OSPAR COMMISSION

Implementation Report of PARCOM Recommendation 91/4 Report from Spain

Radioactive Substances Series

2011

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. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Union and Spain.

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.
La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, 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 et la Suisse et approuvée par l'Union européenne et l'Espagne.

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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*".

After the third round of implementation reporting on PARCOM Recommendation 91/4, the OSPAR Radioactive Substance Committee agreed revised guidelines at its 2004 meeting in La Rochelle (France).

This document, which is the fifth submitted by Spain, has been elaborated according to the OSPAR-guidelines 2004-03 and contains information , over the seven-year period 2003-2009 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) and the 15/1980 Law, of April 22nd, creating the Nuclear Safety Council (CSN), reformed by Law 33/2007 of November 7th. 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.

2.1.1 Regulation on Nuclear and Radioactive Facilities

The Regulation governing Nuclear and Radioactive Facilities (approved by Royal Decree 1838/1999, December 3rd, and modified by Royal Decree 35/2008, January 18th) 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 current best techniques and practices must be analysed, in accordance with the requirements that the CSN establishes, and implement those that are suitable in the opinion of said body. The CSN may require at any time the licensee's analysis for the implementation of improvements on nuclear safety and radiation protection.

The licensee is also required to develop a Continuous Safety Assessment Programme (CSA) taking into account the evolution of the normative, the progress in technology (BAT), and the operational experience. According to Article 73, an annual report on the results of that Programme is submitted to the CSN including the design modifications proposed, implemented or/and going on; the adaptation to the new requirements of Spanish law and to the international regulations that are applicable to them; the applicability of the new regulations of the country origin of the design and, according to those regulations, to propose the necessary modifications.

As a result, many operational and procedural improvements have been introduced in order to minimise the production of radioactive waste and their discharge into the environment.

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, July 6th) 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 Regulation 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 Royal Legislative Decree 1/2008, modified by the Law 6/2010, March 24th 2010, on the evaluation of the environmental impact. The Decree 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]

As regards the CSN Instructions legal standing, these are genuine regulations designed to remain over time and are fully integrated in the legal system. Like any general standard, they are open to contentious-administrative revision. Non-compliance is considered to constitute an administrative infringement.

In the process of drawing up Council instructions, the participation of the stakeholders and public is promoted in the terms contemplated in Law 27/2006, of July 18th, regulating rights to access to information and public participation and access to justice in environmental matters.

The instructions are communicated to the Congress and, in the case of those referring to radiological protection, also to the European Union, in compliance with article 33 of the EURATOM Treaty, all the above following approval by the Council.

This 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 years basis, following the recommendations of the CSN Safety Guide 1.10[2]. The goal of the PRS 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 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.

2.1.5 Reference Levels

Reference Levels (RL) have been established by the CSN for liquid and gaseous effluents, set up in terms of activity for groups of nuclides.

These RL, which indicates optimal operation of the reactor in terms of radioactive wastes generation and discharges into the environment, are reviewed regularly after a critical examination of the history of discharges and emissions and their relationship to the authorised limits, and the status of the current techniques and operating procedures adopted by the facility in radioactive waste management (technology and best practice).

2.2 DOSE CONSTRAINT/LIMITS FOR NUCLEAR FACILITIES

In Spain, the regulatory dose limits for members of the public are an effective dose of 1mSv/y and an equivalent dose of 50 mSv/y to the skin, and 15 mSv/y to the lens.

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.

Since 1993, the dose constraint is set as an effective dose of 0,3 mSv/y for nuclear power plants and other fuel cycle installations.

Therefore, 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 BAT is required, which follows closely the requirements and recommendations of competent international bodies, and which adopts principles calculated to ensure the application of the precautionary principle and the prevention of pollution.

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

[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. 1996. Rev. 1, 2008

established as a proper percentage of a Dose Constraint previously defined by the CSN for 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 2003 the Technical Specifications of Juzbado fuel fabrication plant were review in order to normalise them with those of the other nuclear installations and since them an effective dose of 0,1 mSv/y is also the only limit applicable to the liquid and gaseous effluents as a whole.

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

The values that were determined taking into account an optimisation process of the effluents treatment systems are:

Facility	**Type of effluent**	**Effective dose (mSv/y)**
Almaraz NPP	Liquid	0,02
	Gaseous	0,08
José Cabrera NPP*	Liquid	0,08
	Gaseous	0,02
Trillo NPP	Liquid	0,04
	Gaseous	0,06

* Since April 30th 2006 in definitive shutdown situation and since February 1irst 2010 in the dismantling phase.

There is no specific discharge limit distribution between gaseous and liquid for the effluents released by Juzbado fuel fabrication plant.

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 Off Site 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.

Since discharge limits in the Spanish nuclear facilities are formulated in terms of dose, operators shall demonstrate compliance with them by estimating monthly the cumulative doses in the last twelve consecutive months considering as source terms all the radionuclides detected by mean of the effluent sampling and analysis programmes and following the procedures specified in the ODCM.

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 basic goals of these programmes are:

- To provide representative measurements of radioactivity in the most relevant exposure pathways to man.
- To verify the effectiveness of the effluent monitoring programmes.
- To allow verifications of model-based dose calculations.

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

- To provide data for reporting to relevant national and international bodies and to inform to the public.

The main requirements for the nuclear power plants environmental monitoring programmes are defined in the CSN Safety Guide 4.1[4] and include:

- A minimum sampling, analysis and measurement programme, within a 30 km radius zone around the installation.
- Quality assurance and quality control programmes including the existence of written procedures related to all the programme stages and the analysis of duplicated samples by two different laboratories, usually over a range of 5%-15% of the total programme samples. The site operator coordinates this analysis of duplicated samples (Internal Quality Control Programme).

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 Offsite Dose Calculation Manual ODCM, where requirements about Lower Limits of Detection (LLD) and the existence of procedures related to the phases of the programme are included. The OCDM also includes “Reporting Levels” (RL) of isotopic activity concentrations in environmental samples of air, water, milk, meat, vegetables, fishes, seafood and soil. RL are derived activity concentration values put in place by the CSN on the basis of effluent discharge limits. If these values are exceeded, the facility has to report it to the CSN and undertake a study to determine a possible relationship with the plant’s releases according to the origin of the radionuclides detected.

The number and location of sampling points, the type of samples to be selected and the required analysis are defined in the preoperational stage, intended to characterise the site radiologically, before the facility’s operation. The main pathways of human exposure to radiation are monitored as well as other ecosystem elements that are good indicators of the evolution of radioactivity in the terrestrial and aquatic environments. The programmes are updated periodically during the different lifetime phases of the facilities.

Although the José Cabrera NPP is not operative, its monitoring programme has been maintained and completed with some more gamma radiation sampling points, due to survey the 12 dry storage modules where used fuel is being kept, and with a series of extra analysis that will make part of the programme during the dismantling phase. For the inclusion of these new analyses, different factors have been taken into account. These are the operating history of the facility, its radiologic characterization and the scheduled dismantling activities, taking into account the isotopes foreseen during these activities.

Tables 1 and 2 respectively, summarise the sampling and analysis programme required for nuclear power plants and the fuel fabrication plant of Juzbado.

Table 3 shows, related to OSPAR zone nuclear installations, 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 rage 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.

Until the year 1998 sampling was carried out by the CSN staff and the analysis performed at the laboratories of the Research Centre for Energy, Environment and Technology (CIEMAT).

From 1999 on the independent programme, sampling and analysis, has been entrusted to laboratories from universities.

Related to the OSPAR zone installations, the laboratories involved are the following:

- NNPPs Trillo and José Cabrera - Castilla-La Mancha University
- NNPP Almaraz - Extremadura University.(Cáceres).
- FFP Juzbado - Salamanca University.

The university laboratories inform directly to the CSN the results obtained.

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

The CSN also performs periodic inspections and audits to verify that the facilities comply with the programmes, which are revised annually. Operators are requested to send annual reports to the CSN including the results obtained and the evaluation of the radiological conditions of the environment.

The results obtained from each of the programmes (main programme, internal quality control and external quality control programmes) are stored in the CSN´s environmental radioactivity measurement database (KEEPER). The CSN evaluates the data received.

2.4.2 Nationwide monitoring network

CSN runs a nation-wide environmental radiological monitoring network. This network is independent form the network associated with nuclear facilities.

This network operates since 1992 (rivers since 1984) and has the following goals.

- Ascertain the distribution and evolution of radioisotopes present in the environment and the levels of environmental radiation.
- Provide an environmental database to be able to obtain reference levels at any time.
- Provide data for estimating the potential radiological impact on the population.
- Provide data for reporting every year, to the Parliament, and to the public on the radiological quality of the environment.

In order to achieve these goals, two networks have been implemented by the CSN:

- A network for automatic environmental radiological surveillance (REA).
- A network of sampling stations (REM).

The REA network consists of 25 automatic stations with a nation-wide distribution. Most of the CSN managed stations are located in measurement stations of the National Meteorology Institute. The radiological and meteorological data are recorded and stored every 10 min at the stations and are transmitted through the switched telephone network to the Emergency Management Room (SALEM) at the CSN premises in Madrid. Specifically designed software for the network operation and data evaluation is operated from this room.

The radiological data measured, are gamma dose rate and 131I, 222Rn, α and β emitters, radon progeny contribution discounted in the air. The meteorological data recorded are wind speed, wind direction, air temperature, relative humidity, rainfall and atmospheric pressure.

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. At the present moment the results from the years 2000-2009 have been published.

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) follow the European Commission recommendations to comply with the related articles of the Euratom Treaty. These programmes 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 4 shows the sampling and analysis programme that is currently being developed in Spain.

The surface water programme comprises the river and the coastal waters. More than 80 sampling stations cover the main rivers of the country. Table 5 shows the number of sampling stations and samples taken during the year 2009, in the OSPAR area rivers.

The Spanish coast is surrounded by a series of fifteen sampling stations, seven 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.

Tables 6, 7 and 8 summarise the results obtained during the 2003-2009 period in the OSPAR zone stations. Gamma Spectrometry values are not shown because all of them have been below the detection limit. The coastal waters surveillance programmes show no influence of radioactive releases.

All data from the REM network, is also stored in the CSN´s database KEEPER.

CSN reports annually to the Parliament about the results obtained from this network. In compliance with the requirements on environmental surveillance issued by the European Commission in article 36 of the Euratom Treaty, CSN sends annually these results to the European Commission. The results are held on the REM data bank at the CEC Joint Research Centre in Ispra. The European Commission periodically publishes these data.

CSN, by means of the CSN publications plan, is editing the results of the environmental radiological monitoring programmes. (Nuclear installations and REM programmes).At the present moment eleven technical documents with the results from the 1980-2008 period have been published, and the results of 2009 are due to be published within the first quarter of 2011.

2.5 ENVIRONMENTAL NORMS AND STANDARDS

Measuring radioactivity in environmental samples involves a complex and lengthy process that includes several steps, from collection and preparation of representative samples and their chemical analysis, to calibration of measurement equipment. Representative samples have to be taken and the treatment in the laboratory should guarantee that the final data reproduce as close as possible the contents of radioactivity in the environment.

A working group, formed by staff of the main environmental laboratories of the country and coordinated by the CSN staff, has been established to develop monitoring standards and procedures for the main stages of the environmental sample radioactivity measurement process: sampling, sample preservation and preparation, analytical methods and measurement equipment. It was considered convenient that this working group would carry out their activities in coordination with AENOR (Spanish Organisation of Standardisation and Certification) giving rise to a group of environmental Spanish norms and CSN publications.

