OSPAR COMMISSION

Protecting and conserving the North-East Atlantic and its resources

Spanish Seventh Round Implementation Report of PARCOM Recommendation 91/4 on Radioactive Discharges

Radioactive Substances Series

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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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1 INTRODUCTION

PARCOM Recommendation 91/4 states that contracting parties agree "*to respect the relevant Recommendations of the competent international organisations and to apply the Best Available Technology to minimise and, as appropriate, eliminate any pollution caused by radioactive discharges from all nuclear industries, including research reactors and reprocessing plants, into the marine environment. Contracting parties shall present a statement on progress made in applying such technology every four years in accordance with the guidelines annexed to this recommendation*".

This document, which is the seventh submitted by Spain, has been elaborated according to the OSPAR-guidelines 2004-03 and contains information, over the five-year period 2014-2018 inclusive, on the Spanish nuclear facilities located in the OSPAR Convention Area.

2 GENERAL INFORMATION

2.1 IMPLEMENTATION OF BAT/BEP IN TERMS OF THE OSPAR CONVENTION IN SPANISH LEGISLATION AND REGULATION

In Spain the basic laws governing nuclear activities are the Nuclear Energy Act (Law 25/1964, partially reformed by Law 12/2011) and the 15/1980 Law, of April 22nd, creating the Nuclear Safety Council (CSN), amended by Law 33/2007. They are further developed in regulations that provide the framework for standards, guidelines and objectives in this field.

The best available techniques are introduced at different levels of the Spanish legislation and regulation in order to reduce the levels of discharges and the radiological impact to both humans and the environment.

No new legislation on the implementation of BAT/BEP has been approved since the latest implementation round.

2.1.1 Regulation on Nuclear and Radioactive Facilities

The Regulation governing Nuclear and Radioactive Facilities (approved by Royal Decree 1838/1999, amended by Royal Decree 35/2008) in its Article 8.3 establishes that the licensee must continuously ensure the improvement of the nuclear safety and radiation protection conditions of its facility. To this end, the Best Available Techniques (BAT) and practices must be analysed, in accordance with the requirements that the CSN establishes, and those that are suitable, implemented.

2.1.2 Regulation on the Protection of Health against Ionising Radiations

The Title V of the Regulation on the protection of health against ionising radiations (approved by Royal Decree 783/2001, amended by Royal Decree 1439/2010) sets up requirements on the system applied to limit emissions and discharges, where several articles deal with the system of limitation, surveillance and control of radioactive effluents. Article 55 specifically stipulates that facilities generating radioactive wastes must be provided with adequate treatment and removal systems in order to ensure that doses due to releases are lower than the limits established in the administrative licences and that they are kept at the lowest possible value.

A specific authorisation is needed for every facility, setting up specific limits, surveillance requirements and conditions for the releases. The authorised limits guarantee that in normal operating conditions, the doses to members of the public will be in accordance with the ALARA principle that is applied in the design of the treatment systems.

According to Article 52 during operation, licensees have to demonstrate that every reasonable effort is made, from the generation of wastes to the operation proceedings of the effluent treatment systems, to reduce releases and to keep the radiological impact as low as is technically and economically feasible.

2.1.3 Law on the Evaluation of the Environmental Impact

The policy and main precepts governing in Spain the protection of the environment are laid down in the Law on the evaluation of the environmental impact (approved by Law 21/2013, reformed by Law 9/2018). The law involves a wide range of activities, including the generation of nuclear energy and requires the submission of a "Declaration of Environmental Impact" report in the licensing process.

2.1.4 The Nuclear Safety Council's Instruction IS-26[1]

The instruction IS-26, of 16th June 2010, sets the basic nuclear safety requirements applicable to nuclear installations.

Points 3.19 to 3.21 are related with the Periodic Safety Review (PSR) programme that licensees have to perform on a ten year basis, following the recommendations of the CSN Safety Guide 1.10[2]. The goal of the PSR will be to make an overall assessment of the behaviour of the installation during the considered period by means of a systematic analysis of all nuclear safety and radiological protection aspects. According to Point 3.21 the nuclear installations must carry out, within the framework of the PSR, the appropriate modifications to converge, wherever it is feasible, with the best nuclear safety and radiological protection practices and standards internationally in effect at the time.

Points 3.24 to 3.27 deal with Dose Limits and Restrictions. In accordance with Point 3.25 the release of radioactive effluents into the environment must comply with the established limits, aiming, in addition, that it must be as low as possible by taking socioeconomic factors and the best available techniques into consideration. In addition, Point 3.27 specifies that the design of nuclear installations must ensure that the radiological consequences that are reasonably foreseeable in future generations are not greater than those allowed for the current generation.

2.2 DOSE CONSTRAINT/LIMITS FOR NUCLEAR FACILITIES

In Spain, an effective dose value of 0,3 mSv/y is use as dose constraint for nuclear power plants and other fuel cycle installations.

The effective dose in a period of 12 consecutive months have to take into account the contribution of the external exposure in that time along with the committed dose, over a period of 50 years, due to the ingestion and inhalation of radioactive substances occurred in that period.

2.3 DISCHARGE LIMITS

Regarding the discharge limits, an effective dose value of 0,1 mSv/y applies to nuclear facilities both during operation and decommissioning. This value, that it is applicable to liquid and gaseous effluents considered as a whole, was established as a proper percentage of a Dose Constraint previously defined by the CSN for

[1] Nuclear Safety Council's Instruction IS-26, of 16th June 2010, on basic nuclear safety requirements applicable to nuclear installations. CSN. 2010

[2] GSG-1.10: "Periodic Safety Review in Nuclear Power Plants". CSN. Rev. 2, 2017

the nuclear power plants and fuel cycle facilities (0,3 mSv/y), and the dose limit for public required in Spanish legislation (1 mSv/y).

In the nuclear power plants the discharge limit is distributed between gaseous and liquid effluents. A different apportionment is applied in each plant, based on specific site characteristics.

The system of limitation, surveillance and control of radioactive effluents is included in the operation permits as part of the Technical Specifications, which comprise the discharge limits, the sampling and analysis programmes required to verify compliance, the conditions on the operability of the on-line monitoring instrumentation and the effluent treatment systems operability requirements. The procedural details of these Radiological Technical Specifications are developed in an official document, the Offsite Dose Calculation Manual (ODCM). According to the CSN Safety Guide 7.09[3], the ODCM also includes the methodology and parameters used in estimating offsite doses due to the radioactive emissions and discharges and in calculating the monitoring alarm/trip set points.

The basic requirements for the effluents monitoring programmes are defined in the CSN Safety Guide 1.04[4].

2.4 MONITORING PROGRAMMES OF ENVIRONMENTAL CONCENTRATIONS OF RADIONUCLIDES

The environmental radiological monitoring in Spain consists of three networks:

a) The network associated to nuclear installations.

b) The national monitoring network.

c) The network made up of the so-called “specific programmes”.

The specific programmes are those that arise as consequence of an incident, a society request, or an interest in knowing a radiological situation.

2.4.1 Programmes around nuclear installations

Environmental radiological monitoring programmes in the vicinity of nuclear facilities were implemented at the beginning of the Spanish nuclear programme, and they are being developed according to the different lifetime stages of the facilities: pre-operation, operation, dismantling and decommissioning.

The main requirements for the nuclear power plants environmental monitoring programmes are defined in the CSN Safety Guide 4.1[5].

The requirements of the environmental radiological monitoring programmes are set out in the operation permits as part of the Technical Specifications, which comprise, the environmental monitoring programme, the internal quality control programme and the land and water use census. The procedural details are developed in the ODCM. This document also includes “Reporting Levels” (RL) of isotopic activity concentrations in environmental samples of air, water, milk, meat, vegetables, fishes, seafood and soil.

[3] GSG-7.09: “Off-site dose calculation manual of nuclear installations”. CSN. 2006.

[4] GSG-1.04: “Radiological surveillance and control of liquid and gaseous effluents from nuclear power plants”. CSN. 1988.

[5] GSG-4.1: “Design and development of environmental radiological monitoring programmes for nuclear power plants” CSN. 1993

Related to the OSPAR area nuclear installations, Table 1 shows the number of sampling stations for each of the pathways sampled in every site.

The environmental monitoring programmes around nuclear installations are undertaken by the operators and the CSN implements an independent programme, the scope of which has been established generally over a range of 5-15% of the number of total samples (External Quality Control Programme). The independent monitoring programme of the CSN includes the same sampling locations and types of samples and analysis as the operator's programme.

2.4.2 Nationwide monitoring network

Since 1992 (rivers since 1984) the CSN runs a nation-wide environmental radiological monitoring network that is independent from the network associated with nuclear facilities. This nation-wide network is formed by a network for automatic environmental radiological surveillance (REA) and a network of sampling stations (REM).

The REA network consists of 25 automatic stations with a nation-wide distribution. The data are transmitted daily to the European Commission Joint Research Centre according to the program EURDEP (European Union Radiological Data Exchange Platform), since the year 2003. Also the results obtained from this network are being published by the CSN through its website. Currently, this monitoring network is being updated to a network of 180 gamma spectrometry automatic stations distributed throughout the country and that will be operational by January 2020.

On the website (http://www.csn.es), values of daily and monthly average gamma dose rate are shown.

The programmes carried out in the network of sampling stations (REM) provide relevant information to ensure that concentrations of radioactive materials do not constitute a risk to the population as a whole. The monitoring system that is currently being developed in Spain consists of two complementary networks: the REM-dense network with numerous sampling points covering the entire national territory, and the REM-sparse network with a limited number of selected locations.

Table 2 shows the sampling and analysis programme that is currently being developed in Spain.

The Spanish coast is surrounded by a series of fifteen sampling stations, six of them in the OSPAR zone. The Centre of Civil Works Studies and Experimentation (CEDEX) of the Ministry of Public Works, by means of a collaboration agreement with the CSN, is conducting the aquatic radiological monitoring programme. The Centre of Energetic, Environmental and Technological Research (CIEMAT) also performs some analytical determinations.

CSN, by means of the CSN publications plan, edits in a yearly basis an assessment of the results of the environmental radiological monitoring programmes, all of these data can be also consulted on the following link https://www.csn.es/kprgisweb2/

Most of the laboratories are accredited by ISO 17025 or have a plan in progress for accreditation. Within the analysis, all laboratories work with internal quality assurance procedures (certified activity standards are used for calibrations and background and efficiency are regularly checked for all instruments) and have written standards for performing their work.

Additionally, since 1992, the CSN has been organising annual analytical intercomparison campaigns using samples similar to those analysed in the Radiological Environmental Monitoring Program (REMP) in which all of these laboratories participate. They also participate in several international intercomparison exercises and proficiency tests, as the ones organized by the IAEA and the EC.

2.5 ENVIRONMENTAL NORMS AND STANDARDS

Monitoring standards and procedures for the main stages of the environmental sample radioactivity measurement process were developed by a working group formed by staff of the main environmental laboratories of the country and coordinated by the CSN staff. This working group worked in coordination with AENOR (Spanish Organisation of Standardisation and Certification) giving rise to a group of environmental Spanish norms and CSN publications.

There are no edited norms or standards at the present moment for the protection of the environment from a radiological point of view.

Juzbado Fuel Fabrication Plant (FFP), in order to continuously improve its environmental performance, implemented in April 1999 an Environmental Management System that was certified by AENOR, in accordance with the requirements of Standard UNE-EN ISO 14001:1996, and in 2003 accredited with the requirements of several essays of the Standard UNE-EN ISO/IEC 17025:2017. Moreover, the factory obtained the AENOR verification of its Environmental Management System and Environmental Declaration, pursuant to the requirements of European Regulation[6] 761/2001, EMAS(VDM-03/10).

In order to comply with the requirements of EMAS, the Environmental Declaration validated by AENOR, is prepared and published on a yearly basis.

Almaraz and Trillo Nuclear Power Plants (NPPs) had also implemented, certified by AENOR, since November 2005, an Environmental Management System in accordance with the requirements of UNE-EN ISO 14001.

2.6 NATIONAL AUTHORITY RESPONSIBLE FOR SUPERVISION OF DISCHARGES

In accordance with Law 15/1980 creating the Nuclear Safety Council, modified by Law 33/2007, the CSN is set up as an independent institution, separate from both the Central Government and the industry and stakeholder sectors, and as the sole competent authority in matters relating to nuclear safety and radiological protection.

The CSN provides annual information to the Spanish Parliament, sending a report which covers in great detail the activities carried out during the year. After the Law 33/2007 came into effect, this obligation has been expanded to the regional parliaments of those regions with nuclear power plants at their territory. The president of the CSN holds a yearly hearing at the Spanish Parliament to present this report. Apart from that, some ad-hoc appearances of representatives of the CSN have been arranged to give information about specific questions or events, usually related to safety issues.

2.7 NATURE OF INSPECTION AND SURVEILLANCE PROGRAMME

The Integrated Plant Supervision System (SISC), which was implemented for the systematic evaluation of the Spanish nuclear power plants and control of their safety, is focus on three key strategic performance areas: Nuclear Safety, Radiological Protection, and Security. These areas are detached into seven cornerstones of safe operation being two of them involved with the radiological protection; one concerns the occupational radiological protection and the other the public radiological protection. The public radiological protection cornerstone measures the procedures and systems designed to minimize radioactive releases from a nuclear plant during normal operations and to keep those releases within the

[6] Regulation (EC) nº 761/2001 of 19 March 2001.

authorised limits. The CSN procedure PG.IV.07[7] describes the SISC and establishes the methodology to evaluate the results of its application.

