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25 YEARS OF MONITORING THE WASTE MANAGEMENT CENTER OF THE ALMIRANTE ÁLVARO ALBERTO NUCLEAR POWER STATION

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ABSTRACT

The goal of this paper is to present an assessment of 25 years of monitoring of the environment around the Waste Management Center (WMC) of the Almirante Alvaro Alberto Nuclear Power Station (AAANPS) since 1986 until 2011.
The Environmental Monitoring Laboratory (EML) has, for purposes, to monitor the environment around the station to verify if there's a potential impact caused by the operation of the two units and to verify the dose rate levels around the waste deposits.
The WMC is located in an area belonging to the AAANPS and receive solid waste of low and medium activities from Angra 1 NPP. The waste generated from Angra 2 NPP is stored inside the unit.
The EML monitors the environment around the WMC to determine the environmental dose rate. The monitoring is made by direct measurement of the radiation using thermoluminescent dosimeters (TLD).
Nowadays, the TLD are installed, at this time, in 6 points at the boundaries of WMC and are changed monthly. The locations of these points were already changed several times to allow the construction of new buildings.
The constitution of the TLD are 4 crystals, being 3 crystals of Calcium Sulphate doped with Thulium ($CaSO_4$:Tm) with 3 shields and 1 crystal of Lithium Borate doped with Copper ($Li_2B_4O_7$:Cu) without shield.
The results of the TLD measurements are normalized to a period of 30 days to compensate accidental statistical variations of the dose rates. The results, in these 25 years, show that the external area of the WMC is a supervised area, following the Norm CNEN-NN-3.01 – "Diretrizes Básicas de Proteção Radiológica" – with access permited only for authorized people.

1. INTRODUCTION

The Almirante Álvaro Alberto Nuclear Power Station (AAANPS) is located in Itaorna Beach, in Angra dos Reis, Rio de Janeiro and belongs to Eletrobras Eletronuclear S.A. – ELETRONUCLEAR. It is formed by three units: Angra 1, a 650 MW PWR (Pressurized Water Reactor) designed by Westinghouse, in commercial operation since 1985, Angra 2, a 1,350 MW plant, designed by Siemmens-KWU, in commercial operation since 2001 and Angra 3, a unit similar to Angra 2, under construction.

The AAANPS is responsible to manage the Waste Management Center and the Initial Deposit of Steam Generators, both located in the site of the Station.

The Waste Management Center (WMC) is an installation which receives solid waste of low and medium activities only from Angra 1 NPP and is formed by three deposits (the waste generated from Angra 2 is stored inside the unit).

The Initial Deposit of Steam Generators is an installation which keeps the used steam generators of Angra 1, changed in Jan. – Mar. 2009.