The procedures and norms already produced are listed below:

NORMS	
Sampling.	**Conservation and handling.**
Soil- Superficial layer(UNE-73311-1) Aerosols and radio iodine in air (UNE-73320-3) Continental and sea sediments (UNE-73320-2)	Soil samples (UNE-73311-5). Aerosol filters and charcoal cartridges.
Analytical methods.	**Measuring equipment**
Gross β in water by proportional counter (UNE-73311-4) Residual β in water by proportional counter (UNE-73340-2). Determination of $^{89-90}$Sr in soils and sediments. (UNE-73340-3). Gross α in water. Coprecipitation and evaporation methods.	γ Spectrometry with semi-conductor detectors (UNE-73350-1). α Spectrometry with semi-conductor detectors (UNE-73350-2). Liquid scintillation detectors. (UNE-73350-3).
CSN PUBLICATIONS	
1.1. Sampling procedure for the determination of radioactivity in soil: surface layer. (CSN, 2003)	
1.2. Procedure for the conservation and preparation of soil samples for the determination of radioactivity (CSN, 2003)	
1.3. Procedure for the assessment of uncertainties in the determination of environmental radioactivity. (CSN, 2003).	
1.4. Selection, preparation and use of standards for gamma spectrometry (CSN, 2004)	
1.5. Procedure for the determination of the gross beta and residual beta indicators in water with proportional counter. (CSN, 2004)	
1.6. Procedure for the determination of the concentration of ^{89}Sr and ^{90}Sr in soil and sediments. (CSN, 2005)	
1.7. Sampling procedure of aerosols and radio iodine in air for the determination of radioactivity. (CSN, 2005).	
1.8. Procedure for the reception, conservation and preparation of samples of aerosols in filters and of radio iodines in active carbon for environmental radioactivity determination. (CSN, 2005).	
1.9. Procedure for the determination of the gross alpha activity indicator in water samples. Cooprecipitation and evaporation methods. (CSN, 2005)	
1.10. Sampling procedure of sediments for environmental radioactivity determination. (CSN, 2007).	
1.11. Procedure for the conservation and preparation of sediment samples for environmental. Radioactivity determination. (CSN 2007).	
1.12. Sampling procedure of wet and dry deposition for its radioactivity determination. (CSN, 2007).	

1.13.	Procedure for the preparation of water samples for the determination of gamma emitters. Iodine retention and selective extraction of Caesium. (CSN, 2007).
1.14.	Sampling procedure for the determination of tritium in water vapour samples. (CSN, 2009).
1.15.	Sampling, reception and conservation procedure for the environmental radioactivity determination in water samples (CSN, 2009).

There are no edited norms or standards at the present moment for the protection of the environment from a radiological point of view. Nevertheless, Spain is participating within the international projects to develop a framework for the assessment of environmental impact of ionising radiation in ecosystems.

Juzbado fuel fabrication plant in order to continuously improve its environmental performance implemented since April 1999 an Environmental Management System that has been certified by AENOR, in accordance with the requirements of Standard UNE-EN ISO 14001:1996. Moreover, the factory obtained the AENOR verification of its Environmental Management System and Environmental Declaration, pursuant to the requirements of European Regulation[5] 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 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.

One of the missions assigned to the CSN is the supervision of the radiological protection measures applied for the public and the environment, and control and surveillance of the following:

- The off-site release of radioactive materials from nuclear and radioactive facilities and their specific or accumulated impact in the area of influence, and estimation of their radiological impact.
- The radiological quality of the environment throughout the national territory, in compliance with Spain's international obligations and collaboration with the competent authorities in the different aspects of environmental radiological surveillance.

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.

The Industry, Trade and Tourism Parliamentary Committee dictates as well resolutions urging the CSN to produce reports or provide answers to specific questions. Following these requests, the CSN has the legal mandate to provide with a timely answer to all parliamentary questions formulated.

The Ministry of Industry, Tourism and Trade is responsible for granting permits to nuclear and radioactive facilities, but the legislation requires a mandatory and binding report from the CSN prior to any authorisation.

The CSN limits the liquid and gaseous radioactive effluents that might be released by the facilities and requires the development of an effluent control programme allowing for the following:

- Insight into and surveillance and control of radioactive effluents.
- Verification of compliance with release limits.
- Ensured the operability of waste treatment systems.
- Estimation of the doses received by the public.

The release limits and the effluent control programmes are specified in the Technical Specifications of the facility and developed in the ODCM.

[5] Regulation (EC) nº 761/2001 of 19 March 2001 allowing voluntary participation by organisations in Community eco-management and audit scheme (EMAS).

The CSN verifies compliance with these programmes by evaluating the data provided by the licensees in their monthly operating reports and by carrying out inspections at the installations.

The basic requirements for the effluents monitoring programmes are defined in the CSN Safety Guide 1.04[6].

2.7 NATURE OF INSPECTION AND SURVEILLANCE PROGRAMME

In 2007 the Integrated Plant Supervision System (SISC) was implemented for the systematic evaluation of the Spanish nuclear power plants and to control their safety. The SISC 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 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]

2.7.1 Radioactive effluent inspections and surveillance

Regarding the radioactive effluents, the CSN inspectors verify the following subjects throughout the inspections:

- Compliance with the authorisation procedure (sampling, measurement and analysis) prior to a discharge as well as witness the control performs in order to ensure compliance with the discharge limits. As part of the inspection, samples can be collected and analysed by the methods normally applied by the operator. Additionally an independent sampling and analyse by the CSN is foreseen as a quality control.
- Applicable actions required by the Technical Specifications when monitors have not been operable.
- Actions carried out when alarm set points have been exceed.
- Operability of the radioactive effluent treatment systems.
- Operability of the radiological surveillance instrumentation.
- Supervision of corrective actions implemented after incidents.
- Problem identification by licensees through self-assessments, audits and monitoring results, their inclusion into the Corrective Action Program, and their resolution

Moreover, CSN inspectors analyse the results of the radioactive effluent monitoring instrumentation surveillance requirements carried out to ensure the operability of that instrumentation and the implementation of the design modifications.

Checks on chosen samples in order to verify the data transmission chain between initial measurements of the sample and final reporting to the CSN and on the information submitted every month by the facilities are also carried out.

To complement the results found during the inspections, the CSN carries out independent analysis of selected gamma spectres obtained in the measurement process in order to verify the suitability of the results reported by the facilities.

Concerning the surveillance, a generic programme for liquid and gaseous radioactive effluents of PWR facilities is included in Table 9. The required detection limits are those of the 2004/2/Euratom Recommendation.

[6] GSG-1.04: "Radiological surveillance and control of liquid and gaseous effluents from nuclear power plants". CSN. 1988.
7 PG.IV.07: "Nuclear power plant integrated supervision system". Rev.0. CSN. 2006
[8] PA.IV.202: Manual for calculation and verification of SISC operating indicators". Rev.0. CSN. 2007.
[9] PT.IV.251: "Treatment, surveillance and control of liquid and gaseous radioactive effluents".Rev.1. CSN. 2009
[10] PT.IV.252: "Environmental radiological surveillance program".Rev.1. CSN. 2010.

The 2004/2/Euratom Recommendation is being applied to the effluent activity determination since 2008. Therefore, the 2008 and 2009 reported activity values have been estimated taking into account that where measurements outcomes are below the decision threshold, these outcomes are substituted by one half of the decision threshold. However, if repeated measurement outcomes in the considered year are all bellow the decision threshold, it is assumed that the true value is zero.

Although C-14 in the gaseous effluents has always been measured by Trillo NPP, the other Spanish NPP's have begun to determine the activity of this isotope in 2007.

2.7.2 Environmental monitoring programmes

Regarding the environmental monitoring programmes, throughout the inspections, the CSN inspectors verify among others the following subjects:

- Existence of adequate equipment for sampling, its operability, and the calibration and maintenance process carried out in the course of the period.
- The implementation of the quality control programme according to the previous programme approved by the CSN
- The correct use of the procedures in the sampling of previously selected samples by the CSN. In some cases shared samples are taken and analysed by two different laboratories.
- The correct application of the procedures to the phases of treatment, conservation, identification and transport of samples.
- Traceability of the information throughout all the process.
- The programme of audits carried out by the operator, internal audits about the monitoring programme development, and external audits to the analytical laboratories involved.

The quality of the information coming from the environmental monitoring programmes, as basic data for the assessment of the potential risk to the public or the environment, has been a continuous CSN concern. To evaluate regularly the reliability of the data produced by the laboratories, the CSN organises in collaboration with CIEMAT annual inter-laboratory exercises where all the Spanish laboratories analysing environmental samples participate.

The exercises carried out in the period 2003-2009, were those collected in Table 10.

Technical documentation has to be provided by each of the laboratories participating in the sampling stations network (REM) to the CSN. This documentation must include the following:

- o Description of sampling, detection and measurement equipment.
- o Sampling, analysis and measurement procedures used by the laboratory
- o A quality assurance programme for the measurements made.
- o Results of participation in analytical intercomparison exercises organised by the CSN.

In 1997 the CSN required formally to the laboratories involved in the REM network, implement a quality system and develop Quality Manuals and a programme for establishing, implementing and optimising them. The quality system integrates the organisation's structure, responsibilities, processes and resources required for suitably managing quality. The CSN staff periodically audits the laboratories.

In order to verify that established quality programmes are properly enforced, internal controls are introduced into the organisation and external actions are taken, such as the participation in inter-laboratory exercises and audits.

Under Article 35 of the Euratom Treaty, The European Commission has the right to access to facilities in Member States for monitoring the levels of radioactivity in air, water and soil, in order to verify their operation and efficiency.

3 SITE SPECIFIC INFORMATION

3.1 NUCLEAR POWER PLANTS

Three Spanish nuclear power plants discharge their radioactive liquid effluents into rivers that flow into the Atlantic Ocean: José Cabrera NPP, Almaraz 1 & 2 NPP, and Trillo NPP.

Each of them belongs to a different generation of the Spanish nuclear power stations, being José Cabrera the oldest and Trillo the newest. By a government decision, the April 30th 2006 José Cabrera ceased its operation and the February 1irst 2010 began its dismantling.

3.1.1 Discharges and Emissions

The information to be submitted in accordance with the BAT Guidelines is given in Annex I.

Beside the activity of the effluents in GBq, normalised values have also been compiled for each nuclear power plant by calculating the activity per net electrical output. These normalised values can be compared with the mean values for all nuclear power plants of the same type published by the European Commission for the period 1995-1999 (Radiation Protection 127) and by UNSCEAR for the period 1998-2002 (UNSCEAR 2008 Report), which are included in Table 11.

3.1.2 Application of BAT

The radiological protection principles and regulatory arrangements described above have been applied in the Spanish facilities in order to reduce the levels of discharges and the radiological impact to both humans and the environment. The principal radionuclides arising in liquid waste are tritium and, to a much lesser degree, activation, corrosion and fission products.

The general policy practised to decrease releases is focussed on some key issues, namely:

- Reduction of the radioactive wastes produced by means of improving the surveillance and control of defects in the fuel cladding during operation and refuelling, and the chemical quality and conditions of the coolant systems.
- Changes in the components materials to reduce the activation products
- Modifications of the effluent treatment systems, incorporating state of the art components leading to more effective purification of the streams treated
- Reinforcement on the maintenance programmes
- Revision of the operating procedures, optimising the methods applied

Additionally, specific practices introduced in the Spanish facilities to minimise discharges are described in Annex I.

On the other hand, the CSN assesses the monthly information submitted by the operators and analyses the evolution of discharges and emissions to study their trends. Likewise, the compliance with the Reference Levels (RL) is analysed. Even though RL values were well below the limitations, the operator is asked to justify any ever-increasing tendency and to restore the original values if feasible. Moreover, data on the highest activity detected by monitors are also reviewed to check if any alarm set point has been exceeded; if yes, the operator is asked to explain the reason and the actions adopted. The operator response to findings is analysed and verified by the CSN immediately or during the next inspection to the plant.

Moreover, during the normal operation of the plant, licensees carry out a self-continuous evaluation program. This program requires analyses of detected problems and so applicable corrective actions are defined in order to assure that those problems will not happen anymore. The following subjects are considered in this program:

- Overflows and abnormal releases
- Repetitive cases of inoperable radioactive monitoring instrumentation
- Deviations between activity measured by monitors and analysed activity for batch discharges
- Increasing trends in activity releases

By making the operators to apply the best available technologies and to improve the operation procedures releases are minimised, maintaining the quality of the natural environment.

3.1.3 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 the sample is taken, the liquid in the tank is recirculated 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. Additionally, there is an automatic discharge cut-off if the activity exceeded a certain value. If the monitor is not functioning, 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.

