NUCLEBRAS

KFA

Centro de Desenvolvimento da Tecnologia Nuclear

SEMINÁRIO
PROTEÇÃO RADIOLÓGICA
E CONTROLE AMBIENTAL

8 a 12 de agosto de 1988

CALIBRATION AND DOSIMETRY AT CNEN/SÃO PAULO

Linda V. E. Caldas
Instituto de Pesquisas Energéticas e Nucleares
Comissão Nacional de Energia Nuclear

ABSTRACT

Seven different groups concerning calibration and dosimetry have developed own methods or have improved methods used at other institutions. The Calibration Laboratory performs calibration of instruments used at the Radiological Protection as well at the Radiotherapy level. The Nuclear Metrology Laboratory produces standard radioactive sources and solutions. The individual dosimetry group uses the photographic technique. The Radiotoxicological Laboratory analyses radioactive compounds in urine and blood, searching for possible internal contaminations. A whole-body counter is also used for internal dose evaluations. Thermoluminescent dosimeters ($CaSO_4$: Dy pellets) are produced for use at the institute and also for sale to the brazilian private dosimetry laboratories. Plastic scintillators are also produced, in order to substitute imported material. All groups are engaged in routine and research activities, offering any services concerning the related activities. Four PhD theses and seven MSc theses are under preparation.

CALIBRATION AND DOSIMETRY AT CNEN/SÃO PAULO

Linda V.E. Caldas
Instituto de Pesquisas Energéticas e Nucleares
Comissão Nacional de Energia Nuclear
São Paulo, Brazil

The calibration and dosimetry activities at the Radiological Department at CNEN/São Paulo are carried out by seven different groups, totalizing 17 researchers and 22 technicians. All groups are engaged in routine and research activities, offering any services concerning the activities. Four PhD theses and seven MSc theses are being developed. Two groups work in the calibration branch; they calibrate instruments and radioactive sources. Two other groups develop radiation detectors: dosimetric thermoluminescent materials and plastic scintillators. Three groups deal with individual monitoring: external and internal dosimetry ("in vitro" and "in vivo").

The Calibration Laboratory performs calibration of instruments used at Radiological Protection and at Radiotherapy level as well. Radiation monitoring instruments are calibrated utilizing standard radioactive sources in special experimental set-ups, with gamma radiation from ^{60}Co and ^{137}Cs and beta radiation from $^{90}Sr + ^{90}Y$, ^{204}Tl and ^{147}Pm. Clinical dosemeters may be calibrated against secondary standards (thimble and superficial chambers) with soft X-rays (60 kV) and gamma radiation from ^{60}Co and ^{137}Cs. Since 1980 the number of

calibrated instruments has increased from 170 up to 710 (1987). Among the main research projects, ionization chambers with parallel plates and made of materials commercialized in Brazil, for soft X-rays and beta radiation detection, are being developed at this Laboratory. The prototypes present good sensitivity to these radiations, low energy dependence and a very promising behaviour for substituting imported instruments. The Laboratory has been participating at the annual national intercomparisions for the secondary standards, organized by the Secondary Standard Dosimetry Laboratory of Brazil, Instituto de Radioproteção e Dosimetria, Rio de Janeiro.

The Nuclear Metrology Laboratory was founded in 1964 primarly for developing methods of standardization of solid and liquid radioactive sources. One of the main goals of the Laboratory has been to supply users at IPEN and other institutions with standard radioactive sources. The Laboratory has several measurement systems in operation able to calibrate solid or liquid sources in the range between tens of Bq up to GBq. For absolute activity measurements the Laboratory has a gas-flow and a pressurized 4π proportional counters, both can be operated in coincidence with NaI (Tl) detectors. Recently it was developed in the Laboratory another absolute system that uses surface barrier detectors operating in coincidence with NaI (Tl) thin window scintillation counters. For relative measurements, there are two well type ionization chambers (pressurized and non-pressurized), a Ge (Li) counter with well defined geometry and plane or well-type

NaI (Tl) scintillation counters.Research and development in the neutron field are being done. The activation method is being used for neutron flux and spectra determination; a standard filtered neutron beam will be installed at the IPEN research reactor in a near future.