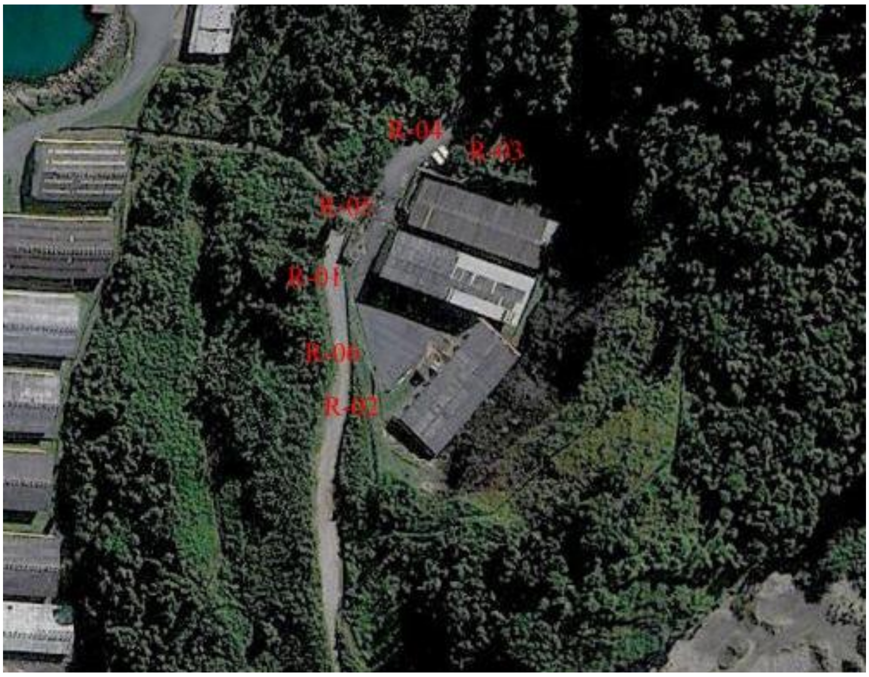

Figure 1: Aerial view of the AAANPS Waste Management Center

The Environmental Monitoring Laboratory (EML) is an installation belonging to ELETRONUCLEAR and is located in Mambucaba Residential Village, 13 Km far from AAANPS. It was created in 1978 with the purpose of monitoring the environment around the Station to verify if there is a potential impact caused by the operation of the units and to verify the dose rate levels around the waste deposits.

The EML is responsible for the execution of several environmental programs. One of these programs is the Operational Radiological Environmental Monitoring Program of the Waste Management Center [3], that establishes the location of the points in which are installed thermoluminescent dosimeters (TLD) and the frequencies they are changed. The results of the TLD measurements are normalized to a period of 30 days to compensate accidental statistical variations of the dose rates.

This paper presents an evaluation of 25 years of monitoring of the environment around the WMC, in the period from 1986 to 2011 and show that the external area of the WMC is a supervised area, following the Norm CNEN-NN-3.01 – “Diretrizes Básicas de Proteção Radiológica” [3] – with access only permited for authorized people.

Every year, reports are emitted to CNEN, IBAMA and INEA including evaluations of each monitoring done.

2. METHODOLOGY

2.1. Description of the Method

2.1.1. Materials

To perform monitoring over the past twenty-five years, the EML used two dosimetry systems with different configurations. In the period 1986-1999, was used Harshal's system with TLD-700 dosimeters, being replaced by a Panasonic system using dosimeters UD-814 since year 2000, which configuration is shown below.

Table 1. Configuration of UD-814 dosimeter

	Chemical Composition	Element 1 $Li_2B_4O_7$:Cu	Element 2 $CaSO_4$:Tm	Element 3 $CaSO_4$:Tm	Element 4 $CaSO_4$:Tm
Front	Attenuation – mg/cm^2	14	860	860	860
	(substrate + support)	mylar	plastic + lead	plastic + lead	plastic + lead
	Holder (UD874 A-T)	5	160	160	160
	mg/m^2	mylar	plastic	plastic	plastic
	Total	19	1020	1020	1020
Back	Attenuation – mg/cm^2	14	860	860	860
	(substrate + support)	mylar	plastic + lead	plastic + lead	plastic + lead
	Holder (UD874 A-T)	160	160	160	160
	mg/m^2	mylar	plastic	plastic	plastic
	Total	174	1020	1020	1020

2.1.2. Proceedings

Before the dosimeters are placed at the monitoring points, they are "annealed" with a sequence of six steps of heating, this clean them of any energy previously absorbed (natural radiation). Control dosimeters are also annealed and used to provide the background results.

So, these dosimeters are placed in six points around the WMC and in ten points around the Initial Deposit of Steam Generators. They are changed every month and analyzed in the Panasonic UD-716 Dosimeter Reader. They are placed 1 meter height and protected from the rain to avoid humidity. These dosimeters are not affected by natural light.

Since 2009, is carried out with an interval of four months, a quality control test where sets of dosimeters are irradiated in a known radiation field, within the values of 0.250 mSv and 0.500 mSv and recorded the results for the assembly of a control chart process.

3. RESULTS

Due to the large volume of data generated by the monitoring carried out during the past twenty-five years, we present the averages for each point and a graphically entire series of data for each point.

