

Application of BAT and BEP in the Portuguese Nuclear Facilities

(OSPAR Agreement: 2018-01)

Presented by:

Department of Emergencies and Radiological Protection (Portuguese Environment Agency), 2024

OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les Parties contractantes sont l'Allemagne, la Belgique, le Danemark, l'Espagne, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède, la Suisse et l'Union européenne

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Country Profile

This document, which is the third submitted by Portugal, has been elaborated according to the new guidelines and contains information, over the period 2018-2023 inclusive, on the Portuguese nuclear facility located in the OSPAR Convention Area.

Radiation protection and nuclear safety authorities in Portugal

The Decree-Laws 156/2013 and 108/2018 (as corrected by Declaration 4/2019 and amended by DL 81/2022 and DL 139-D/2023) define the responsibilities for the radiological protection, the safe management of Spent Fuel (SF) and Radioactive Waste (RW).

The Portuguese Environment Agency, I. P. (APA) and the Health Regulatory Authority (ERS) are the competent authorities responsible for ensuring a high level of radiological protection and nuclear safety, as well as the safe management of spent fuel and radioactive waste. APA is responsible for ensuring a high level of radiological protection and of nuclear safety, as well as the safe management of SF and RW, under the tutelage of the Ministry of Environment and Climate Action. APA is responsible for, namely:

- proposing legislation and regulations,
- classifying radioactive waste,
- radiation protection,
- applying exclusion and clearance levels,
- authorising spent fuel and radioactive waste management facilities and the transport of spent fuel and radioactive waste within the national territory of Portugal,
- reviewing and approving safety assessment carried out by the applicants for spent fuel and radioactive waste management facilities and approving the management systems for these facilities prepared by the operator,
- establishing and maintaining a national inventory of spent fuel and radioactive waste,
- collaborating in the development of national plans for radiological emergencies and assuming all the obligations arising from them,
- promoting cooperation with foreign counterpart institutions and international institutions, and
- preparing and submitting periodic reports to the European Commission on the implementation of Directive 2011/70/Euratom.
- ERS is responsible for ensuring a high level of radiological protection in practices associated with medical exposures.

ERS is responsible for ensuring a high level of radiological protection in practices associated with medical exposures.

Inspections and enforcement duties are carried out by General-Inspection of Agriculture, Sea, Environment and Territorial Planning (IGAMAOT), General Inspection of Health Activities (IGAS), Authority for Labour Conditions (ACT) and the Food Safety and Economic Authority (ASAE) according to their mission. IGAMAOT is responsible for inspections of spent fuel and radioactive waste facilities and associated management activities, as well as for safe transport of spent fuel and radioactive waste within Portuguese territory.

National legislation and basis for regulation

The Portuguese radiation protection policy is based on UE Directives, on international conventions and on recommendations of appropriate international bodies like the International Commission on Radiological Protection (ICRP) and the International Atomic Energy Agency (IAEA).

The Portuguese Environment Agency (APA) is the competent authority of the regulatory body for radiological protection, nuclear safety and the safe management of radioactive waste. These competences are laid down in Decree-Law no. 108/2018, which established the legal regime for radiological protection, as well as the powers of the competent authority and the inspection authority, and which transposed into the internal legal order Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation.

This regulation was supplemented with,

Ministerial Order no. 138/2019, published in DR No. 90, Series I, of May 10, approves the exemption and release criteria, which include the general criteria and levels, provided for in article 23(1)(a) and (3) and article 28(7) of Decree-Law no. 108/2018, of 3 December;

Ministerial Order no. 150-A/2022; approves the National Radon Plan;

Decree-Law no. 81/2022, amends the legal regime for radiological protection, adapting the rules on incompatibilities to the administrative offence regime and application in space;

Decree-Law 139-D/2023, amends the legal framework for radiological protection;

Ministerial Order no. 254/2023, approves the Radioactivity Environmental Monitoring Programme (PRAD);

These regulations complete the transposition of the Directive 2013/59/EURATOM of the Council of the European Union into the Portuguese law.