This system takes into account both the findings of inspections and the data provided by certain operating indicators; one performance indicator, defined in term of doses, it is established for the public radiological protection cornerstone. Calculation and verification of the SISC operating indicators are carried out according to the CSN procedure PA.IV.202[8].

The nuclear installations are inspected regularly by qualified CSN experts, verifying different aspects in relation to the radioactive gaseous and liquid effluent treatment and discharge systems, monitoring and analytical instrumentation, data included in the effluent and environmental programmes reports, and procedures applied to the different processes. The CSN Resident Inspector performs an additional control in the nuclear power plants.

Inspections are carried out according to the CSN procedures PT.IV.251[9] and PT.IV.252[10]. These procedures have not been updated since the latest implementation round.

Concerning the surveillance, Table 3 shows a generic programme for radioactive effluents of NPPs, while Tables 4 and 5 summarise the sampling and analysis environmental programme required for nuclear power plants and the fuel fabrication plant of Juzbado respectively.

3 SITE SPECIFIC INFORMATION – NUCLEAR POWER PLANTS

Three Spanish nuclear power plants discharge their radioactive liquid effluents into rivers that flow into the Atlantic Ocean: Almaraz NPP, Trillo NPP and José Cabrera NPP.

[7] PG.IV.07: "Nuclear power plant integrated supervision system".Rev.3. CSN. 2016

[8] PA.IV.202: "Manual for calculation and verification of SISC operating indicators". Rev.2. CSN. 2015.

[9] PT.IV.251: "Treatment, surveillance and control of liquid and gaseous radioactive effluents". Rev.2. CSN. 2014

[10] PT.IV.252: "Environmental radiological surveillance program". Rev.1. CSN. 2010.

3.1 ALMARAZ NUCLEAR POWER PLANTS

3.1.1 Site Characteristics

3.1.1.1 Name of the site

Almaraz Nuclear Power Plant.

3.1.1.2 Type of facility

Almaraz is a nuclear power plant with two twin pressurised water reactor, PWR, (Westinghouse). Iberdrola with 53%, Endesa (36%) and Gas Natural (11%) are the owners of Almaraz I and II.

Within the site there are two Reactor buildings, but both units share the other auxiliary buildings (Turbine, Auxiliary, Electric, etc).

3.1.1.3 Year for commissioning/licensing/decommissioning

The first group initiated operation in 1981 and the second in 1983.

3.1.1.4 Location

The plant is located in the municipal area of Almaraz, province of Cáceres, at the tail end of the Arrocampo reservoir on the left bank of the Tajo River, 180 km WSW far from Madrid.

3.1.1.5 Receiving waters and catchment area

The Almaraz I&II reactors are cooled, through an open circuit, by water from the Arrocampo reservoir, on the Tajo River. Discharges take place into this reservoir whose capacity is 3,55E+07 m^3.

3.1.1.6 Production

The installed electrical capacity is 1050 MW(e) for Unit I and 1045 MW(e) for Unit II.

The electrical output in GW(e)a has been:

Year	2014	2015	2016	2017	2018
Gross Electrical Output:					
Almaraz I	0,857	1,002	0,888	0,919	0,929
Almaraz II	0,946	0,905	0,913	1,020	0,933
Net Electrical Output:					
Almaraz I	0,828	0,963	0,850	0,885	0,895
Almaraz II	0,907	0,872	0,882	0,981	0,897

3.1.1.7 Other relevant information

There is not any relevant additional information.

3.1.2 Discharges

3.1.2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

Almaraz I&II NPP share a liquid radwaste treatment plant so the liquid wastes from both units are treated together.

In Almaraz there are two types of radioactive liquid wastes: quality reactor and non-quality reactor. Quality reactor wastes, also called primary system wastes, are processed by the boric acid recovery system and coolant water cleanup system. After treatment, these liquids are mainly reused for reactor makeup water but sometimes can be discharged. The treatment system for this type of wastes consists of two lines with a parallel design including retention tanks, double system of filters and two evaporators with a treatment capacity of 4 m^3 each. Slurries are treated in the solid waste plant and the condensed effluent is sent, after new demineralisation and filtration, to a decay tank and from this one to the surveillance tank prior to discharge.

The non-quality reactor wastes represent the main contribution to the liquid effluents discharged by the plant. These wastes, that include laundry, shower and floor drains, are clarified, filtered and demineralised. Effluents from the liquid waste treatment system are directed, along with other non-contaminated water streams, to the discharge structure.

Regarding emissions, three types of radioactive gaseous effluents are considered in Almaraz NPP: gaseous wastes; air-ejector gases and gland-seal effluents; and building ventilation gases.

Gaseous wastes, after treatment, are retained in decay tanks and are released through the Auxiliary building roof vent after passing through a bank of filters (coarse+HEPA+carbon bed). The condensed vapour formed in the catalytic recombination process is drained to radioactive liquid treatment system.

Air-ejector gases and gland seal effluents are discharged through the Turbine building roof vent of each unit. After condensation of the steam, depending on the activity level, the residual gas pass through a HEPA filter, a carbon bed and another HEPA filter to remove suspended particles and retain much of the iodine.

The third category of gaseous wastes consist of large volumes of ventilation air, which serve to reduce the radioactivity concentration inside different buildings (Reactor, Fuel, Auxiliary, Safeguards, etc). All these gaseous effluents are released through three roof vents or stacks of the Fuel building of each unit and of the Auxiliary building, that both units share it. Before being released, the air is passed through particle filters (coarse and HEPA) and carbon beds. Moreover, the different contributions reaching these emission points are also suffered previous filtration to remove suspended particles and retain the iodine.

Since the last implementation round, a redundant filtering ventilation system in fuel buildings has been installed in order to reduce suspended particles releases. Additionally radioiodine and particle sampler have been installed in the discharge from the condenser air evacuation system to improve the monitoring of that emission route.

3.1.2.2 Efficiency of abatement

This information is given in Table 6.

3.1.2.3 Annual liquid discharges

The principal radionuclides arising in liquid waste are tritium and, to a much lesser degree, activation, corrosion and fission products.

A policy to minimise the production of waste is applied in Almaraz I&II NPP. This policy includes aspects such as:

- Surveillance and control of defects in the fuel cladding during operation and refuelling, and the chemical quality and conditions of the coolant systems.
- Reinforcement on the maintenance programmes.
- Revision of the operating procedures, optimising the methods applied.
- Segregation and piping of drains.
- Use of low radioactive water for conditioning of solid wastes instead of demineralised water.

- Improvements in the ion-exchange resin treatment system according to the liquid waste characteristics.
- Improvements in the procedures of sampling and analysis.
- Improvements in the procedures of the effluent management and control.
- Decay of the primary coolant prior to its evaporation treatment in the boric acid recovery system.

However, no relevant additional measures have been introduced throughout the period of time considered in this report in order to minimise the waste production.

Information on annual activity in the liquid effluents for the period 2014-2018 is summarised in Table 7. The absolute total activity excluding tritium shows a slightly downward trend while the tritium activity presents a global steady trend.

Normalised discharges from Almaraz I&II NPP for the period 2014-2018 and the reference values given in the UNSCEAR 2008 Report are shown in Table 8. This table also include the reference values given for 2010 in the UNSCEAR 2016 Report. The main basis for deriving the 2010 values was the IAEA PRIS database, the EC RADD database and the discharge data for the year 2002 in the UNSCEAR 2008 Report. Using these data the normalised discharges for 2002 were recalculated and adjusted to electricity generation in 2010.

According to this table:

- Total activity excluding tritium in the liquid discharges is lower than the UNSCEAR 1998-2002 reference value and fluctuates around the UNSCEAR 2010 reference value.
- Tritium activity in the liquid effluents fluctuates around both UNSCEAR reference values.

3.1.2.4 Emissions to air

Concerning the emissions, Table 9 puts on view the data of tritium and carbon-14 throughout the period 2014-2018. The absolute annual activity of both radionuclides presents a global downward trend.

Regarding with the normalised activity:

- Tritium activity fluctuates around both UNSCEAR reference values, except in 2016 when it is higher.
- Carbon-14 activity fluctuates around the UNSCEAR 1998-2012 reference level from 2014 to 2015 and around the UNSCEAR 2010 reference value from 2016 to 2018.

3.1.2.5 Quality assurance of retention systems performance and data management

The performance of the retention systems is assured by controlling the fluid activity after treatment.

Liquid effluents can be divided into continuous and non-continuous discharges. Continuous discharges are continuously monitored. If an alarm set point is exceeded, the discharge pump is stopped, automatically or manually, and the liquid is sent to the radioactive liquid treatment system. In addition a weekly bulk composite sample is collected with an automatic sampling system for laboratory analysis.

Non-continuous discharges are only carried out after gamma spectrometry analyses to determine the isotopic composition and the dilution factor in the discharge channel. Before sampling, the liquid in the tank is re-circulated for enough time to guarantee homogeneity. If the sample activity is not enough low for discharge, the tank content is redirected to the liquid treatment plant.

During the discharge, the control room operator is able to regulate the flow and thus the dilution factor in the discharge channel. There is also an activity monitor in the discharge line, so the control room operator is able to check the actual discharge activity. If this activity deviates more than 50% from the activity result based on the tank sample, the discharge is stopped. In addition, the discharge is automatically interrupted if the activity exceeds a certain value. If the monitor is not operable, the discharge is automatically stopped.

Regarding emissions, gases are also continuously monitored. Likewise discharges, if an alarm set point is exceeded, the emission can be stopped, automatically or manually. Charcoal and particulate filters to quantify the emissions activity are replaced weekly and analysed to determine the isotopic composition.

Instrumentation for continuous discharges and emissions monitoring is calibrated periodically using standard sources. Beside, several checks are carried out, with different periodicity, in order to ensure that monitors works properly.

On the other hand, the laboratory instrumentation used for discharges and emissions activity quantification is periodically calibrated using standards. For gamma spectrometry systems, detector efficiency Q/A plots are produced on a weekly basis in order to control system stability. The system performs an automatic background correction based on a weekly background measurement.

Laboratory from Almaraz NPP participates in intercomparison exercises.

Data and parameters related to treatment, discharges and emissions are kept in notebooks and computer files. Data from laboratory analyses are kept in computerised databases.

The Almaraz NPP quality control program also includes procedures and instructions for the suitable data management, as well as their correct filed according to the applicable regulations. During the inspections the CSN inspectors perform checks on chosen samples in order to verify the data transmission chain between initial measurements of the sample and final reporting to the CSN.

Information on discharges and emissions is submitted every month by Almaraz NPP (on paper and electronic format). That information is checked by the CSN according to the CSN procedure PT.IV.401[11] , to validate the data and identify discrepancies and mistakes.

3.1.2.6 Site specific target discharge values

The licensee establishes annual target values as radiological protection and environmental indicators. These target discharge values, which are set in terms of annual activity for the different considered groups of radionuclides, were for 2017 and 2018:

Target Values (GBq/y)	**2017**	**2018**
Radioactive Liquid Effluents		
• Total activity excluding Tritium	1,3E+01	1,70E+01
• Tritium	4,5E+04	7,50E+04
Radioactive Gaseous Effluents		
• Noble Gases	6,00E+03	6,00E+03
• Halogens	6,00E-04	6,00E-04
• Particles	1,6E-03	1,80E-03
• Tritium	8,00E+03	8,00E+03
• Carbon-14	4,00E+02	4,00E+02

[11] PT.IV.401: “Supervision of the periodical information related to the radioactive effluents”. Rev.1. 2014

3.1.2.7 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Absolute total activity excluding tritium in the liquid effluents released from Almaraz NPP exhibits a slightly downward trend throughout the years 2014-2018. Normalized activity is lower than the UNSCEAR 1998-2002 reference value and fluctuates around the UNSCEAR 2010 reference value. It is also lower than the target discharge values.

Absolute tritium activity in the liquid effluents presents a global steady trend throughout the years 2014-2018. Normalized activity fluctuates around both UNSCEAR reference values.

Absolute tritium and carbon-14 activities in gaseous effluents present a global downward trend throughout the considered years. Normalized tritium activity fluctuates around both UNSCEAR reference values except in 2016, when is higher, while normalized carbon-14 activity fluctuates around the UNSCEAR 1998-2012 reference level from 2014 to 2015 and around the UNSCEAR 2010 reference level from 2016 to 2018.

3.1.3 Environmental Impact

3.1.3.1 Concentrations of radionuclides of concern in representative samples of water, sediment and fish.

In Tables 10, 11 and 12, the mean activity concentrations of Cs-137, Co-60 and Mn-54 in river water, sediments and fishes in the area surveyed around Almaraz NPP are presented.

3.1.3.2 Environmental monitoring programme.

The environmental monitoring programme of Almaraz NPP is run by the operator of the plant in an area within a 30 km radius. The main pathways of human exposure to radiation are monitored, as well as other ecosystem elements that are good indicators of the behaviour of radionuclides in the environment, as described in Table 4.