Table 2. Annual Averages of each Point (mSv.30d^{-1})

	R01	R02	R03	R04	R05	R06
1987	0.196	0.183	0.627	0.280	0.219	-----
1988	0.299	0.348	1.623	0.781	0.272	-----
1989	0.175	0.251	2.680	1.295	0.225	-----
1990	0.176	0.233	2.475	1.222	0.227	-----
1991	0.181	0.226	2.801	1.358	0.264	-----
1992	0.189	0.166	2.678	1.244	0.260	-----
1993	0.270	0.233	3.121	1.866	0.349	-----
1994	0.343	0.291	3.953	2.340	0.430	-----
1995	0.286	0.259	3.402	1.959	0.493	-----
1996	0.289	0.245	3.218	1.853	0.784	-----
1997	0.450	0.345	3.251	2.893	0.938	-----
1998	0.534	0.416	3.739	6.444	1.103	-----
1999	0.472	0.374	3.147	5.440	0.931	-----
2000	0.446	0.353	2.643	4.780	0.841	-----
2001	0.294	0.242	1.862	3.618	0.541	-----
2002	0.305	0.206	1.515	2.692	0.482	-----
2003	0.190	0.200	1.417	0.681	0.310	-----
2004	0.161	0.153	0.665	0.255	0.219	-----
2005	0.174	0.136	0.377	0.273	0.170	-----
2006	0.175	0.168	0.384	0.292	0.201	-----
2007	0.151	0.168	0.353	0.263	0.203	-----
2008	0.166	0.174	0.396	0.300	0.210	0.199
2009	0.144	0.138	0.341	0.260	0.175	0.166
2010	0.158	0.122	0.370	0.281	0.179	0.158
2011	0.141	0.119	0.315	0.236	0.160	0.148