In addition, the following Portuguese regulations provide specific regulation on different fields of radiation protection:

- DL 156/2013 sets out the legal and regulatory framework for the responsible and safe management of spent fuel and radioactive waste and transposes the provisions of the Council Directive no. 2011/70/EURATOM, dated 19 July 2011, which establishes a community framework for the responsible and safe management of spent fuel and radioactive waste.
- This decree-law applies to all stages of spent fuel management, when it results from civil activities; to all stages of radioactive waste management, from production to disposal,

when they result from civil activities; and to spent fuel management and radioactive waste management facilities.

- DL 135/2017 of October 20 makes the first amendment to Decree-Laws 30/2012 of 9 February and 262/2012 of 17 December, transposing into national law Council Directive 2014/87/EURATOM of 8 July 2014 amending Directive 2009/71/EURATOM establishing a community framework for the nuclear safety of nuclear installations. In addition, Decree Law 262/2012 establishes the obligations of license holders of nuclear installations.

Application of BAT/BEP in Portugal

The Best Available Techniques (BAT) are defined as “the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of techniques for providing in principle the basis for release limitations designed to prevent and, where that is not practicable, generally to reduce releases of radioactive elements and their impact on the environment as a whole”.

The Best Environmental Practices (BEP) are defined as “the application of the most appropriate combination of environmental control measures and strategies”.

In the country’s context, BAT and BEP were introduced at different levels of the Portuguese legislation and regulation to reduce the levels of the radiological impact on people and the environment.

Under the article 13 of the Decree-Law 108/2018, the obligations of the competent authority are:

- b) Propose the adoption of legislation and regulations in the field of radiological safety and protection, aiming at the continuous improvement of the activity regulation instruments and the monitoring of technical development;
- c) Issue the necessary guidelines for the implementation of the provisions of this decree-law, within the scope of its competence;
- i) Determine that the holder takes corrective actions, if unsafe or potentially unsafe conditions are detected in facilities where authorized practices are carried out;
- j) Establish, whenever necessary, the maximum dose constraint value;
- k) Establish reference levels in accordance with the provisions of articles 90, 95, 123, 131, 142 and 148, as well as others defined in a specific legislation;
- w) Maintain a continuous measurement network operational so that situations of abnormal increase in radioactivity in the environment may be detected and the record of measurements made by this network updated; x) Propose corrective measures to guarantee the protection of the environment and populations in situations of emergency exposure or situations of existing exposure and ensure coordination of the radiological aspects of environmental remediation;
- ai) Ensure the correct monitoring of radioactive discharges;
- al) To ensure the monitoring of radioactivity in the environment and the management of the monitoring program of radioactivity in the environment;

The Article 6 of this decree-law, establishes that “the Radiation protection of people subject to occupational exposure or the public exposure shall be optimized in order to maintain the value of individual doses, the probability of occurrence of exposures and the number of people exposed, at a level as low as reasonably possible, taking into account the current state of technical knowledge and economic and social factors”. So, to establish the Best Available Techniques (BAT) all practices must be analysed, in accordance with the requirements that the regulator establishes.

The licensing procedure of a radiological practice carried out by the competent authority, APA, establish authorised limits and conditions for discharging radioactive effluents considering the results of the optimisation of radiation protection and the operation of the facility should reflect a good practice.

Dose limit, constraints, and discharge

The dose limit for members of the public and non-occupationally exposed workers from ionizing radiation, specified in the Portuguese Law (DL N^o 108/2018), is an effective dose of 1 mSv/year. It is also specified an effective dose constraint of 1/3 of the annual dose (0.3 mSv/year).

APA defines radionuclide-specific discharge limits for each facility and activity. The limits are based on the ALARA principle and previous discharge data, while ensuring compliance with the dose limits. The discharge limits are the annual activity level in discharge to water and air.

The operators of facilities and activities must also ensure that the dose constraint, and the dose limits, are not exceeded for the sum of all discharges at a given site.