3.1.3.3 Systems for quality assurance of environmental monitoring.

The application of quality systems that fully integrate the organisation's structure, responsibilities, procedures, processes and resources required for suitably managing quality have been implemented.

Sampling is carried out by specialized NPP staff, based on sampling procedures that are permanently available to the personnel. Instrumentation for radiological environmental monitoring is calibrated periodically and several checks are carried out, with different periodicity, in order to ensure that monitors work properly.

Measurement of the samples is mainly subcontracted to an external laboratory. The operator is required in the ODCM to develop an analysis quality control programme which has been implemented by Almaraz NPP by handling a certain percentage (usually between 5% and 15%, sometimes up to 50% depending on the medium) of the samples over to another laboratory different from that performing the analysis of the main REMP for parallel analysis. Both laboratories are accredited or have a plan in progress for accreditation. Within the analysis, these laboratories work with internal quality assurance procedures (Certified activity standards are used for calibrations and background and efficiency are regularly checked for all instruments) and have written standards for performing their work.

In parallel to the operator's REMP, the CSN runs a complementary environmental monitoring programme by collaboration agreements with laboratories in different universities, which conduct the sampling and analysis programmes.

Additionally, since 1992, the CSN has been organising annual analytical intercomparison campaigns using samples similar to those analysed in the REMPs in which all of these laboratories participate. They also participate in several international intercomparison exercises and proficiency tests, as the ones organized by the IAEA and the EC.

3.1.3.4 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Regarding to the radiological environmental impact around Almaraz NPP for the 2014-2018 period, the levels of radionuclides found in all the measured matrixes and exposure pathways have been lower than the reporting levels mentioned in section 2.4.1.

3.1.4 Radiation Doses to the Public

3.1.4.1 Average annual effective dose to individuals within the critical group caused by current discharges

Annual doses to individuals are estimated taking into account not only the actual discharges but also the cumulative concentration of radionuclides in the Arrocampo reservoir.

Information on annual effective dose to the most exposure member of the public due to the discharge of the radioactive liquid effluents is given in Table 13.

3.1.4.2 Total exposures

The annual effective dose due to the liquid and gaseous effluents is also shown in Table 13. The inorganic form of carbon-14 is usually the main contributor to the total dose.

Total effective dose shows a global downward trend and is well below the present authorised limits.

3.1.4.3 Critical group /Reference group

Conservative assessments of doses to the critical group are carried out to verify that discharge limits are complied with. In this case the critical group is defined taking into account the most conservative assumptions.

Additionally, according to Article 53 of the Regulation on the Protection of Health against Ionising Radiations, the licensee estimates with more realistic criteria the radiological impact on the members of the public due to the radioactive releases into the environment. In this case a reference group is established. This reference group corresponds to the critical group as defined by ICRP-60 and is intended to be representative of those people living in the vicinity of Almaraz NPP who receive the highest dose.

The critical group includes three age groups: infant (1-2 years), child (7-12 years), and adult (>17 years); according to EC Radiation Protection 129[12], these are the three groups who receive the highest doses.

[12] EC Radiation protection 129: "Guidance on the realistic assessment of radiation doses to members of the public due to the operation of nuclear installations under normal conditions"

The critical group is hypothetical but realistic, having combinations of maximum and average habits, based on local knowledge and plausible assumptions. Food consumption rates are based on the result of site-specific habit surveys carried out by the CSN/CIEMAT in 2001. Inhalation rates from ICRP-71[13], water ingestion rates from ICRP-23[14], and exposure time to shoreline deposits from EUR 15760[15] are considered.

During the period 2014-2018 the critical group living in the vicinity of Almaraz NPP has been the adult.

3.1.4.4 Exposure pathways

Taking into account productions, food consumption, occupancy and other usage of the region in the vicinity of the plant site, the specific pathways considered in the assessment of doses for the critical group of Almaraz NPP are:

- External exposure to the cloud (only noble gases are considered).
- Inhalation.
- External exposure to deposits on the ground (gaseous effluents) and on the shorelines (liquid effluents).
- Consumption of fish.
- Consumption of leafy vegetables.
- Consumption of vegetables, roots and fruits.
- Consumption of meat (beef, goat).
- Consumption of goat milk.

All releases exposure pathways are individually considered and the total dose is calculated by adding the contribution of each of them.

Throughout the period 2014-2018, the critical exposure pathways have been the consumption of fish and leafy vegetables.

3.1.4.5 Basis for methodology

The methodology used to estimate doses, defined in the ODCM of Almaraz NPP, is the same in all Spanish NPP and it is based on calculation models given in the NRC- Regulatory Guide 1.109[16]. To this end, a computer program was developed by the adaptation of the NRC computer programs LADTAP and GASPAR.

The general aspects of this methodology may be summarised as follows:

- Local characteristics, population habits, and land and water usage are site specific
- Straight-line Gaussian plume models are used for atmospheric dispersion
- Hydrological dispersion considers the specific characteristics of the effluent receiving water body (reservoir)
- Generic values, such as period of animals on pasture, time from production and consumption, etc., are used

[13] ICRP-71: "Age-dependent doses to members of the public from intake of radionuclides: Part 4 inhalation dose coefficients"

[14] ICRP-23: "Reference man: anatomical, physiological and metabolic characteristics"

[15] EUR 15760: "Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment"

[16] Regulatory Guide 1.109: "Calculation of annual dose to man from routine releases of reactor effluents for the purpose of evaluating compliance with 10CFR part 50, Appendix I"

- Local specific values, such as food consumption rates, irrigation rates, humidity, etc., and site specific exposure pathways, are also used.

The dose coefficients used in the calculation of doses to members of the public are:

- For intake by ingestion and inhalation, those specified in the Spanish Regulation on the protection of health against ionising radiations (approved by Royal Decree 783/2001, July 6th) and in the Euratom 96/29 Directive.
- For external exposure to the cloud those specified in the BSS (Safety Series No. 115).
- For external exposure to deposits on to the ground and to shoreline deposits, those included in the US EPA Federal Guidance Report 13, CD Supplement.

3.1.4.6 Site-specific factors for significant nuclides

Site-specific activity-dose factors for all nuclides included in libraries used in laboratory analyses have been calculated in Almaraz NPP for estimating doses to the critical group. These factors are included in the ODCM.

3.1.4.7 Site specific target annual effective dose

The licensee establishes an annual effective dose target as radiological protection and environmental indicators. This target, which is set in terms of effective dose to the most exposed individual, has been 3,0E-03 mSv/y in 2017 and in 2018.

Total effective doses to the critical group were lower than the target dose values.

3.1.4.8 Quality assurance of processes involved in dose estimates

The licensee has verified the computer program suitability through a validation process and this validation has been supervised by the CSN inspectors. Additionally, during the inspections, the CSN inspectors check the doses estimated for a particular month.

On the other hand, the CSN has evaluated the suitability of the site-specific parameters considered in calculations. Furthermore, parallel calculations have been carried out by the CSN, both with own computer programs and excel sheets.

3.1.4.9 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Total effective dose to the critical group living in the vicinity of Almaraz NPP is well below the authorised release limit.

Taking into account liquid and gaseous effluents, the highest dose in the period of time considered in this report was 6,87E-04 mSv/y in 2014. This value represents a 0,3 % of the release limit.

3.2 TRILLO NUCLEAR POWER PLANTS

3.2.1 Site Characteristics

3.2.1.1 Name of site

Trillo Nuclear Power Plant.

3.2.1.2 *Type of facility*

Essentially, the plant is made up of a nuclear steam supply system designed and supplied by KWU, consisting of a pressurised water reactor (PWR) with three loops. Iberdrola (48%), Gas Natural Fenosa (34,5%), HC Energía (15,5%) and Nuclenor (2%) own the facility.

The main installations within the site are: Reactor building that includes the containment structure and the annular shielding building; Turbine building; Auxiliary building; Electric building; Solid waste building; and Dry interim storage building for spent fuel containers.

3.2.1.3 *Year for commissioning/licensing/decommissioning*

Trillo NPP initiated operation in 1988.

3.2.1.4 *Location*

Trillo NPP is located alongside the river Tajo in the municipal area of Trillo, in the province of Guadalajara, approximately 100 km E from Madrid.

3.2.1.5 *Receiving waters and catchment area*

The plant is cooled by water from the Tajo River through a close circuit. The plant discharges into that river. The average annual flow rate of the Tajo river is 18,1 m^3/s.

3.2.1.6 *Production*

The installed electrical capacity is 1066 MW(e).

The electrical output in GW(e)a has been:

Year	2014	2015	2016	2017	2018
Gross Electrical Output	0,948	0,966	0,976	0,974	0,944
Net Electrical Output	0,889	0,905	0,914	0,911	0,883

3.2.1.7 *Other relevant information*

There is not any relevant additional information.

3.2.2 Discharges

3.2.2.1 *Systems in place to reduce, prevent or eliminate discharges and emissions*

Two types of radioactive liquids wastes can be found in Trillo NPP: those originated in coolant purification processes and drains resulting from maintenance operations.

Certain volume of water is withdrawn from the pressurised primary circuit and treated in the chemical and volume control system (CVCS) where gases are removed. After that the liquid passes to an ion exchanger for the removal of fission products and then to an evaporator in order to recover the boric acid. The condensed vapour can be stored for later use as coolant or sent to the radioactive liquid treatment system for its discharge to the river.

According to their origin, liquid radwastes are collected in five hold-up tanks where they are analysed to determine the chemical and radioactive characteristics. After conditioning for precipitation, control of pH, etc., liquids are evaporated. To this end, the plant has two evaporators in parallel, being assigned each unit to a type of liquid waste. Although a filter is also installed as an alternative treatment, it has never used and liquids are always treated by evaporation. Where it is considered desirable to decrease the radioactivity level further, the condensate is demineralised.

Regarding emissions, three types of radioactive gaseous effluents are considered in Trillo NPP: gaseous wastes; air-ejector gases and gland-seal effluents; and building ventilation gases. All of them are released through a stack with a height of 100 meters.

Gaseous wastes are processed by the treatment system. After a catalytic recombination process to covert the hydrogen gas into water, which is condensed and removed, gases are passed through two delay banks in series, with five charcoal beds each one, where they are retained by adsorption for noble gases decay. Most of the treated gases are reused in the plant while only 10% is released through the stack.

Air-ejector gases and gland seal effluents are emitted after a condensation process of the steam.

Ventilation air is passed through particle filters (coarse and HEPA) and carbon beds before being released through the stack.

Since the latest implementation round, the following modifications have been introduced in the radioactive effluent treatment systems:

- A new liquid sampler and flow rate monitor have been installed in order to control the discharge of the secondary circuit during the refueling.
- A new carbón-14 sampler has been installed as a result of the Regulator - Licensees working group on Offsite Dose Calculation Manual.
- Increment of the efficiency of the spent fuel pool cleaning system filters.

3.2.2.2 Efficiency of abatement systems

This information is shown in Table 14

3.2.2.3 Annual liquid discharges

A policy to minimise the production of waste is applied in Trillo NPP. This policy includes aspects such as:

- Surveillance and control of defects in the fuel cladding during operation and refuelling, and the chemical quality and conditions of the coolant systems.
- Reinforcement on the maintenance programmes.
- Revision of the operating procedures, optimising the methods applied.
- Segregation and piping of drains.
- Reuse of contaminated liquids.
- Improvements in the procedures of sampling and analysis.
- Improvements in the procedures of the effluent management, control and evaluation.
- Reduction of the activity concentration value required to treat the radioactive liquid waste by evaporation.
- Implementation of a program of periodic cleaning of the liquid effluents tanks (storage and discharge)
- During the refuelling outages, longer primary coolant purification; recirculation of the water from the reactor cavity through filters; and vacuum cleaning of the cavity bottom of the reactor.

Information on absolute annual activity in the liquid effluents for the period 2014-2018 is summarised in Table 15. The absolute total activity excluding tritium shows a downward trend while the tritium activity presents a global steady trend.

Normalised discharges from Trillo NPP for the years 2014-2018 and the reference values given in the UNSCEAR 2008 and UNSCEAR 2016 Reports are shown in Table 16. According to this table, every year the total activity excluding tritium is well below both UNSCEAR reference values while the tritium activity fluctuates around both UNSCEAR reference values.

3.2.2.4 Emissions to air

Concerning the emissions, Table 17 puts on view the data of tritium and carbon-14 activities throughout the period 2014-2018. The tritium activity exhibits a global downward trend while the activity of carbon-14 presents a slightly upward trend.

Regarding with the normalised activity, tritium is well below both UNSCEAR reference values while carbon-14 is between them except in 2018 when is higher.

3.2.2.5 Quality assurance of retention systems performance and data management

The performance of the retention systems is assured by controlling the fluid activity after treatment.

Liquid effluents can be divided into continuous and non-continuous discharges. Continuous discharges are continuously monitored. If an alarm set point is exceeded, the discharge pump is stopped, automatically or manually, and the liquid is sent to the radioactive liquid treatment system. In addition a weekly bulk composite sample is collected with an automatic sampling system for laboratory analysis.

