Comissão Nacional de Energia Nuclear-Brasil

Organismo Internacional de Energia Atomica

CURSO REGIONAL DE CAPACITACION SOBRE LOS SISTEMAS NACIONALES DE CONTABILIDAD Y CONTROL DE MATERIALES NUCLEARES

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NUCLEAR MATERIAL MEASUREMENT SYSTEM IN BRAZIL

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INTRODUCTION

The International Safeguards Agreements between Brazil and other countries has been concluded with the participation of the International Atomic Energy Agency (AIEA), and involve activities of physical protection and control of nuclear materials in order to garantee their exclusively use for peaceful purposes. However, at least this material is potentially dangerous and expensive, and an effective accounting and control system has to be established in order to prevent unauthorized use of nuclear material for purpose other than those it has been specified, as well as timely detection of any loss.

So, one of the main present tasks of the Safeguards Division of CNEN is to establish and maintain an effective and credible National System of Nuclear Material Control and Accounting. In this way, in 1980 the CNEN decided to set up a Safeguards Laboratory (LASAL), expanding its role in the material accounting verification through independent measurements of the amount of nuclear materials present at any facility by DA or NDA as an important aspect to facilitate the implementation of International Safeguards.

THE SAFEGUARDS LABORATORY (LASAL)

It is located within the perimeter of the Radiation Protection and Dosimetry Institute of CNEN (IRD), Rio de Janeiro , about 30km from CNEN-headquarter, and consists of about 450m^2 usable space (see Fig. 1).

Although the main additional suports for its operation is coming from IRD and its general infrastructure, LASAL is only subordinated to the Safeguards Division of CNEN, which was

responsible for the construction and setting up, and presently for its operation, in consultations and guidance of SAL/IAEA on technical requirements and design criteria, as well as the procurement of adequate equipment and personal training in order to have achieved highest possible technical standards.

The construction of LASAL was begun in April 1981 and finished by September 1982, and at moment it is under partial operation carring out and implementing independent verification measurements according to destructive (DA) and non-destructive(NDA) assays of nuclear materials, in special for uranium and thorium analyses.

It is operated by 8 researches and technicians , allocated in six main sections or activities as follow:1. Internal accounting and control of samples;2. Internal radiation protection; 3. Wet chemistry;4. Radiometry;5. Impurities and process waste measurements; and 6. Mass spectrometry (see Fig. 2).

SCOPE

Independent measurements of nuclear materials for safeguards purposes means to provide a quantitative verification in order to detect any diversions of such materials assuming that facility and inspection measurements are of sufficiently quality of performance to permit this detection, aplicable to generic types of nuclear facilities. In any cases destructive and or non-destructive assays must be available to perform the measurement of verification of the integrity of such nuclear materials.

In order to obtain meaningful and sufficiently accurate results of destructive analysis verification it is absolutely necessary not only to have available the adequate analytical techniques but also to establish for each type of nuclear material and any relevant conditions of inspection optimized sampling, preparation and packaging of the samples, shipment, methodology of analysis, and data collection and treatment procedures.

So, the following procedures as instruction forms

have been implemented and incorporated to our national verification system for all types of material as very critical steps in the measurement process:

A) Material stratification for sampling to atempt to each diferent inspection plan;

B) Sampling, sample conditioning (special sample bottles) and operator's data collection;

C) Packaging and transport of samples;

D) Receipt of samples at LASAL;

E) Analysis at LASAL;

F) Reporting of analytical results;

G) Preparation and characterization of NDA and DA working standards;

H) Data evaluation;

I) Utilization of evaluation results and measurement error goals.

METHODS AND TECHNIQUES

Samples taken by national inspectors at nuclear facilities are sent for analyses at LASAL or properly checked at own facility using NDA techniques.

In order to analyse accurately samples LASAL is being sufficiently equiped, and methodology of routine analysis by optimized analytical schemes as well as for implementing qualified methods and techniques of analytical measurements as required in material accountancy for safeguards use have been implemented. In addition, the precision and accuracy of the measurements are established, and periodically observed through the standardization and internal quality control of the measurements performance.

Very good results have been obtained, in particular those related with uranium concentration determination in pure non-irradiated nuclear materials by potentiometric titration and ignition-gravimetry (measurement precision and accuracy of 0,05 % rel. or better) as well as spectrophotometry in low concentrated U-scrap and waste solutions.

Computer programmes to acquire and evaluate the analytical data and final results have been implemented using a calculator HP-97 and a personal computer HP-85B.

In order to estimate or determine the U-235 content in a large number of nuclear materials in different types of packaging, the use of appropriate instruments and procedures of gamma spectrometry by non-destructive assays are in progress, also whenever necessary the personal computer HP-85B is used interfaced to the gamma meters.