The Portuguese Research Reactor

In Portugal, dose limits for the Portuguese Research Reactor (RPI) are established by Decree-Law No. 262/2012 of 17 December, as amended by Decree-Law 135/2017, meeting the requirements of Council Directive 2009/71/EURATOM, as amended by Directive No. 2014/87/Euratom.

The discharge limits for liquid effluents for nuclear facilities, authorized on a case-by-case basis depending on local conditions, are defined aiming to limit the exposure of the public to a maximum of 1/10th of the dose limit for the public, 1mSv per year, due to ingestion.

Discharges Limits

Regarding the discharge limits, applicable to liquid and gaseous effluents considered as a whole, were established in 2007 by the Competent Authority, having as a base the safety analysis report.

Annual Limits for Gaseous effluents	
Noble Gases	20TBq
Particles	200MBq
Iodine 131	100MBq
H-3	5GBq
C-14	5GBq

Annual Limits for Liquid effluents	
H-3	500MBq
C-14	500MBq
β Emissions (other than H-3 and C-14)	500MBq

These values, applicable to gaseous and liquid effluents considered as a whole, were established as a proper Dose Constraint for the Portuguese Research Reactor regarding the public and environment protection against radiation exposure.

Regulation on Nuclear and Radioactive Facilities

DL 30/2012, of February 9 (amended by Decree-Law 135/2017, 20 October), transposes the provisions of Directive No. 2009/71/Euratom, of the Council, was amended by Directive No. 2014/87/Euratom, which establishes a community framework for the nuclear safety of nuclear installations, and creates the respective authority into the internal legal order the competent regulator, establishing its scope and powers. Article 2 states “the present diploma applies to any civil nuclear installation in national territory operated under a license, as well as to the regulation of the activities of these installations”.

Its objectives are:

- a) The preservation and promotion of the continuous improvement of nuclear safety and its regulation;
- b) The adoption of provisions leading to a high level of nuclear safety, which protects workers and the general population from the risks of nuclear contamination.

In terms of nuclear installation safety, article 4 (amended by Decree-Law 135/2017, 20 October), states that:

“The operator is responsible for the nuclear installation, from the choice of the site to its dismantling.

The nuclear installations must be located, designed, built, put into service, operated and dismantled to prevent accidents and, in the event of an accident, to minimize the respective consequences and avoid:

- a) Early radioactive releases, which would require emergency measures outside the premises, without however enough time to put them into practice;
- b) Substantial radioactive releases, which would require protective measures that would not be possible to limit in time or space.

The operator bears the primary responsibility for the safety of the installation, including the promotion and continuous reinforcement of a true nuclear safety culture, under the control of the regulatory authority, which cannot be delegated or transferred and includes responsibility for the activities of contractors and subcontractors whose activities may affect the nuclear safety of a nuclear installation.

The granting of a license for the construction or operation of a nuclear installation is based on an appropriate specific assessment of the site and the installations that includes the

demonstration of nuclear safety with respect to national nuclear safety requirements based on the objective defined in the paragraph 2”.

The Decree-Law 108/2018, of December 3, establishes the legal regime in force for radiation protection, as well as the powers of the competent authority and the inspection authority for radiation protection, transposing the Council Directive 2013/59/Euratom, of 5 December, into the internal legal order, which sets the basic safety standards for protection against hazards resulting from exposure to ionizing radiation.

Regulation on radioactive discharges on the Environment

The article 95º, of the Decree-Law 108/2018, regulates the monitoring of radioactive discharges, which indicates, in point 1, “The holder whose license includes, during normal operation, the discharge of radioactive gaseous or liquid effluents into the environment, shall monitor or evaluate said discharges and communicate the results to the competent authority.”. In point 2, “The holder responsible for a nuclear reactor or for reprocessing plant shall monitor the radioactive discharges and report them in a standardized and periodic manner, in terms to be defined by the competent authority.”

APA, as the competent authority, is responsible for ensuring the existence of a high level of radiological protection and nuclear safety, safe management of spent fuel and radioactive waste (article 12 of DL 108/2018), and ensure the correct monitoring of radioactive discharges (article 13 of DL 108/2018).