Laboratories from the nuclear power plants participate 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 facilities 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 performs 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 the facilities (on paper and electronic format) according to the CSN Nuclear Safety Guide 1.7[11]. That information is checked by the CSN according to the CSN procedure PT.IV.401[12] , to validate the data and identify discrepancies and mistakes.

3.1.4 Doses

Assessments of doses to the critical group are carried out to verify that discharge limits are complied with and to estimate the radiological impact on the members of the public due to the radioactive releases into the environment. This 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 have to carried out a more realistic dose estimation to the reference group.

In 2009 the results of an epidemiological study of the possible effect of ionising radiations deriving from the operation of Spanish nuclear fuel cycle facilities on the health of the population living in their vicinity were published. The report was drawn up by the Carlos III Institute of Health (ISCIII) and the CSN, each within its respective realm of competence and function as regards the issues dealt with. The CSN was responsible for all aspects relating to the reconstruction of the history of exposure of the population to ionising radiations arising from the operation of the facilities and to those of natural origin. The ISCIII was responsible for the design and performance of all aspects of the cancer mortality study and for drawing up all the sections of the report referring to this issue.

The study, that covers a period of time from the beginning of the operation until 2003, includes all the nuclear power plants and other nuclear fuel cycle facilities in the country, regardless of whether they are in operation, in the final shutdown condition or in the phase of dismantling and decommissioning. Doses related with the facilities in the OSPAR Convention area are shown in Table 12.

This study shows that, using realistic methods of estimation, the doses of artificial radiation accumulated over the entire study period that would have been received by the population as a result of the operation of the facilities are very small. Current understanding of radiobiology and epidemiology does not suggest that this exposure might be related to a higher degree of cancer mortality in the populations existing around the facilities.

In general terms, the study of cancer mortality in the areas surrounding the nuclear power plants and nuclear fuel cycle facilities has not detected any consistent results showing any effect of increasing mortality due to different types of cancer and associated with the artificial radiation dose received. These results are independent from the natural radiation and other socio-demographic variables controlled in the analysis.

More detailed information can be found in the CSN web page (www.csn.es).

[11] GSG-1.7: "Information to be submitted by owners to the CSN regarding the NPP operation". CSN.
[12] PT.IV.401: "Supervision of the periodical information related to the radioactive effluents". Rev.0. 2006

Dose data to be submitted in accordance with the BAT Guidelines are given in Annex I.

3.1.4.1 Critical Group / Reference Group

For every facility a reference group is established. This 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), children (7-12 years), and adult (>17 years); according to EC Radiation protection 129[13], these are the three groups who receive the highest doses.

The critical group is hypothetical but realistic, having combinations of habits, both high 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[14], water ingestion rates from ICRP-23[15], and exposure time to shoreline deposits from EUR 15760[16] are considered.

3.1.4.2 Exposure Pathways

The assessment of doses takes into account the following exposure pathways:

- 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)
- Drinking water
- Consumption of fish, seafood and shellfish
- Consumption of leafy vegetables
- Consumption of cereals, vegetables, roots and fruits
- Consumption of meat (beef, goat, pork)
- Consumption of goat and cow milk

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

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 each nuclear power plant is specified in Annex I.

3.1.4.3 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[17]. To this end, a computer program was initially developed by the adaptation of the NRC computer programs LADTAP and GASPAR, which was updated in 2001, after the radiation protection Regulations transposing the 1996 BSS Euratom Directive, came into force. A deep review of the offsite dose calculations was accomplished, modifying not only the dose coefficients, but also different factors such as the food ingestion rates, after the study of the national values mentioned above.

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

- Local characteristics, population habits, and land and water usage are site specific
- Gaussian models-straight line trajectory are used for atmospheric dispersion
- Hydrological dispersion considers the specific characteristics of the effluent receiving water body (river, pond, sea, etc.)
- 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

[13] 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"
[14] ICRP-71: "Age-dependent doses to members of the public from intake of radionuclides: Part 4 inhalation dose coefficients"
[15] ICRP-23: "Reference man: anatomical, physiological and metabolic characteristics"
[16] EUR 15760: "Methodology for assessing the radiological consequences of routine releases of radionuclides to the environment"
[17] 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"

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.

3.1.4.4 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 1&2 and Trillo NPP for estimating doses to the critical group. In José Cabrera, doses are calculated every month using the activity-dose conversion factors included in the Regulations.

3.1.4.5 Quality Assurance of Processes Involved in Dose Estimates

The licensees have 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, parallel calculations have been carried out by the CSN, both with own computer programs and excel sheets.

3.2 NUCLEAR FUEL FABRICATION

Juzbado is the only installation manufacturing nuclear fuel in Spain.

3.2.1 Discharges

The information to be submitted in accordance with the BAT Guidelines is given in Annex II.

3.2.2 Application of BAT

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.

Some procedures have been used to minimise the production of waste such as the revision of the operating procedures; optimising the methods applied; conversion of wet process into dry process and the centrifugation of the floor decontamination water to remove the suspended particles; covering of the outdoor pond to prevent the entrance of rainwater and organic matter; and substitution of outdoor pipes to reduce the leakage probability.

3.2.3 Quality assurance of retention systems performance and data management

As for nuclear power plants, the performance of the retention systems is assured by the fluid activity 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 performs checks on chosen samples in order to verify the data transmission chain between initial measurements of the sample and final reporting to the CSN.

3.2.4 Doses

Regarding doses, all the statements made for nuclear power plants are also applicable to dose calculations to members of the public living in the vicinity of the Juzbado fuel fabrication plant.

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.

Data to be submitted in accordance with the BAT Guidelines are given in Annex II.

TABLES

Table 1: **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] I-131
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. 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. Only José Cabrera NPP.

Table 2: 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 3: Number of sampling stations. Nuclear installations OSPAR Zone

Type of sample	Trillo NPP	José Cabrera NPP*	Almaraz NPP	Juzbado FFP
Air	6	6	6	7
Gamma Radiation (DTL)	21	30	21	21
Soil	8	7	7	9
Rainwater	5	4	6	4
Drinking water	6	4	3	1
Surface and ground water	5	4	10	9
Sediments and Biological indicators	6	6	10	4
Fish	3	3	3	2
Milk	5	5	7	3
Honey	2	2	2	---
Vegetables, meat and eggs.	6	10	10	8
Total number	**73**	**74**	**85**	**68**

* NPP under decommissioning.

Table 4: **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 5: **National Monitoring Network (REM). Surface water. Hydrological Basin Rivers. OSPAR zone. Year 2009.**

Hydrological Basins	**Dense Network**	
	Number of sampling points	**Number of samples.**
Miño and North Spain rivers	10	90
Duero	13	116
Tagus	21	183
Guadiana	5	19
Guadalquivir	12	76
Total	**61**	**490**

Table 6: **National Monitoring Network (REM). Dense Network. Coastal waters. Gross-α and ^{3}H concentrations 2003-2009 period.**

Location	Gross-α concentrations Bq/m³							Tritium concentrations Bq/m³						
	2003	2004	2005	2006	2007	2008	2009	2003	2004	2005	2006	2007	2008	2009
Cabo de Ajo (MAS 01) 3ª 34´ 41” W 3ª38´04”N	8,9E+01	8,6E+01	8,1E+01	7,8E+01	7,9E+01	8,2E+01	8,6E+01	1,7E+02	1,3E+02	1,5E+02	1,2E+02	1,7E+02	1,3E+02	1,1E+02
Cabo de Ortegal (MAS 03) 7º 48´ W 43º 52´N	8,8E+01	8,6E+01	8,3E+01	8,3E+01	8,4E+01	8,2E+01	8,8E+01	1,4E+02	1,1E+02	1,4E+02	8,9E+01	1,5E+02	1,1E+02	8,3E+01
Cabo Villano (MAS 04) 9º 22´W 43ª 0´	8,7E+01	8,1E+01	8,5E+01	8,2E+01	8,1E+01	8,3E+01	8,7E+01	1,5E+02	1,4E+02	1,5E+02	8,8E+01	1,5E+02	9,3E+01	7,7E+01
Cabo Silleiro (MAS 05) 8º 52´W0 42º 15´N	8,6E+01	8,2E+01	8,5E+01	7,8E+01	7,8E+01	8,2E+01	8,2E+01	1,5E+02	1,6E+02	1,5E+02	1,2E+02	1,6E+02	1,0E+02	8,7E+01
Isla Cristina (MAS 06) 7º 20´W 37º 3´N	8,3E+01	8,3E+01	8,6E+01	8,3E+01	8,0E+01	8,0E+01	8,4E+01	1,4E+02	1,7E+02	1,5E+02	9,8E+01	1,8E+02	1,0E+02	6,6E+01
Puerto de Cadiz (MAB 07) 6º 19´W 36º 35´N	9,3E+01	8,4E+01	8,4E+01	8,4E+01	8,5E+01	7,7E+01	8,9E+01	1,3E+02	1,9E+02	1,6E+02	1,3E+02	1,5E+02	8,5E+01	8,3E+01
Estrecho de Gibraltar (MAS 08) 5º 22,7´W 36º 6,20´N.	8,7E+01	7,4E+01	9,2E+01	8,0E+01	7,7E+01	8,5E+01	8,8E+01	1,2E+02	1,3E+02	1,4E+02	1,4E+02	1,6E+02	8,5E+01	7,4E+01

Table 7: National Monitoring Network (REM). Dense Network. Coastal waters. Gross-β and Residual-β concentrations 2003-2009 period.

Location	Gross-β concentrations Bq/m^3							Residual-β concentrations Bq/m^3						
	2003	2004	2005	2006	2007	2008	2009	2003	2004	2005	2006	2007	2008	2009
Cabo de Ajo (MAS 01) 3ª 34´ 41" W 3ª38´04"N	1,4E+04	1,5E+04	1,3E+04	1,3E+04	1,3E+04	1,4E+04	1,4E+04	1,2E+03	1,2E+03	1,1E+03	*<0,9E+03*	*1,3E+03*	<0,8E+02	<0,9E+03
Cabo de Ortegal (MAS 03) 7º 48´ W 43º 52´N	1,4E+04	1,4E+04	1,4E+04	1,3E+04	1,3E+04	1,4E+04	1,4E+04	<0,8E+03	<0,8E+03	1,3E+03	*<0,9E+03*	*<0,9E+03*	*<0,9E+03*	*<0,8E+03*
Cabo Villano (MAS 04) 9º 22´W 43ª 0´	1,4E+04	1,4E+04	1,3E+04	1,4E+04	1,4E+04	1,4E+04	1,3E+04	<0,9E+03	<0,9E+03	<0,9E+03	<0,9E+03	<0,9E+03	<0,9E+03	<0,9E+03
Cabo Silleiro (MAS 05) 8º 52´W 42º 15´N	1,4E+04	1,4E+04	1,4E+04	1,2E+04	1,4E+04	1,4E+04	1,3E+04	<0,8E+03	1,1E+03	1,1E+03	*<0,7E+03*	*1,4E+03*	*<0,9E+03*	*<0,8E+03*
Isla Cristina (MAS 06) 7º 20´W 37º 3´N	1,4E+04	1,4E+04	1,5E+04	1,4E+04	1,5E+04	1,4E+04	1,4E+04	<0,9E+03	<0,9E+03	<0,9E+03	*<0,9E+03*	*1,1E+03*	*<0,9E+03*	*<0,9E+03*
Puerto de Cadiz (MAB 07) 6º 19´W 36º 35´N	1,4E+04	1,4E+04	1,4E+04	1,4E+04	1,4E+04	1,4E+04	1,4E+04	<0,9E+03	<0,9E+03	1,2E+03	*<0,9E+03*	*1,3E+03*	*<0,8E+03*	*<0,9E+03*
Estrecho de Gibraltar (MAS 08) 5º 22,7´W 36º 6,20´N.	1,5E+04	1,5E+04	1,5E+04	1,4E+04	1,3E+04	1,5E+04	1,4E+04	<0,9E+03	<0,8E+03	1,3E+03	*<0,9E+03*	*<0,9E+03*	*<0,9E+03*	*<0,8E+03*

Table 8: **National Monitoring Network (REM). Sparse Network. Coastal waters. ^{137}Cs concentrations 2003-2009 period.**

