



Rad. Waste Management in Brazil

***IAEA – Workshop on Sustainable Management of
Disused Sealed Radioactive Sources (DSRS)***

Lisbon - Portugal

October 2010

Manoel M. O. Ramos

***Contributors: Antonio Fernando Costa, Claudia Wailant,
Elizabeth May, Manoel Ramos, Marcelo Mallat[†], Marco Aurélio
Leal, Nerbe Ruperti, Paulo Heilbron Filho, Rubemar Ferreira,
Vera Lúcia Cavalcante, Walter Mendes.***



•National Report of Brazil - 2008

*for The 3rd Review Meeting of the
JOINT CONVENTION ON THE SAFETY OF SPENT
FUEL MANAGEMENT AND ON THE SAFETY OF
RADIOACTIVE WASTE MANAGEMENT*

- **CNEN was created in 1956 (Decree 40.110 of 10/10/1956) to be responsible for all nuclear activities in Brazil.**
- **Its responsibilities were established by the Law 4.118/62 amended by Laws 6.189/74 and 7.781/89.**
- **Thereafter, CNEN became the Regulatory Body for the nuclear field in Brazil, in charge of regulating, licensing and controlling nuclear energy uses.**

Preliminary Safety Analysis Report (PSAR) → CNEN

Environmental Impact Assessment (EIA) → IBAMA (Environmental Regulatory Body)

- **Nuclear electricity generation was transferred to a state-owned company (Eletrobrás - 1961).**





CNEN's Responsibilities Related To Radioactive Waste - Law 7.781:

The Law 7.781 of 16 December 1989, attributed to CNEN the responsibility for the final disposal of radioactive wastes.



Specific Waste Law - Law 10.308:

Law n. 10.308 of November 20, 2001 established the rules for the siting, licensing, operation and regulation of radioactive waste facilities in Brazil

Waste Classification Adopted in Brazil – Same of IAEA

Categories	Description
I - Exempt Waste	Activity levels at or below clearance levels, which are based on an annual dose to members of the public of less than 0.01 mSv.
II - Low and Intermediate Level Waste	Activity levels above clearance levels and thermal power below about 2 kW/m ³ .
II.1 - Short Lived Waste	Restricted long lived radionuclide concentration (limitation of long lived alpha emitting radionuclides to 4000 Bq/g in individual waste packages and to an overall average of 400 Bq/g (per waste package).
II.2 - Long Lived Waste	Long lived radionuclide concentrations exceeding limitations for short lived waste.
III-High level Waste	Thermal Power about 2kW/m ³ and long-lived radionuclide concentrations exceeding limitations for short-lived waste.



Radioactive Waste Management in Brazil

Waste Management Regulations

BRAZILIAN REGULATIONS	ENFORCEMENT	IAEA REGULATIONS	PRESENT SITUATION
NE - 1.10 SEGURANÇA DE SISTEMAS DE BARRAGEM DE REJEITOS CONTENDO RADIONUCLÍDEOS (SAFETY OF MINING WASTE DAM)	D.O.U. 27 DE NOVEMBRO DE 1980	NO	
NE - 5.01 TRANSPORTE DE MATERIAIS RADIOATIVOS (TRANSPORT OF RADIOACTIVE MATERIAL)	D.O.U. 01 DE AGOSTO DE 1988	TS-R-1 Regulations for the Safe Transport of Radioactive Material - 2005	UNDER REVIEW TS-R-1 OF AIEA
NE - 5.02 TRANSPORTE, RECEBIMENTO, ARMAZENAGEM E MANUSEIO DE ELEMENTOS COMBUSTÍVEIS DE USINAS NUCLEOELÉTRICAS (SPENT FUEL STORAGE AND TRANSPORT)	D.O.U. 17 DE FEVEREIRO DE 2003	TS-R-1	
NE - 6.05 GERÊNCIA DE REJEITOS RADIOATIVOS EM INSTALAÇÕES RADIATIVAS (WASTE MANAGEMENT)	D.O.U. 17 DE DEZEMBRO DE 1985	111-F, 111-G-1.1, DS292, WS-G-2.7, DS336	UNDER REVIEW 111-F, TECDOC 1000, and 111-G-1.1