Environmental Monitoring Programme

The monitoring of radioactivity in the environment is a national concern, operating within three agreements:

- ✓ The Euratom Treaty which, in its Article 35, requires Member States to establish permanent control structures for radioactivity in the atmosphere, waters, and the soil, to ensure checks on compliance with basic standards for the protection of the health of populations and workers against the dangers resulting from ionizing radiation.
- ✓ From the appropriate authorities, is required to periodically communicate information on the checks referred to in Article 35 to the Commission so that it is kept informed of the level of radioactivity to which the public is exposed (article 36).
- ✓ The OSPAR Convention, whose strategy for a Joint Assessment and Monitoring Programme (JAMP) provides for the establishment of a program of monitoring for radioactive substances in the marine environment.

The current program has the name “Programa de Monitorização Ambiental da Radioatividade (PRAD)” (Environmental Radioactivity Monitoring Programme) and implemented in 2023, preceding the previous Environmental Radioactivity Monitoring Programme. The report will be available through online publishing of the available results on the online reporting of environmental status on the webpage of APA.

The Environmental Radiological Monitoring Programme was defined according to the specificities of the country. It consists of measuring artificial and natural radionuclides in

environmental compartments (atmospheric, aquatic and terrestrial environments) considered as direct pathways of contamination to humans: inhalation, ingestion and external radiation.

Inhalation: Continuous sampling and weekly evaluation by airborne radioactive particles using Gamma measurement of radionuclides: Be-7; Cs-137; Cs-134; Pb-210; I-131;

External Radiation: Stations from the Portuguese RADNET network (national environmental radioactivity alert network), measures the dose rates of gamma radiation in the environment (in the magnitude of H*(10)), have the ability to identify the radionuclides that contribute to the measured dose rate, making it possible to distinguish whether the radioactivity present in the environment is due to natural radionuclides or those of anthropogenic origin, are used to obtain the ambient dose equivalent output.

Ingestion: Samples from complete meals, milk and drinking water are sampled and periodically evaluated in the following radionuclides: U-238; U-235; U-234; Ra-226; Pb-210; Po-210; Cs-137; Cs-134; Sr-90; Pu-239+240; Pu-238; Am-241; K-40.

Environmental norms and standards

In Portugal, for the nuclear installations, the DL 108/2018, defines that liquid discharges in surface waters or sewer canalizations must be monitored and imposes annual limit discharge on each nuclear facility.

The Environment Monitoring Program is based on the protection of human health through the application of dose constraints/limits in different compartments. APA is developing a framework for the protection of the environment from ionizing radiation, and this work is contributing to the development of environmental norms and standards and the development and application of relevant assessment methodologies.

Quality assurance

At this moment there are no formal credentials required by APA for laboratories performing analysis and measurements in programmes for monitoring of radioactivity in the environment due to global contamination. In Portugal, there are two laboratories implemented a Quality Management System (QMS) based on the Portuguese Standard NP EN ISO / IEC 17025. In this context, the Portuguese Institute of Accreditation (IPAC) issued the Accreditation Certificate No. L0620 to the Laboratory of Radiological Protection and Safety (LPSR), from IST, and the Accreditation Certificate No. L0720 to the Laboratory of Natural Radioactivity (LRN), from UC, which formalizes, the accreditation of radioanalytical techniques described:

ISO 5667-5 (1996). Water Quality-Sampling, Part 5- Guidance on Sampling of Drinking Water Used for Food and Beverage Processing, September 1996.

ISO 13164-4 (2015). Water quality - Radon-222 - Part 4: Test method using two-phase liquid scintillation counting, June 2015.

ISO 9696 (2017). Water quality - Gross alpha activity - Test method using thick source, October 2017.

ISO 9697 (2018). Water quality - Gross beta activity - Test method using thick source, November 2018.

ISO 11704 (2018). Water quality - Gross alpha and gross beta activity - Test method using liquid scintillation counting, November 2018.

ISO 9698 (2019). Water Quality - Tritium - Test method using liquid scintillation counting, May 2019.