Non-continuous discharges are only carried out after gamma spectrometry analyses to determine the isotopic composition and the dilution factor in the discharge channel. Before sampling, the liquid in the tank is re-circulated for enough time to guarantee homogeneity. If the sample activity is not enough low for discharge, the tank content is redirected to the liquid treatment plant.

During the discharge, the control room operator is able to regulate the flow and thus the dilution factor in the discharge channel. There is also an activity monitor in the discharge line, so the control room operator is able to check the actual discharge activity. If this activity deviates more than 50% from the activity result based on the tank sample, the discharge is stopped. In addition, the discharge is automatically interrupted if the activity exceeds a certain value. If the monitor is not operable, the discharge is automatically stopped.

Regarding emissions, gases are also continuously monitored. Likewise discharges, if an alarm set point is exceeded, the emission can be stopped, automatically or manually. Charcoal and particulate filters to quantify the emissions activity are replaced weekly and analysed to determine the isotopic composition.

Instrumentation for continuous discharges and emissions monitoring is calibrated periodically using standard sources. Beside, several checks are carried out, with different periodicity, in order to ensure that monitors works properly.

On the other hand, the laboratory instrumentation used for discharges and emissions activity quantification is periodically calibrated using standards. For gamma spectrometry systems, detector efficiency Q/A plots are produced on a weekly basis in order to control system stability. The system performs an automatic background correction based on a weekly background measurement.

Laboratory from Trillo NPP participates in intercomparison exercises.

Data and parameters related to treatment, discharges and emissions are kept in notebooks and computer files. Data from laboratory analyses are kept in computerised databases.

The facility quality control program also includes procedures and instructions for the suitable data management, as well as their correct filed according to the applicable regulations. During the inspections the CSN inspectors check on chosen samples in order to verify the data transmission chain between initial measurements of the sample and final reporting to the CSN.

Information on discharges and emissions is submitted every month by Trillo NPP (on paper and electronic format). That information is checked by the CSN according to the CSN procedure PT.IV.401[17] , to validate the data and identify discrepancies and mistakes.

3.2.2.6 Site specific target discharge values

The licensee establishes annual target values as radiological protection and environmental indicators. These target discharge values, which are set in terms of annual activity for the different considered groups of radionuclides, were for 2017 and 2018:

Target Values (GBq/y)	**2017**	**2018**
Radioactive Liquid Effluents		
• Total activity excluding Tritium	5,5E-01	5,3E-01
• Tritium	2,1E+04	2,0E+04
Radioactive Gaseous Effluents		
• Noble Gases	6,0E+02	5,00E+02
• Halogens	<	<UD
• Particles	2,0E-03	2,00E-03
• Tritium (inorganic form)	7,0E+02	6,8E+02
• Carbon-14 (inorganic form)	3,0E+01	3,7E+01

The activity of the effluents released from Trillo NPP has always been lower than these target values.

3.2.2.7 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Absolute total activity excluding tritium in the radioactive liquid effluents released from Trillo NPP exhibits a downward trend throughout the years 2014-2018, with values lower than the UNSCEAR reference values given in the UNSCEAR 2008 report for the years 1998-2002 and in the UNSCEAR 2016 report for the year 2010.

Absolute tritium activity in liquid effluents also presents a global steady trend with values that fluctuate around both UNSCEAR reference values.

Absolute tritium in the emissions exhibits a global downward trend while carbon-14 presents a slightly upward trend. The normalised activity of both radionuclides is below both UNSCEAR reference values.

3.2.3 Environmental Impact

3.2.3.1 Concentrations of radionuclides of concern in representative samples of water, sediment, and fish.

Tables 18, 19 and 20 show respectively the Cs-137, Co-60 and Mn-54 mean activity concentrations in river water, sediments and fish in the area surveyed around Trillo NPP.

[17] PT.IV.401: "Supervision of the periodical information related to the radioactive effluents". Rev.1. 2014

3.2.3.2 Environmental monitoring programme.

The environmental monitoring programme of Trillo NPP is conducted by the plant operator in an area within a 30 km radius. The main pathways of human exposure to radiation are monitored, as well as other ecosystem elements that are good indicators of the behaviour of radionuclides in the environment, as described in Table 4.

3.2.3.3 Systems for quality assurance of environmental monitoring.

The application of quality systems that fully integrate the organisation's structure, responsibilities, procedures, processes and resources required for suitably managing quality have been implemented.

Sampling is carried out by specialized NPP staff, based on sampling procedures that are permanently available to the personnel. Instrumentation for radiological environmental monitoring is calibrated periodically and several checks are carried out, with different periodicity, in order to ensure that monitors work properly.

Measurement of the samples is mainly subcontracted to an external laboratory. The operator is required in the ODCM to develop an analysis quality control programme which has been implemented by Trillo NPP by handling a certain percentage (usually between 5% and 15%, sometimes up to 50% depending on the medium) of the samples over to another laboratory different from that performing the analysis of the main REMP for parallel analysis. Both laboratories are accredited or have a plan in progress for accreditation. Within the analysis, these laboratories work with internal quality assurance procedures (Certified activity standards are used for calibrations and background and efficiency are regularly checked for all instruments) and have written standards for performing their work.

In parallel to the operator's REMP, the CSN runs a complementary environmental monitoring programme by collaboration agreements with laboratories in different universities, which conduct the sampling and analysis programmes.

Additionally, since 1992, the CSN has been organising annual analytical intercomparison campaigns using samples similar to those analysed in the REMPs in which all of these laboratories participate. They also participate in several international intercomparison exercises and proficiency tests, as the ones organized by the IAEA and the EC.

3.2.3.4 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Regarding to the radiological environmental impact around Trillo NPP for the 2014-2018 period, the levels of radionuclides found in all the measured matrixes and exposure pathways have been lower than the reporting level mentioned in section 2.4.1.

3.2.4 Radiation Doses to the Public

3.2.4.1 Average annual effective dose to individuals within the critical group caused by current discharges

Information on average annual effective dose to the most exposure member of the public due to the discharge of the radioactive liquid effluents is given in Table 21.

3.2.4.2 Total exposures

The annual effective dose due to the liquid and gaseous effluents is also shown in Table 21. Tritium is the main contributor to the total dose.

Total effective dose shows a steady trend and is well below the present authorised limits.

3.2.4.3 Critical group /Reference group

Conservative assessments of doses to the critical group are carried out to verify that discharge limits are complied with. In this case the critical group is defined taking into account the most conservative assumptions.

Additionally, according to Article 53 of the Regulation on the Protection of Health against Ionising Radiations, the licensee estimates with more realistic criteria the radiological impact on the members of the public due to the radioactive releases into the environment. In this case a reference group is established. This reference group corresponds to the critical group as defined by ICRP-60 and is intended to be representative of those people living in the vicinity of Trillo NPP who receive the highest dose.

The critical group includes three age groups: infant (1-2 years), child (7-12 years), and adult (>17 years); according to EC Radiation protection 129[18], these are the three groups who receive the highest doses.

The critical group is hypothetical but realistic, having combinations of habits, both maximum and average, based on local knowledge and plausible assumptions. Food consumption rates are based on the result of site-specific habit surveys carried out by the CSN/CIEMAT in 2001. Inhalation rates from ICRP-71[19], water ingestion rates from ICRP-23[20], and exposure time to shoreline deposits from EUR 15760[21] are considered.

Considering the liquid and gaseous effluents released during the years 2014-2018, the critical group living in the vicinity of Trillo NPP has been the infant.

3.2.4.4 Exposure pathways

Taking into account productions, food consumption, occupancy and other usage of the region in the vicinity of the plant site, the specific pathways considered in the assessment of doses for the critical group of Trillo NPP are:

- External exposure to the cloud (only noble gases are considered)
- Inhalation
- External exposure to deposits on the ground (gaseous effluents) and on the shorelines (liquid effluents)
- Consumption of fish
- Consumption of leafy vegetables
- Consumption of cereals, vegetables, roots and fruits
- Consumption of meat (beef and goat)
- Consumption of milk (cow and goat)

Water consumption is also taken into account but only in those villages where people drink water coming from the Tajo River.

All releases exposure pathways are individually considered and the total dose is calculated by adding the contribution of each of them.

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[18] EC Radiation protection 129: "Guidance on the realistic assessment of radiation doses to members of the public due to the operation of nuclear installations under normal conditions"

[19] ICRP-71: "Age-dependent doses to members of the public from intake of radionuclides: Part 4 inhalation dose coefficients"

[20] ICRP-23: "Reference man: anatomical, physiological and metabolic characteristics"

[21] EUR 15760: "Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment"

Consumptions of cow milk and leafy vegetables were the critical exposure pathways in 2014 while the consumptions of water and vegetables (cereals, vegetables, roots and fruits) were the critical exposure pathways from 2015 to 2018.

3.2.4.5 Basis for methodology

The methodology used to estimate doses, defined in the ODCM of Trillo NPP, is the same in all Spanish NPP and it is based on calculation models given in the NRC- Regulatory Guide 1.109[22]. To this end, a computer program was developed by the adaptation of the NRC computer programs LADTAP and GASPAR.

The general aspects of this methodology may be summarised as follows:

- Local characteristics, population habits, and land and water usage are site specific
- Straight-line Gaussian plume models are used for atmospheric dispersion
- Hydrological dispersion considers the specific characteristics of the effluent receiving water body (reservoir)
- Generic values, such as period of animals on pasture, time from production and consumption, etc., are used
- Local specific values, such as food consumption rates, irrigation rates, humidity, etc., and site specific exposure pathways, are also used

The dose coefficients used in the calculation of doses to members of the public are:

- For intake by ingestion and inhalation, those specified in the Spanish Regulation on the protection of health against ionising radiations (approved by Royal Decree 783/2001, July 6th) and in the Euratom 96/29 Directive
- For external exposure to the cloud those specified in the BSS (Safety Series No. 115)
- For external exposure to deposits on to the ground and to shoreline deposits, those included in the US EPA Federal Guidance Report 13, CD Supplement.

3.2.4.6 Site-specific factors for significant nuclides

Site-specific activity-dose factors for all nuclides included in libraries used in laboratory analyses have been calculated in Trillo NPP for estimating doses to the critical group. These factors are included in the ODCM.

3.2.4.7 Site specific target annual effective dose

The licensee establishes an annual effective dose target as radiological protection and environmental indicators. In 2017 and 2018 this target, which is set in terms of effective dose to the most exposed individual, was 4,0E-03 mSv/y.

Effective dose to the critical group has been lower than the target value during the years 2014-2018.

3.2.4.8 Quality assurance of processes involved in dose estimates

The licensee has verified the computer program suitability through a validation process and this validation has been supervised by the CSN inspectors. Additionally, during the inspections, the CSN inspectors check the doses estimated for a particular month.

[22] Regulatory Guide 1.109: "Calculation of annual dose to man from routine releases of reactor effluents for the purpose of evaluating compliance with 10CFR part 50, Appendix I"

On the other hand, the CSN has evaluated the suitability of the site-specific parameters considered in calculations. Furthermore, parallel calculations have been carried out by the CSN, both with own computer programs and excel sheets.

3.2.4.9 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Total effective dose to the critical group living in the vicinity of Trillo NPP is well below the authorised release limit.

Taking into account liquid and gaseous effluents, the highest dose in the period of time considered in this report was 1,67E-03 mSv/y in 2015. This value represents a 1,7 % of the release limit.

Effective dose to the critical group has been lower than the target value during the years 2014-2018.

3.3 JOSE CABRERA NUCLEAR POWER PLANT

3.3.1 Site Characteristics

3.3.1.1 Name of site

José Cabrera Nuclear Power Plant.

3.3.1.2 Type of facility

Essentially, the plant was made up of a nuclear steam supply system designed and supplied by Westinghouse, consisting of a pressurised water reactor (PWR). Gas Natural Fenosa operated the facility. On February 1^{st} 2010 the Ministry of Industry, Tourism and Trade authorised the transfer of ownership of the José Cabrera plant to the public company in charge of the safe management, storage and disposal of the radioactive wastes produced in Spain (Enresa).

The main installations within the site were: Reactor building, Turbine building, Auxiliary building, Decontamination plant building, Evaporator building and the Solid radioactive waste management building. Nowadays the old Turbine building has been adapted and converted into the Dismantling auxiliary building.

3.3.1.3 Year for commissioning/licensing/decommissioning

Start-up took place in 1968. The plant, also called Zorita, cessed its activity on April 30^{th} 2006 (Ministerial Order by the Ministry of Industry, Tourism and Trade of April 20th 2006). Since February 1^{irst} 2010 it is under dismantling.

3.3.1.4 Location

José Cabrera is located in the municipal area of Almonacid de Zorita, in the province of Guadalajara, approximately 66 km E from Madrid.

3.3.1.5 Receiving waters and catchment area

Radioactive liquid effluents flow into the Tajo River through two successive reservoirs (Zorita and Almoguera). The liquid effluents are discharged to the Zorita reservoir from where the water flows into the Almoguera reservoir that is located 20 km downstream from the nuclear power plant.