Mass spectrometry for isotopic analysis as well as emission spectrography for impurities analysis should be routinely performed as basic techniques available at LASAL. For instance, the procurement of such equipments is not foreseen in the budget planning of the near future, because of the high investment cost and currency exchange restrictions to import them. So, isotopic composition analysis is provided from a research institute of CNEN supporting temporarily the LASAL, while the impurity analysis, whenever necessary, and in particular cases is backed-up by a very precise and accurate determination of the U-concentration by potentiometric titration.

Concerning the U-235 determination, instead of isotopic composition measurements on uranyl nitrate solutions, it is in progress the use of well detector and suitable arrangements, which could provide for sufficient precise and accurate measurements as an intermediate solution.

Other essential point is related to suitable standard reference materials available to perform a reliable internal quality control programme of the measurement system concerning destructive assay procedures for elemental and isotopic analysis, as well as well-characterized reference materials similar in composition, shape and packaging to the samples of nuclear materials to calibrate NDA techniques or to verify their accuracy. At moment, there is available at LASAL some uranium working standards reference materials for NDA provided by national nuclear facility and characterized for enrichment by SAL/IAEA, as well as NBS-primary standards reference materials, characterized for elemental and isotopic

composition of uranium as required for DA. Considering that such materials are available at the LASAL in limited quantities and it is intended to be used carefully so that the stock last as long as possible a fully detailed programme to prepair and characterize working reference materials are in progress.

Equally important tasks of the LASAL are calibration and providing maintenance of inspection equipment, preparing statistical sampling plans for national safeguards inspection, and taking active part in the application and the further development of safeguards methods and techniques, as well as to arrange all necessary consultation for the other facilities in order to assist them to establish its own effective accountancy and control, to develop a measurement system for the nuclear material, movements and physical inventory taking.

NATIONAL AND INTERNATIONAL CO-OPERATION AND TECHNICAL ASSISTANCE

Research and development are not the main activity of LASAL, although in particular the optimization of analytical procedures is one important aspect to be considered.

Programmes for co-operation and technical assistance at the national and international levels are provided from organizations and research laboratories supporting temporarily the LASAL, which give the possibility to the staff to be involved in the research and development works as an important instrument for increasing the professional qualification of the staff, in order to be able to establish optimized analytical working plants.

So, under LASAL'S coordination and financial support adeguate projects of research and development of safeguards methods and techniques have been provided by universities and research centers related to DA techniques to be available to implement them at LASAL, such as: Polarography, redox titration, and laser fluorimetry techniques, as well as volumetric calibration of tanks by isotopic dilution mass spectrometry.

Under a regular program of technical assistance and cooperation provided by IAEA to the member states, its Department

of Technical Assistance and Co-operation have been maintained a project by 1985 and 1986/1987 for procurement of advanced equipments not available in Brazil, and training, in order to implement NDA techniques, as well as providing standard reference materials for calibration of all techniques (DA and NDA) in use.

Cooperative bilateral safeguards technical exchange program between Brazil and United States are in progress , and involve both U.S. Department of Energy and the National Nuclear Energy Comission of Brazil. As the first activity it was successfully performed an "In Plant Test and Evaluation of the Neutron Collar for Verification of PWR Fuel Assemblies at Rezende, Brasil" over a period of 6 months in 1985 at the "Fábrica de Elementos Combustíveis" plant by LANL and CNEN-LASAL. As a follow-on activity , a test and evaluation of the fuel rod measurements of spent fuel at Angra-I reactor storage pool have been taken since 1986, in which are involved again both LANL and CNEN-LASAL.

In order to check the quality of its measurements LASAL have participated in intercomparison programmes provided by the IAEA-Analytical Quality Control Service and the European Safeguards Research and Development Association (ESARDA) through KfK Federal Republic of Germany by performing uranium analyses on UO_2-powder and uranil-nitrate solutions. Coeficient of variation and deviation from the reference value of orders of 0,062% and 0,052wt%U have been respctively reported.

With the Comission Nacional de Energia Atomica(CNEA) Argentina are also in progress some programmes in the safeguards area, mainly those related to interchange of methods and techniques to be used for safeguards measurements verification.

CONCLUSIONS

Efforts to increase the quality of the works and the independence in carrying out the measurements verification of nuclear material for safeguards purposes are continued and it is no doubt that such close co-operation agreements to get internal qualification programmes of analysis and international assistance like those provided by IAEA are very important instrument for

increasing the professional qualification of the staff, which has the biggest influence on the effectiveness of regulatory funtions.

