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CONCEPTION OF CTMSP IONIZING RADIATION CALIBRATION LABORATORY

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ABSTRACT

The present paper describes the implantation process of an ionizing radiation calibration laboratory in a pre-existent installation in CTMSP (bunker) approved by CNEN to operate with gamma-ray for non destructive testing. This laboratory will extend and improve the current metrological capacity for the attendance to the increasing demand for services of calibration of ionizing radiation measuring instruments. Statutory and regulatory requirements for the licensing of the installation are presented and deeply reviewed.

1 INTRODUCTION

Currently, in Brazil there are seven laboratories for calibration of instruments for measuring ionizing radiation:

a. National Laboratory of Metrology of Ionizing Radiations (LNMRI), Institute of Radiological Protection and Dosimetry (IRD), Rio de Janeiro/RJ;
b. Nuclear Technology Development Center (CDTN), Belo Horizonte/MG.;
c. Federal University of Pernambuco (UFPE), Recife/PE;
d. Nuclear and Energy Research Institute (IPEN/CNEN), São Paulo/SP;
e. Radiological Sciences Laboratory of Rio de Janeiro State University (UERJ), Rio de Janeiro/RJ;
f. Radiation Monitors Calibration Laboratory of METROBRAS – Metrology Testing and Research Center, Jardinópolis/SP;
g. Radiation Monitors Calibration Laboratory of ELETRONUCLEAR – Eletrobrás Termonuclear S.A., Angra dos Reis/RJ.

The demand for calibrations of instruments for measuring radiation is increasing in the last years, especially in the region of São Paulo. Nowadays, the Institute for Energy and Nuclear Research (IPEN) and METROBRAS are responsible for the largest attendance to the demand for these services in this region of the country.

Currently, Centro Tecnológico da Marinha em São Paulo (CTMSP) is showing interest in developing and implementing a laboratory for calibration of instruments for measuring radiation in the Experimental Center ARAMAR, in the city of Iperó, region of Sorocaba, São Paulo state. This laboratory will extend and improve the infrastructure for metrology of ionizing radiation found in Brazil, aiming to meet the internal demand of CTMSP, the Brazilian Navy and the surplus of the national demand for such services.

2 OBJECTIVES

This paper aims to describe the general steps for implementing a laboratory for calibration of instruments for measuring radiation in CTMSP.

To achieve this objective, the following specific objectives must be met:

a. Description of the stages of expansion and improvement of building installation (bunker), pre-existent, approved by CNEN, which shall consist of the laboratory
b. Definition of calibration standards to be acquired for operation of the laboratory;
c. Licensing of the facility;
d. Implementation of the management system of the laboratory.

3 EXPANSION AND IMPROVEMENT OF BUILDING INSTALLATION (BUNKER)

A pre-existent building installation (bunker), approved by CNEN to work with radioactive sources of X-rays of 160 kV, 10 mA and sources of gamma-rays of iridium 192 with activity of 35 Ci (1.295 TBq) will be used to accommodate the Calibration Laboratory of Ionizing Radiation Measuring Instruments (LACIMRI), which will operate with a source of Cs-137 with activity of 30 Ci (1,110 TBq).

The improvement and adequacy of the building installation (bunker) consists of the following steps:

a. Environmental and electrical conditioning of the installation (air conditioning, humidity control, power supply control etc.);
b. Design and construction of arrangements for the performance of calibrations;
c. Implementation of calibration techniques;
d. Development of data acquisition systems and automation.

4 ACQUISITION OF CALIBRATION STANDARDS

The acquisition of calibration standards consists of the following equipments:

a. Gamma beam irradiator, single source, 30 Ci of Cs-137, as shown in Fig.1;
b. Linear positioning system, 2 axis, manual, 4 m x 30 cm, as shown in Fig.2;
c. Attenuator set. X2, X4, X10, X100. Pneumatic operation;
d. Laser alignment system;
e. Video camera and monitor;
f. Upgrade to computer control and automated software control;
g. Standard radiation detector - ionization chamber type.

Gamma irradiator will be imported, through the presentation of the "Import License for Radioactive Material and / or Generator Equipment of Ionizing of Radiation - SLI" to CNEN.