The Zorita reservoir capacity is 2,7E+06 m^3, while the Almoguera´s capacity is 6,5E+06 m^3. The average annual flow rate of the Tajo river is 39,58 m^3/s

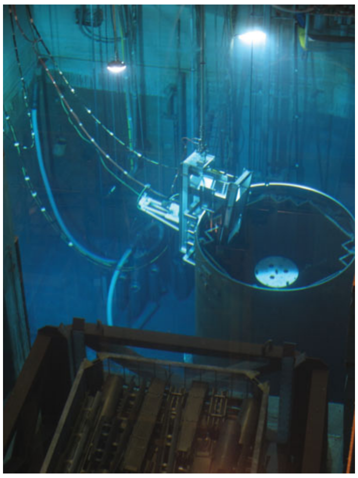
3.3.1.6 Production

The installed electrical capacity was 160 MW(e).

3.3.1.7 Other relevant information

The dismantling of Jose Cabrera NPP has continued during the period of time covered by this report.

Among the dismantling works performed in 2014 can be highlighted the underwater segmentation of the reactor internals and the reactor vessel, operations that took place in the former spent fuel pool, using remotely operated cutting tools. This year also continued the segmentation of the steam generator water box and begun the segmentation of one of the liquid effluent hold up tanks.



Segmentation under water of the José Cabrera's reactor vessel

The segmentation and packaging of the large components, such as the steam generator and the reactor vessel, was finalized during 2015. Works were also underwent on the segmentation of the reactor cavities, fuel pool and biological shield of the reactor and the decontamination of the reactor and auxiliary buildings.

During 2016 it was completed the decontamination and segmentation of the cavities of the biological shielding and the diamond wire cutting of the old cover of the vessel among other activities. Besides, it continued the decontamination work on the paraments of the Contention and Auxiliary buildings that finalized in 2017.

Additionally, works for the dismantling and decontamination of the evaporator buildings and other singular elements such as the chimney for gaseous emissions started in 2017.

Segmentation of the José Cabrera's chimney for radioactive gaseous emissions

The removal of embedded contaminated elements of the contention building, as well as the decommissioning and decontamination of the evaporator buildings and other elements of the effluent treatment systems (tanks and chimney) were completed in 2018. This year took also place the startup of the operation of the soil washing plant with the aim of reducing the volume of waste arising from contaminated soils.

3.3.2 Discharges

3.3.2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

In order to treat the radioactive liquid effluents, the plant had an evaporator and several storage tanks until 2017 when a new treatment system was installed and began to work. This system, which includes storage tanks and equipment of microfiltration and ion exchange, will be used until the end of the dismantling process.

Concerning emissions, the José Cabrera NPP gaseous effluents were initially released through one stack with a height of 60 meters. Ventilation air was the large contribution to the stack releases. Before being discharged through the stack, the air passed through particulate filters. Since 2017 portable ventilation and particulate filtration units are used to reduce the activity of the emissions. These units are provided with coarse and HEPA filters.

3.3.2.2 Efficiency of abatement systems

The information on the former systems is shown in Table 22. The new filtering system are provided with coarse (45% atmospheric dustspot efficiency), and HEPA filters (99,97 % for particle of 0,3 microns).

Regarding the new liquid treatment system, the ion exchange decontamination coefficient is 10 for Cs-137.

3.3.2.3 Annual liquid discharges

With respect to the policy to minimise the production of waste, the ALARA criteria and BAT are applied to reduce the liquid wastes produced during the dismantling process.

Information on absolute annual activity for the period 2014-2018 is given in Table 23.

Tritium activity exhibits an exponential downward trend while total activity excluding tritium shows a global steady trend.

3.3.2.4 Emissions to air

Tritium emissions, which are given in Table 24, also show an exponential downward trend.

3.3.2.5 Quality assurance of retention systems performance and data management

The performance of the retention systems is assured by controlling the fluid activity after treatment.

Liquid effluents are discharged in a non-continuous way. These discharges are only carried out after gamma spectrometry analyses to determine the isotopic composition and the dilution factor in the discharge channel. Before sampling, the liquid in the tank is re-circulated for enough time to guarantee homogeneity. If the sample activity is not enough low for discharge, the tank content is redirected to the liquid treatment plant.

During the discharge, the control room operator is able to regulate the flow and thus the dilution factor in the discharge channel. There is also an activity monitor in the discharge line, so the control room operator is able to check the actual discharge activity. If this activity deviates more than 50% from the activity result based on the tank sample, the discharge is stopped. In addition, the discharge is automatically interrupted if the activity exceeds a certain value. If the monitor is not operable, the discharge is automatically stopped.

Regarding emissions, gases are also continuously monitored. Particulate filters to quantify the emissions activity are replaced weekly and analysed to determine the isotopic composition.

Instrumentation for continuous discharges and emissions monitoring is calibrated periodically using standard sources. Beside, several checks are carried out, with different periodicity, in order to ensure that monitors works properly.

On the other hand, the laboratory instrumentation used for discharges and emissions activity quantification is periodically calibrated using standards. For gamma spectrometry systems, detector efficiency Q/A plots are produced on a weekly basis in order to control system stability. The system performs an automatic background correction based on a weekly background measurement.

Data and parameters related to treatment, discharges and emissions are kept in notebooks and computer files. Data from laboratory analyses are kept in computerised databases.

The facility quality control program also includes procedures and instructions for the suitable data management, as well as their correct filed according to the applicable regulations. During the inspections the CSN inspectors perform checks on chosen samples in order to verify the data transmission chain between initial measurements of the sample and final reporting to the CSN.

Information on discharges and emissions is submitted every month by José Cabrera plant (on paper and electronic format). That information is checked by the CSN according to the CSN procedure PT.IV.401[23] , to validate the data and identify discrepancies and mistakes.

3.3.2.6 Site specific target discharge values

No specific target discharge values have been established in José Cabrera plant.

3.3.2.7 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Discharges and emissions are due to the dismantling works. Activity in the liquid and gaseous effluents presents a downward trend.

No reference data are published for plants under dismantling.

3.3.3 Environmental Impact

3.3.3.1 Concentrations of radionuclides of concern in representative samples of water, sediment, and fish.

Tables 25, 26 and 27 show respectively the Cs-137, Co-60 and Mn-54 mean activity concentrations in river water, sediments and fish in the area surveyed around José Cabrera plant.

3.3.3.2 Environmental monitoring programme.

The dismantling phase environmental monitoring programme of José Cabrera plant is conducted by the plant operator in an area within a 30 km radius. The main pathways of human exposure to radiation are monitored, as well as other ecosystem elements that are good indicators of the behaviour of radionuclides in the environment, as described in Table 4. Since 2008 results on Fe-55, Ni-63 have been collected in

[23] PT.IV.401: "Supervision of the periodical information related to the radioactive effluents". Rev.1. 2014

surface water, sediment and fish samples, and also Am-241 and Pu-238 in surface water and sediment samples. All the results obtained present values under the detection limit.

3.3.3.3 Systems for quality assurance of environmental monitoring.

The application of quality systems that fully integrate the organisation's structure, responsibilities, procedures, processes and resources required for suitably managing quality have been implemented.

Sampling is carried out by specialized staff, based on sampling procedures that are permanently available to the personnel. Instrumentation for radiological environmental monitoring is calibrated periodically and several checks are carried out, with different periodicity, in order to ensure that monitors work properly.

Measurement of the samples is mainly subcontracted to an external laboratory. The operator is required in the ODCM to develop an analysis quality control programme which has been implemented by José Cabrera plant by handling a certain percentage (usually between 5% and 15%, sometimes up to 50% depending on the medium) of the samples over to another laboratory different from that performing the analysis of the main REMP for parallel analysis. One of the laboratories is accredited. Within the analysis, these laboratories work with internal quality assurance procedures (Certified activity standards are used for calibrations and background and efficiency are regularly checked for all instruments) and have written standards for performing their work.

In parallel to the operator's REMP, the CSN runs a complementary environmental monitoring programme by collaboration agreements with laboratories in different universities, which conduct the sampling and analysis programmes.

Additionally, since 1992, the CSN has been organising annual analytical intercomparison campaigns using samples similar to those analysed in the REMPs in which all of these laboratories participate. They also participate in several international intercomparison exercises and proficiency tests, as the ones organized by the IAEA and the EC.

3.3.3.4 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Regarding to the radiological environmental impact around José Cabrera plant for the years 2014-2018, the level of radionuclides found in all the measured matrixes and exposure pathways have been lower than the reporting levels mentioned in section 2.4.1.

3.3.4 Radiation Doses to the Public

3.3.4.1 Average annual effective dose to individuals within the critical group caused by current discharges

Annual doses to individuals are estimated taking into account not only the actual discharges but also the cumulative concentration of radionuclides in the Zorita and Almoguera reservoirs.

Information on average annual effective dose to the most exposure member of the public due to the discharge of the radioactive liquid effluents is given in Table 28.

3.3.4.2 Total exposures

The annual effective dose due to the liquid and gaseous effluents is also shown in Table 28. Dose due to the liquid effluents is the major contribution to the total dose.

Total effective doses are well below the present authorised limits.

3.3.4.3 Critical group /Reference group

Conservative assessments of doses to the critical group are carried out to verify that discharge limits are complied with. In this case the critical group is defined taking into account the most conservative assumptions.

Additionally, according to Article 53 of the Regulation on the Protection of Health against Ionising Radiations, the licensee estimates with more realistic criteria the radiological impact on the members of the public due to the radioactive releases into the environment. In this case a reference group is established. This reference group corresponds to the critical group as defined by ICRP-60 and is intended to be representative of those people living in the vicinity of José Cabrera plant who receive the highest dose.

The critical group includes three age groups: infant (1-2 years), child (7-12 years), and adult (>17 years); according to EC Radiation protection 129[24], these are the three groups who receive the highest doses.

The critical group is hypothetical but realistic, having combinations of habits, both maximum and average, based on local knowledge and plausible assumptions. Food consumption rates are based on the result of site-specific habit surveys carried out by the CSN/CIEMAT in 2001. Inhalation rates from ICRP-71[25], water ingestion rates from ICRP-23[26], and exposure time to shoreline deposits from EUR 15760[27] are considered.

Considering the liquid and gaseous effluents released during the years 2014-2018, the critical group living in the vicinity of José Cabrera plant has been the infant.

3.3.4.4 Exposure pathways

Taking into account productions, food consumption, occupancy and other usage of the region in the vicinity of the plant site, the specific pathways considered in the assessment of doses for the critical group of José Cabrera plant are:

- Inhalation
- External exposure to deposits on the ground (gaseous effluents) and on the shorelines (liquid effluents)
- Consumption of water
- Consumption of fish
- Consumption of leafy vegetables
- Consumption of non-leafy vegetables
- Consumption of meat (beef and goat/sheep)
- Consumption of milk (cow and goat/sheep)

All releases exposure pathways are individually considered and the total dose is calculated by adding the contribution of each of them.

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[24] EC Radiation protection 129: "Guidance on the realistic assessment of radiation doses to members of the public due to the operation of nuclear installations under normal conditions"

[25] ICRP-71: "Age-dependent doses to members of the public from intake of radionuclides: Part 4 inhalation dose coefficients"

[26] ICRP-23: "Reference man: anatomical, physiological and metabolic characteristics"

[27] EUR 15760: "Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment"

3.3.4.5 *Basis for methodology*

The methodology used to estimate doses, defined in the ODCM's, is the same in all Spanish NPP and it is based on calculation models given in the NRC- Regulatory Guide 1.109[28]. To this end, a computer program was developed by the adaptation of the NRC computer programs LADTAP and GASPAR.

The general aspects of this methodology may be summarised as follows:

- Local characteristics, population habits, and land and water usage are site specific
- Straight-line Gaussian plume models are used for atmospheric dispersion
- Hydrological dispersion considers the specific characteristics of the effluent receiving water body (reservoir)
- Generic values, such as period of animals on pasture, time from production and consumption, etc., are used
- Local specific values, such as food consumption rates, irrigation rates, humidity, etc., and site specific exposure pathways, are also used

The dose coefficients used in the calculation of doses to members of the public are:

- For intake by ingestion and inhalation, those specified in the Spanish Regulation on the protection of health against ionising radiations (approved by Royal Decree 783/2001, July 6th) and in the Euratom 96/29 Directive
- For external exposure to the cloud those specified in the BSS (Safety Series No. 115)
- For external exposure to deposits on to the ground and to shoreline deposits, those included in the US EPA Federal Guidance Report 13, CD Supplement.

3.3.4.6 *Site-specific factors for significant nuclides*

In José Cabrera plant doses are calculated every month using the activity-dose conversion factors given in the Regulations that are included in the ODCM.

3.3.4.7 *Site-specific target annual effective dose*

No site specific target effective dose values are set in José Cabrera plant.

3.3.4.8 *Quality assurance of processes involved in dose estimates*

The licensee has verified the computer program suitability through a validation process and this validation has been supervised by the CSN inspectors. Additionally, during the inspections, the CSN inspectors check the doses estimated for a particular month.

On the other hand, the CSN has evaluated the suitability of the site-specific parameters considered in calculations. Furthermore, parallel calculations have been carried out by the CSN, both with own computer programs and excel sheets.

3.3.4.9 *Any relevant information not covered by the requirements specified above*

In addition to the release limit (0,1 mSv/y), a dose limit of 0,25 mSv/y to the critical group is established. This limit applies to the exposure to the liquid and gaseous effluents plus the exposure to the radiation from the ATI facility.

