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CONTROL OF RADIATION SOURCES THROUGH REGULATORY INSPECTIONS OF RADIATION SAFETY IN BRAZILIAN INDUSTRIES

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Abstract. This work presents a brief description of the situation of Brazilian Regulatory Authority with regard to safety control of industrial radioactive installations. It shows the national regulatory infrastructure responsible for radiation safety inspections, the regulation infrastructure, the national inventory of industrial installations, the national system of inspection and enforcement and the national system for qualifying radiation protection officers. Some results of regulatory safety inspections are also shown.

GENERAL ASPECTS

The Brazilian Regulatory Authority is the National Commission of Nuclear Energy (Comissão Nacional de Energia Nuclear–CNEN), which is responsible for all activities related to nuclear or radioactive materials. CNEN's infrastructure for controlling industrial radioactive installations comprises a Director of Radiation Protection and Nuclear Safety with two general co-ordinators: the Co-ordinator of Licensing and Control–SLC, responsible for the national system of licensing, and the Institute of Radiation Protection and Dosimetry-IRD, responsible for the national system of radiation safety inspections.

The Brazilian regulation infrastructure related to industrial radioactive installations consists of general guidelines and six specific guidelines. CNEN has the following regulation infrastructure:

General guideline

The Basic Guidelines for Radiation Protection, NE3.01-CNEN, 1988, specify basic principles; occupational radiation limits and limits for the public; obligations for the director of an installation, radiation protection officer and workers; basic controls for human and environmental protection against the potential negative effects of ionizing radiation. It also contains the necessary minimum items for the elaboration of a radiation protection programme.

Specific guidelines

Radiation Protection Service, NE3.02-CNEN, 1988, establishes the requirements to operate such a service in nuclear and radioactive facilities and presents a structure for facilities to qualify personnel and operate equipment. It determines the activities to be carried out by the service concerning the control of radiation sources, workers, radioactive areas, the environment, the population, radioactive waste and radiation equipment. It also presents a training programme for workers and records to be kept.

Certification of Qualification for Radiation Protection Officer, NE3.03-CNEN, 1999, establishes the requirements to certify radiation protection officers' qualifications for duty in nuclear and radioactive facilities, and also in the transport of radioactive material. It specifies

the areas of performance, and requirements for personnel and training documentation. It also presents the methodology for evaluation, issuance and validation of the certification. The main violations of requirements that cancel the certification issued by CNEN are also shown.

Licensing of Radioactive Installations, NE6.02-CNEN, 1998, establishes the process for licensing radioactive facilities concerning the activities related to their location, construction, operation and modification. It presents the classification of facilities and license methodology for issuing prior approval, construction license, authorization for acquisition of radioactive material and authorization for operation of radioactive facilities. It also determines the minimum requirements to be fulfilled concerning the authorization for modification and operation and defines the limits of exemption.

Operation of Industrial Radiography Service, NE6.04-CNEN, 1989, establishes the requirements for the operation of an industrial radiography service and the procedures for acquisition and transfer of radioactive sources or X-ray equipment used in fixed or movable installations. It specifies the requirements to be fulfilled for the issuance of a construction license, authorization for acquisition or transfer of radioactive sources and irradiator equipment, and for authorization of operation. It also presents the main topics of the General Plan of Radiation Protection including programmes of operation, staff training, emergency and physical protection. It presents specifications for radiation protection officers, for staff responsible for movable installations, and for facility operators.

Management of Radioactive Waste in Radioactive Facilities, NE-6.05, 1985, establishes general criteria and relative basic requirements for management of radioactive waste in radioactive facilities. It presents waste classification and the general requirements for waste management. It also specifies the criteria to be followed during transport, temporary storage and disposal of radioactive waste.

Transport of Radioactive Material, NE-5.01, 1988, establishes all requirements of radiation protection and safety for the transport of radioactive materials necessary to guarantee an appropriate level of control of potential exposure of people, goods and the environment to ionizing radiation.

Table 1. Number of industrial radioactive facilities in Brazil — 1999

Application area		Number of facilities	
Industrial radiography	Movable installations [1]	15	100
	Fixed installation: gamma ray	25	
	Fixed installation: X-ray	60	
Industrial irradiator plant		06	06
Well logging petroleum - bases		13	13
Nuclear gauges	Manufacturers	03	403
	Installation with less than 10 radioactive sources	240	
	Installation with up to 40 radioactive sources	120	
	Installation with more than 40 radioactive sources	40	
Total		522	

[1] That number is related only for installation officer. The radiation works number is explained above.

All industrial installations that use radiation sources must be licensed by the regulatory authority, CNEN, and subjected to regulatory inspection. CNEN's database programme with the national inventory shows that there are 522 facilities that use radioactive sources as a work tool (see Table 1). Facilities are classified for purposes of inspection management [1], as: industrial radiography, well logging petroleum, industrial irradiator plant and nuclear gauge.