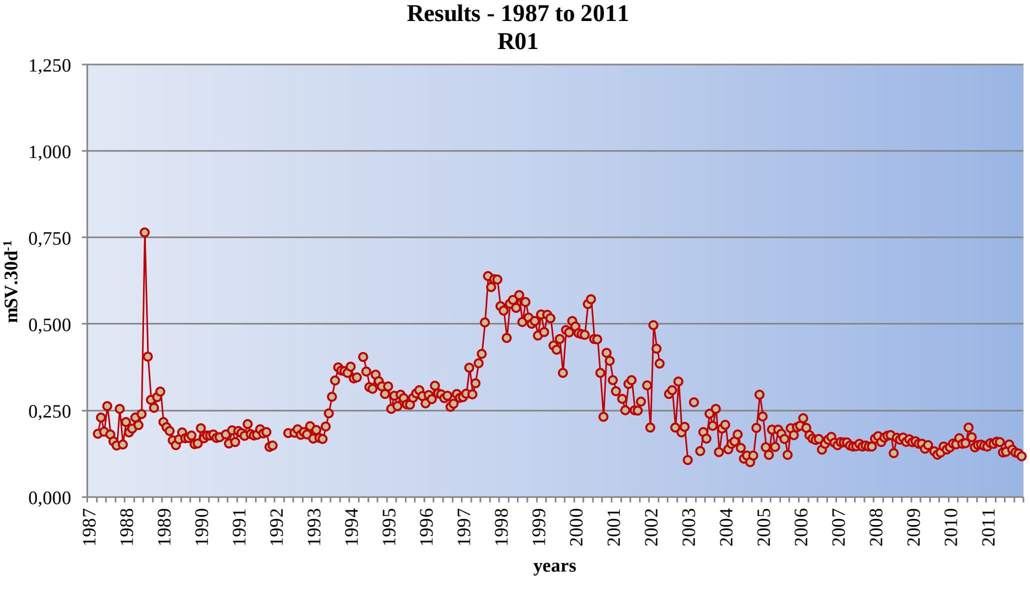

Figure 2: Results from point R01

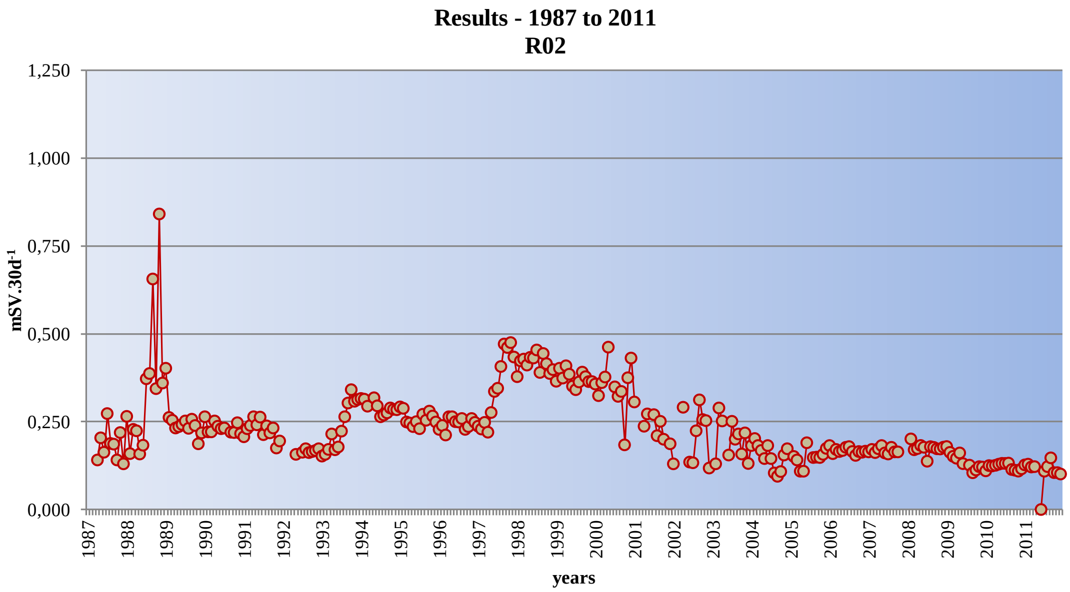

Figure 3: Results from point R02

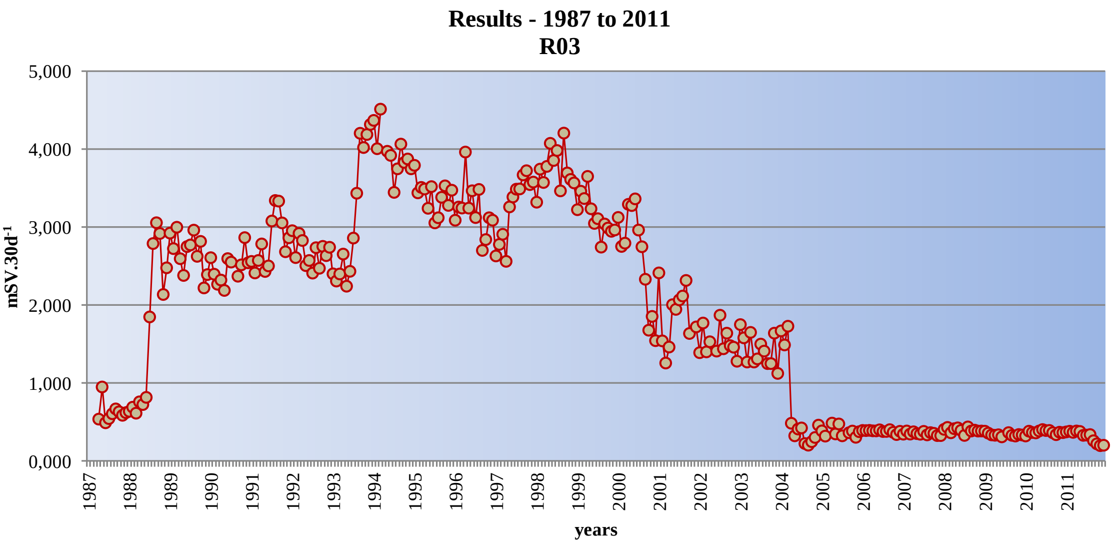

Figure 4: Results from point R03

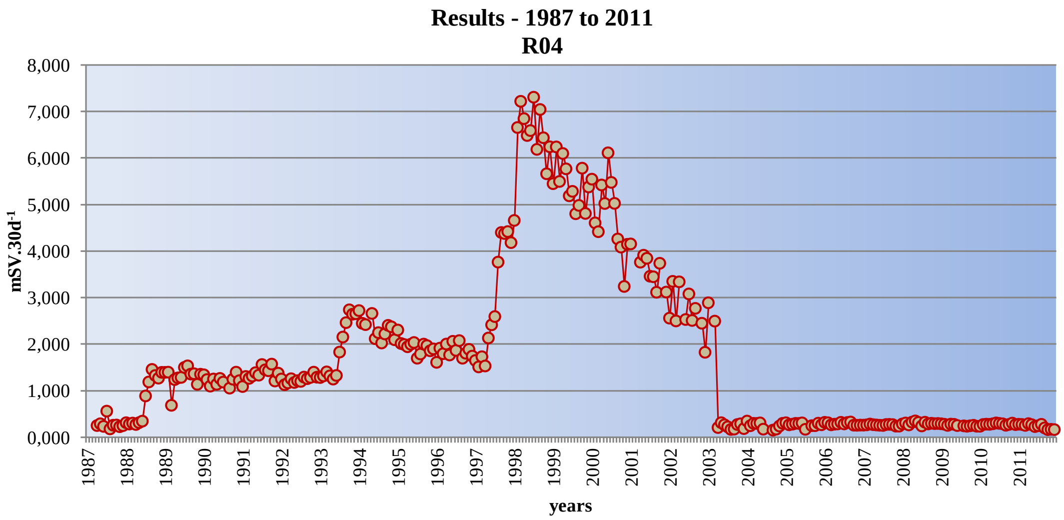

Figure 5: Results from point R04

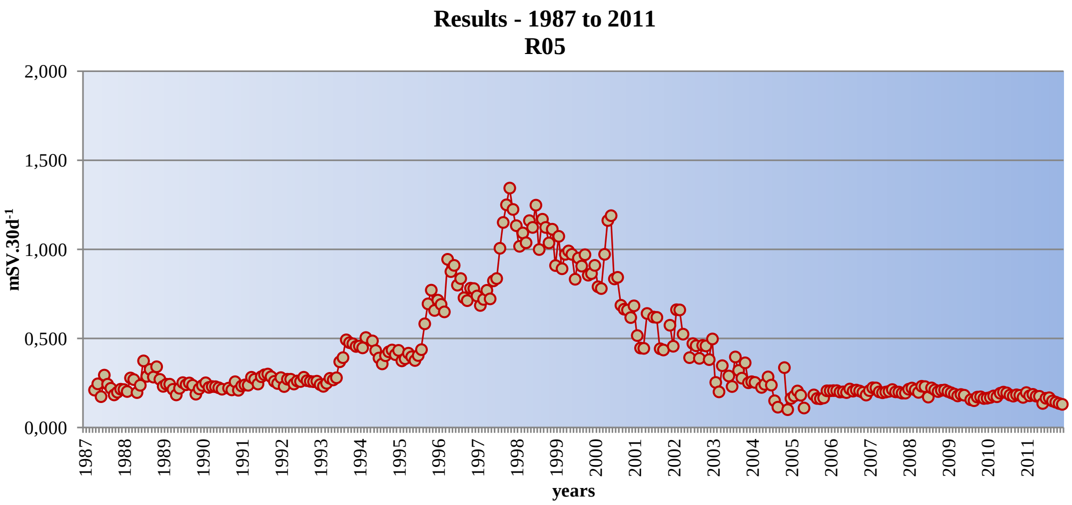

Figure 6: Results from point R05

The results obtained with the implementation of quality control are shown below in tables and control charts.

Table 3. Quality control – delivered dose 0,250 mSv

		Results	- 30%	- 15%	Delivered dose	15%	30%
2009	January	0.252	0.1750	0.2125	0.2500	0.2875	0.3250
	May	0.216	0.1750	0.2125	0.2500	0.2875	0.3250
	September	0.222	0.1750	0.2125	0.2500	0.2875	0.3250
2010	January	0.220	0.1750	0.2125	0.2500	0.2875	0.3250
	May	0.278	0.1750	0.2125	0.2500	0.2875	0.3250
	September	0.263	0.1750	0.2125	0.2500	0.2875	0.3250
2011	January	0.245	0.1750	0.2125	0.2500	0.2875	0.3250
	May	0.275	0.1750	0.2125	0.2500	0.2875	0.3250
	September	0.274	0.1750	0.2125	0.2500	0.2875	0.3250

