LEGAL AND REGULATORY FRAMEWORK ON DECOMMISSIONING OF RESEARCH REACTORS

NATIONAL REPORT

OF

BRAZIL

FOR THE

RESEARCH REACTOR DECOMISSIONING AND DEMONSTRATION PROJECT (R^2D^2P)

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1. THE BRAZILIAN NUCLEAR POLICY

The Brazilian Federal Constitution of 1988 states that the Union has the exclusive competence for managing and handling all nuclear energy activities, including the operation of nuclear power plants. The Union holds also the monopoly for the survey, mining, milling, exploitation and exploration of nuclear minerals, as well as the activities related to industrialization and commerce of nuclear minerals and materials. The Union is also the ultimate responsible for the safe disposal of radioactive waste. All these activities shall be solely carried out for peaceful uses and always under the approval of the National Congress.

The national policy for the nuclear sector is implemented according the Plan for Science and Technology (Plano Plurianual de Ciência e Tecnologia – PPA). The National Commission for Nuclear Energy (Comissão Nacional de Energia Nuclear - CNEN) was created in 1956. Nowadays, CNEN comprises the Regulatory Body in charge of regulating, licensing and controlling nuclear energy utilization, and is also responsible for the research and development aspects and the production of radioisotopes. CNEN is also the governmental body responsible to receive and dispose of radioactive waste in the whole country.

2. LEGISLATIVE AND REGULATORY SYSTEM

Brazil has taken legislative, regulatory and administrative measures to ensure the safety of its nuclear installations, including irradiated fuel and radioactive waste. The Federal Constitution of 1988 specifies the distribution of responsibilities among the Federal Union, the States and the Municipalities with respect to the protection of the public health and the environment, including the control of radioactive products and installations. Furthermore, the constitutional principles regarding protection of the environment require that any installation which may cause significant environmental impact shall be subject to environmental impact studies that shall be made public.

2.1 Nuclear licensing process

CNEN is Regulatory Body in charge of regulating, licensing and controlling nuclear energy. CNEN responsibilities include:

- preparation and issuance of regulations on nuclear safety, radiation protection, radioactive waste management and physical protection;
- accounting and control of nuclear materials (safeguards);
- licensing and authorization of siting, construction, operation and decommissioning of nuclear facilities;
- regulatory inspection;
- to act as a national authority for the purpose of implementing international agreements and treaties related to nuclear safety activities;
- to participate in the national preparedness for, and response to nuclear emergencies.

The licensing regulation CNEN-NE-1.04 establishes that no nuclear installation shall operate without a licence. It also establishes the necessary review and assessment process, including the specification of the documentation to be presented to CNEN at each phase of the licensing process. It finally establishes a system of regulatory inspections and the corresponding enforcement mechanisms to ensure that the licensing conditions are being fulfilled. The enforcement mechanisms include the authority of CNEN to modify, suspend or revoke the licence.

The licensing process is divided in several steps:

- Site Approval;
- Construction Licence;
- Authorization for Nuclear Material Utilization;
- Authorization for Initial Operation;
- Authorization for Permanent Operation;
- Authorization for Decommissioning

Federal Law 9756, approved in 1998, establishes taxes and fees for each individual licensing step, as well as for the routine work of supervision of the installation by CNEN.

Other governmental bodies are involved in the licensing process, through appropriate consultations. The most important ones are the Institute for Environmental and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA), which is in charge of environmental licensing.

2.2. Responsibility of Licence Holder

The Brazilian legislation defines the operating organization as the prime responsible for the safety of a nuclear or radioactive installation, including the management of spent fuel and radioactive waste.

2.3. Radioactive Waste Legal and Regulatory Framework

Law n. 10.308 of 20 November 2001 establishes the new legal framework for the solution of the radioactive waste issue in Brazil. The Law confirms Government responsibility for the final destination of radioactive wastes, through the action of CNEN. However, it also opens the possibility for the delegation of the administration and operation of the radioactive waste deposits to third parties.

The Law defines 3 types of deposits: initial, intermediate and final, and establishes the rules for site selection, construction and operation. The Law also establishes the financial arrangements for the transfer of the waste to CNEN and the compensation to the municipalities that accept in their territory the construction of the waste deposits. Additional regulations related to waste disposal already in place are now being revised to conform to the new Law.

2.3.1 Radioactive Waste Types and Classification

The waste classification categories in Brazil are the same adopted by the IAEA. Radioactive wastes are classified in three categories, as shown on Table 1 below. In the Table, short lived are those radionuclides which half-lives of approximately 30 years such as: ^{60}Co, ^{90}Sr, ^{137}Cs, etc.