Location	^{137}Cs concentrations Bq/m^3						
	2003	2004	2005	2006	2007	2008	2009
Cabo de Ajo 3ª 34´ 41" W 3ª38´04"N (MAS 01)	2,0E+00	2,1E+00	2,5E+00	2,0E+00	1,8E+00	1,5E+00	1,4E+00

Table 9: **Radioactive Effluent Sampling and Analysis Program**

TYPE OF RELEASE	SAMPLING FRECQUENCY	MINIMUM ANALYSIS FRECQUENCY	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 [1]	H-3
			Gross Alpha
	Prior to Each Batch	Quarterly Composite [1]	Sr-89, Sr-90
Continuous Releases	Continuous [2]	Weekly Composite [1]	Principal Gamma Emitters
			Fe-55; Ni-63
	Monthly Grab Sample	Monthly	Dissolved and Entrained Gases (Gamma Emitters)
	Continuous [2]	Monthly Composite [1]	H-3
			Gross Alpha
	Continuous [2]	Quarterly Composite [1]	Sr-89, Sr-90
Radioactive Gaseous Effluents			
Waste Gas Storage	Prior to Each Tank Grab Sample	Prior to Each Tank	Principal Gamma Emitters
Containment Purge or Vent	Prior to Each Purge Grab Sample	Prior to Each Purge	Principal Gamma Emitters
		Monthly	H-3
Building Ventilation	Monthly Grab Sample	Monthly	Principal Gamma Emitters
	Continuous	Monthly	H-3
			C-14
All previous Gaseous Emissions	Continuous	Weekly Charcoal Sample	I-131
		Weekly Particulate Sample	Principal Gamma Emitters
		Monthly Composite Particulate Sample	Gross Alpha
		Quarterly Composite Particulate Sample	Sr-89, Sr-90
		Noble Gas Beta or Gamma	Noble Gases

(1) A composite sample is one in which the quantity of liquid sampled is proportional to the quantity of liquid waste discharged and in which the method of sampling employed results in a specimen that is representative of the liquids released.

(2) To be representative of the quantities and concentrations of radioactive materials in liquid effluents, samples shall be collected continuously in proportion to the rate of flow of the effluent stream. Prior to analyses, all samples taken for the composite shall be thoroughly mixed in order for the composite sample to be representative of the effluent release.

Table 10: **Quality Control Programme. Intercomparison exercises. 2003-2009.**

Exercise	Type of sample	Analysis
2005-2006	Vegetal Ash	^{60}Co’ ^{40}K, ^{226}Ra, ^{137}Cs, ^{90}Sr, ^{238}Pu, ^{241}Am, ^{208}Tl, ^{210}Pb, ^{228}Ra, ^{230}Th, ^{238}U
2007-2008	TLD, dosimeters irradiated at laboratory	H* (10)
	TLD, dosimeters irradiated at field.	
2008-2009	Phosphogypsum with natural radionuclides with modified activity concentrations.	^{226}Ra, ^{210}Pb, ^{214}Pb, ^{210}Po, ^{214}Bi, ^{230}Th, ^{232}Th, ^{234}Th, ^{234}U, ^{235}U, ^{238}U

Table 11: **Normalised releases EC – UNSCEAR (GBq/Gwa)**

Year	EC Report	UNSCEAR 2008 Report
	1995-99	**1998-2002**
Total activity without tritium (liquids)	3,78E+00	1,10E+01
Tritium (liquids)	1,71E+04	2.00E+04
Tritium (gases)	1,05E+03	2,10E+03
C-14 (gases)	1,96E+02	2,20E+02

Table 12: **Range of accumulated artificial radiation and annual natural radiation doses in the municipalities located in the vicinity of each of the plants and facilities**

	0-30 km Nº municipalities	**Accumulated artificial radiation. Dose range (microSievert)**	**Annual natural radiation Dose range (microSievert)**
Nuclear power plants			
José Cabrera	60	0,1015159 – 267,50550000	2031 – 2837
Almaraz	33	0,01881667 – 27,58200000	2340 – 5840
Trillo	62	0,04578781 – 10,63200000	1752 – 2040
Fuel cycle facilities Juzbado	76	0,00001500 – 0,05791200	2416 – 5112

ANNEX I: NUCLEAR POWER PLANTS

AI-1 ALMARAZ 1 & 2 NUCLEAR POWER PLANTS

AI-1.1 Site Characteristics

AI-1.1.1 Name of site

Almaraz

AI-1.1.2 Type of facility

Almaraz is a nuclear power plant with two twin pressurised water reactor, PWR, (Westinghouse). Hiberdrola 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. buildings).

AI-1.1.3 Year for commissioning/licensing/decommissioning

Almaraz 1 was critically in 1981, starting the commercial operation in 1983. Almaraz 2 was critically in 1983, starting the commercial operation in 1984.

AI-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.

AI-1.1.5 Receiving waters and catchment area

The Almaraz 1&2 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

AI-1.1.6 Production

The installed electrical capacity is 1050 MW(e) for Unit 1 since May-2008, and 980 MW(e) for Unit 2. The annual electrical output is given in table AI-1.1

AI-1.1.7 Other relevant information

There is no other relevant information

AI-1.2 Discharges

AI-1.2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

Almaraz 1&2 NPP share a liquid radwaste treatment plant so the liquid wastes from both units are treated together and no independent data can be reported.

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 the coolant water clean-up 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.

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, flittered 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 where are stored throughout the life of the plant; it is not foreseen their emission but if took place, they would be released through the Auxiliary building roof vent where it is previously passed 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.

AI-1.2.2 Efficiency of abatement systems

This information is shown in Table AI-1.2.

AI-1.2.3 Annual liquid discharges and emissions

With respect to the policy to minimise the production of waste, besides the measures previously mentioned in the report (3.1.2), specific actions are applied in Almaraz 1&2 NPP, such as:

- 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, control and evaluation
- 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.

Table AI-1.3 presents Information on absolute annual activity in the liquid effluents for the period 2003-2009, while a semi-logarithmic representation of data is given in Figure AI-1.1.

Table AI-1.4 shows normalised liquid discharges from Almaraz 1&2 NPP for the same period of time.

The absolute Total activity excluding Tritium shows a slight global upward trend throughout the considered period of time due to the 2008 and 2009 activity values, which are moderately higher than the previous years because of the application of the 2004/2/Euratom Recommendation. Nevertheless, although the activity can be higher, the actual discharge is similar to that of the previous years.

The absolute Tritium discharges show a small global decreasing trend.

Regarding the emissions, Table AI-1.5 puts on view the evolution of Tritium and Carbon-14 (absolute and normalised activity) throughout the considered years, while a semi-logarithmic representation of data is given in Figure AI-1.2. Measurement of C-14 in airborne effluents is carrying out since January-2007.

Tritium emissions exhibit a slight downward trend, while Carbon-14 shows an upward trend.

Table AI-1.6 illustrates the relation between the average normalised discharges and emissions from Almaraz NPP and the considered European Commission and UNSCEAR reference values. As is shown by that table:

- Total activity excluding Tritium for liquid discharges is bellow both reference values
- Tritium for liquid and gaseous effluents is slightly higher than both reference levels.
- Carbon-14 is lower than both reference levels.

AI-1.3 Environmental Impact

AI-1.3.1 Concentrations of radionuclides of concern in representative samples of water, fish and sediment.

In tables AI-1.7, AI-1.8 y AI-1.9 are presented respectively the ^{137}Cs, ^{60}Co and ^{54}Mn mean activity concentrations in river water, sediments and fishes in the area surveyed around Almaraz NPP.

AI-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. The following table AI-1.10 details the type of samples, the sampling frequency and the analyses included in the programme.

AI-1.3.3 Systems for quality assurance of environmental monitoring.

Systems for quality assurance applicable to Almaraz NPP have been detailed in sections 2.6 and 2.8

AI-1.4 Radiation Doses to the Public

Information on annual effective dose to the most exposure member of the public is given in Table AI-1.11 and Figure AI-1.3.

The exposure pathways considered in these calculations are:

- Liquids: Exposure to river shoreline deposits, and Ingestion of fish, goat/sheep milk, and meat (beef, goat/sheep).
- Gases: Inhalation, Exposure to the cloud, Exposure to deposits on the ground surface, and Ingestion of vegetables (leafy and non-leafy vegetables, fruits, grain), goat/sheep milk, and meat (beef, goat/sheep)

Critical group / Main exposure pathways:

- Liquids: Adult (>17 years) / Exposure to river shoreline deposits, and Fish consumption.
- Gases: Infant (1-2 years) / Non leafy vegetables consumption, and Inhalation.

Effective doses are well below the present authorised limit. Taking into account liquid and gaseous effluents, the average dose in the considered period of time is 4,54E-4 mSv that represents a 0,45 % of the release limit. There is an increasing trend along the considered period of time due to two factors: 1) the application of the 2004/2/Euratom Recommendation, and 2) the measurement of C-14 in gaseous effluents since 2007, being this isotope the main contributor to the total dose in 2008 and 2009 (around 80%).

The critical group taking into account the liquid and gaseous effluents has been the adult being the main exposure pathways the consumption of non-leafy vegetables (29%) and inhalation (16%).

Table AI-1.1: Almaraz 1&2 NPP. Annual electrical output in GW(e)a

Year	2003	2004	2005	2006	2007	2008	2009
Gross Electrical Output:							
Almaraz 1	0,892	0,973	0,893	0,849	0,971	0,853	0,816
Almaraz 2	0,784	0,894	0,975	0,856	0,849	0,983	0,810
Net Electrical Output:							
Almaraz 1	0,856	0,934	0,858	0,816	0,935	0,575	0,785
Almaraz 2	0,757	0,863	0,942	0,828	0,821	0,951	0,784

Table AI-1.2: Almaraz 1&2 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 series	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 AI-1.3: Almaraz 1&2 NPP. Annual liquid effluent activity (GBq/year)

Nuclide	2003	2004	2005	2006	2007	2008	2009
Gross Alpha							
H-3	**4,51E+04**	**4,42E+04**	**1,69E+04**	**4,60E+04**	**3,80E+04**	**2,58E+04**	**2,74E+04**
Co-58	7,04E-01	3,05E-01	7,06E-01	8,44E-01	1,05E+00	9,99E-01	1,49E+00
Co-60	1,22E+00	8,50E-01	1,26E+00	1,04E+00	6,48E-01	6,08E-01	1,67E+00
Zn-65	2,44E-03		3,25E-03	5,84E-03	3,48E-03	1,91E-02	3,45E-02
Sr-90		5,26E-04	3,66E-02	1,24E-02	6,09E-02	5,00E-02	1,29E-01
Zr/Nb-95	1,40E-01	1,03E-01	3,04E-01	4,77E-01	2,09E-01	3,68E-01	2,04E+00
Ru-106						8,34E-02	
Ag-110m	2,01E-01	1,11E-01	6,32E-01	4,87E-01	5,67E-03	3,71E-01	5,06E-01
Sb-125	3,61E-01	2,31E-01	1,93E-01	1,04E-01	2,14E-01	1,94E-01	1,63E-01
Cs-134	9,71E-02	2,65E-02	1,39E-02	6,52E-03	8,80E-03	1,30E-02	1,85E-02
Cs-137	6,65E-01	3,15E-01	2,83E-01	1,41E-01	1,61E-01	2,57E-01	2,27E-01
Ce-144						5,58E-04	8,17E-02
Other nuclides	7,88E-01	2,31E-01	1,08E+00	4,97E-01	7,20E-01	3,28E+00	4,57E+00
Total Activity excluding H-3	**4,18E+00**	**2,17E+00**	**4,51E+00**	**3,61E+00**	**3,08E+00**	**6,24E+00**	**1,09E+01**

Table AI-1.4: Almaraz 1&2 NPP. Normalised annual liquid effluent activity (GBq/GWa)

Year	2003	2004	2005	2006	2007	2008	2009
Total activity without H-3	2,59E+00	1,21E+00	2,51E+00	2,20E+00	1,75E+00	4,09E+00	6,95E+00
Tritium	2,80E+04	2,46E+04	9,39E+03	2,79E+04	2,16E+04	1,69E+04	1,75E+04