Industrial radiography accounts for 100 facilities (19% of total), 15% of which are movable installations with their high concentration of workers and irradiation equipment. These movable installations that use industrial gamma radiography equipment account for almost 200 off-site radiation jobs per year around the country, as shown in Figure 1. Well logging petroleum, with its industrial bases, accounts for 13 facilities (2.5%). Although industrial irradiator plants comprise only six facilities nationwide (1%), they are responsible for 185PBq (3MCi) of cobalt-60. Brazil has five industrial irradiator plants built by a Canadian company and one plant designed and built by a Brazilian company. Nuclear gauges account for the greatest number of facilities, 403 installations (77%), with a variety of radioisotopes with activities of up to 0.37TBq (10Ci).

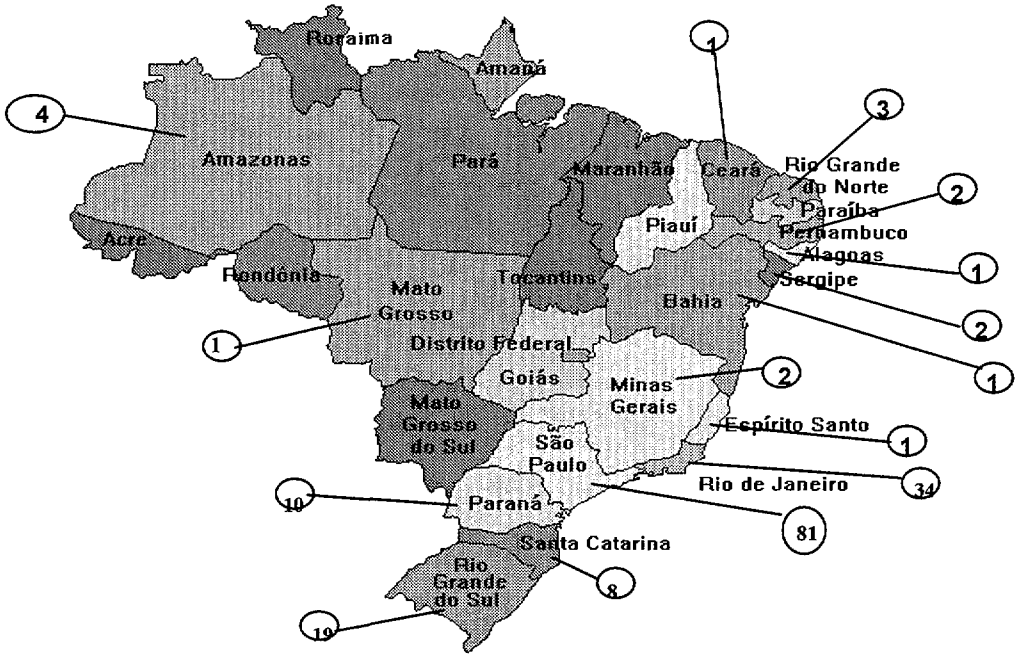

Fig.1. Distribution of movable installations using industrial gamma radiography equipment.

The national system of inspection to control the safe use of radioactive sources in industrial activities is provided by the Institute of Radiation Protection and Dosimetry (IRD), which has been inspecting a great number of radioactive facilities in recent years. The inspections are based on indicators and performed over specific periods for each installation type [2].

The main indicators used to guide the inspections are:

a) installation never inspected by CNEN – new installation;
b) installation with any dose registry above 4mSv/month;
c) installation with problems in the licensing process;
d) installation that shows problems with radiation protection and safety.

The minimum periods for routine regulatory safety inspections are:

(a) for industrial radiography:
  - movable installation: once a year;
  - fixed installation with gamma rays: once every two years;
  - fixed installation with X-rays: once every three years;

(b) for well logging petroleum: once every two years;

(c) for industrial irradiator plants: once every two years;

(d) for nuclear gauges:
  - manufacturers: once a year;

The frequency of inspection of installations is determined by the number of radioactive sources:

- up to 10 radioactive sources: once every five years; if the installation has neutron radioactive sources, the frequency is once every four years;
- between 11 and 40 radioactive sources: once every four years; if the installation has neutron radioactive sources, the frequency is once every three years;
- more than 41 radioactive sources: once every three years; if the installation has neutron radioactive sources, the frequency is once every two years.

According to regulations, all industrial installations that use radiation sources must have at least one radiation protection officer responsible for the radiation protection service. The national system for qualifying radiation protection officers requires the candidate to:

1. be a graduate professional; and
2. pass two types of examinations.
   - a general written examination about all basic aspects of radiation protection and safety, legislation, etc;
   - a specific examination on each area. This examination is divided in two parts: a written test and a practical, oral test.
3. The certification is valid for five years, and can be cancelled when violation of requirements or unsafe conditions are found during the radiation protection officer's performance of duties.

RESULTS

Using this methodology for selecting facilities to be inspected, 430 radiation protection and safety inspections were performed from 1996 to 1999, as shown in Figure 2. These were 89 inspections during 1996, 115 during 1997, 122 during 1998 and 104 during 1999. Figure 3 shows the number of inspections for each area during this period. There were 232 inspections in industrial radiography, 159 in nuclear gauges, 25 in well logging petroleum and 14 inspections in industrial irradiator plant.