Table 1. Waste Classification

Category	Characteristics	Disposition Option
1.Exempt waste	Activity levels equal or bellow the exemption limits that was based in a maximum impact dose of 0,01 mSv/a for public	No radiological restriction
2. Low and Intermediate level	Activity levels above exemption limit and heat generation equal or below 2 kW/m^3.	Near surface repository or geological.
2.1. Short lived	Long lived Alfa emitters contents equal or below 4000 Bq/g and the average specific activity of all radionuclides in the package (immobilised) below 400 Bq/g).	
2.2. Long lived	Radionuclides alfa emitters concentration above limits cited before for short live	Geological repository
3. High level waste	Heat generation above 2kW/m^3 and alfa emitters concentration above the limits allowed for low and intermediate level waste – short lived (2.1)	Geological repository

2.4. Decomissioning

Brazil does not have yet a national regulation that establishes rules for the composition of funds for decommissioning spent fuel and waste management facilities.

2.4.1. Research Reactors

No decommissioning policy has been adopted.

2.4.2. Nuclear Installations

2.4.2.1. Decommissioning of Usina de Santo Amaro (USAM)

Up to now, the Santo Amaro monazite sand treatment facility (USAM) is the only decommissioned nuclear facility in Brazil. USAM operated since 1950's in a small town near São Paulo, separating rare earth materials from monazite sand, and belonged to the state-owned company INB. The growth of urban areas around the site led to the decision to decommission the facility. The facility went through a complete decommissioning process, which took approximately 5 years, under close surveillance of CNEN. After transporting all separated useful material and the waste to other site at USIN, the buildings were demolished and the site decontaminated. A detailed radiation monitoring program was conducted and the site was declared free for irrestricted usage.

CNEN also required from INB the submission of: (i) a detailed decommissioning plan, including waste management and radiological procedures for the demolishing of the buildings (floors, walls, sanitary system, water distribution system, etc); (ii) procedures that would be adopted for the radiological characterization of the site (deepness of soil samples, frequency, etc) and frequency of reports to be submitted to CNEN; (iii) the radiological criteria to be used for clearance; (iv) a radioactive waste plan including the necessary and appropriate description of packages; (v)description of the scenarios that would be used for the determination of soil clearance values (cutoff limit) due to necessity to liberate the area for unconditional use; (vi) radiological procedures for the workers involved in the clean up; and (vii) procedures to control and guarantee that the doses on the neighbouring population would not exceed 1 mSv/y.

2.4.2.2 Decommissioning of the Mineral Treatment Facility at Poços de Caldas

Parts of the old Mineral Treatment Facility (UTM) at Poços de Caldas mining and milling complex is currently under decommissioning by state-owned INB.

3. THE BRAZILIAN RESEARCH REACTORS

3.1. IEA- R1

IEA-R1, the most important Brazilian RR, is the oldest in the Southern Hemisphere. Located at the Nuclear and Energetic Research Institute (Instituto de Pesquisas Energéticas e Nucleares - IPEN), in the campus of São Paulo University, in the city of São Paulo, it was started to be built in 1956 within the US program Atoms for Peace and reached criticality for the first time on September 1957. Initially operating at a power level between 200 kW and 2 MW, nowadays it operates continuously at 5 MW. The burn-up rate, currently at 240 MW-Day per year, is expected to increase to 1100 MW-Day per year. Initially operating with highly-enriched fuel, it has been converted to Low Enriched Uranium (LEU).

3.2. IPR – R1

The 250 kW Triga reactor operating at the Nuclear Technology Development Centre (Centro de Desenvolvimento de Tecnologia Nuclear - CDTN) on the campus of Federal University of Minas Gerais in Belo Horizonte is mainly used for research. IPR-R1 was the second Brazilian RR, in 1960. The integrated burn-up of the reactor since its first criticality is about 130 MW-Days. Due to the low nominal power, except for aging concerns, spent fuel is not considered a problem. The first fuel assembly replacement of the reactor is expected to occur in 2010.

3.3. Argonauta – IEN

The third Brazilian RR is named Argonauta, and is located at the Institute of Nuclear Engineering (Instituto de Engenharia Nuclear – IEN) on the campus of the Federal University of Rio de Janeiro, in Rio de Janeiro, since 1965. The reactor can operate at a maximum power of 1kW during an hour or 500 W continuously. It is usually operated in the range of 170 to 340 W. The accumulated burn-up of the reactor since its first criticality is about 0,25 MW-Day, and, due to the low nominal power, storage of spent fuel is not a problem. It is used mainly for training purposes, research and sample irradiation.