Table AI-1.5: Almaraz 1&2. Absolute and normalised Tritium and C-14 emissions

Year	2003	2004	2005	2006	2007	2008	2009
Tritium (GBq/y)	3,32E+03	4,43E+03	5,74E+03	6,19E+03	4,36E+03	2,95E+03	3,17E+03
C-14 (GBq/y)					2,99E+01	1,41E+02	2,53E+02
Tritium (GBq/Gwa)	2,06E+03	2,47E+03	3,19E+03	3,76E+03	2,48E+03	1,93E+03	2,02E+03
C-14 (GBq/Gwa)					1,70E+01	9,30E+01	1,61E+02

Table AI-1.6: Normalised releases (GBq/Gwa)

Year	Almaraz NPP	EC Report	UNSCEAR 2008 Report
	2003-2009	**1995-99**	**1998-2002**
Total activity without tritium (liquids)	3,04E+00	3,78E+00	1,10E+01
Tritium (liquids)	2,08E+04	1,71E+04	2.00E+04
Tritium (gases)	2,56E+03	1,05E+03	2,10E+03
C-14 (gases) (1)	9,03E+01	1,96E+02	2,20E+02

(1) Available data since 2007

Table AI-1.7: Almaraz 1&2. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in river water (Bq/m^3)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	<85,9	63,8	<73,8	<40,4	<40,1	<38,0	<40,4
^{60}Co	<76,8	<70,8	<61,7	<36,6	<35,9	<34,0	<36,6
^{54}Mn	<70,8	<58,7	<53,8	<37,8	<37,8	<35,7	<38,4

Table AI-1.8: Almaraz 1&2. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in sediments (Bq/kg.dry.wt)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	13,2	14,9	13,1	10,5	9,2	7,5	7,6
^{60}Co	28,4	18,7	12,7	9,7	9,6	6,4	6,6
^{54}Mn	1,23	1,27	<0,41	<0,18	<0,26	<0,18	<0,20

Table AI-1.9: Almaraz 1&2. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in fish (Bq/kg.wet.wt)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	0,37	0,35	0,34	<0,26	<0,26	<0,22	<0,25
^{60}Co	*<0,13*	0,10	*0,14*	*<0,24*	<0,23	*<0,20*	*<0,22*
^{54}Mn	*<0,11*	<0,11	*<0,11*	*<0,24*	*<0,24*	*<0,21*	*<0,23*

Table AI-1.10: Environmental Monitoring Programme around Almaraz NPP.

Sample	Frequency	Measurement/analysis
Air (Aerosols) Iodine	Continuous (weekly)	Gross- β ^{90}Sr γ spectrometry I-131
Gamma radiation (TLD)	Continuous (quarterly)	Dose rate
Rain water	Continuous (monthly)	γ spectrometry ^{90}Sr
Soil	Yearly	γ spectrometry ^{90}Sr
Drinking water	Fortnightly	Gross-β Residual-β ^{90}Sr ^{3}H γ spectrometry
Ground water	Quarterly	Gross- β Residual-β ^{3}H γ spectrometry
Surface water	Monthly. Continuous in one station.	Gross- β Residual-β ^{3}H γ spectrometry
Sediment and biological indicators[1]	Half-yearly	^{90}Sr γ spectrometry
Milk[2]	Fortnightly	^{90}Sr γ spectrometry ^{131}I
Crops[3]	Harvest season	^{90}Sr γ spectrometry ^{131}I (leafy vegetables)
Meat[4] and eggs	Half-yearly	γ spectrometry
Fishes.[5]	Half yearly. Monthly in one station.	γ spectrometry
Honey	Yearly	γ spectrometry

1Scirpus, typha, retama **//** **2.** Goat, sheep and cow milk samples **// 3.** Tomato, pepper, eggplant, chard, lettuce cabbage, onion, melon, watermelon**. // 4.** Chicken, lamb, pig, beef // 5. Barbel, carp.

Table AI-1.11: Almaraz 1&2. Annual effective dose to the critical group (mSv/y)

Year	2003	2004	2005	2006	2007	2008	2009
Liquids	1,99E-04	2,25E-04	1,62E-04	2,02E-04	1,37E-04	1,20E-04	2,17E-04
Gases	4,73E-05	3,59E-05	7,61E-05	8,35E-05	2,45E-04	6,74E-04	1,08E-03
Total	2,35E-04	2,61E-04	2,14E-04	2,57E-04	3,31E-04	7,22E-04	1,16E-03

Figure AI-1.1: Almaraz 1&2 NPP. Annual liquid effluent activity (GBq/year)

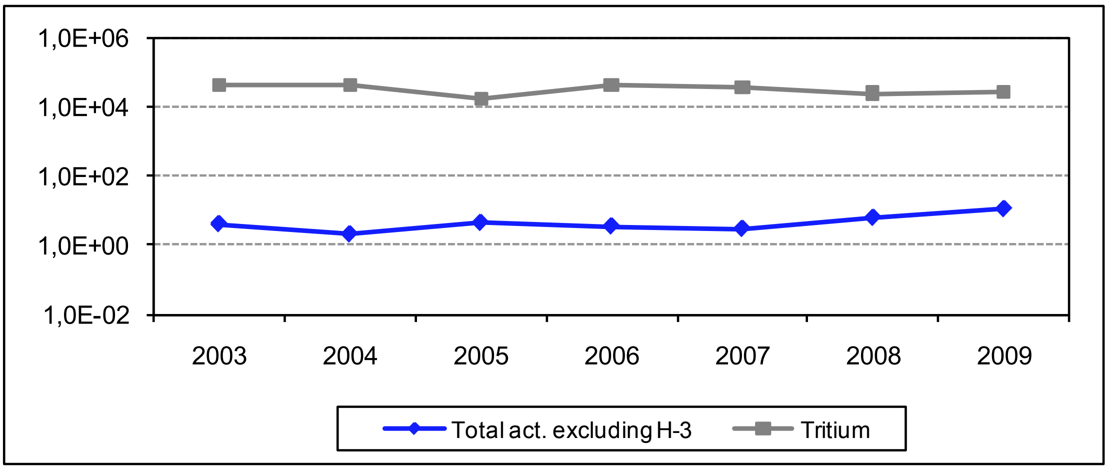


Figure AI-1.2: Almaraz 1&2 NPP. Annual gaseous effluent activity (GBq/year)

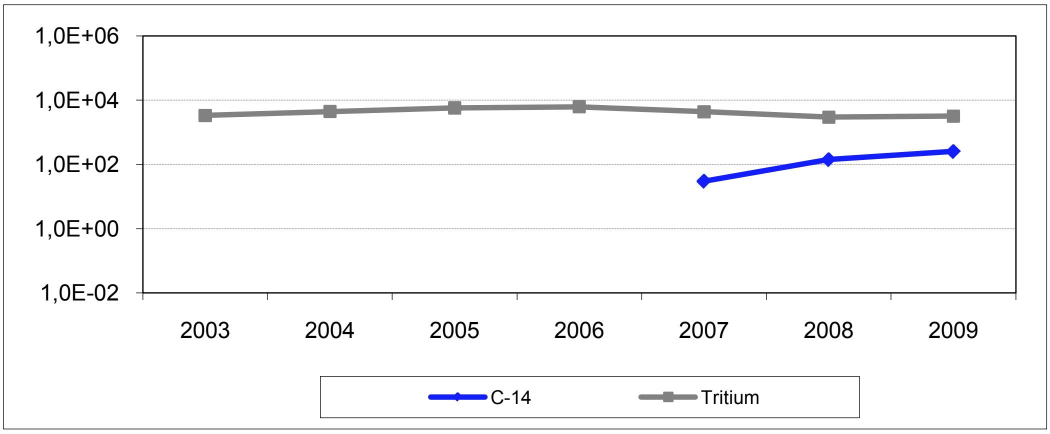
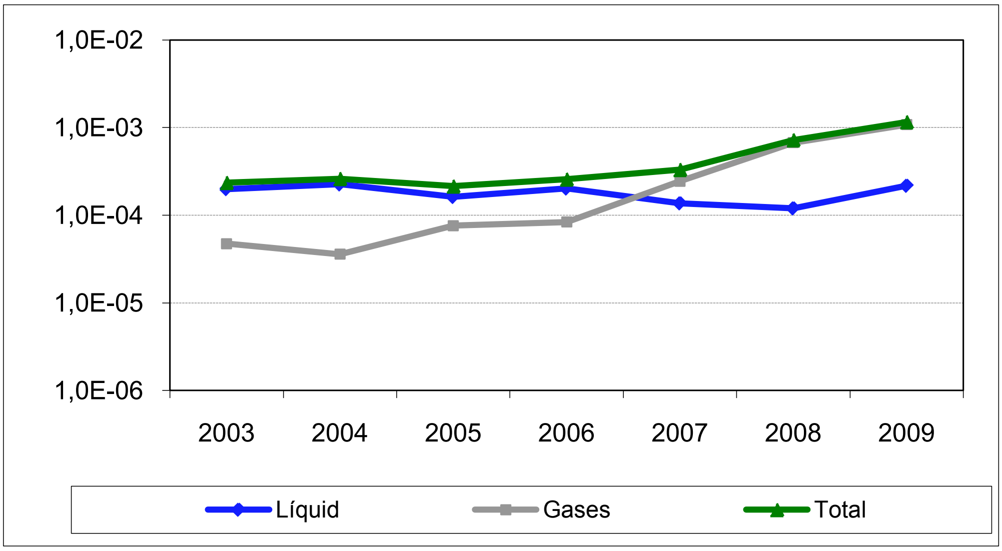


Figure AI-1.3: Almaraz 1&2 NPP. Annual effective dose to the critical group (mSv/y)



AI-2 JOSE CABRERA NUCLEAR POWER PLANT

AI-2.1 Site Characteristics

AI-2.1.1 Name of site

José Cabrera

AI-2.1.2 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.

The main installations within the site were: Reactor building, Turbine building, Auxiliary building, Decontamination plant building, Evaporator building and the new Solid radioactive waste management building.

AI-2.1.3 Year for commissioning/licensing/decommissioning

The reactor was critically in 1968, starting the commercial operation in 1969. The plant, also called Zorita, has been in the definitive shutdown situation since April 30th 2006 (Ministerial Order by the Ministry of Industry, Tourism and Trade of April 20th 2006). Since February 1irst 2010 it is under dismantling.

AI-2.1.4 Location

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

AI-2.1.5 Receiving waters and catchment area

The plant was cooled through a close circuit by water from the Zorita reservoir, on the Tajo River.

Radioactive liquid effluents flow into the Tajo River through two successive reservoirs (Zorita and Almoguera). The plant discharges into 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 9,5 m^3/s

AI-2.1.6 Production

The installed electrical capacity was 160 MW(e). The annual electrical output until the plant definitive shutdown is given in Table AI-2.1

AI-2.1.7 Other relevant information

In order to initiate the dismantling it has been necessary to condition all the operating wastes and remove the spent fuel from the spent fuel pool. In this respect, the Ministry of Industry, Tourism and Trade authorised the construction of an Individual Temporary Storage (ITS) facility on the site on December 15th 2006. This facility implies the housing of the fuel assemblies in casks especially designed for this purpose at the plant site. The casks to be used are of the HI-STORM type, this being the model currently used for the storage of spent fuel in the United States.

Previous to the dismantling a decontamination of the primary circuit has been carried out with two objectives: to eliminate deposits of removable material and to decontaminate the surface of the piping, equipment and components that have been in contact with the primary coolant. The chemical decontamination of the primary system of the José Cabrera nuclear power plant has been carried out in three stages, from November 2006 to July 2007. The final activity values obtained have been around 3E+13 Bq, the decontamination factors being comparable to those of other similar projects.

Therefore, the radioactive effluents generated since 2006 are a consequence of the works performed previous to the beginning of the dismantling.

AI-2.2 Discharges

AI-2.2.1 Systems in place to reduce, prevent or eliminate discharges and emissions

High-level activity liquids were purified by ion exchange. To this end, the plant was provided with five filter demineralises: one of them for cationic retention; two, in parallel, for anionic retention; and finally two, in parallel, provided with mixed cation and anion exchange resins. After that, the liquids were treated by evaporation.