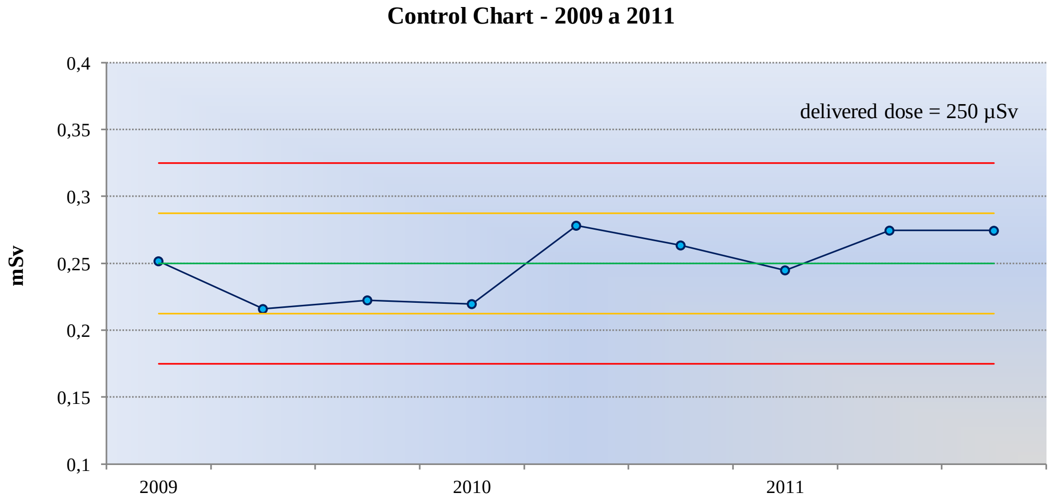

Figure 7: Control chart – 250 mSv

Table 4. Quality control – delivered dose 0,500 mSv

		Results	- 30%	- 15%	Delivered dose	15%	30%
2009	January	0.502	0.350	0.425	0.500	0.575	0.650
	May	0.452	0.350	0.425	0.500	0.575	0.650
	September	0.440	0.350	0.425	0.500	0.575	0.650
2010	January	0.432	0.350	0.425	0.500	0.575	0.650
	May	0.562	0.350	0.425	0.500	0.575	0.650
	September	0.558	0.350	0.425	0.500	0.575	0.650
2011	January	0.487	0.350	0.425	0.500	0.575	0.650
	May	0.555	0.350	0.425	0.500	0.575	0.650
	September	0.560	0.350	0.425	0.500	0.575	0.650

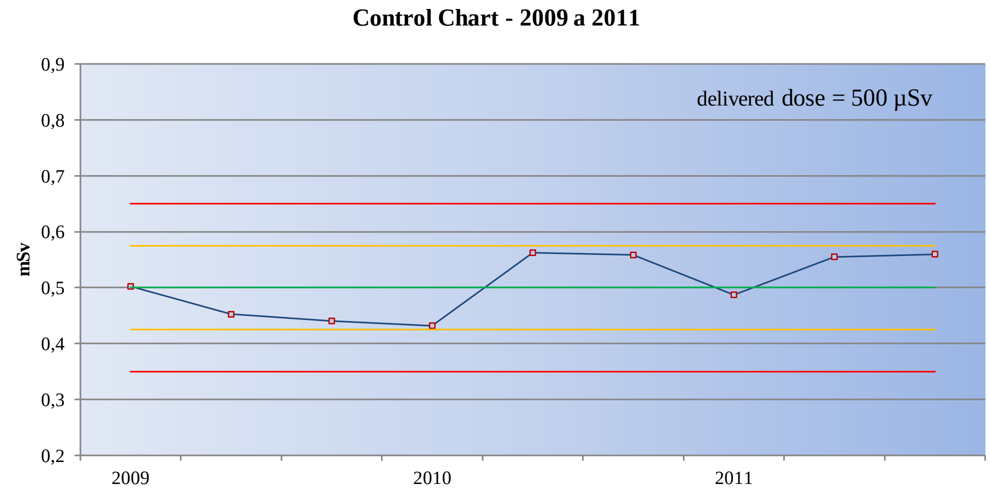

Figure 8: Control chart – 500 mSv

Noting that the limits of 30% used in the assembly of the control chart, were taken from ANSI N545-1975. [3]

4. OBSERVATIONS AND COMMENTS

As can be seen in the graphs shown before, over the years there was an increase in dose rates at all monitoring points until 1999, mostly caused by the transfer of medium activity waste for the CGR. Even with the change in position of some points over the years, we observe that the points R-03 and R-04 were the most affected in this regard.