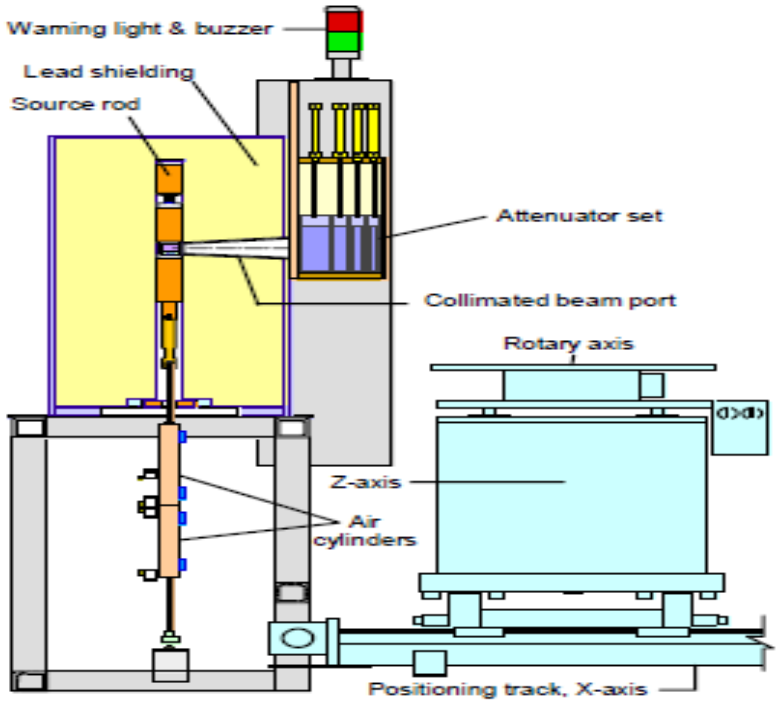

Fig. 1. Cross-Section of Source Gamma Beam Irradiator with Attenuator and Positioning Track.

Fig. 2. Linear positioning system, 2 axes.

5 LICENSING OF INSTALLATION

The licensing of the facility will follow the requirements of standard CNEN-NE-6.02 [1].

According to this standard, the facility which will accommodate the LACIMRI is classified as installation of Group III, which is an installation that uses sealed source not characterized as being of Group I (installations that use large sealed sources in industrial processes induced by radiation) nor of Group II (installations that use sealed sources in equipments used for radiotherapy or industrial radiography).

According to CNEN-NE-6.02 [1], LACIMRI must obtain a license to acquire radioactive material and a license to operate. Thus, according to an administrative act of CGMI/CNEN, the laboratory shall obtain a license to use a radioactive source and, according to an administration act of CASEC/IRD, the laboratory shall obtain a license to perform calibration services.

Authorization for the acquisition of radioactive material or other sources of radiation shall be granted upon proof that the design of the facility meets the conditions required by specific standards of CNEN, particularly those relating to the management of radioactive wastes.

The granting of authorization to operate will be given based on the following considerations:

a. The construction of the facility had been fully completed in accordance with the laws, regulations and norms and with the conditions of the Licenses of Construction and its additions;
b. There is evidence that the proposed operation will be conducted without radiological risk.

A safety report must be submitted to CNEN, including at least the following aspects, as applicable.

a. Final design of the facility;
b. Organization of staff and responsibilities;
c. Staff training plan;
d. Plan for conducting operations;
e. Quality assurance of the applicant and their contractors' products ;
f. Administrative controls to be applied during operation;
g. Emergency plan ;
h. Technical specifications to be adopted for operation;
i. Plan for physical protection in accordance with specific standards;
j. Radioprotection plan according to specific standards.

On September 8th, 2008, the public consultation process that revises and updates the standard CNEN-NE-6.02, an experimental standard, into the standard CNEN-NN-6.02, a nuclear standard, was closed. Derived from this public consultation, the draft standard CNEN-PN-6.02 [2] was elaborated in 2008.

According to draft standard CNEN-PN-6.02:2008 [2], the LACIMRI radioactive facility is classified as Group III-C that applies to facilities that use or store sealed sources, including those for distribution purposes, other than facilities that use sealed sources in large industrial processes induced by radiation or in equipments.

Thus, in accordance with this draft standard, the laboratory will require, in addition to the authorization for the acquisition of radioactive material and to the authorization for operation, a license for withdrawal of operation.

