDL field and dosimeter responses show acceptable results of the SSDL calibration fields.

IAEA Postal Audit (2020) OSLDs irradiated in air at 1 meter from the Cesium-137 radioactive source for reference air kerma measurements.

IAEA
International Atomic Energy Agency
Atoms for Peace

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IAEA OSLD POSTAL QUALITY AUDIT FOR RADIATION PROTECTION CALIBRATIONS, FOR SSDLs

Institution: *Philippine Nuclear Research Institute (PNRI-SSDL)*
Address: *Commonwealth Avenue, Diliman, Quezon City*
Country: *Philippines*

OSLD batch No: *RP17*
OSLDs irradiated by: *Romallosa*
Date of irradiation: *2017-05-24*
Date of evaluation: *2017-10-06*

RESULTS OF OSLD AIR KERMA MEASUREMENTS FOR Cs-137

Radiation unit	Beam	OSLD set #	User (stated) air kerma [mGy]	IAEA (measured) air kerma [mGy]*	IAEA mean air kerma [mGy]	% deviation relative to IAEA mean air kerma**	IAEA mean air kerma / User stated air kerma
NIEN #C5-492	*Cs-137*	*RP1702*	*5.00* *5.00*	*4.89* *5.01*	*4.95*	*1.0*	*0.99*

* The relative combined standard uncertainty in the OSLD measurements of the air kerma is 1.5%.

** % deviation relative to IAEA mean air kerma = 100 x (User stated air kerma - IAEA mean air kerma)/ IAEA mean air kerma. A relative deviation with negative (positive) sign indicates that the user estimates lower (higher) air kerma than what is measured.

Agreement within +/-7% between the user stated air kerma and the IAEA measured air kerma is considered satisfactory.

PNRI SSDL intercomparison results from 2017 showing 1% acceptability of the Cs-137 radiation field compared to the BIPM primary standard laboratory.

ORGANIZATION OF THE SECONDARY STANDARD DOSIMETRY LABORATORY

	Photon Laboratory		Beta Laboratory	Neutron Laboratory
	Gamma Laboratory	**X-ray Laboratory**		
Radiation Field	Cs-137	Narrow Spectrum Series	Sr-90	Cf-252 Am241/Be
Traceability	BIPM	BIPM	AIST	NPL
Provided Services	Calibration of Radiation Monitoring Instruments Testing and Irradiation of Materials and Devices			

REFERENCE INSTRUMENTS AND TRACEABILITY

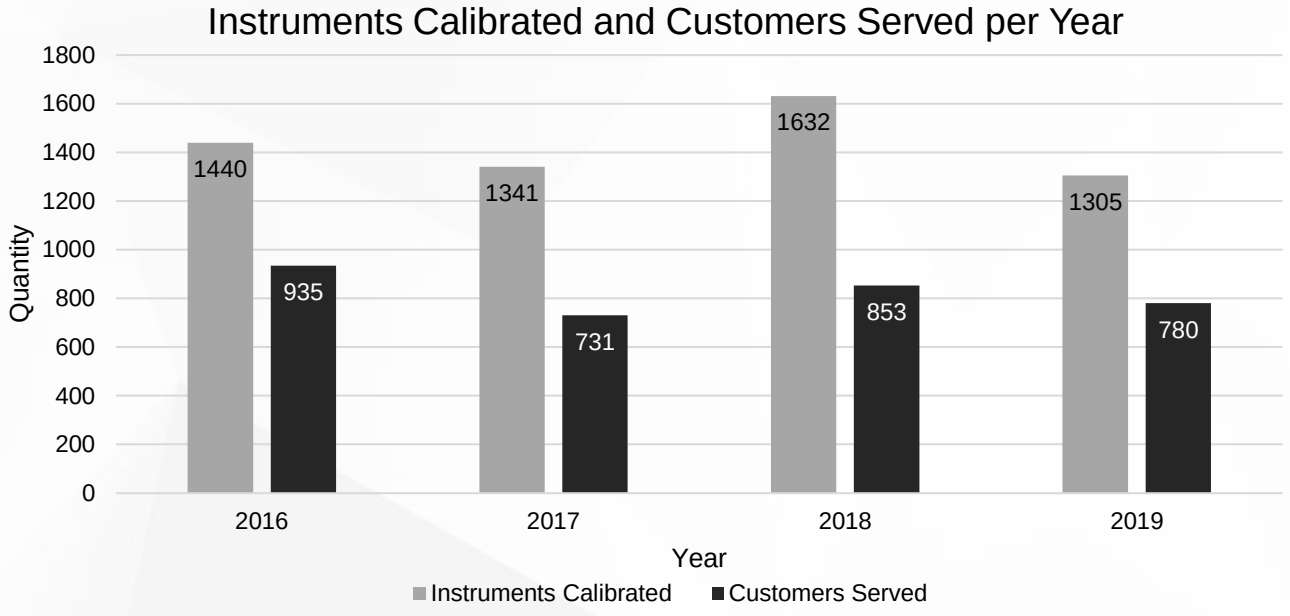
Instrument	Use	Radiological Quantity	Radiation Quantity	Traceability
LS-01 1-Liter Spherical Ionization Chamber	Protection Level Dosimetry	Air Kerma	Cs-137, Co-60, ISO 4370 Narrow Spectrum Series	BIPM (through IAEA SSDL)
SP9 He-3 Spherical Proportional Counter in a 10" Bonner Sphere	Protection Level Dosimetry	Fluence	Cf-252, AmBe	NPL
HDR Well-type Ionization Chamber	Brachytherapy	Air Kerma	Cs-137, Ir-192, I-125	University of Wisconsin SSDL
A3 Spherical Ionization Chamber	Diagnostic Level Dosimetry	Air Kerma	RQR	PTB (through IAEA SSDL)
A4 Spherical Ionization Chamber	Diagnostic Level Dosimetry	Air Kerma	RQA	PTB (through IAEA SSDL)
Beta Reference Survey Meter	Protection Level Dosimetry	Absorbed Dose Rate	Sr-90	AIST