[28] Regulatory Guide 1.109: "Calculation of annual dose to man from routine releases of reactor effluents for the purpose of evaluating compliance with 10CFR part 50, Appendix I"

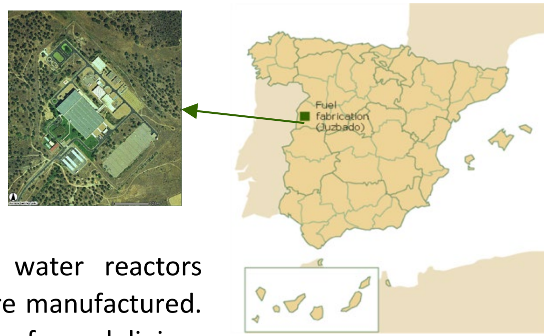
Summary Evaluation

Total effective dose to the critical group living in the vicinity of José Cabrera plant is well below the authorised release limit.

Taking into account liquid and gaseous effluents, the highest dose in the period of time considered in this report has been 2,98E-04 mSv/y. This value represents a 0,3 % of the release limit.

4 SITE SPECIFIC INFORMATION – FUEL FABRICATION PLANT

4.1 JUZBADO NUCLEAR FUEL FABRICATION



4.1.1 Site Characteristics

4.1.1.1 Name of site

Juzbado Fuel Fabrication Plant

4.1.1.2 Type of facility

Juzbado FFP is a facility where fuel assemblies for light water reactors (Westinghouse PWR, General Electric BWR and Loviisa VVER) are manufactured. The plant has three fabrication lines for U_2O fuel and another line for gadolinium oxide. The plant is operated by Enusa Industrias Avanzadas, S.A.

The main installations within the site are: Fabrication building, Radioactive liquid effluent treatment building, Auxiliary building, and Environmental radioactivity laboratory.

4.1.1.3 Year for commissioning/licensing/decommissioning

The plant was commissioned in 1985.

4.1.1.4 Location

The plant is located in the municipal area of Juzbado, in the province of Salamanca, at a distance of 26.55 km from Salamanca city.

4.1.1.5 Receiving waters and catchment area

Radioactive liquid effluents are discharged to the Tormes River, tributary to the Duero River. The average annual flow rate of the Tormes River is 17,8 m^3/s.

4.1.1.6 Production

The annual capacity is 500 tonnes of uranium. The production, expressed as annual amount of processed uranium (t/y), is:

Year	**2014**	**2015**	**2016**	**2017**	**2018**
Production	334	323	279	287	276

4.1.1.7 Other relevant information

There is no other relevant information.

4.1.2 Discharges

4.1.2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

Floor cleaning water is initially treated by centrifugation. Although the system treatment includes a filter, this has not been used since November-1994 when the centrifuge was installed. After sampling and analyse, this treated water passes to the liquid waste treatment plant where, along with all other facility radioactive liquid wastes, undergo other filtration processes. After that, the radioactive liquid wastes are newly analysed and then discharged, directly or after storing in an outdoor pond, to the Tormes River.

Concerning the emissions, ventilation air is the largest contribution to the releases, particularly from those areas where non-encapsulated material is managed. In Juzbado FFP there are thirteen released points, one in the radioactive liquid treatment building and twelve in the fabrication building. Before been discharged to the environment, the air passes through two consecutive high efficiency particulate filters (HEPA filters) to remove the suspended particles from the air.

Since the latest implementation round, no modifications have been introduced in the radioactive effluent treatment systems.

4.1.2.2 Efficiency of abatement systems

This information is shown in Table 29.

4.1.2.3 Annual liquid discharges

The radiological protection principles and regulatory arrangements described above have been applied in Juzbado FFP in order to reduce the level of discharges and the radiological impact to both humans and the environment.

To minimise the production of waste the licensee performs the revision of the operating procedures; optimising the methods applied; and centrifugation of the floor decontamination water to remove the suspended particles.

Information on annual total alpha activity is given in Table 30.

Alpha activity in the liquid discharges from Juzbado FFP shows a global steady trend over the period 2014-2018. As no reference data are published for fuel fabrication plants, normalised discharged data have not been calculated.

4.1.2.4 Emissions to air

Information on annual total alpha activity in gaseous effluents is also shown in Table 30.

Alpha activity in the gaseous effluents shows a slight downward trend over the period.

4.1.2.5 Quality assurance of retention systems performance and data management

The performance of the retention systems is assured by the activity in the fluids after treatment.

Only batch discharges of radioactive liquid effluents take place in the facility after a total alpha analysis in order to determine the activity to be released and the required dilution factor.

Gases are only emitted in a continuous way through monitored release points. Calibration with standard sources and other additional test are periodically performed to ensure that the monitors operate properly. Alpha particulate sampling filters in the ventilation system are weekly replaced and analyse to determine the total alpha activity released into the environment.

The laboratory instrumentation used for discharges and emissions activity quantification is periodically calibrated using standards.

Data and parameters related to treatment, discharges and emissions as well as data from laboratory analyses are kept in notebooks and computer files.

The facility quality control program also includes procedures and instructions for the suitable data management, as well as their correct filed according to the applicable regulations. During the inspections the CSN inspectors perform checks on chosen samples in order to verify the data transmission chain between initial measurements of the sample and final reporting to the CSN.

4.1.2.6 Site specific target discharge values

No specific target values have been established in Juzbado FFP.

4.1.2.7 Any relevant information not covered by the requirements specified above

A review of the radioactive gaseous effluents instrumentation system was begun on May 2009 in the framework of a systematic program of review of the conditions of the safety systems of Juzbado FFP. In this context, some probes for sampling gaseous effluents were replaced with new ones. The aim of this process was to improve the control of the gaseous effluents and quantification of the emitted activity.

Summary Evaluation

Total alpha activity in the liquids effluents presents a global steady evolution.

Total alpha activity in the gaseous effluents shows a slight downward.

No reference data are published for fuel fabrication plants.

4.1.3 Environmental Impact

4.1.3.1 Concentrations of radionuclides of concern in representative samples of water, sediment, and fish.

Tables 31, 32 and 33 show respectively the U-238, U-324 and U-235 mean activity concentrations in river water, sediments and fish in the area surveyed around Juzbado FFP.

4.1.3.2 Environmental monitoring programme.

The environmental monitoring programme of Juzbado FFP is conducted by the plant operator in an area within a 10 km radius. The main pathways of human exposure to radiation are monitored, as well as other ecosystem elements that are good indicators of the behaviour of radionuclides in the environment, as described in Table 5.

4.1.3.3 Systems for quality assurance of environmental monitoring.

The application of quality systems that fully integrate the organisation's structure, responsibilities, procedures, processes and resources required for suitably managing quality have been implemented.

Sampling is carried out by specialized FFP staff, based on sampling procedures that are permanently available to the personnel. Instrumentation for radiological environmental monitoring is calibrated periodically and several checks are carried out, with different periodicity, in order to ensure that monitors work properly.

Measurement of the samples is mainly subcontracted to an external laboratory. The operator is required in the ODCM to develop an analysis quality control programme which has been implemented by the plant by handling a certain percentage (usually between 5% and 15%, sometimes up to 50% depending on the medium) of the samples over to another laboratory different from that performing the analysis of the main REMP for parallel analysis. Both laboratories are accredited or have a plan in progress for accreditation. Within the analysis, these laboratories work with internal quality assurance procedures (Certified activity standards are used for calibrations and background and efficiency are regularly checked for all instruments) and have written standards for performing their work.

In parallel to the operator's REMP, the CSN runs a complementary environmental monitoring programme by collaboration agreements with laboratories in different universities, which conduct the sampling and analysis programmes.

Additionally, since 1992, the CSN has been organising annual analytical intercomparison campaigns using samples similar to those analysed in the REMPs in which these laboratories participate. They also participate in several international intercomparison exercises and proficiency tests, as the ones organized by the IAEA and the EC.

4.1.3.4 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Regarding to the radiological environmental impact around Juzbado FFP for the 2014-2018 period, the level of radionuclides found in all the measured matrixes and exposure pathways have been lower than the reporting levels mentioned in section 2.4.1.

4.1.4 Radiation Doses to the Public

4.1.4.1 Average annual effective dose to individuals within the critical group caused by current discharges

As only total alpha activity is measured, the isotopic composition to estimate doses is calculated from that of the processed uranium. This approach is valid because only mechanical processes take place in the facility.

Information on annual effective dose to the most exposure member of the public due to the discharge of the radioactive liquid effluents is given in Table 34. The annual effective dose shows a downward trend.

4.1.4.2 Total exposures

The annual effective dose due to the liquid and gaseous effluents is also shown in Table 34. The increasing trend that is observed is due to the contribution of the gaseous effluents.

Effective doses are well below the present authorised limit. Taking into account liquid and gaseous effluents, the highest dose in the considered period of time has been 2,80E-05 mSv/y in 2014. This value represents a 0,03 % of the release limit.

4.1.4.3 Critical group /Reference group

Conservative assessments of doses to the critical group are carried out to verify that discharge limits are complied with. In this case the critical group is defined taking into account the most conservative assumptions.

Additionally, according to Article 53 of the Regulation on the Protection of Health against Ionising Radiations, the licensee estimates with more realistic criteria the radiological impact on the members of the public due to the radioactive releases into the environment. In this case a reference group is established for every facility. These reference groups correspond to critical groups as defined by ICRP-60 and are intended to be representative of those people in the population who receive the highest dose.

The critical group includes three age groups: infant (1-2 years), child (7-12 years), and adult (>17 years); according to EC Radiation protection 129[29], these are the three groups who receive the highest doses.

The critical group is hypothetical but realistic, having combinations of habits, both maximum and average, based on local knowledge and plausible assumptions. Food consumption rates are based on the result of site-specific habit surveys carried out by the CSN/CIEMAT in 2001. Inhalation rates from ICRP-71[30], water ingestion rates from ICRP-23[31], and exposure time to shoreline deposits from EUR 15760[32] are considered.

Considering the liquid and gaseous effluents released during the years 2014-2018, the critical group living in the vicinity of Juzbado FFP has been the infant from 2015 to 2018 and the adult in 2014.

4.1.4.4 Exposure pathways

Taking into account productions, food consumption, occupancy and other usage of the region in the vicinity of the plant site, the specific pathways considered in the assessment of doses for the critical group of Juzbado FFP are:

- Inhalation
- Exposure to airborne aerosols
- External exposure to deposits on the ground (gaseous effluents) and on the shorelines (liquid effluents)
- Consumption of water
- Consumption of fish
- Consumption of leafy vegetables
- Consumption of non-leafy vegetables
- Consumption of meat
- Consumption of milk

All releases exposure pathways are individually considered and the total dose is calculated by adding the contribution of each of them.

4.1.4.5 Basis for methodology

The methodology used to estimate doses, defined in the ODCM, is based on calculation models given in the NRC- Regulatory Guide 1.109[33]. To this end, a computer program was developed by the licensee.

The dose coefficients used in the calculation of doses to members of the public are:

- For intake by ingestion and inhalation, those specified in the Spanish Regulation on the protection of health against ionising radiations (approved by Royal Decree 783/2001, July 6th) and in the Euratom 96/29 Directive
- For external exposure to the cloud those specified in the BSS (Safety Series No. 115)

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[29] EC Radiation protection 129: “Guidance on the realistic assessment of radiation doses to members of the public due to the operation of nuclear installations under normal conditions”

[30] ICRP-71: “Age-dependent doses to members of the public from intake of radionuclides: Part 4 inhalation dose coefficients”

[31] ICRP-23: “Reference man: anatomical, physiological and metabolic characteristics”

[32] EUR 15760: “Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment”

[33] Regulatory Guide 1.109: “Calculation of annual dose to man from routine releases of reactor effluents for the purpose of evaluating compliance with 10CFR part 50, Appendix I”

- For external exposure to deposits on to the ground and to shoreline deposits, those included in the US EPA Federal Guidance Report 13, CD Supplement.

4.1.4.6 Site-specific Factors for Significant Nuclides

No site-specific activity-dose factors have been calculated in Juzbado FPP. Doses to the critical group are calculated every month using the activity-dose conversion factors given in the Regulations and included in the ODCM.

4.1.4.7 Site-specific target annual effective dose

No site specific target effective dose values are set in Juzbado FFP.

4.1.4.8 Quality Assurance of Processes Involved in Dose Estimates

The licensee has verified the computer programs suitability through validation process and these validations have been supervised by the CSN inspectors and periodically, during the inspections, the CSN inspectors check the dose estimates for a particular month.

On the other hand, the CSN has evaluated the suitability of the site-specific parameters considered in calculations.

Furthermore, a parallel calculation has been performed by the CSN with excel sheets.

4.1.4.9 Any relevant information not covered by the requirements specified above

There is not any relevant additional information.

Summary Evaluation

Effective doses to the critical group living in the vicinity of Juzbado FFP are well below the authorised limit. Taking into account liquid and gaseous effluents, the highest dose in the considered period of time has been 2,80E-05 mSv/y that represents a 0,03 % of the release limit.

5 CONCLUSION

The Spanish regulatory system in the field of controlling radioactive substances sets up a framework for the effective application of a clearly stated policy under which the application of BAT is required. 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 2014-2018 the doses to the critical group living in the vicinity of the installations have represented 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 nuclear Spanish installations.