Radioactive Waste Management in Brazil

Waste Management Regulations

BRAZILIAN REGULATIONS

ENFORCEMENT

IAEA REGULATIONS

PRESENT SITUATION

NE - 6.06 SELEÇÃO E ESCOLHA DE LOCAIS PARA DEPÓSITOS DE REJEITOS RADIOATIVOS (SITE SELECTION LLW)	D.O.U. 24 /01/1990	DS334, 111-G-4.1	
NE-6.09 CRITÉRIOS DE ACEITAÇÃO PARA DEPOSIÇÃO DE REJEITOS RADIOATIVOS DE BAIXO E MÉDIO NÍVEIS DE RADIAÇÃO (WASTE ACCEPTANCE CRITERIA)	D.O.U. 23/09/2002		
NE-4.01 REQUISITOS DE SEGURANÇA E PROTEÇÃO RADIOLÓGICA PARA INSTALAÇÕES MÍNERO-INDUSTRIAIS (SAFETY OF MINERAL-INDUSTRIAL FACILITIES)	D.O.U. 06/01/2005	WS-G-1.2	

Radioactive Waste Management in Brazil

Waste Management Regulations

BRAZILIAN REGULATIONS

ENFORCEMENT

IAEA REGULATIONS

PRESENT SITUATION

DESOMISSIONING (NO REGULATION AVAILABLE TO DATE)		WS-G-2.1. WS-G-2.2, WS-G-2.4	
CONTAMINATED SITES (NO REGULATION AVAILABLE TO DATE)		DS332	
SPECIFIC FOR EFFLUENTS (NO REGULATION AVAILABLE TO DATE)		WS-G-2.3	PART IN CNEN-NE-6.05 AND CNEN-NE-3.01
COMODITIES (NO REGULATION AVAILABLE TO DATE)		RS-G-1.7	
PRE-DISPOSAL OF HLW,LILW (NO REGULATION AVAILABLE TO DATE)		WS-G-2.5, WS-G-2.6 DS353	PART IN CNEN-NE-6.09 AND PART IN THE DRAFT ALREADY MADE

Radioactive Waste Management in Brazil

Waste Management Regulations

BRAZILIAN REGULATIONS

ENFORCEMENT

IAEA REGULATIONS

PRESENT SITUATION

<p>BOREHOLES</p> <p>(NO REGULATION AVAILABLE TO DATE)</p>		<p>DS335</p>	
<p>MONITORIG FINAL DISPOSAL SITES</p> <p>(NO REGULATION AVAILABLE TO DATE)</p>		<p>DS357</p>	
<p>NORM</p> <p>(NO REGULATION AVAILABLE TO DATE)</p>		<p>DS352</p>	
<p>OPERATION OF DEEP GEOLOGICAL DISPOSAL</p> <p>(NO REGULATION AVAILABLE TO DATE)</p>		<p>DS356, 111-G-3.1</p>	



CNEN's Offices in Brazil

Distrito Federal

- Distrito do Planalto Central

Goiás

- Centro Regional de Ciências Nucleares em Abadia de Goiás (CRCN-CO) ~ 30
- Near surface disposal repository (Goiânia accident)

Minas Gerais

- Centro de Desenvolvimento da Tecnologia Nuclear (CDTN) ~ 400
- Laboratório de Poços de Caldas (COLAB) ~50

São Paulo

- Instituto de Pesquisas Energéticas e Nucleares (IPEN) ~ 1000

Ceará

- Distrito de Fortaleza (DIFOR)

Pernambuco

- Centro Regional de Ciências Nucleares em Recife (CRCN-NE) ~ 60

Bahia

- Distrito de Caetitê

Rio de Janeiro

- SEDE (Headquarter) ~ 400
- Instituto de Radioproteção e Dosimetria (IRD) ~ 300
- Instituto de Engenharia Nuclear (IEN) ~ 250
- Distrito de Angra dos Reis (DIANG)

Rio Grande do Sul

- Distrito de Porto Alegre

- Research institutes
- Research institutes with interim storage
- Districts of CNEN ~ 1 to 20



Two Nuclear Power Plants (RJ) Angra 1 and 2

- Partial license for construction of Angra 3 in March 2010

Two Uranium Mining and Milling Facilities (MG and BA)

One Fuel Element Assembly Facility (RJ)

Four Research Reactors (1 RJ, 2 SP, 1 MG)

One Pilot Scale Fuel Cycle Facility, including a plant for the conversion of uranium to UF_6 , and another for uranium enrichment (SP)



3750 Medical, Industrial and Research Facilities (all states)

One Industrial Facility for Processing Monazite Sands (ES)

Petroleum Exploitation (NORM) (mainly RJ and BA)

**Mining and Milling Activities with U and Th Associated
(Niobium, Tantalum, Zirconite, etc - several states)**

They all produce
waste...