The radioactive facilities that decide to terminate their activities shall request to CNEN the cancellation of the authorization to operate, on a request accompanied by at least the following information, supported by a plan of withdrawal of operation, in addition to compliance with provisions contained in specific standards:

a. Brief history of the facility;
b. Inventory of radioactive materials and or emitting ionizing radiation equipments;
c. Technical procedures to evaluate the levels of radiation and for the decontamination of areas, surfaces and equipments, as applicable;
d. Destination to be given to radioactive materials and other sources of radiation;
e. Technical and administrative procedures for the total decontamination of the facility, as applicable;
f. Management program of wastes generated in the process of decontamination, as applicable;
g. Destination to be given to the records to be kept.

6 IMPLEMENTATION OF THE LABORATORY MANAGEMENT SYSTEM

The laboratory will implement a management system in accordance with the requirements of standard ISO / IEC 17025:2005 [3] and with the document of the National Laboratory of Metrology of Ionizing Radiation - LNMRI, "Requirements for the Operation of Calibration Laboratories of Ionizing Radiation Measuring Instruments used in Radioprotection" [4], issued in 2004.

6.1 ISO/IEC 17025:2005 [3]

This standard specifies the general requirements for the competence to carry out tests and/or calibrations, including sampling. It covers testing and calibration performed using standard methods, non-standard methods, and laboratory-developed methods.

This standard is applicable to all organizations performing tests and/or calibrations and for use by laboratories in developing their management system for quality, administrative and technical operations.

It comprises two main chapters, Chapter 4, which provides management requirements, and Chapter 5 that provides technical requirements, as described bellow:

4. Management requirements

4.1 Organization;
4.2 Management system;
4.3 Document control;
4.4 Review of requests, tenders and contracts;
4.5 Subcontracting of tests and calibrations;
4.6 Purchasing services and supplies;

4.7 Service to the customer;
4.8 Complaints;
4.9 Control of nonconforming testing and/or calibration work;
4.10 Improvement;
4.11 Corrective action;
4.12 Preventive action;
4.13 Control of records;
4.14 Internal audits;
4.15 Management reviews.

5 Technical requirements

5.1 General;
5.2 Personnel;
5.3 Accommodation and environmental conditions;
5.4 Test and calibration methods and method validation;
5.5 Equipment;
5.6 Measurement traceability;
5.7 Sampling;
5.8 Handling of test and calibration items;
5.9 Assuring the quality of test and calibration results;
5.10 Reporting the results.

6.2 LNMRI - "Requirements for the Operation of Calibration Laboratories of Ionizing Radiation Measuring Instruments used in Radioprotection" [4]

This document establishes the technical requirements for the calibration of measuring instruments used in radiological protection.

These requirements apply to laboratories that wish to offer the following services:

a. Calibration of area monitors and personal monitors with gamma radiation;
b. Calibration of area monitors and personal monitors with X radiation;
c. Calibration of surface contamination monitors.

According to this document, a calibration laboratory candidate for an operation authorization must be legally constituted and its facilities located in national territory. The laboratory must meet the municipal, state and federal legislation related to safety and occupational health, and be duly licensed by the competent bodies. The radioactive installation of the laboratory must meet the requirements of CNEN radioprotection standards, and be duly licensed by CNEN responsible sector.

The laboratory shall consist of management and technical staff. The management staff shall be consisted of the laboratory director, of a person responsible for technical support (RT) and its substitute (RTS), and of a person responsible for administrative support (RA).

The director of the laboratory should have a position in the organizational structure that ensures the authority to conduct the operations of the laboratory free of any influence that adversely affects the quality or impartiality of the services offered. He is responsible for ensuring that the laboratory procedures are being followed, promote and record the

assessment of competence of the technical staff, checking and promoting training as necessary.

RT shall be responsible for verifying that the documented procedures are being followed properly and check the correct calibration of each instrument. Records of such conferences should be maintained and be available for audit.

RT is responsible for operating the laboratory, with full dedication and should have university level degree recognized by the Ministry of Education in scientific or technological area. He must demonstrate training or experience in the area of the authorization and be approved on an assessment examination of his technical capability. The same criteria apply to the substitute of the person responsible for technical support.

RA shall be responsible for the planning of services (according to criteria defined by RT and / or Director of the Laboratory), receipt and dispatch of instruments, as well as for the control and archiving of documents issued and received. He must be able to clarify all customers' doubts as to the progress of services, which are not strictly technical in nature.