Even though industrial installations have radiation protection officers, many regulatory violations were noticed during safety inspections. Table 2 shows the main violations committed by radiation protection services and detected by inspectors.

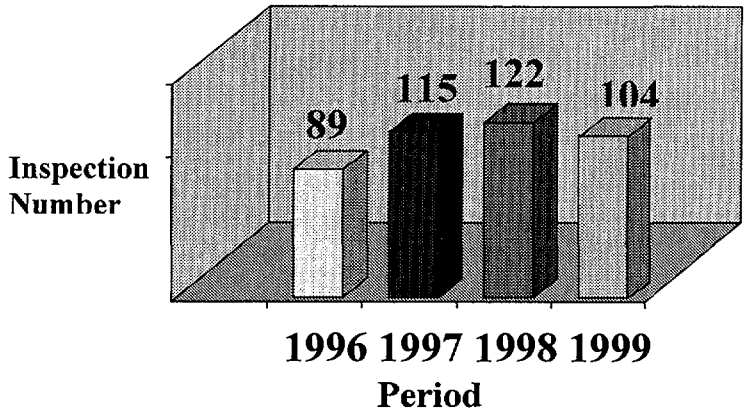

Fig. 2. Number of regulatory inspections of radiation safety in Brazilian industries from 1996 to 1999.

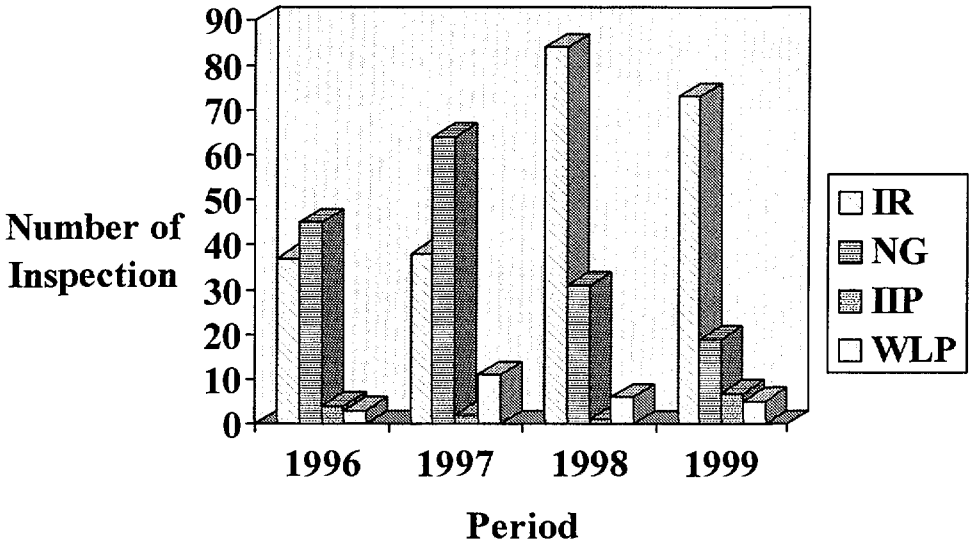

Fig .3. Number of regulatory inspections of radiation safety in Brazilian industries from 1996 to 1999 for each area of application.

Table 2. Main Violations detected during Radiation Safety Inspection

Violation	Industrial radiography	Nuclear gauges	Well logging petroleum	Industrial irradiation facilities
Operation authorization expired	x			
Lack of radiation protection officer		x	x	
Inappropriate radiation protection programme		x	x	
Lack of record of personnel dosimetry	x	x	x	x
Lack of record of worker's medical examination		x	x	
Lack of record of workers training	x	x	x	
Lack of record of workplace monitoring	x	x	x	
Lack of record of maintenance of equipment	x	x		
Lack of record of leaking source		x		
Inappropriate storage radiation source		x		
Inappropriate emergency programme				x
Lack of calibration or operational testing of survey equipment		x	x	
Lack of warning signals		x		

At the end of an inspection, a report is written recording all violations of requirements that were detected. On the basis of this report, CNEN can temporarily or definitively suspend authorization of the installation, and suspend or cancel the certification of the radiation protection officer or operator. From 1996 to 1999, the most important actions were taken in industrial radiography. Many installations had their authorizations temporarily suspended and three installations had their authorizations definitively suspended. Also, in industrial radiography, many radiation protection officers and operators had their certification suspended and one had it cancelled.

CONCLUSIONS

The number of inspections accomplished during these years shows that radioactive sources are being controlled by the regulatory authority.

Safety inspections are being performed throughout the country, taking a significant sampling of the radioactive facilities. This means that the inspection programme statistically embraces the whole country.

More attention should be paid to operational procedures in industrial radiography and well logging petroleum and to the administrative controls for nuclear gauges.

It is intended to increase the number of inspections year by year to adapt to the IAEA frequency of inspections recommended for industrial radioactive facilities.

REFERENCES

[1] IRD/CNEN: "Reports of Safety Inspection in Conventional Industries", 1996 to 1999.
[2] IAEA: "Recommendations for the Safe Use and Regulation of Radiation Sources in Industry, Medicine, Research and Teaching", IAEA, 1990.