3.4. IPEN MB-01

The most recent Brazilian RR is IPEN/MB-01, located also at IPEN. The reactor, a water tank type critical facility rated 100 W, is mainly used for simulation of

small LWR and research in reactor physics. It reached criticality for the first time on November of 1988. The accumulated burn-up is below 0,1 MW-Day.

3.5. Spent Fuel Management

Table 2. Research Reactors in Brazil

	Facility	*Power (kW)*	*Type*	*Status*
BRA	ARGONAUTA	0.20	ARGONAUTA	OPER
BRA	IEA-R1	5,000.00	POOL	OPER
BRA	IPEN-MB 01	0.10	ZPR TANK	OPER
BRA	IPR-R1	250	TRIGA-Mark I	OPER

As shown on Table 2, the only RR that has concerns related to spent fuel is IEA-R1. Part of its spent fuel was returned to USA, when in 1999 Brazil shipped 127 LEU and HEU fuel elements. The concerns are based on the fact that in May of 2006 the option to send SFA to USA will cease, and a national solution will have to be adopted. These concerns were the driving force for Brazil to join an IAEA Regional Project. The objectives of the Project are to provide the basic conditions to define a regional strategy for managing spent fuel and to provide solutions taking into consideration the economic and technological realities of the countries involved. In particular, to determine the basic conditions for managing RR spent fuel during operational and interim storage as well as final disposal, and to establish forms of regional cooperation for spent fuel characterization, safety, regulation and public communication.

The Brazilian part of the Latin American Spent Fuel Database is presented on Table 3, ilustrating the main characteristics of the fuel elements utilized in the RRs of Brazil.

Table 3. Fuel Elements Characteristics

Facility	Fuel Type	Fuel Material	Enrichment	Cladding Mater.
IEA-R1	MTR	U_3O_8-AL	LEU 19.9%	Aluminum
		U_3Si_2-Al		
IPR-R1	TRIGA Rods	U-Zr-H	LEU 20%	Aluminum
ARGONAUTA	MTR	U_3O_8-Al	LEU-19.0-19.9%	Aluminum
IPEN-MB-01	Pin PWR	UO_2 Pellets	LEU 4.35 %	SS

The present RR spent fuel inventory is shown on Table 4. The only reactors with reasons for concern related to storage over medium and long-range periods are IEA- R1 and IPR- R1. The others are low and zero power reactors with very low burn up. Taking these facts into consideration and the storage capacities presently available, some projections for the next 10-15 years have been made.

Presently, storage facilities at IEA-R1 consist of racks located in the reactor pool with a capacity of 156 assemblies. Currently, 21 storage positions are occupied, suggesting that in 7-10 years the wet storage facility at the reactor will be full. If no provisions are made for increasing storage facilities, the reactor may have to be shut down. In view of these facts, a project to assess and define an “at-reactor” drystorage, with a capacity for~200 SFA has been initiated.

IPR-R1 has no short and medium range storage problems, due to its low nominal power. The first fuel assembly replacement is expected to occur only in 2010.

Table 4. SFA Inventory at Brazilian Research Reactors

Facility	*# of FA in Present Core*	*Average # used per year*	*SFA Storage*		*SFA Burnup% Average*
			At RR	Away RR	
IEA-R1	24 LEU, Silicide-7; Oxyde-17	~18, expected for 120 h /week, 5MW	39 wet	0	~30
IPEN-MB-01	680 pins	NA	0	0	NA
IPR-R1	59 rods	NA	0	0	NA
IEN-R1	8 LEU	NA	0	0	NA

The design and additional modifications of the Brazilian Research Reactors have been made in accordance with IAEA Safety Standards, Safety Guides and Safety Practices of IAEA Safety Series, in particular Safety Guide 35-G2 (Safety in the Utilization and Modification of Research Reactors), Safety Guide 35-S2 (Code on the Safety of Nuclear Research Reactors: Operation), Safety Series 116 (Design of Spent Fuel Storage Facilities), and Safety Guide 117 (Operation of Spent Fuel Storage Facilities). Such documents present the fundamental principles of safety for research reactors and associated facilities for handling, storage and retrieving of spent fuel before it is reprocessed or disposed of as radioactive waste. The adoption of these principles assures that the spent fuel represents no hazard to health or to the environment, and the maintenance of the following conditions for the spent fuel:

- Subcriticality
- Capacity for spent fuel decay heat removal
- Provision for radiation protection
- Isolation of radioactive material.

Finally, Brazil has not yet defined a policy regarding spent fuel or high-level waste disposal. However, given that the Brazilian legal framework regarding waste disposal has been defined, this issue will be discussed at the national level.