Although initially the evaporation was planned for the high activity liquid treatment, the policy of the plant changed and all the radioactive liquid waste has been treated by that technique throughout the period of time considered in this report.

Only the liquid phase of the steam generator purge was discharged directly into the discharge structure if the activity level was low enough; if not, it was derived to the radwaste treatment system.

The radwaste treatment system is still provided with several storage tanks but the most important, due to its capacity (1135 m3), is the one where the clean distillate from the evaporator is storage. This tank allows to choose not only the volume to be discharged, but also the moment when the release can be done, in order to minimise the environmental radiological impact.

Concerning emissions, the José Cabrera NPP gaseous effluents are release through one stack with a height of 60 meters, except the vapour phase of the steam generator purge that was emitted through a Turbine building roof vent.

The radioactive gaseous treatment system processed the primary system gases. They included gases vented from the CVCS and from clean liquid waste hold-up tanks. For collecting these gases, the system was provided with five storage tanks that allowed their decay before being released into the environment; these tanks are out of service since 2006. Prior to tanks, the gases were filtered for the retention of particles and iodine. To this end, the system included coarse and HEPA filters for retention of particles and charcoal beds for adsorption of iodine.

Ventilation air is the large contribution to the stack releases, particularly from: Auxiliary building, Reactor building, Evaporator building, and Solid radioactive waste management building. Before been discharged through the stack, the air passes through particulate filters and charcoal beds. Detailed information on the available filters in each line is included in section 2.2.2.

AI-2.2.2 Efficiency of abatement systems

This information is shown in Table AI-2.2

AI-2.2.3 Annual liquid discharges

With respect to the policy to minimise the production of waste, besides the measures previously mentioned in the report (3.1.2), specific actions have been applied in this plant until its shutdown, such as: the planning of works which require primary cooling system drainages in order to get their co-ordination; the change of the primary treatment system spent ion-exchange resins before their saturation level; the use of dry decontamination processes; the dry decay of clothes for a year to minimise the laundry wastes; and the application of the ALARA criteria to reduce the liquid wastes produced by works carried out in refuelling shutdown. Nevertheless, no relevant additional measures have being introduced to minimise the production of wastes throughout the period of time considered in this report.

Information on absolute annual activity for the period 2003-2009 is given in Table AI-2.3 while a semi-logarithmic representation of data is given in Figure AI-2.1.

Table AI-2.4 presents the normalised liquid discharges from José Cabrera for the considered period of time.

The absolute Total activity excluding Tritium shows a slight upward trend owing to the effluents released because of the management of the stored operating wastes and the decontamination of the primary circuit. In contrast, Tritium shows a downward trend.

Table AI-2.5 shows absolute and normalised Tritium emissions from 2003 to 2009, while a semi-logarithmic representation of absolute emissions is presented in Figure AI-2.2. Carbon-14 measurement was no required to this facility due to its coming up shutdown.

Tritium emissions exhibit a slight downward trend.

As is shown by Table AI-2.6 the relation between the average normalised discharges and emissions from José Cabrera NPP and the considered European Commission and UNSCEAR reference values is:

- Total activity excluding Tritium for liquid discharges is bellow both reference values
- Tritium for liquid is above both reference values
- Tritium for gaseous effluents is well below both reference levels.

AI-2.3 <u>Environmental Impact</u>

AI-2.3.1 Concentrations of radionuclides of concern in representative samples of water, sediment, and fish.

In tables AI-2.7, AI-2.8, and AI-2.9 are presented respectively the ^{137}Cs' ^{60}Co and ^{54}Mn mean activity concentrations in river water, sediments and fishes in the area surveyed around Jose Cabrera NPP.

AI-2.3.2 Environmental monitoring programme.

The plant operator in an area within a 30 km radius conducts the environmental monitoring programme of Jose Cabrera NPP. 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. The Table AI-2.10 details the type of samples, the sampling frequency and the analyses included in the programme.

AI-2.3.3 Systems for quality assurance of environmental monitoring.

Systems for quality assurance applicable to Jose Cabrera NPP have been detailed in sections 2.6 and 2.8

AI-2.4 <u>Radiation Doses to the Public</u>

Information on annual effective dose to the most exposure member of the public is given in Table AI-2.11 and Figure AI-2.2.

The exposure pathways considered in these calculations are:

- Liquids: Exposure to river shoreline deposits, and Ingestion of potable water, vegetables (leafy and non-leafy vegetables, fruits, grain), milk (goat/sheep, cow), meat (beef, goat/sheep), and fish.
- Gases: Inhalation, Exposure to the cloud, Exposure to deposits on the ground surface, and Ingestion of vegetables (leafy and non-leafy vegetables, fruits, grain), milk (cow, goat/sheep) and meat (beef, goat/sheep)

Critical group / Main exposure pathways:

- Liquids: Infant (1-2 years) / Potable water ingestion, and Cow milk or Non leafy vegetables consumption dependent on the year
- Gases: Infant (1-2 years) / Exposure to the cloud and Non leafy vegetables consumption until 2006; Exposure to deposits on the ground surface and Non leafy vegetables consumption since 2007.

Effective doses are well below the present authorised limit. Taking into account liquid and gaseous effluents, the average dose in the considered period of time is 6,36E-4 mSv that represents a 0,64 % of the release limit. There is a general decreasing trend along the considered period of time but a peak is observed in 2006 because of the radioactive liquid effluents released as a consequence of the stored operating wastes management carried out that year.

The critical group is the infant (1-2 years) being the main exposure pathways the ingestion of cow milk (36%) and ingestion of potable water (34%).

Table AI-2.1: José Cabrera NPP. Annual electrical output in GW(e)a

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gross Electrical Output	0,130	0,142	0,133	0,048	0,000	0,000	0,000
Net Electrical Output	0,122	0,134	0,125	0,045	0,000	0,000	0,000

Table AI-2.2: José Cabrera NPP. Abatement system and their efficiency

Abatement system/ Management	Efficiency of abatement system		Comments
	Decontamination Factor	Other measure of efficiency	
Discharges:			
Mixed ion exchanger	1 for Noble gases, Cs, Y, Mo 10 for other nuclides except iodine		
Cationic exchanger	10 for Cs, Y, Mo		
Evaporator		Decontamination coefficient: 10^6 for liquids except I and B 10^5 for gases 10^3 for I and B	Although an evaporator has been 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:			
Gaseous treatment system: ▪ Coarse filter	50 %		
▪ HEPA filter	99,95 % (0,3 µm)		
▪ Charcoal bed	99,50 %		
▪ Decay tanks		Delay time 60 days (approximately 8 half periods)	
Auxiliary building: ▪ Coarse filter	50 %		
▪ HEPA filters	99,95 %		
▪ Charcoal bed	99,50 %		
Reactor building: ▪ HEPA filter	99,95 %		
Evaporator building: ▪ Coarse filter	50 %		
▪ HEPA filter	99,95 %		

Table AI-2.3: José Cabrera NPP. Annual liquid effluent activity (GBq/year)

Nuclide	2003	2004	2005	2006	2007	2008	2009
Gross Alpha							
H-3	**9,53E+03**	**2,96E+03**	**3,12E+03**	**1,12E+04**	**7,78E+02**	**1,28E+02**	**2,57E+02**
Co-58	7,35E-03	2,42E-02		8,28E-04	5,25E-03		
Co-60	7,72E-03	1,14E-02	1,95E-03	4,26E-02	3,02E-02	1,64E-01	6,73E-02
Zn-65							
Sr-90							
Zr/Nb-95							
Ru-106							
Ag-110m							
Sb-125							
Cs-134			3,81E-04	8,59E-04			
Cs-137	1,98E-02	5,73E-04	7,75E-02	4,67E-02	8,22E-03		
Ce-144							
Other nuclides	9,58E-03		5,66E-02	3,87E-02			
Total Activity excluding H-3	**4,45E-02**	**3,61E-02**	**1,36E-01**	**1,30E-01**	**4,37E-02**	**1,64E-01**	**6,73E-02**

Table AI-2.4: José Cabrera NPP. Normalised annual liquid effluent activity (GBq/GWa)

Year	2003	2004	2005	2006	2007	2008	2009
Total activity without H-3	3,64E-01	2,69E-01	1,099E+00	2,91E+00	–	–	–
Tritium	7,79E+04	2,21E+04	2,50E+04	2,50E+05	–	–	–

Table AI-2.5: José Cabrera. Absolute and normalised Tritium emissions

Year	2003	2004	2005	2006	2007	2008	2009
GBq/y	4,25E+01	7,56E+01	5,36E+01	7,84E+00	6,98E+00	1,43E+01	6,55E+00
GBq/GWa	3,47E+02	5,64E+02	4,29E+02	1,75E+02	–	–	–

Table AI-2.6: Normalised releases EC – UNSCEAR (GBq/Gwa)

Year	José Cabrera NPP	EC Report	UNSCEAR 2008 Report
	2003-2006	1995-99	1998-2002
Total activity without tritium (liquids)	1,16E+00	3,78E+00	1,10E+01
Tritium (liquids)	9,39E+04	1,71E+04	2.00E+04
Tritium (gases)	3,79E+02	1,05E+03	2,10E+03
C-14 (gases)	–	1,96E+02	2,20E+02

Table AI-2.7: José Cabrera. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in river water (Bq/m^3)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	<67,5	<74,8	<36,8	282,0	<82,7	<77,7	<63,4
^{60}Co	<59,3	<58,0	<33,0	<55,7	<73,3	<67,5	<55,7
^{54}Mn	<57,4	<47,9	<34,6	<51,1	<68,8	<63,7	<51,0

Table AI-2.8: José Cabrera. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in sediments (Bq/kg.dry.wt)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	3,16	12,6	15,8	13,2	10,2	11,8	22,6
^{60}Co	<0,28	0,43	1,39	1,56	2,77	1,60	1,65
^{54}Mn	<0,25	<0,29	<0,25	<0,28	<0,22	<0,20	<0,25

Table AI-2.9: José Cabrera. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in fishes (Bq/kg.wet.wt)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	0,37	0,45	1,56	0,94	0,87	1,17	0,93
^{60}Co	<0,09	<0,09	<0,14	<0,08	<0,12	<0,17	0,56
^{54}Mn	<0,08	<0,07	<0,14	<0,07	<0,08	<0,13	<0,08

Since 2008 results on Fe-55, Ni-63 have been collected in surface water, sediment and fish samples, and also Am-241 and Pu-238 in surface water and sediment samples, as it figures in the table below. All the results obtained present values under the detection limit.

Table AI-2.10: Environmental Monitoring Programme around Jose Cabrera NPP.

Sample	**Frequency**	**Measurement/analysis**
Air (Aerosols) Iodine	Continuous (weekly)	Gross- β ^{90}Sr γ Spectrometry [1] Gross- α ^{55}Fe ^{63}Ni I-131
Gamma radiation (TLD)	Continuous (quarterly)	Dose rate
Rain water	Continuous (monthly)	γ Spectrometry [1] ^{90}Sr ^{55}Fe ^{63}Ni
Drinking water	Fortnightly Quarterly	Gross-β Residual β ^{90}Sr ^{3}H γ Spectrometry [1] ^{55}Fe ^{63}Ni ^{241}Am ^{238}Pu
Surface water	Monthly (continuous in two stations) Quarterly	Gross- β Residual β ^{3}H γ Spectrometry [1] ^{55}Fe ^{63}Ni ^{241}Am ^{238}Pu
Soil,	Yearly	^{90}Sr γ Spectrometry [1] ^{55}Fe ^{63}Ni
Sediment and biological indicators	Every six months	^{90}Sr γ Spectrometry [1] ^{55}Fe ^{63}Ni ^{241}Am ^{238}Pu
Milk	Fortnightly and Monthly.	^{90}Sr γ Spectrometry [1] ^{131}I (milk, leafy vegetables) ^{55}Fe ^{63}Ni
Crops	Harvest season	^{90}Sr γ Spectrometry [1] ^{131}I (leafy vegetables) ^{55}Fe ^{63}Ni
Meat and eggs	Every six months	γ Spectrometry [1] ^{55}Fe ^{63}Ni
Fish	Every six months	γ Spectrometry [1] ^{90}Sr ^{55}Fe ^{63}Ni
Honey	Yearly	γ Spectrometry [1]
Sample	**Frequency**	**Measurement/analysis**

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.