Research reactor in Portugal

The Portuguese Research Reactor

Portugal has one Research Reactor (RPI), which is a light-water moderated, heterogeneous, solid fuel reactor, with a 1MW thermal power, in which water is used both as shielding and cooling. The reactor core is immersed in a two-section concrete pool. One of these sections contains an experimental stall into which beam tubes and thermal column converge. The other section is an open area in front of a dry irradiation window and a gamma room. The reactor can be operated in both sections.

The reactor core is supported by an aluminium structure suspended from a mobile bridge. Control of the reactor is accomplished by the insertion or removal of neutron control rods which are suspended from control drives mounted on the reactor bridge. Heat created in the core is removed by a forced circulation cooling system and dissipated to atmosphere from the heat exchanger by a secondary cooling system.

Location of research reactor

The Portuguese Research Reactor (RPI) is the only civil nuclear installation in the country. The RPI is operated by the IST and is located at the Technological and Nuclear Campus in Loures, 12 km from the centre of Lisbon and 30 m above the average sea level (Figure 1).



Figure 1: Localization of the Portuguese Research Reactor (RPI).

Year for commissioning/licensing/decommissioning

The RPI is in permanent shutdown since 2017 and in 2019 the fuel was transfer from Portugal to the provider. It is currently inactive and waiting for the decommissioning process to start.

Receiving waters and catchment area

Before discharge the effluents to the Municipal Residual Water Treatment Plant (ETAR), the effluents are collected in the tanks of the Radioactive Liquids Effluents Discharge Control Facility (ECoDELiR). This system (ECoDELiR) is divided in two groups that can operate independently, to collect and store liquids effluents if an eventual accident occurs. Samples are taken and analysed in laboratory, by gamma spectrometry with NaI (Tl) detectors, in order to quantify the artificial radionuclides, present before discharge to the ETAR.

Radioactive waste treatment facility

Portuguese waste treatment facility

The Portuguese waste treatment facility, *Pavilhão de Resíduos Radioativos* (PRR), operated by the Instituto Superior Técnico of the University of Lisbon (IST) have a total volume of 350 m³, being currently occupied 265 m³.

In Portugal, Radioactive Wastes (RW) come from medical, industrial, research and teaching activities. The RW can be considered to have very low activity, low activity and intermediate activity. This classification for RW follows the recommendations of the International Atomic Energy Agency.

Residues with a very short half-life can be stored at the producer until they fall below the levels of authorized releases or discharges. The remaining can be disposed in the PRR.

Location of radioactive waste treatment facility

The PRR is the only radioactive waste treatment facility in the country. It is located at its Technological and Nuclear Campus in Bobadela (CTN), 5 km from the Lisbon border, 12 km from its centre and 30 m above the average level of the sea (Figure 1).

Year for licensing

The PRR renewed the license in 2021 by the Portuguese Environment Agency (APA), number LIC-RR-02/.

Receiving waters and catchment area

The PRR is located inside the Technological and Nuclear Campus in Bobadela, in a delimited and controlled area. The installation does not produce waters discharges and the receiving and catchment water is drained for the Radioactive Liquids Effluents Discharge Control Facility (ECoDELiR)

Site-specific information

Nuclear and Technological Campus (CTN)

CTN is structured in three research units, the Nuclear Engineering Laboratory (LEN), integrating the Portuguese Research Reactor (RPI), the Laboratory of Radiological Protection and Safety (LPSR) and the Laboratory of Accelerators and Radiation Technologies (LATR) and the Portuguese waste treatment facility (PRR).



Figure 2 – Localization of Units inside CTN.

All these facilities are connected to the Radioactive Liquids Effluents Discharge Control Facility (ECoDELiR) where the radioactive liquids effluents are discharged. Figure 3 shows the sewage system of CTN.