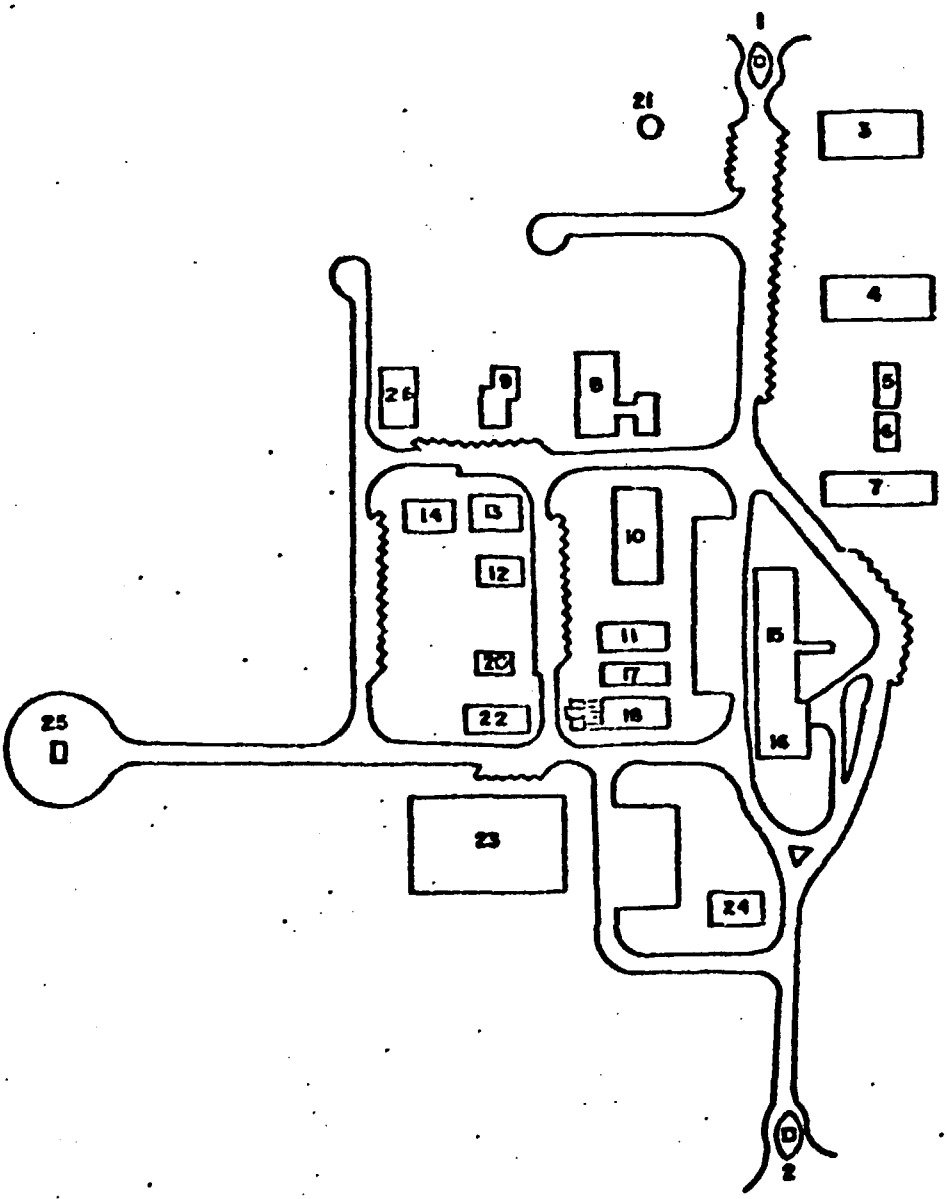

Fig.1 - SAFEGUARDS LABORATORY - LOCATION

Fig. 1 - Location of the Safeguards Laboratory

LEGEND

1. South entrance
2. North entrance
3. Safeguards Laboratory (DEx-III, Division of Safeguards)
4. Department of Occupational Radiological Protection
5. Neutron calibration (Department of Metrology)
6. Neutron calibration (Department of Metrology)
7. Department of Human Resources
8. Department of Metrology
9. Radioisotopes Calibration Laboratory (Department of Metrology)
10. Radiometry and Radiochemistry Laboratories (Department of Environmental Radiological Protection)
11. Radiobiology Laboratory and Environmental Impact Assessment Division (Department of Environmental Radiological Protection)
12. Effluents Laboratory (Department of Environmental Radiological) Protection)
13. Mineral Analysis Laboratory (DEx-III)
14. Fuel Cycles Process Laboratory (DEx-III)
15. Department of Individual Monitoring
16. Medical Service
17. Carpentry (Department of Administration)
18. Civil Engineering Maintenance Service (Department of Administration)
19. Vehicles Maintenance Service (Department of Administration)
20. Volley-Ball field
21. Soccer field
22. Central Warehouse
23. Director'soffice
    - Department of Administration
    - Detectors Development Laboratory, Mechanics and Eletronics Workshop (Department of Technical Support
24. Restaurant
25. Meteorological tower
26. Filters Laboratory (DEx-III)