Table AI-2.11: José Cabrera. Annual effective dose to the critical group (mSv/y)

Year	2003	2004	2005	2006	2007	2008	2009
Liquids	1,09E-03	3,83E-04	3,58E-04	2,13E-03	1,19E-04	4,64E-05	5,27E-05
Gases	1,36E-5	6,14E-05	2,27E-05	9,35E-06	3,74E-07	3,89E-07	6,93E-08
Total	1,10E-03	4,96E-04	4,96E-04	2,14E-03	1,19E-04	4,68E-05	5,27E-05

Figure AI-2.1: José Cabrera NPP. Annual liquid effluent activity (GBq/year)

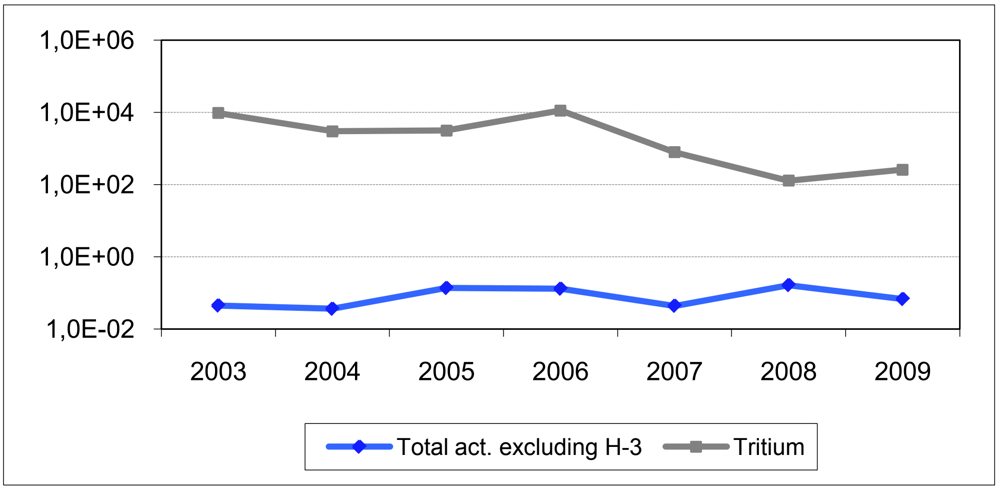


Figure AI-2.2: José Cabrera NPP. Annual gaseous effluent activity (GBq/year)

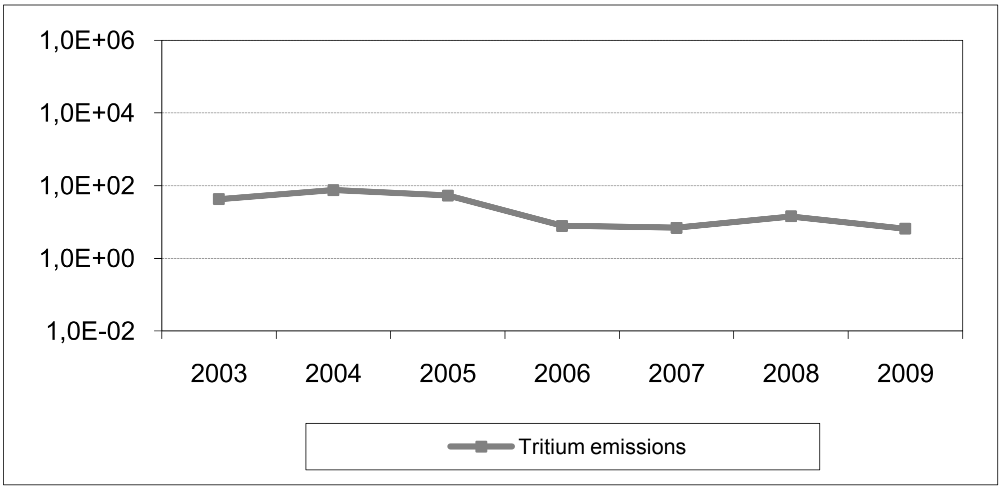
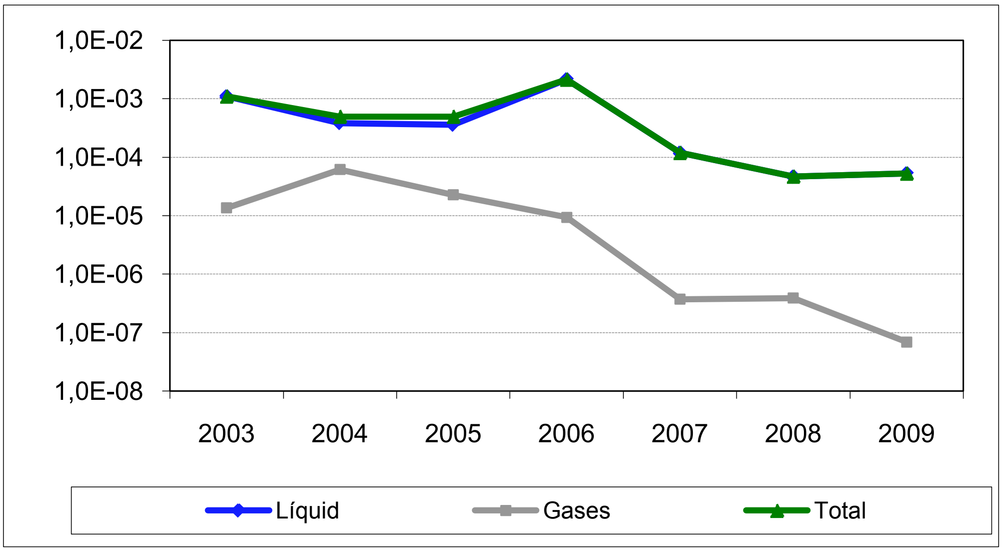


Figure AI-2.3: José Cabrera NPP. Annual effective dose to the critical group (mSv/y)



AI-3 TRILLO NUCLEAR POWER PLANT

AI-3.1 Site Characteristics

AI-3.1.1 Name of site

Trillo

AI-3.1.2 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.

AI-3.1.3 Year for commissioning/licensing/decommissioning

The reactor was critically in May-1988, starting the commercial operation in Agost-1988.

AI-3.1.4 Location

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

AI-3.1.5 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.

AI-3.1.6 Production

The installed electrical capacity is 1066 MW(e). The annual electrical output is given in Table AI-3.1

AI-3.1.7 Other relevant information

There is no other relevant information

AI-3.2 Discharges

AI-3.2.1 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 discharged 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, as it is shown in section 3.2, before being released through the stack. Detailed information on the available filters in each line is included in section 3.2.2.

AI-3.2.2 Efficiency of abatement systems

This information is shown in Table AI-3.2

AI-3.2.3 Annual liquid discharges

With respect to the policy to minimise the production of waste, besides the measures previously mentioned in the report (3.1.2), specific actions are applied in this plant, such as reuse of contaminated liquids. Nevertheless, no relevant additional measures have being introduced to minimise the production of wastes throughout the period of time considered in this report.

The licensee establishes annual target values as radiological protection and environmental indicators. With regard to the radioactive effluents those target values, which are set in terms of annual activity for the different considered groups of radionuclides, were for 2008:

Parameter	Target Values (GBq/y)
Radioactive Liquid Effluents	
• Total activity excluding Tritium	8,00E-01
• Tritium	3,00E+04
Radioactive Gaseous Effluents	
• Noble Gases	7,40E+02
• Halogens	3,70E-03
• Particles	3,70E-03
• Tritium	1,85E+03
• Carbon-14	7,00E+01

Information on absolute annual activity is given in Table AI-3.3 for Tritium and Total activity excluding Tritium, while a semi-logarithmic representation of data is given in Figure AI-3.1

Table AI-3.4 presents normalised liquid discharges from Trillo for the period 2003-2009.

Regarding discharges, the absolute Total activity excluding Tritium, as well as Tritium, presents a stable trend throughout the considered period.

Regarding emissions, Table AI-3.5 shows absolute and normalised Tritium and Carbon-14 emissions from Trillo NPP for the period 2003-2009, while a semi-logarithmic representation of data is given in Figure AI-3.2.

Tritium and Carbon-14 present a stable trend throughout the considered period.

Table AI-3.6 illustrates the relation between the average Trillo NPP normalised discharges and emissions and the considered European Commission and UNSCEAR reference values. As is shown by that Table:

- Total activity excluding Tritium for liquid discharges is well below both reference values
- Tritium for liquid discharges is similar to the UNSCEAR reference value and slightly higher than the European Commission reference value.
- Tritium and Carbon-14 emissions are well below both reference values.

AI-3.3 Environmental Impact

AI-3.3.1 Concentrations of radionuclides of concern in representative samples of water, sediment, and fish.

Tables AI-3.7, AI-3.8, and AI-3.9 show respectively the ^{137}Cs, ^{60}Co and ^{54}Mn mean activity concentrations in river water, sediments and fish in the area surveyed around Trillo NPP.

AI-3.3.2 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. The Table AI-3.10 details the type of samples, the sampling frequency and the analyses included in the programme.

AI-3.3.3 Systems for quality assurance of environmental monitoring.

Systems for quality assurance applicable to Trillo NPP have been detailed in sections 2.6 and 2.8

AI-3.4 Radiation Doses to the Public

Information on annual effective dose to the most exposure member of the public is given in Table AI-3.7 and Figure AI-3.3. Until 2007 Trillo NPP was the only power plant measuring C-14.

The exposure pathways considered in these calculations are:

- Liquids: Potable water consumption, Exposure to river shoreline deposits, and Ingestion of vegetables (leafy and non-leafy vegetables, fruits, grain), milk (cow, goat/sheep), meat (beef, goat/sheep), and fish.
- Gases: Inhalation, Exposure to the cloud, Exposure to deposits on the ground surface, and Ingestion of vegetables (leafy and non-leafy vegetables, fruits, grain), milk (cow, goat/sheep) and meat (beef, goat/sheep)

Critical group / Main exposure pathways:

- Liquids: Infant (1-2 years) / Non leafy vegetables, fruits and grain consumption, and Cow milk ingestion
- Gases: Infant (1-2 years) / Non-leafy vegetables, fruits and grain consumption, and Cow milk ingestion.

Effective doses are well below the present authorised limit. Taking into account liquid and gaseous effluents, the average dose in the considered period of time is 1,34E-3 mSv that represents a 1,34 % of the release limit. There is an increasing trend along the considered period of time due to the application of the 2004/2/Euratom recommendation since 2008.

Taking into account the liquid and gaseous effluents the critical group is the infant (1-2 years), being the main exposure pathways the ingestion of cow milk (52%) and ingestion of non-leafy vegetables, fruits and grain (44%).

The licensee also establishes target release value in terms of annual dose for the different considered groups of radionuclides. For 2008 this target value was an effective dose of 4,5E-3 mSv/y taking into account the contribution of liquid and gaseous effluents.