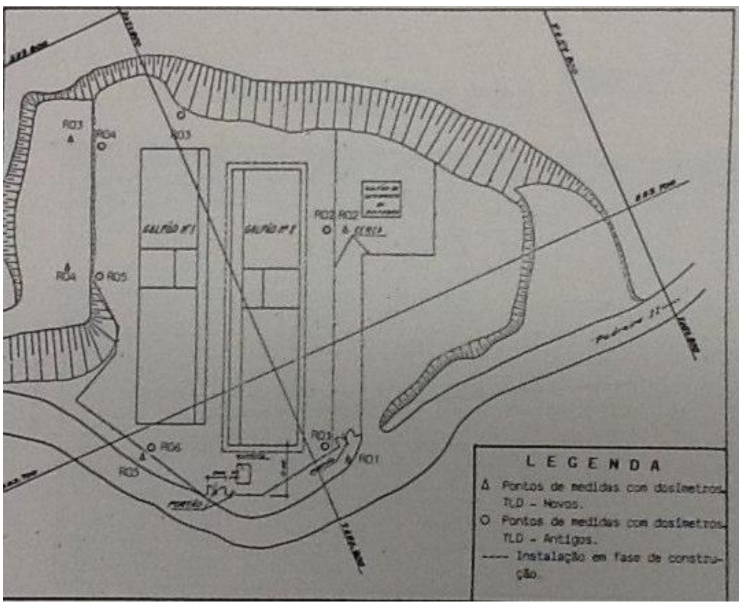

Figure 9: Layout of the WMC in 1987 showing the first change of location of monitoring points and the construction of the deposit number 2.

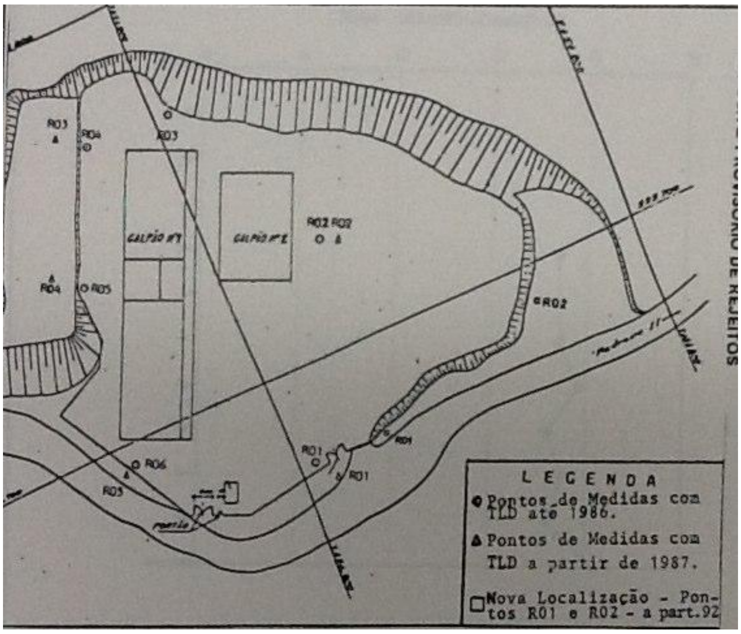

Figure 10: Layout of the WMC in 1992 - with the configuration held from 1992 to 2003.

Still based on the graphs, we see that from 2004 to 2005 there was a decrease in the values of dose rates at all monitoring points, due primarily to the transfer of medium activity waste for the second deposit, which came into operation during this period. From 2006 until 2011, all points had a stable behavior.