RADIOACTIVE WASTES FROM MEDICAL, **INDUSTRIAL AND RESEARCH INSTALLATIONS**



- The R&D Directorate operates a system aimed at collecting radwaste all over the country. Thousands of spent sources were collected and stored at CNENs Institutes since 1988.
- Mainly Am-241/Ra-226 smoke detectors and lightning rods, Ra-226 tubes and needles, Co-60 and Cs-137 from industrial applications

→ CNEN Institutes Interim Storage

Inventory of radioactive wastes from medical, industrial and research installations are provisionally stored at CNENs Institutes (IPEN, IEN and CDTN) for treatment

Institute	Spent Sources			Total Activity Ci		
	Till 2007	2008	Total	Till 2007	2008	Total
IEN/RJ	2,031	61	2,092	1,334.04	100.13	1,434.17
CDTN/MG	1,607	50	1,657	8,414.64	914.00	9,328.64
IPEN/SP	10,792	245	11,037	32,353.65	4,105.46	36,459.11
TOTAL	14,430	356	14,786	42,102.33	5,119.59	47,221.92

Lightning rods

Institute	Number			Total Activity Ci		
	Till 2007	2008	Total	Till 2007	2008	Total
IEN/RJ	567	12	579	343.32	6.84	350.16
CDTN/MG	2205	368	2573	1266.84	209.76	1476.6
IPEN/SP	13107	237	13344	7624.35	137.67	7762.02
TOTAL	15879	617	16496	9201.51	354.27	9588.78

Smoke detectors

Institute	Number			Total Activity Ci		
	Até 2007	Em 2008	Total	Até 2007	Em 2008	Total
IEN/RJ	3009	2016	5025	13.69	10.09	23.78
CDTN/MG	1351	184	1535	9.03	0.92	9.95
IPEN/SP	22980	2261	25241	104.18	11.30	115.48
TOTAL	27340	4461	31801	126.9	22.31	149.22

Disused Sources in storage

Institute	Number of sources	Total Volume (m ³)	Total Activity (Bq)	Occupation rate (%)
IPEN/SP	149,727*	172	5.07 x 10 ¹⁴	~99
CDTN/MG	15,204**	133	1.7 x 10 ¹⁴	~ 27
IEN/RJ	7,567	114	7.60 x 10 ¹²	~ 99

*This includes 141,320 ²⁴¹Am and ²²⁶Ra sources from lightning rods and smoke detectors and excludes 113 neutron sources repatriated to USA.

**This includes 13,670 ²⁴¹Am and ²²⁶Ra sources from lightning rods and smoke detectors.



Strategy devised and implemented for the management of radioactive waste at CNEN → CNEN-NE-6.05-Waste Management.

The main aspects of the management program are:

- ❑ registry of the waste and spent sources inventory using an electronic database;
- ❑ waste generation minimization by an adequate segregation, characterization, and dismantling (whenever possible);
- ❑ volume reduction by chemical treatment for the liquid waste, compaction and cutting for solid waste of sources;
- ❑ cementation of sludge arising from the chemical treatment and immobilization of the non compactable solid waste in cement/bentonite matrix;
- ❑ quality control of the final product in order to guarantee safety during storage and to minimize doses to workers and individuals of the public.



CNEN
Comissão Nacional
de Energia Nuclear

Radioactive Waste Management in Brazil

Interim Storage at CNENs Institutes

CDTN - Solid Waste Storage Building





CDTN – Liquid Waste Storage Building





CDTN – Waste Treatment Facilities



Imobilization Lab (cement)



**Glove Box for Dismantling
of Lightning Rods**



CDTN – Waste Treatment Facilities



Spent Source Dismantling



Bitumen Plant Lab



CDTN – Waste Treatment Facilities



Compaction Equipment



Cementation Plant



CNEN
Comissão Nacional
de Energia Nuclear

Radioactive Waste Management in Brazil

Interim Storage at CNENs Institutes

CDTN – Transport Package Testing



IPEN – Waste Storage Building





CNEN
Comissão Nacional
de Energia Nuclear

Radioactive Waste Management in Brazil

Interim Storage at CNENs Institutes

IPEN – NEW!! Waste Storage Building (2010)