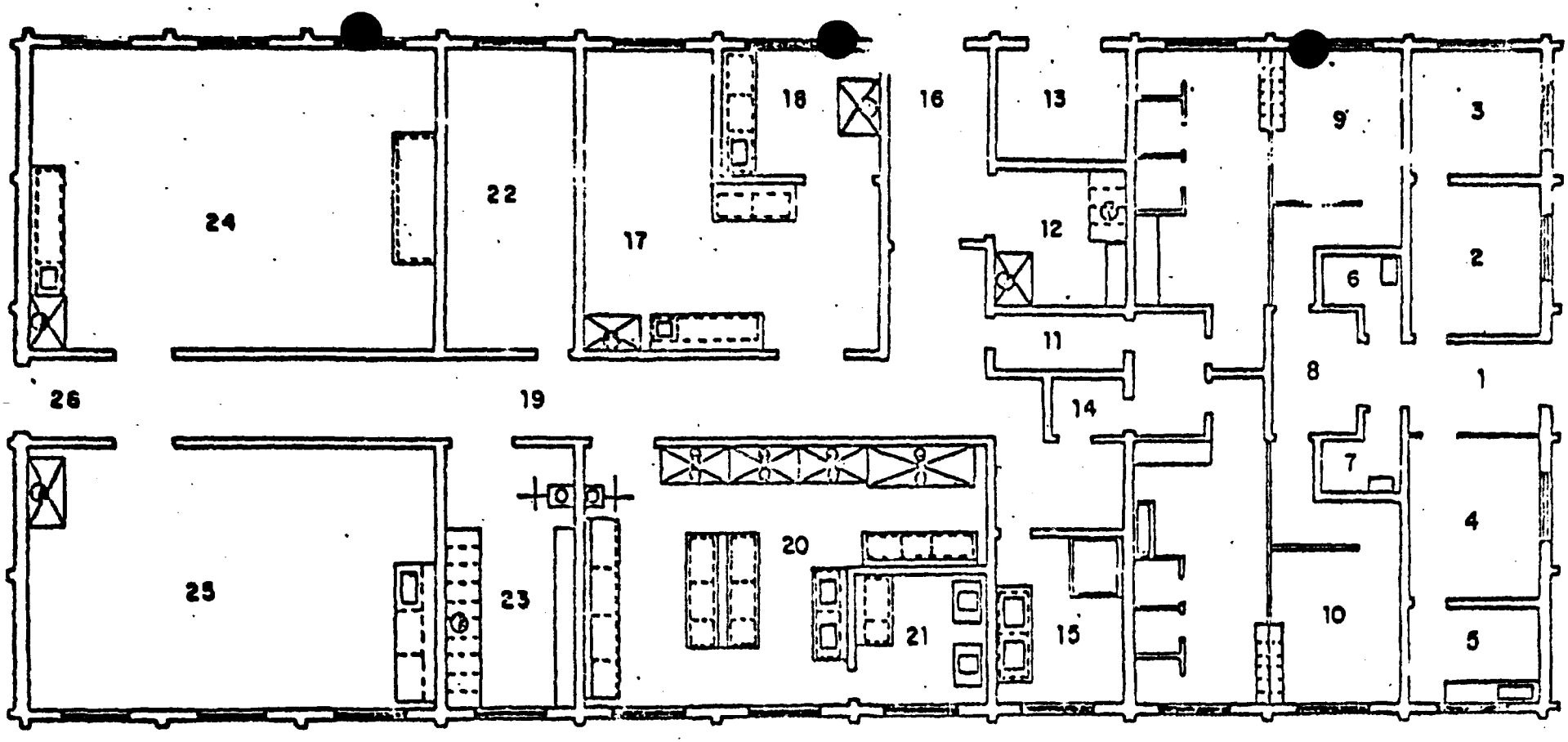

Fig 2 - SAFEGUARDS LABORATORY - GENERAL ORGANIZATION

Fig. 2 - General Organization of the Safeguards Laboratory

LEGEND:

1. Main entrance
2. Meeting room
3. Office
4. Secretary
5. Rest-area
6. WC (women)
7. WC (men)
8. Access control
9. Changing room (women)
10. Changing room (men)
11. Entrance
12. Sample storage
13. Power house
14. Exit
15. Health physics and Decontamination
16. Service entrance-samples and equipments reception
17. Radiometry
18. Physical treatment
19. Mean corridor
20. Wet chemistry
21. Balances
22. Office
23. Chemical storage
24. Instrumental Analysis I - Mass Spectrometry
25. Instrumental Analysis II - Impurities and Process Waste Measurements
26. Emergency Exit