The Dosimetric Materials Production Laboratory has developed thermoluminescent dosemeters of $CaSO_4$:Dy + Teflon (pellets). This phosphor was chosen due to its high sensitivity, ease of preparation and comparatively low cost. Pellets were produced by cold pressing and sintering of a mixture of $CaSO_4$:Dy and Teflon powders. Extensive work was done to study in detail all $CaSO_4$:Dy pellet characteristics from the point of view of dosimetry with the purpose of introducing it in the routine use. A filter combination providing an energy independent response to X and gamma radiation from 20 keV to 1.25 MeV was obtained. The dosemeter consists of three pellets with 0.8 mm thickness, sealed between two thin plastic sheets and placed under plastic and lead filters. The combination of these three filters allows the exposure as well the energy determination of an unknown source. Field trials of this dosemeter have shown very good results. Thin pellets (0.20 mm thickness) were developed for beta radiation detection. A discriminating beta/gamma dosemeter was also developed in order to evaluate beta and gamma doses in mixed fields. The Laboratory has been producing around 30,000 pellets per year, for sale to the brazilian private personal monitoring services, universities and research centers.

The Plastic Detectors Production Laboratory has been developing and producing scintillation detectors of different sizes for alpha, beta, gamma radiation and also for neutrons, in order to fabricate monitoring instruments. The manufacture of these detectors constitute in obtaining the scintillation plastics and the associated electronics for the measurement system. Portable area monitoring instruments of scintillometer type and detectors for the whole-body counter are being developed. An extensive study about the plastics characterization was already done in relation with the physical and chemical parameters: the density, the wave-lenght at which occurs the fluorescent emission maximum, the molecular weight, the energy resolution and the pulse height. The obtained values for these parameters agree with those of the scientific literature and of the main manufactures.

The Photographic Dosimetry Laboratory provides external individual monitoring for 1200 users from IPEN and for 1300 users from external institutions. The group has done research and development in this field since many years. Among the present projects, the angular dependence of the dosimetric films is being investigated under gamma and beta irradiations. The influence of the scattered radiation by the badge on the optical density measured at the open window position is also being studied in X, gamma and beta radiation fields.

The Radiotoxicological Laboratory provides internal ("in vitro") individual monitoring for mainly IPEN workers. Methods were developed for analysis of natural

uranium, tritium, iodine-131, stable fluorine in urine and stable lead in blood. The main objective is to verify a possible internal contamination and establish suitable monitoring of personnel. The bioassay techniques being used are: uranium by fluorimetry, tritium by liquid scintillation, iodine-131 by NaI (Tl) well scintillation counter, fluorine by specific ion electrode and lead by atomic absorption spectrometry. About 3,000 analysis are performed yearly, where the major part is in relation to uranium.

The Whole-Body Counter Laboratory takes care of the internal ("in vivo") individual monitoring of mainly IPEN workers. The measurement chamber was constructed using carcases of desactivated ships before the first nuclear explosions occurred. This whole-body counter is constituted by an analyser of the multichannel type connected to a NaI (Tl) detector (dimensions 20 x 8 cm), a phoswich type detector (diameter 5 in.) and two other detectors os the phoswich type (diameter 3 in.). The Laboratory performs about 1,000 routine individual measurements yearly, including workers of external institutions. The workers involved in the medical radioisotopes production at IPEN constitute the main group controlled by this system.

The researchers involved in the different described activities are listed below:

1. Calibration Laboratory: Dr. L.V.E. Caldas, BSc.M.P.P. Albuquerque, BSc. M.A. Batistella, MSc. L.A.R.da Rosa, BSc. C.M. Cardenete;

2. Nuclear Metrology Laboratory: MSc. M.S. Dias, MSc. M. F. Koskinas;

3. Dosimetric Materials Production Laboratory: MSc. L.L. Campos, BSc. O.O. Fernandes Filho;

4. Plastic Detectors Production Laboratory: MSc. C.H.Mesquita, MSc. M.M. Hamada;

5. Photographic Dosimetry Laboratory: Eng. M.P. Sanches, BSc. M.V. Barbosa;

6. Radiotoxicological Laboratory: BSc. S.A. Bellintani, BSc. J.C.G. Gaburo, BSc. C.L. Duarte;

7. Whole-Body Counter Laboratory: MSc. C.H. Mesquita, BSc. R.B.P. César