The technical staff employed in calibration work, that is, the executor of the calibration, must have verified training and experience, be supervised by RT or his substitute, and follow documented procedures.

The laboratory should have sufficient places and space for fulfilling the following activities:

a. Receipt and storage of customers' instruments;
b. Exposure of instruments to be calibrated or irradiated in terms of radiological safety;
c. Processing of results and issue of reports;
d. Permanence of the laboratory technicians in the periods between calibrations;
e. Storage of radioactive sources in terms of radiological safety.

The laboratory should be located distant, or in any way isolated from electrical interference, radioactivity and electromagnetic sources, as well as other sources that interfere with the calibration of instruments.

The radiation environment of the laboratory should be kept at temperatures fairly uniform so as not to affect the accuracy of the calibration and ensure that a level of stability is reached before the start of the calibration. Its temperature must be maintained between the limits of 18° C and 26° C.

The relative humidity must be between the limits of 30 and 75 percent for routine operation of the laboratory.

The level of background radiation should be kept as low as possible, and not subject to variations that could significantly affect the work of calibration. The temporary storage of radioactive sources not used for calibration and with inappropriate shielding should be avoided.

The equipment available in the laboratory should be appropriate to the services offered and the procedures employed. The laboratory must have positioning systems for instruments and

sources, with rigid supports, enabling the reproduction of the desired source-detector geometry and minimal scattered radiation.

The laboratory facilities shall be operated in a secure manner so as to limit the exposure of operators to levels as low as practically possible and in accordance with the standards of radiological protection of the CNEN.

The laboratory should have a quality assurance system implemented as described by ISO/IEC 17025:2005, with accreditation granted by INMETRO.

The results of tests performed within the scope of the authorization must be formally notified to customers. A certificate or report shall be issued for each instrumentation item tested.

The laboratory should maintain the traceability of the calibration standards and participate in proficiency testing, depending on the scope of the authorization provided.

LACIMRI will provide services for calibrating gamma radiation area monitors and personal dosimeters. For this type of service, the document of LNMRI states that the laboratory should have at least a source of cesium-137, and meet requirements for radiation control (shielding of the source, collimation of the beam of radiation, exposure of the source), as shown in Fig.1.

In addition to the source of cesium-137 and associated control devices, according to this document, the laboratory must have at least the following equipment, properly calibrated, as applicable:

a. A standard ionization chamber suitable for the range of intensity and energy of photons for the services provided;
b. An electrometer to measure the load produced in the ionization chamber;
c. A stable power supply for the chamber polarization potential;
d. A thermometer with resolution of 0.1 ° C;
e. A barometer with resolution of 0.1 kPa;
f. A stopwatch with resolution of 0.01s;
g. A hygrometer with a resolution of 1% relative humidity;
h. A set of phantoms to simulate the thorax, the wrist and finger as specified in ISO 4037-3, if necessary;
i. A system for positioning of instruments in relation to the radioactive source compatible with the uncertainty of the calibration process. For settings in the irradiation beam, the positioning system should define the central axis of the beam range.

7 CONCLUSIONS

CTMSP Calibration Laboratory of Ionizing Radiation Measuring Instruments (LACIMRI) will attend the growing demand for calibration of ionizing radiation measuring instruments, both in the nuclear projects under development in CTMSP, as for the specific demands of health and industry sectors of the country.

As a consequence of the deployment of LACIMRI, it is expected to obtain, as results, the expanding of the provision of ionizing radiation measuring instruments calibration services,

attendance to a larger number of customers, improvement in the quality of services, provision of technology of ionizing radiation metrology in the region of Sorocaba, São Paulo state, training of personnel, and improvement of occupational safety conditions in the nuclear area.

LACIMRI will contribute to the expansion of the technological content of products and services of National Defense, aiming the enrichment of uranium, within the Brazilian Nuclear Program.

The deployment of LACIMRI will also contribute to the improvement of science, technology and innovation support infrastructure to programs and projects of National Defense in the nuclear area.

LACIMRI will provide a vehicle for integration of National Defense science, technology and innovation initiatives in the nuclear area, conducted in research and development military organizations, in civil institutes and universities, promoting the use of intellectual scientists and researchers, the sharing of laboratories and equipments and the rational use of financial resources.

ACKNOWLEDGMENTS

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