IPEN – Waste Treatment Facilities



**Small Activity Spent Source
Dismantling Project**



IPEN – Waste Treatment Facilities



**Waste Reception /
Segregation Unit**



**Glove Box for
Lightning Rods
Dismantling**



IPEN – Waste Treatment Facilities



Decontamination Unit



Liquid Waste Storage



IPEN – Waste Treatment Facilities



Liquid Waste Immobilization Equipament



IPEN – Waste Treatment Facilities



Solid Waste Compaction Equipment - 10.000 kgf, - 5:1



NORM/TENORM ARISING FROM PETROLEUM EXPLOITATION

Petroleum Exploitation Contaminated Pipes and Equipments





Scrap yard merchant → Steel industries



BaSO_4 , SrSO_4 or CaCO_4 → Ra-226 and Ra-228



Scrap yard merchant → Steel industries Orphan sources



COMPANHIA SIDERURGICA TUBARÃO
Engenharia de Segurança do Trabalho

Abaixo Arquivo Fotográfico do encontro, resgate e identificação da 1ª Fonte Radioativa CO 60.



Vista Frontal do Caminhão Transportador.



Vista Lateral Retirando a Carga



Encontro da 1ª Fonte - 23/05/2004



Transferindo a 1ª Fonte Radioativa para o DMR



1ª Fonte Radioativa Segregada no DMR



Placa de Identificação da 1ª Fonte Encontrada

- Once alarmed by portal detectors, the truck has to be unloaded, the burden surveyed to isolate the source...



- Prepare a report to CNEN



Low/intermediate level radwaste disposal

Working group

CNEN – CDTN – IEN – IPEN – IRD – **ETN** - LAPOC

Inventory

Site Selection

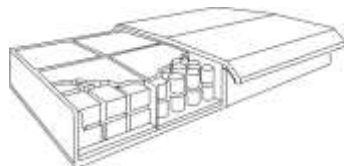
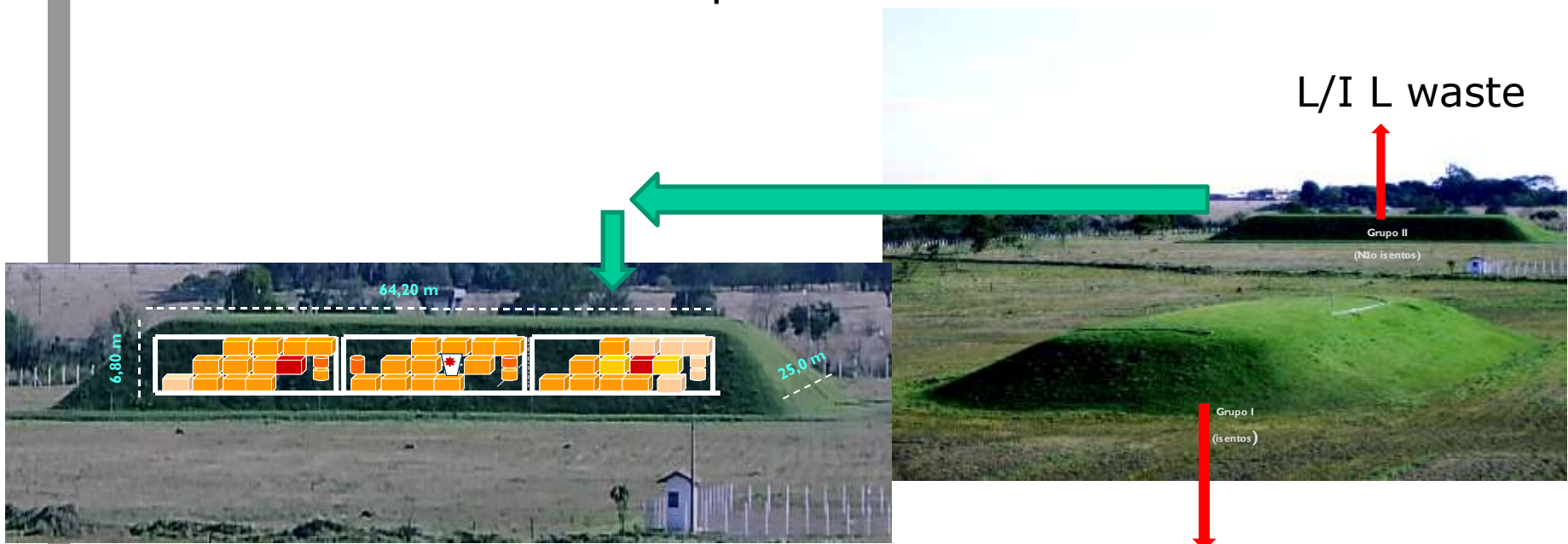
Project options →