ANNEX
LIST OF RELEVANT CONVENTIONS, LAWS AND REGULATIONS

A.1. Relevant International Conventions Of Which Brazil Is A Party

Convention on Civil Liability for Nuclear Damage (Vienna Convention). Signature: 23/12/1993. Entry into force: 26/06/1993.

Convention on the Physical Protection of Nuclear Material. Signature:15/05/1981. Entry into force: 8/02/1987.

Convention on Early Notification of a Nuclear Accident Signature: 26/09/1986. Entry into force: 4/01/1991.

Convention on Assistance in Case of Nuclear Accident or Radiological Emergency. Signature: 26/09/1986. Entry into force: 4/01/1991.

Convention on Nuclear Safety. Signature: 20/09/1994. Entry into force: 24/04/1997.

Convention n. 115 of the International Labor Organization. Signature: 7/04/1964.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Ratification: 14/11/2005.

A.2. Relevant National Laws

Decree 40.110 of 1956.10.10 - Creates the Brazilian Nuclear Energy Commission (CNEN).

Law 4118/62 of 1962.07.27 - Establishes the Nuclear Energy Policy and reorganizes CNEN.

Law 6189/74 of 1974.12.16 - Creates Nuclebras as a company responsible for nuclear fuel cycle facilities, equipment manufacturing, nuclear power plant construction, and research and development activities.

Law 6.453 of 1977.10.17 - Defines the civil liability for nuclear damages and criminal responsibilities for actions related to nuclear activities

Decree 1809 of 1980.10.07 - Establishes the System for Protection of the Brazilian Nuclear Programme (SIPRON).

Law 6938 of 1981.08.31 - Establishes the National Policy for the Environment (PNMA), creates the National System for the Environment (SISNAMA), the Council for the Environment (CONAMA) and Brazilian Institute for the Environment (IBAMA).

Law 7781/89 of 1989.06.27 - Reorganizes the nuclear sectors.

Decree 99.274 of 1990.06.06 - Regulates application of law 6938, establishing the environmental licensing process in 3 steps: pre-licence, installation licence and operation licence.

Decree 2210 of 1997.04.22 - Regulates SIPRON, defines the Secretary for Strategic Affairs (SAE) as the central organization of SIPRON and creates the Coordination of the Protection of the Brazilian Nuclear Programme (COPRON).

Law 9.605 of 1998.02.12 – Defines environmental crimes and establishes a system of enforcement and punishment.

Decree 3719 of 1999.09.21 – Regulates the Law 9.605 and establishes the penalties for environmental crimes..

Law 9.765 of 1998.12.17 – Establishes tax and fees for licensing, control and regulatory inspection of nuclear and radioactive materials and installations.

Decree 3833 of 2001.06.05 – Establishes the new structure and staff of the Brazilian Institute for the Environment (IBAMA).

Law 10.308 of 2001.11.20 – Establishes rules for the site selection, construction, operation, licensing and control, financing, civil liability and garanties related to the storage of radioactive waste.

A.3. CNEN Regulations

NE 1.04 - *Licensing of nuclear installations*

NE 1.16 - *Quality assurance for safety of nuclear power plants and other installations*

NE 1.28 - *Qualification and actuation of independent technical supervisory organizations in nuclear power plants and other installations*

NN 1.01 - *Licensing of nuclear reactor operators.*

NN 1.06 - *Health requirements for nuclear reactor operators*

NN 1.12 *Qualification of independent technical supervisory organizations for nuclear installations.*

NE 2.01 *Physical Protection in operational units of the nuclear area*

NN 3.01 *Radiation protection directives. January 2005*

NE 3.02 *Radiation protection services. August 1988*

NE 3.03 *Certification of the qualification of radiation protection supervisors. September 1999*

NE 5.01 *Transportation of radioactive materials. August 1988*

NE 6.02 *Licensing of radioactive installations. July 1998*

NE 6.05 *Radioactive waste management in nuclear installations. December 1985*

NE 6.06 *Site Selection for radioactive waste deposits.- December 1989*

NN 6.09 *Acceptance criteria for disposal of radioactive waste of low and intermediate radiation level. Setember 2002*

A.4. CONAMA Regulations

CONAMA – 01/86 *Establishes requirements for conducting the environmental study (EIA) and the preparation of the report on environmental impact (RIMA)* - (23/01/1986).

CONAMA-09/86 *Regulates the matters related to public hearings)* - (03/12/1987).

CONAMA-06/86 *Establishes and approves models for licensing application* - (24/01/1986).

CONAMA-06/87 *Regulates environmental licensing of large enterprises, specially in the area of electric energy generation*- (16/09/1987).

CONAMA-237/97 *Establihses procedures for environmental licensing of several types of enterprises* - (19/12/1997).