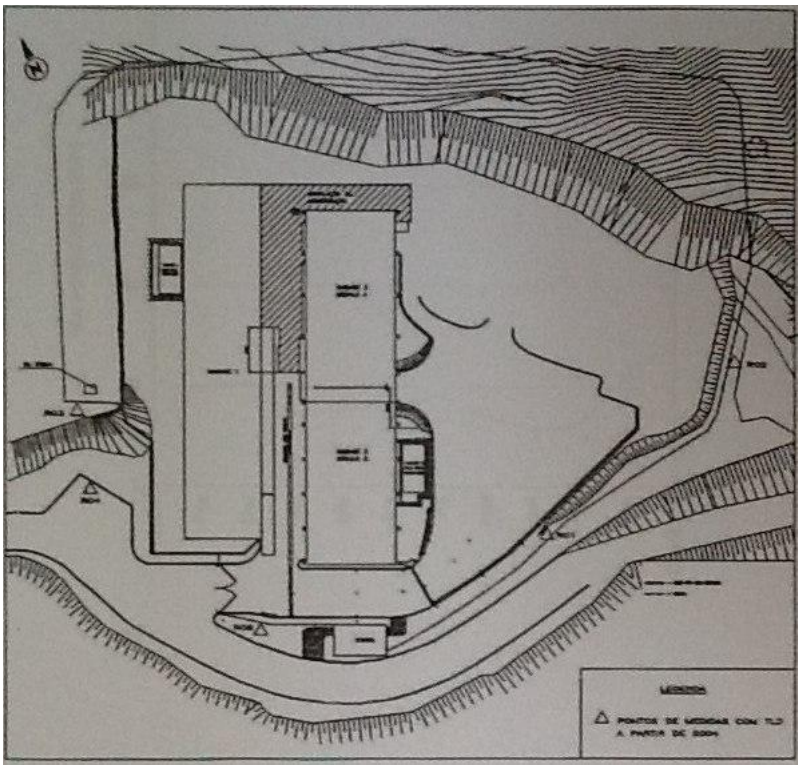

Figure 11: Layout of the WMC from 2004 to 2010.

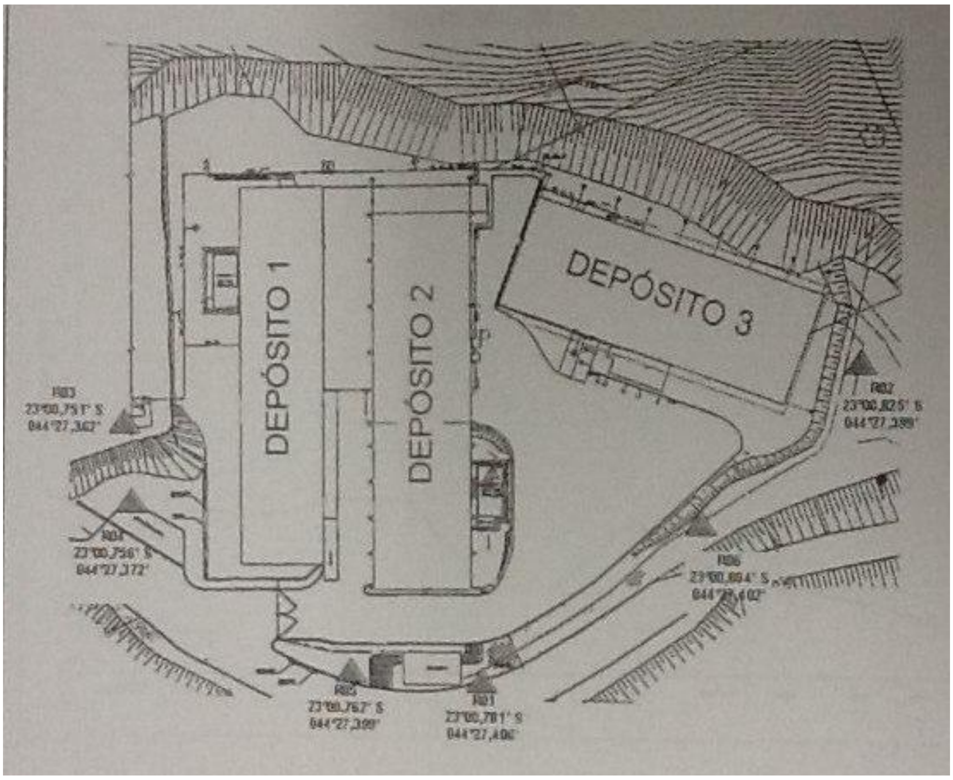

Figure 12: Layout of the WMC after 2010.

5. CONCLUSION

As shown above, the results reflect the evolution of WMC quality over the past twenty five years, such as its expansion of storage capacity and better shielding of radiation to the environment.

Despite being considered a supervised area, the monitoring program continues to be done, even with the addition of one more point from 2008 (R06) and the inclusion of the Initial Deposit of Steam Generators which went into operation in 2009 adding ten more monitoring points by TLDs on the scope of the program.

ACKNOWLEDGMENTS

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