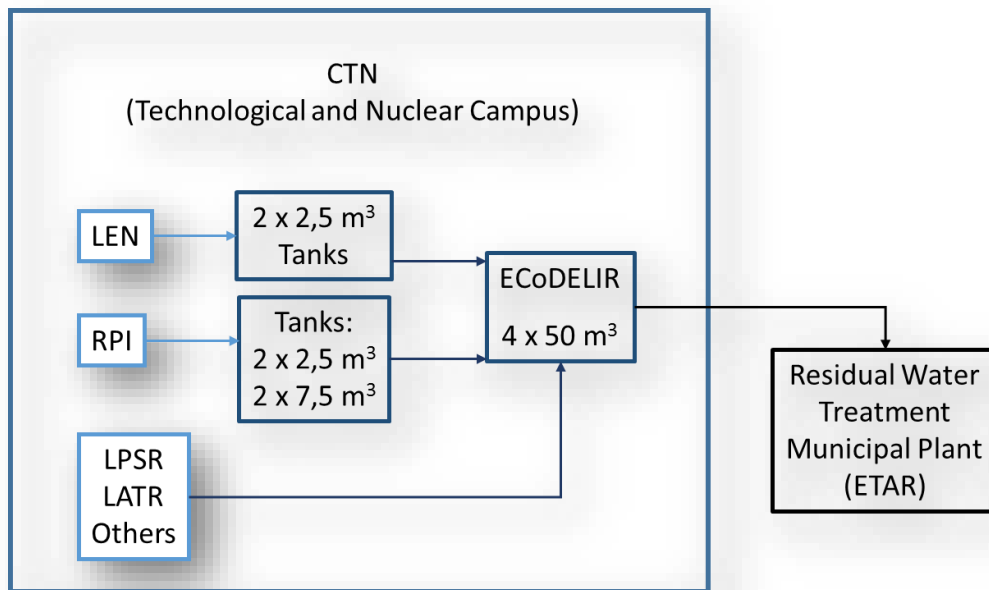


Figure 3 - ECoDELiR – sewage system of CTN.

The effluents from the Portuguese Research Reactor (RPI) are mainly from the washing waters, treatment waters of the ion-exchange resins used to treat the swimming pool and leakage waters. The RPI discharge pipe system ends up in four metallic retention tanks located outside the building and below ground level (9 m), two of them with 2.5 m³ of capacity each and the other two with 7.5 m³ of individual volume each. Radiochemical, radiopharmaceutical and radioisotopes laboratories are operated by LEN and the effluents are discharged into two

metallic tanks with 2.5 m³ capacity each. The other units discharge their effluents directly into ECoDELiR.

Types of facilities

- RPI - Portuguese Research Reactor (shut down)
- PRR - Portuguese waste treatment facility (PRR)

Activities from which liquid effluents arise

The Radioactive Waste Treatment facility receives and manages radioactive low-level and intermediate-level waste from Portuguese industry, universities, hospitals, and other research institutes as well as from CTN own facilities.

Liquid radioactive waste is stored for decay at the production sites or in the Radioactive Waste Treatment tanks.

Systems in place to reduce, prevent or eliminate liquid discharges

The discharge limits are specified in the permits issued by APA according to the Decree-Law 108/2018. The discharge limits are nuclide specific and based on normal activity levels in the effluent water. The discharge shall not result in an annual dose exceeding 1 mSv/Year to the public.

Low-level liquid radioactive wastes are retained in large storage tanks for decay. If sufficient tank capacity is available, short-lived radionuclides are normally allowed to decay to a very low level before being discharged.

Discharges are approved based on measurements of the activity levels of gamma emitting radionuclides and tritium provided that the levels of activity are below specific levels. If gamma and tritium results indicate higher levels than normal, the wastewater is retained until all analyses are according with the emitted licence.

No new systems have been taken into operation during the reporting period. The discharge permits of radioactive substances includes the obligation to limit the discharge to levels as low as reasonably achievable (ALARA) and to use best available technology (BAT). Equipment, methods, and routines are continuously assessed against possible discharge reduction measures.

Annual liquid discharges

As indicated in Table 1, the discharges are low. The research reactor was shut down in 2019. It is unlikely that major investments would be justified to reduce discharges, and corresponding doses to the representative person further. Variations in liquid discharges are caused by variation in the research activities at CTN (Figure 4).