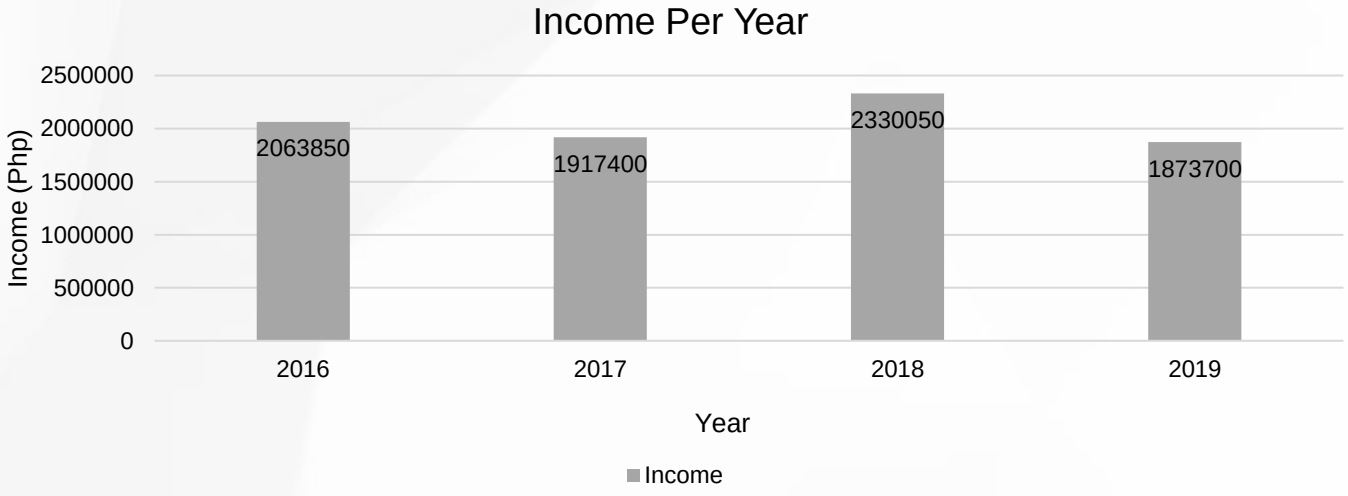
REFERENCE SOURCES, AND TRACEABILITY

Nuclide	Use	Traceability
Cs-137	Harmonization of Dose Calibrator Activity meters	NIST
Ba-133		
C-60		
Cs-137 (planar)	Calibrate alpha and beta/gamma counters for determination of minimum detectable level	NIST
Cs-137 (planchet)		PTB
Sr-90		
C-14		
Am-241		

SSDL ACCOMPLISHMENT

Year	Instruments Calibrated	Customers Served	Income (Php)
2016	1,440	935	2,063,850
2017	1,341	731	1,917,400
2018	1,632	853	2,330,050
2019	1,305	780	1,873,700





PUBLICATIONS AND CONFERENCE PAPERS

Title	Journal/Conference
Sensitivity of Radiation Monitoring Systems in Manila Ports in Detecting Contamination in Foodstuff Shipments	Philippine Nuclear Journal
Preliminary Calibration of thermoluminescent dosimeters (TLD) Used in Radiological Personnel Monitoring	Samahang Pisika ng Pilipinas Conference
Calibration of an Albedo Thermoluminescent Dosimeter Using a Cf-252 Source for Neutron Dose Monitoring in the Philippines	Samahang Pisika ng Pilipinas Conference
Experimental, Computational, and Analytical Methods for the Characterization of a Neutron Field for Calibration of Neutron Monitoring Instruments in the Philippines	Philippine Journal of Science
Dosimetric Uncertainty Analysis of the Optically Stimulated Luminescence Dosimeter System in the Philippines	14th International Congress of the International Radiation Protection Association
Establishment of a Neutron Dosimetry Facility for Protection Level Calibration in the Philippines	International Conference on Radiation Safety: Improving Radiation Protection in Practice
Improving Radiation Protection in Practice: From a Technical Service Provider (TSP) Standpoint	International Conference on Radiation Safety: Improving Radiation Protection in Practice
Neutron Dose Assessment of the Philippine Nuclear Research Institute SSDL – Neutron Laboratory using Albedo OSL Dosimeters	International Conference on Radiation Safety: Improving Radiation Protection in Practice
Effect of varying Cs-137 beam on the response of a radiation monitoring instrument (survey meter)	Samahang Pisika ng Pilipinas
Dose mapping of the cobalt-60 source facility at the Secondary Standard Dosimetry Laboratory of Philippine Nuclear Research Institute	Samahang Pisika ng Pilipinas
Dependence of Response of Personal Dosimeters on Different Calibration Methods	Philippine Journal of Science

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