TABLES

Table 1: Number of sampling stations. Nuclear installations OSPAR Area

Type of sample	Trillo NPP	José Cabrera NPP*	Almaraz NPP	Juzbado FFP
Air	6	6	6	7
Gamma Radiation (DTL)	22	30	21	21
Soil	8	7	7	9
Rainwater	5	5	6	4
Drinking water	7	4	3	1
Surface and ground water	5	4	13	9
Sediments and Biological indicators	7	6	10	4
Fish	3	3	3	2
Milk	5	5	8	3
Honey	2	2	2	---
Vegetables, meat and eggs.	10	10	18	8
Total number	**80**	**74**	**97**	**68**

* NPP under decommissioning.

Table 2: National Monitoring Network (REM). Sample types and measurements

Dense Network	Sparse Network
AIR Gross-α, Gross-β, ^{131}I (Weekly) γ-Spectrometry. (Monthly) ^{90}Sr. (Quarterly)	**AIR** ^{7}Be, ^{137}Cs (Weekly)
DRINKING WATER Gross-α, Gross-β,γ-Spectrometry (Monthly) ^{90}Sr (Quarterly)	**DRINKING WATER** Gross-α, Gross-β, Residual-β, ^{3}H,^{90}Sr, ^{137}Cs (Monthly) Natural radionuclides (Every two years)
MILK. ^{90}Sr,γ-Spectrometry (Monthly)	**MILK.** ^{90}Sr, ^{137}Cs (Monthly)
SOIL. Gross-β,^{90}Sr,γ-Spectrometry (Annually)	
MIXED DIET ^{90}Sr,γ-Spectrometry (Quarterly)	**MIXED DIET**. ^{137}Cs, ^{90}Sr, ^{14}C (Quarterly)
SURFACE WATER Gross-α, Gross-β, Residual-β, ^{3}H, γ-Spectrometry	**SURFACE WATER.** ^{137}Cs.

Minimum nuclide library for gamma-spectrometry: ^{54}Mn,^{58}Co,^{60}Co,^{59}Fe,^{65}Zn,^{95}Nb,^{95} Zr ^{103}Ru,^{106}Ru, ^{131}I,^{134}Cs, ^{137}Cs, ^{140}La, ^{144}C, ^{7}Be, ^{40}K, ^{208}Tl, ^{212}Pb, ^{214}Bi, ^{214}Pb.

Table 3: Radioactive Effluent Sampling and Analysis Program

Type of Release	**Sampling Frequency**	**Minimum Analysis Frequency**	**Type of Activity Analysis**
		Radioactive Liquid Effluents	
Batch Waste Release	Prior to Each Batch	Prior to Each Batch	Principal Gamma Emitters
			Fe-55; Ni-63
	Prior to One Batch / Month	Monthly	Dissolved and Entrained Gases (Gamma Emitters)
	Prior to Each Batch	Monthly Composite	H-3
			Gross Alpha
	Prior to Each Batch	Quarterly Composite	Sr-89, Sr-90
Continuous Releases	Weekly Grab Sample	Weekly	Principal Gamma Emitters
			Fe-55; Ni-63
	Monthly Grab Sample	Monthly	Dissolved and Entrained Gases (Gamma Emitters)
	Weekly Grab sample	Monthly Composite	H-3
			Gross Alpha
	Weekly Grab sample	Quarterly Composite	Sr-89, Sr-90
		Radioactive Gaseous Effluents	
Waste Gas Storage	Prior to Each Tank Grab Sample	Prior to Each Tank	Principal Gamma Emitters (Noble Gases)
Containment Purge or Vent	Prior to Each Purge Grab Sample	Prior to Each Purge	Principal Gamma Emitters (Noble Gases, Particulates, Iodines, Tritium & Carbon-14)
Building Ventilation Systems, Condenser Vacuum System Exhaust, Others	Monthly Grab Sample	Monthly	Principal Gamma Emitters (Noble Gases)
	Biweekly Grab Sample	Biweekly	H-3 (Inorganic and Organic forms)
			C-14 (Inorganic and Organic forms)
	Continuous	Weekly Charcoal Sample	Iodines
		Weekly Particulate Sample	Principal Gamma Emitters
		Monthly Composite Particulate Sample	Gross Alpha
		Quarterly Composite Particulate Sample	Sr-89, Sr-90

Table 4: Generic Environmental Monitoring Programme around Nuclear Power Plants.

Sample	Frequency	Measurement/analysis
Air (Aerosols) Iodine	Continuous (weekly)	Gross- β ^{90}Sr γ Spectrometry [1] Gross- α [2] ^{55}Fe [2] ^{63}Ni [2] ^{131}I
Gamma radiation (TLD)	Continuous (quarterly)	Dose rate
Rain water	Continuous (monthly)	γ Spectrometry [1] ^{90}Sr ^{55}Fe [2] ^{63}Ni [2]
Drinking water	Fortnightly o more frequently Quarterly	Gross-β Residual β ^{90}Sr ^{3}H γ Spectrometry [1] ^{55}Fe [2] ^{63}Ni [2] ^{241}Am [2] ^{238}Pu [2]
Surface and ground water	Monthly or more frequently (river or coastal water). Ground water quarterly Quarterly	Gross- β Residual β ^{3}H γ Spectrometry [1] ^{55}Fe [2] ^{63}Ni [2] ^{241}Am [2] ^{238}Pu [2]
Soil,	Yearly or Half-yearly	^{90}Sr γ Spectrometry [1] ^{55}Fe [2] ^{63}Ni [2]
Sediment and biological indicators	Every six months	^{90}Sr γ Spectrometry [1] ^{55}Fe [2] ^{63}Ni [2] ^{241}Am [2] ^{238}Pu [2]
Milk and fruits, vegetables and cereals.	Milk fortnightly on grazing season and monthly the rest of the year. Fruits, vegetables and cereals on harvest time.	^{90}Sr γ Spectrometry [1] ^{131}I (milk, leafy vegetables) ^{55}Fe [2] ^{63}Ni [2]

Meat, eggs, fish and seafood..	Every six months	γ Spectrometry [1] ^{55}Fe [2] ^{63}Ni [2]
Honey	Every six months	γ Spectrometry [1]

(1) 1.Minimum nuclide library for gamma-spectrometry: ^{54}Mn,^{58}Co,^{60}Co,^{59}Fe,^{65}Zn,^{95}Nb, ^{95}Zr,^{131}I,^{134}Cs, ^{137}Cs, ^{140}La, ^{144}Ce.

(2) 2. Only José Cabrera NPP.

Table 5: Environmental monitoring programme around Juzbado FFP

Sample	**Measurement/analysis**
Air (Aerosols)	Gross- α Uranium α spectrometry
Gamma radiation (TLD)	Dose rate
Ground water, river water and drinking water.	Gross-α Gross β Residual β (river and drinking water) Uranium α spectrometry
Soil	Gross- α Uranium α spectrometry
Sediment and biota	Gross- α Uranium α spectrometry
Food (Vegetables, meat, milk and fishes)	Gross-α Uranium α spectrometry

Table 6: Almaraz I&II NPP. Abatement system and their efficiency

Abatement system/ Management	Efficiency of abatement system		Comments
	Decontamination Factor	Other measure of efficiency	
Discharges:			
Steam- Generator Blow down: ▪ Filter	98% for particles (2 µm)		
▪ 2 Mixed ion exchangers in serie	Respectively each one: 100/ 10 for anions 10/ 10 for Cs, Rb 100/ 10 for other		
▪ Filter	98% for particles (25 µm)		
Quality Reactor Wastes Treatment: ▪ Filter	98% for particles (25 µm)		
▪ Evaporator		Concentration from 10-2500 (entrance) to 21000 ppm of boron (exit)	
▪ Mixed ion exchanger	100 for anions 10 for Cs, Rb 1000 for other		
▪ Filter	98% for particles (25 µm)		
Non Quality Reactor Wastes Treatment: ▪ Filter	1 for corrosion products 98% for particles (25 µm)		
▪ Mixed ion exchanger	100 for anions 2 for Cs, Rb 100 for other		
▪ Filter	98% for particles (25 µm)		
Recovery Boron System: ▪ Ion exchanger	2 for Cs, Rb 10 for other		
▪ Filter	98% for particles (5µm)		
▪ Evaporator		< 10 ppm in condensate	
▪ Ion exchanger	2 for Cs, Rb 10 for other		
▪ Filter	98% for particles (25 µm)		
Coolant Water Drains System: ▪ Mixed ion exchanger	10 for anions 2 for Cs, Rb 10 for other		
▪ Cationic exchanger	1 for anions 10 for Cs, Rb 10 for other		
▪ Filter	98% for particles (25 µm)		
Emissions:			

Reactor building purge: ▪ Coarse filter	≥ 80% for particles		
▪ Charcoal bed	≥ 95% for iodine		
▪ HEPA filter	≥ 99,97%		
Hydrogen purge from reactor building: ▪ Coarse filter	≥ 90%		
▪ Charcoal bed	≥ 99 %		
▪ HEPA filter	≥ 99 %		
Reactor building ventilation: ▪ Coarse filter	≥ 80%		
▪ HEPA filters	≥ 99,97 %		
▪ Charcoal bed	≥ 99,9 %		
Safeguard building ventilation: ▪ Coarse filter	≥ 80%		
▪ HEPA filters	≥ 99,97 %		
▪ Charcoal bed	≥ 99,9 %		
Fuel building ventilation: ▪ Coarse filter	≥ 80%		
▪ HEPA filters	≥ 99,9 %		
▪ Charcoal bed	≥ 99,9 %		
Purge treatment building ventilation: ▪ Coarse filter	≥ 80%		
▪ HEPA filters	≥ 99,9 %		
▪ Charcoal bed	≥ 99,9 %		
Ejector gases: ▪ HEPA	N.A.		
▪ Charcoal bed	90 %		
Gland-seal effluents: ▪ HEPA filter	99,9 %		
▪ Charcoal bed:	90 %		

Table 7: Almaraz I&II NPP. Absolute annual liquid effluent activity (GBq/year)

Nuclide	2014	2015	2016	2017	2018
Gross Alpha	**ND**	**ND**	**ND**	**ND**	**ND**
H-3	**2,66E+04**	**4,30E+04**	**3,41E+04**	**4,45E+04**	**3,51E+04**
Co-58	7,17E-01	8,99E-01	1,39E+00	1,30E+00	1,87E+00
Co-60	1,58E+00	7,27E-01	1,41E+00	8,31E-01	9,80E-01
Zn-65	3,04E-02	2,47E-02	3,80E-02	2,07E-02	3,56E-02
Sr-90	6,42E-03	1,00E-02	1,73E-02	1,06E-01	3,02E-02
Zr/Nb-95	4,75E-01	4,32E-01	6,16E-01	3,03E-01	5,62E-01
Ru-106	1,31E-01	1,04E-01	1,43E-01	9,96E-02	1,28E-01
Ag-110m	5,05E-01	2,34E-01	9,74E-01	5,24E-01	1,02E+00
Sb-125	2,41E-01	1,01E-01	3,30E-01	2,64E-01	4,12E-01
Cs-134	9,99E-01	3,35E-01	4,87E-01	3,80E-01	9,97E-02
Cs-137	1,18E+00	6,48E-01	1,16E+00	1,12E+00	5,41E-01
Ce-144	3,35E-02	5,68E-02	7,86E-02	ND	ND
Other nuclides	4,36E+00	1,80E+00	3,14E+00	1,97E+00	2,58E+00
Total Activity excluding H-3	**1,03E+01**	**5,38E+00**	**9,78E+00**	**6,91E+00**	**8,26E+00**

Table 8: Almaraz 1&2 NPP. Normalised discharges (GBq/GWa)

Nuclide	2014	2015	2016	2017	2018	UNSCEAR 1998-2002	UNSCEAR 2010
Total activity without H-3	5,94E+00	2,93E+00	5,65E+00	3,70E+00	4,61E+00	1,10E+01	3,80E+00
Tritium	1,53E+04	2,34E+04	1,97E+04	2,38E+04	1,96E+04	2,00E+04	1,80E+04

Table 9: Almaraz I&II NPP. Annual tritium and C-14 emissions

Nuclide	2014	2015	2016	2017	2018	UNSCEAR 1998-2002	UNSCEAR 2010
Tritium (GBq/year)	4,16E+03	5,29E+03	8,91E+03	3,67E+03	3,12E+03		
C-14 (GBq/year)	3,72E+02	3,70E+02	2,04E+02	1,09E+02	1,71E+02		
Tritium (GBq/GWa)	2,40E+03	2,88E+03	5,14E+03	1,97E+03	1,74E+03	2,10E+03	1,50E+03
C-14 (GBq/GWa)	2,14E+02	2,02E+02	1,18E+02	5,84E+01	9,54E+01	2,20E+02	8,30E+01

Table 10: Almaraz I&II NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in river water (Bq/m^3)

Isotope	2013	20014	2015	2016	2017	2018
^{137}Cs	<35,8	<37,9	<32,2	<33,1	<33,8	<42,9
^{60}Co	<32,8	<34,6	<29,2	<29,9	<30,3	<38,8
^{54}Mn	<34,7	<36,6	<31,2	<31,8	<32,3	<40,9