Table 1 Annual liquid discharges from CTN, 2018 - 2023

Radionuclide	Annual liquid discharge (MBq)					
	2018	2019	2020	2021	2022	2023
Calculated Total-b	994,5	61,6	32,4	23,5	104	374
H-3	350	21,5	11,3	8,21	36,6	132
C-14	643	39,6	20,9	15,1	67,4	242
other b-emitters	1,5	0,5	0,22	0,21	0,024	0,02

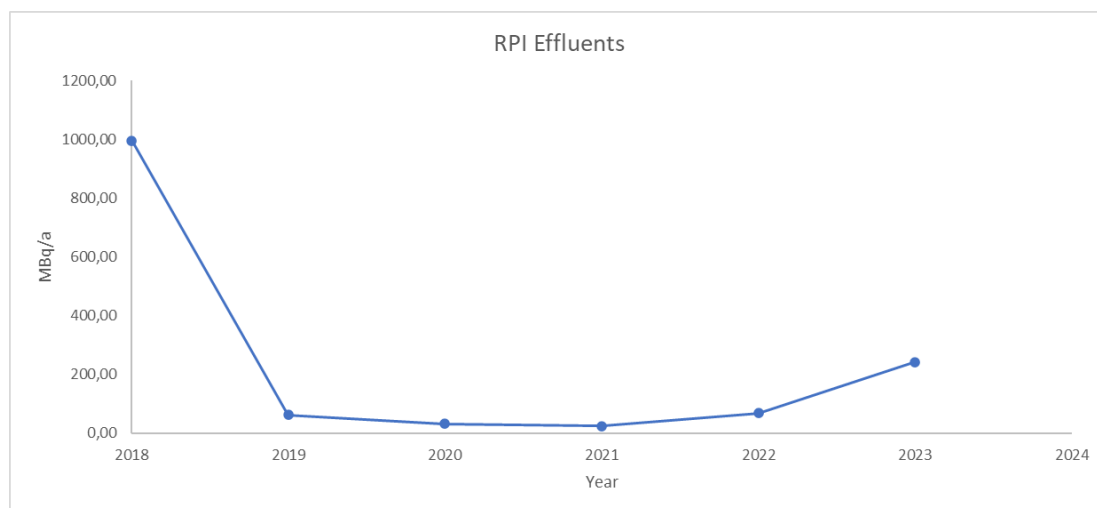


Figure 4: Discharges activity from the RPI since 2018 until 2023.

Emissions to air

APA has issued permits for nuclide specific discharge limits for emissions to the air. Additional restrictions on the emission of iodine isotopes apply in the form of a limit to an annual dose of 1 mSv/Year to the public.

During operation of the RPI, the main emissions to air was from 131I.

Table 2 Annual emissions to air from CTN, 2018 - 2023

Radionuclide	Annual emissions to air (GBq)					
	2018	2019	2020	2021	2022	2023
Total released per annum	763	850	348	798	797	784
I-131	0.0000465	0.000149	0.00854	0.151	0.151	0.576

Summary of BAT/BEP for the CTN site

Based on the evaluation of BAT/BEP concerning discharges, environmental impact and radiation dose to the public it is generally concluded that BAT/BEP is applied at CTN during the period covered by this report.

CONCLUSION

The Portuguese Environment Agency, as the competent authority for the radiation protection, ensures the control of radioactive substances and the effective application of a clear policy under which the application of the Best Available Techniques and the Best Environmental Practices (BAT/BEP) are required at all levels. This policy follows closely the requirements and recommendations of competent international bodies and adopts several principles to ensure the application of the precautionary principle and the prevention of pollution.

Throughout the years 2018-2024 the absolute total activity, in the liquid effluents released from the Portuguese Research Reactor (RPI) exhibits a slightly stable trend throughout the years doses to the environment and humans in the vicinity of the installations, representing a small percentage of the authorised limit.

From the evaluations of the BAT/BEP indicators for discharges, environmental impact and radiation doses to the public it is concluded that BAT is applied in the Portuguese Research Reactor.