Security Analysis

Legislation, Standardization and Licensing

Project option 1 - Near surface repository

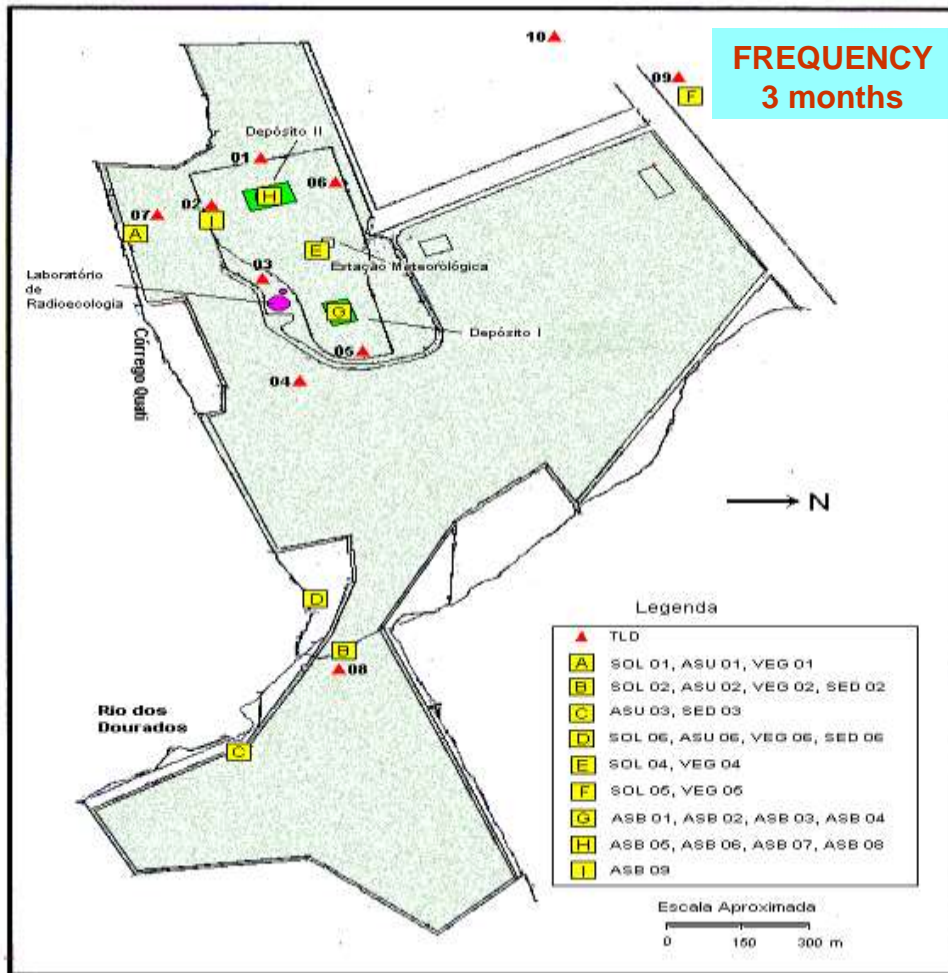
The Goiânia accident disposal vaults



Exempt waste

Project option 1 - Near surface repository

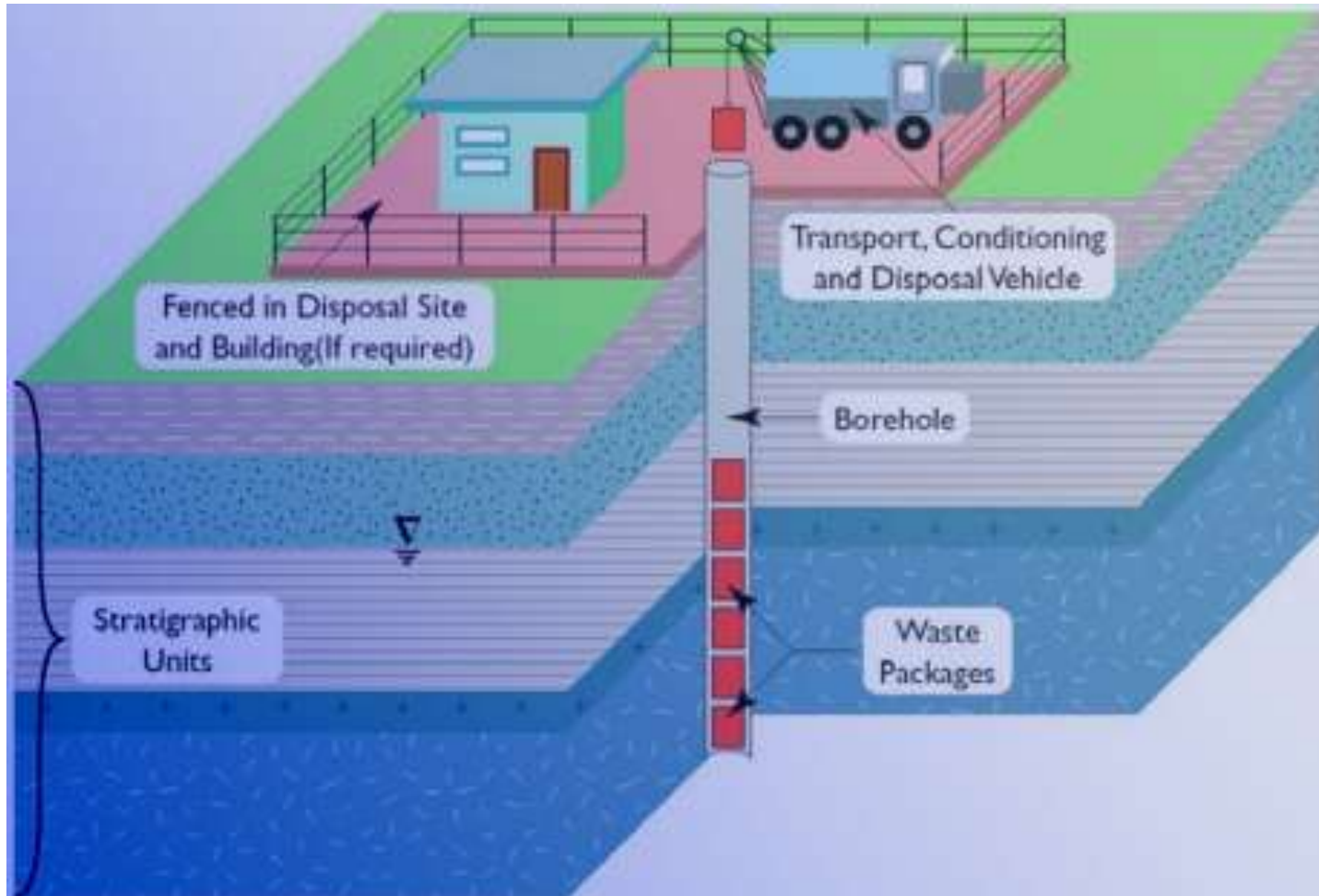
Monitoring agreement between CNEEN and the state of Goiás for 50y



SAMPLE	HIGHEST VALUE	LOWER VALUE
SEDIMENT	7.34 Bq/Kg	<0,42 Bq/kg
SOIL	5.62 Bq/kg	<0,72 Bq/kg
GROUND WATER	0.12 Bq/L	0,0015 Bq/L
SURFACE WATER	< 0.04 Bq/L	-
EXT GAMMA	0.85 mSv/y	0,57 mSv/y
MILK	0.62 Bq/L	<0,17 Bq/L
GRASS	1.49 Bq/kg	<0,27 Bq/kg
AIR PARTICULATES	<0.01 mBq/m ³	-



Project options - Deep repository, Cave, Borehole?





- **The development of a unified and standardized database that records the national radioactive waste inventory;**
- **Increasing of the capacity of CNEN institutes to treat and store radioactive waste;**
- **The need to review and update Waste Management Regulations**
- **The need to select the site and implement the National Repository for Radioactive Waste, providing final disposal for low- and intermediate level radioactive waste; ~ 2020??**
- **The development of public acceptance and democratic participation programs for waste repositories;**



- **Training, recruiting and retention of human resources, in light of the forecasted resurgence of nuclear activities in the country and of the foreseen reduction of the labor force in the field, due to retirements and lack of retention;**
- **The development of a regulatory body which is independent of all its regulated agents. (ARN – Argentina)**
- **EBRR (Brazilian Enterprise for the Management of Radioactive Waste) – ANDRA (France) – ENRESA (Spain)**



CNEN

Comissão Nacional
de Energia Nuclear

OBRIGADO
MUCHAS GRACIAS
THANK YOU