Table 11: Almaraz I&IINPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in sediments (Bq/kg.dry.wt)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	3,2	4,1	3,6	4,5	4,1	4,7
^{60}Co	2,2	2,4	3,6	3,8	1,6	8,4
^{54}Mn	<0,26	<0,29	<0,33	<0,23	<0,23	<0,22

Table 12: Almaraz I&II NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in fish (Bq/kg.wet.wt)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	0,43	0,38	0,27	0,38	0,46	0,31
^{60}Co	<0,21	<0,23	<0,21	<0,24	<0,21	<0,21
^{54}Mn	<0,21	<0,24	<0,22	<0,23	<0,25	<0,22

Table 13: Almaraz I&II NPP. Annual effective dose to the critical group (mSv/y)

Effluent	2014	2015	2016	2017	2018
Liquids	4,01E-04	2,08E-04	4,08E-04	2,37E-04	2,12E-04
Gases	2,85E-04	1,90E-04	2,52E-04	1,04E-04	2,67E-04
Total	6,87E-04	3,98E-04	6,60E-04	3,40E-04	4,78E-04

Table 14: Trillo NPP. Abatement system and their efficiency

Abatement system/ Management	Efficiency of abatement system		Comments
	Decontamination Factor	Other measure of efficiency	
Discharges:			
Liquid Wastes Treatment: ▪ Filter	5		
Evaporator		Decontamination coefficient from 100 to 1E+06	
Mixed ion exchanger	3		
Coolant treatment: ▪ Mixed ion exchanger	1000		
▪ Degasification system	10-1000		
▪ Filter	particles (5 µm)		
▪ Ion exchanger	100		
▪ Evaporator	100		
▪ Degasification system		Degasification factor: 4,6E+04	
▪ Filter	98% for particles (25 µm)		
Steam-generator blow-down: ▪ Mixed ion exchanger	>15 for iodine >25 for Na-24		
Emissions:			
Containment structure purge: ▪ Coarse filter	50%		
▪ Charcoal bed	99%		
▪ HEPA filter	99,97 %		
Containment structure ventilation: ▪ Coarse filter	50 %		
▪ Charcoal bed	99 % for ICH_3		
▪ HEPA filters	99,97 %		
Annular shielding building ventilation: ▪ HEPA filters	99,97 %	DIN 24184	
▪ Charcoal bed	99 % for ICH_3		
Auxiliary building ventilation: ▪ Coarse filter	85%		
▪ HEPA filters	99,97 %	DIN 24184	
▪ Charcoal bed	99% for ICH_3		
Radwastes treatment: ▪ Filter	Particles (0,1mm)		
▪ Delay banks		Delay time: 60 days for Xe 60 hours for Kr	

▪Filter	Particles (5µm)		

Table 15: Trillo NPP. Absolute annual liquid effluent activity (GBq/year)

Nuclide	2014	2015	2016	2017	2018
Gross Alpha	**ND**	**ND**	**ND**	**ND**	**ND**
H-3	**2,01E+04**	**1,47E+04**	**1,77E+04**	**8,31E+03**	**2,24E+04**
Co-58	7,34E-03	6,28E-03	3,95E-03	5,07E-03	2,57E-03
Co-60	5,87E-02	3,70E-02	2,51E-02	2,99E-02	2,04E-02
Zn-65	ND	ND	ND	ND	ND
Sr-90	ND	ND	ND	2,16E-03	ND
Zr/Nb-95	8,96E-03	3,49E-03	3,63E-03	3,49E-03	2,47E-03
Ru-106	ND	ND	ND	ND	ND
Ag-110m	3,61E-03	3,77E-03	5,75E-03	6,41E-03	2,44E-03
Sb-125	8,46E-03	5,44E-03	ND	ND	ND
Cs-134	2,94E-03	ND	ND	ND	ND
Cs-137	1,22E-02	4,28E-03	4,56E-03	4,07E-03	2,32E-03
Ce-144	ND	ND	ND	ND	ND
Other nuclides	2,74E-01	2,64E-01	5,18E-01	4,35E-01	1,64E-01
Total Activity excluding H-3	**3,76E-01**	**3,25E-01**	**5,61E-01**	**4,86E-01**	**1,94E-01**

Table 16: Trillo NPP. Normalised discharges (GBq/GWa)

Nuclide	2014	2015	2016	2017	2018	UNSCEAR 1998-2002	UNSCEAR 2010
Total activity without H-3	4,23E-01	3,59E-01	6,14E-01	5,33E-01	2,20E-01	1,10E+01	3,80E+00
Tritium	2,26E+04	1,62E+04	1,94E+04	9,12E+03	2,54E+04	2,00E+04	1,80E+04

Table 17: Trillo NPP. Tritium and C-14 emissions

Nuclide	2014	2015	2016	2017	2018	UNSCEAR 1998-2002	UNSCEAR 2010
Tritium (GBq/year)	6,56E+02	6,37E+02	5,04E+02	6,55E+02	5,79E+02		
C-14 (GBq/year)	1,02E+02	1,51E+02	1,49E+02	1,75E+02	2,68E+02		
Tritium (GBq/GWa)	7,38E+02	7,04E+02	5,52E+02	7,19E+02	6,56E+02	2,10E+03	1,50E+03
C-14 (GBq/GWa)	1,15E+02	1,67E+02	1,63E+02	1,92E+02	3,04E+02	2,20E+02	8,30E+01

Table 18: Trillo NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in river water (Bq/m3)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	*<36*	*<39*	*<32*	*<34*	*<35*	*<41*
^{60}Co	*<33*	*<36*	*<29*	*<31*	*<31*	*<37*
^{54}Mn	*<35*	*<38*	*<31*	*<33*	*<33*	*<39*

Table 19: Trillo NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in sediments (Bq/kg.dry.wt)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	1,5	2,1	2,1	2,3	2,7	1,7
^{60}Co	1,3	0,79	0,93	0,91	0,48	0,95
^{54}Mn	<0,25	<0,26	<0,26	*<0,26*	<0,27	<0,24

Table 20: Trillo NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in fishes (Bq/kg.wet.wt)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	0,23	<0,20	<0,25	<0,21	<0,18	<0,16
^{60}Co	<0,21	<0,18	<0,22	<0,19	<0,17	<0,15
^{54}Mn	<0,22	<0,19	<0,23	<0,20	<0,18	<0,16

Table 21: Trillo NPP. Annual effective dose to the critical group (mSv/y)

Effluent	2014	2015	2016	2017	2018
Liquids	1,36E-03	1,63E-03	1,13E-03	1,47E-03	8,02E-04
Gases	2,47E-05	3,87E-05	8,07E-06	1,48E-05	1,72E-05
Total	1,39E-03	1,67E-03	1,14E-03	1,49E-03	8,19E-04

Table 22: José Cabrera NPP. Abatement system and their efficiency

Abatement system/ Management	Efficiency of abatement system		Comments
	Decontamination Factor	**Other measure of efficiency**	
Discharges:			
Evaporator		Decontamination coefficient: 10^6 for liquids except I and B 10^3 for I and B	Although an evaporator was available from the start of the operation, it was replaced with a new one to get a higher concentration factor
Store tank		Delay time 1-2 months	
Emissions:			
Solidification & drumming plant: ▪Coarse filter	25-30 %		
▪HEPA filter			
Dismantling auxiliary building: ▪Coarse filters	45 %		atmospheric-dust-spot efficiency
▪HEPA filters	99,97 % (0,3 μm)		
Containment building: ▪HEPA filters	99,97 % (0,3 μm)		
▪Coarse filters	50 %		atmospheric-dust-spot efficiency
Evaporator building: ▪Coarse filters	50 %		
▪HEPA filters	99,97 % (0,3 μm)		
Auxiliary building: ▪Coarse filters	50 %		
▪HEPA filters	99,97 %		

Table 23: José Cabrera NPP. Annual liquid effluent activity (GBq/year)

Nuclide	2014	2015	2016	2017	2018
Gross Alpha	**4,09E-04**	**2,85E-04**	**1,58E-05**	**6,84E-06**	**6,57E-04**
H-3	**7,43E+01**	**1,40E+02**	**5,52E+00**	**1,39E+00**	**1,03E-01**
Co-58	ND	ND	ND	ND	ND
Co-60	1,55E-01	5,03E-02	1,43E-03	6,52E-04	3,85E-02
Zn-65	ND	ND	ND	ND	ND
Sr-90	1,68E-03	8,58E-04	ND	8,02E-06	1,41E-02
Zr/Nb-95	ND	ND	ND	ND	ND
Ru-106	ND	ND	ND	ND	ND
Ag-110m	ND	ND	ND	ND	ND
Sb-125	ND	ND	ND	ND	ND
Cs-134	ND	ND	ND	ND	ND
Cs-137	7,98E-02	2,75E-02	2,47E-03	1,61E-03	4,17E-01
Ce-144	ND	ND	ND	ND	ND
Other nuclides	2,17E-01	7,29E-02	2,30E-03	1,14E-03	7,41E-02
Total Activity excluding H-3	**4,53E-01**	**1,52E-01**	**6,20E-03**	**3,41E-03**	**5,44E-01**

(1) There were no liquid discharges

Table 24: José Cabrera NPP. Annual gaseous effluent activity (GBq/year)

Nuclide	2014	2015	2016	2017	2018
H-3	5,01E+00	3,70E+00	1,78E+00	3,55E-01	1,42E-01

Table 25: José Cabrera NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in river water (Bq/m^3)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	<73	<71	<46	<32	<35	<34
^{60}Co	<68	<68	<43	<33	<37	<36
^{54}Mn	<62	<60	<39	<27	<31	<30

Table 26: José Cabrera. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in sediments (Bq/kg.dry.wt)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	11	11	10	16	13	17
^{60}Co	<0,22	0,67	0,42	0,49	<0,33	0,65
^{54}Mn	<0,20	<0,19	<0,19	<0,26	<0,33	<0,30

Table 27: José Cabrera. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in fishes (Bq/kg.wet.wt)

Isotope	2013	2014	2015	2016	2017	2018
^{137}Cs	1,4	1,2	0,81	0,35	0,34	0,15
^{60}Co	<0,10	<0,10	<0,09	<0,09	<0,10	<0,08
^{54}Mn	<0,08	<0,08	<0,08	<0,08	<0,11	<0,08

Table 28: José Cabrera. Annual effective dose to the critical group (mSv/y)

Effluent	2014	2015	2016	2017	2018
Liquids	1,08E-04	3,61E-05	2,71E-06	9,62E-07	2,98E-04
Gases	4,91E-08	2,44E-07	5,70E-08	1,37E-08	4,92E-09
Total	1,08E-04	3,64E-05	2,77E-06	9,75E-07	2,98E-04

Table 29: Juzbado FFP. Abatement system and their efficiency

Abatement system/ Management	Efficiency of abatement system		Comments
	Decontamination Factor	Other measure of efficiency	
Discharges:			
Floor washing water: ▪ Filter	60-70% (5 µm)		Not used since November-1994 when the centrifuge was installed
▪ Ultra centrifugation process	95%		
Liquid treatment system: ▪ Filter	10%		
Emissions:			
Building ventilations: ▪HEPA filters	> 99,95% (0,3µm)		
▪HEPA filters	> 99,97 % (0,3µm)		

Table 30: Juzbado FFP. Total alpha activity (GBq/y)

Effluent	2014	2015	2016	2017	2018
Liquids	1,30E-02	1,63E-02	1,96E-02	2,14E-02	1,79E-02
Gases	8,73E-05	8,25E-05	6,73E-05	7,32E-05	6,26E-05

Table 31: Juzbado FFP. ^{238}U, ^{234}U and ^{235}U concentrations in river water (Bq/m^3)

Isotope	2013	2014	2015	2016	2017	2018
^{238}U	20	7,5	13	14	3,7	8,1
^{234}U	27	9,1	23	21	8,3	16
^{235}U	1,7	0,77	1,2	1,0	<2,0	0,41

Table 32: Juzbado FFP. ^{238}U, ^{234}U and ^{235}U concentrations in sediments (Bq/kg.dry.wt.)

Isotope	2013	2014	2015	2016	2017	2018
^{238}U	78	60	51	77	52	69
^{234}U	119	91	77	120	85	107
^{235}U	5,2	3,0	2,7	4,0	2,6	3,5

Table 33: Juzbado FFP. ^{238}U, ^{234}U and ^{235}U concentrations in fishes (Bq/kg.wet.wt.)

Isotope	2013	2014	2015	2016	2017	2018
^{238}U	0,03	0,05	0,04	0,07	0,09	0,07
^{234}U	0,05	0,06	0,05	0,13	0,13	0,08
^{235}U	0,01	<0,01	<0,02	<0,02	0,007	<0,01

Table 34: Juzbado FFP. Annual effective dose to the critical group (mSv/y)

Effluent	2014	2015	2016	2017	2018
Liquids	7,89E-07	6,31E-06	3,10E-06	1,08E-06	2,93E-06
Gases	2,72E-05	1,47E-05	1,11E-05	1,62E-05	1,29E-05
Total	2,80E-05	2,10E-05	1,42E-05	2,70E-05	1,58E-05

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