Table AI-3.1: Trillo NPP. Annual electrical output in GW(e)a

Year	2003	2004	2005	2006	2007	2008	2009
Gross Electrical Output	0,989	0,974	0,987	0,940	0,971	0,944	0,879
Net Electrical Output	0,926	0,911	0,922	0,878	0,907	0,884	0,822

Table AI-3.2: 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			
Containment structure ventilation: ▪ Coarse filter			
▪ Charcoal bed	99 %		
▪ HEPA filter			
Annular shielding building ventilation: ▪ Coarse filter			
▪ HEPA filters		DIN 24184	
▪ Charcoal bed	99,9 % for ICH_3		
Auxiliary building ventilation: ▪ Coarse filter	85%		
▪ HEPA filters		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 AI-3.3: Trillo NPP. Annual liquid effluent activity (GBq/year)

Nuclide	2003	2004	2005	2006	2007	2008	2009
Gross Alpha							
H-3	**1,94E+04**	**2,85E+04**	**1,22E+04**	**1,83E+04**	**2,17E+04**	**1,59E+04**	**2,02E+04**
Co-58	6,61E-02	2,65E-02	1,70E-02	2,19E-02	1,02E-02	2,21E-02	1,82E-02
Co-60	2,35E-01	1,30E-01	1,42E-01	3,00E-01	1,83E-01	1,47E-01	2,28E-01
Zn-65						5,80E-03	
Sr-90							
Zr/Nb-95	7,27E-02	5,27E-02	1,13E-02	8,69E-03	3,20E-03	2,27E-02	2,66E-02
Ru-106							
Ag-110m	6,32E-02	4,55E-02	1,87E-02	3,25E-02	1,91E-02	2,49E-02	2,18E-02
Sb-125	8,69E-03	5,25E-03	7,07E-02	3,97E-02	1,28E-02	9,99E-03	9,91E-03
Cs-134	4,67E-03	8,80E-05	7,67E-03	9,17E-03	5,10E-04		
Cs-137	1,22E-01	3,90E-02	1,03E-01	1,53E-01	6,57E-02	2,64E-02	1,88E-02
Ce-144							
Other nuclides	2,20E-01	5,78E-02	2,27E-02	2,39E-02	2,48E-02	6,61E-01	6,29E-01
Total Activity excluding H-3	**7,92E-01**	**3,56E-01**	**3,93E-01**	**5,88E-01**	**3,20E-01**	**9,20E-01**	**9,53E-01**

Table AI-3.4: Trillo NPP. Normalised annual liquid effluent activity (GBq/GWa)

Year	2003	2004	2005	2006	2007	2008	2009
Total activity without H-3	8,55E-01	3,91E-01	4,26E-01	6,70E-01	3,52E-01	1,04E+00	1,16E+00
Tritium	2,09E+04	3,13E+04	1,32E+04	2,09E+04	2,39E+04	1,80E+04	2,46E+04

Table AI-3.5: Trillo NPP. Absolute and normalised tritium and C-14 emissions

Nuclide	2003	2004	2005	2006	2007	2008	2009
H-3 (GBq/y)	7,31E+02	1,18E+03	7,96E+02	6,74E+02	7,46E+02	8,77E+02	8,53E+02
C-14 (GBq/y)	4,82E+01	3,18E+01	6,12E+01	6,70E+01	4,45E+01	3,03E+01	3,70E+01
H-3 (GBq/GWa)	7,89E+02	1,29E+03	8,63E+02	7,68E+02	8,22E+02	9,93E+02	1,04E+03
C-14 (GBq/GWa)	5,21E+01	3,49E+01	6,63E+01	7,63E+01	4,90E+01	3,43E+01	4,50E+01

Table AI-3.6: Normalised releases EC – UNSCEAR (GBq/Gwa)

Year	Trillo NPP	EC Report	UNSCEAR 2008 Report
	2003-2009	**1995-99**	**1998-2002**
Total activity without tritium (liquids)	6,99-01	3,78E+00	1,10E+01
Tritium (liquids)	2,18E+04	1,71E+04	2.00E+04
Tritium (gases)	9,38E+02	1,05E+03	2,10E+03
C-14 (gases)	5,11E+01	1,96E+02	2,20E+02

Table AI-3.7: Trillo NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in river water (Bq/m^3)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	*<40,9*	*<39,7*	*<38,3*	*<40,0*	*<41,7*	*<33,1*	*<37,1*
^{60}Co	*<37,1*	*<35,3*	*<34,5*	*<36,3*	*<37,3*	*<29,6*	*<33,7*
^{54}Mn	*<38,5*	*<37,1*	*<35,8*	*<37,6*	*<39,1*	*<31,2*	*<35,3*

Table AI-3.8: Trillo NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in sediments (Bq/kg.dry.wt)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	3,54	1,68	3,07	3,22	6,10	4,59	1,12
^{60}Co	1,80	0,63	20,35	3,18	2,87	2,15	2,44
^{54}Mn	<0,24	<0,21	*1,21*	*<0,26*	<0,24	<0,16	<0,25

Table AI-3.9: Trillo NPP. ^{137}Cs, ^{60}Co and ^{54}Mn mean concentrations in fishes (Bq/kg.wet.wt)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{137}Cs	0,48	<0,21	0,53	0,46	0,52	0,29	<0,27
^{60}Co	*<0,25*	<0,19	<0,17	*<0,19*	<0,21	*<0,18*	*<0,24*
^{54}Mn	*<0,26*	<0,20	*<0,17*	*<0,20*	*<0,22*	*<0,19*	*<0,25*

Table AI-3.10: Environmental Monitoring Programme around Trillo NPP.

Sample	Frequency	Measurement/analysis
Air (Aerosols) Iodine	Continuous (weekly)	Gross- β ^{90}Sr γ spectrometry I-131
Gamma radiation (TLD)	Continuous (quarterly)	Dose rate
Rain water	Continuous (monthly)	γ spectrometry ^{90}Sr
Soil	Yearly	γ spectrometry, ^{90}Sr
Drinking water	Fortnightly and monthly	Gross-β Residual β ^{90}Sr ^{3}H γ spectrometry
Ground water	Quarterly	Gross- β Residual β ^{3}H γ spectrometry
Surface water	Fortnightly. Continuous first station downstream	Gross- β Residual β ^{3}H γ spectrometry
Sediment and biological indicators[1].	Half-yearly	^{90}Sr γ spectrometry
Milk[2]	Fortnightly and Monthly	^{90}Sr γ spectrometry ^{131}I
Crops[3]	Harvest season	^{90}Sr γ spectrometry ^{131}I (leafy vegetables)
Meat[4] and eggs	Half-yearly	γ spectrometry
Fishes[5]	Half yearly.	γ spectrometry ^{90}Sr
Honey	Yearly	γ spectrometry

1 Typha, Phragmites Communis, Lythrum Salicaria, Molina Caerulea//2 Cow and goat milk samples //3 Chard Oats, cabbage, cucumber, tomato… // 4. Lamb and chicken meat samples/ 5. Pike-fish, barbel, carp

Table AI-3.11: Trillo. Annual effective dose to the critical group (mSv/y)

Year	2003	2004	2005	2006	2007	2008	2009
Liquids	7,98E-04	1,42E-03	1,47E-03	1,57E-03	1,52E-03	1,06E-03	1,15E-03
Gases	5,42E-05	3,61E-05	6,38E-05	6,93E-05	8,51E-05	3,98E-05	5,74E-05
Total	8,52E-04	1,45E-03	1,53E-03	1,64E-03	1,61E-03	1,10E-03	1,21E-03

Figure AI-3.1: Trillo NPP. Annual liquid effluent activity (GBq/year)

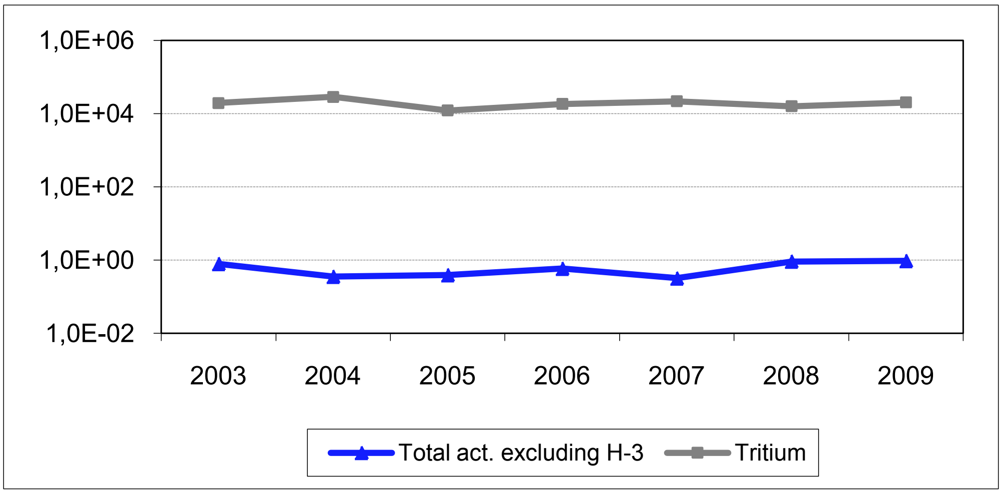


Figure AI-3.2: Trillo NPP. Annual gaseous effluent activity (GBq/year)

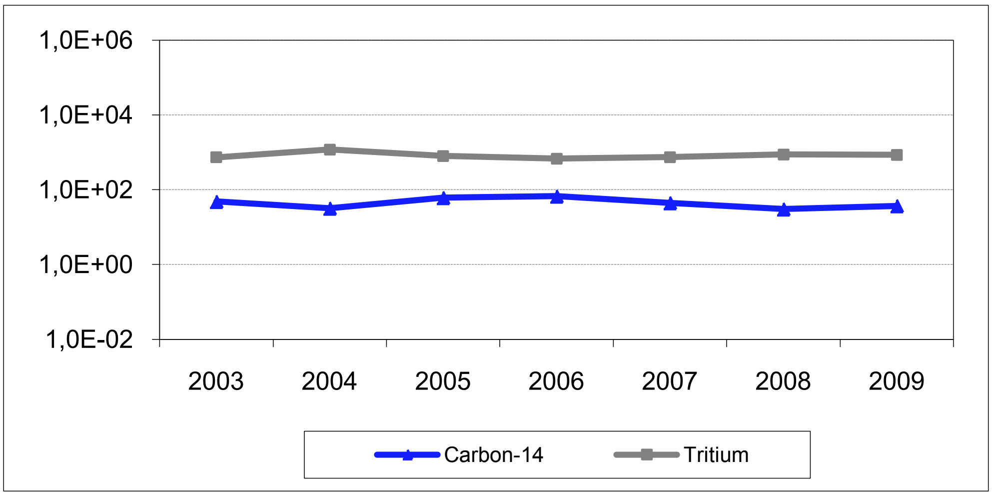
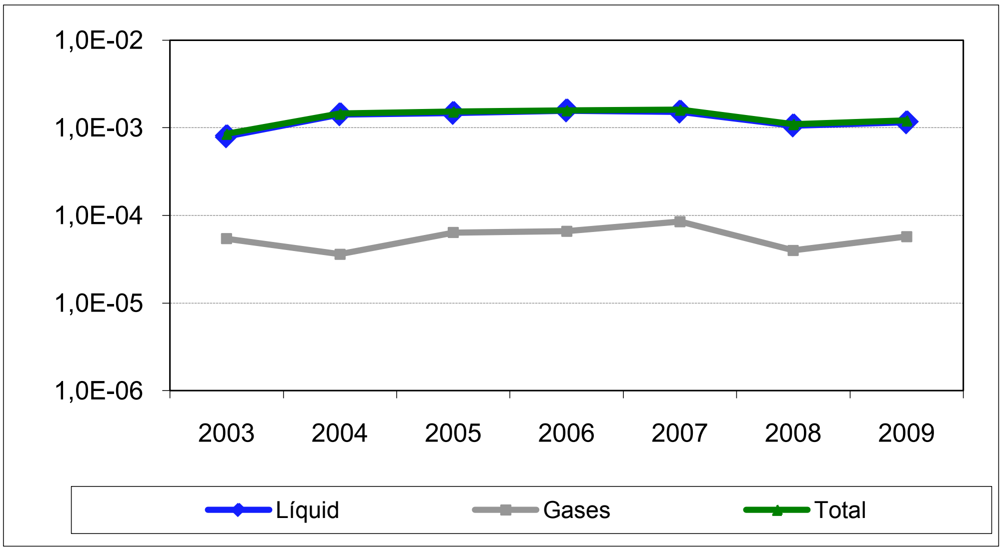


Figure AI-3.3: Trillo NPP. Annual effective dose to the critical group (mSv/y)



ANNEX II: FUEL FABRICATION PLANTS

AII-1. JUZBADO FUEL FABRICATION PLANT

AII-1.1. Site Characteristics

AII-1.1.1. Name of site

Juzbado

AII-1.1.2. Type of facility

Juzbado is a facility where fuel for light water reactors (PWR, BWR, WER) is 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.

AII-1.1.3. Year for commissioning/licensing/decommissioning

The plant was commissioned in 1985.

AII-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.

AII-1.1.5. Receiving waters and catchment area

Radioactive liquid effluents are discharged into the Tormes River, tributary to the Duero River. The average annual flow rate of the Tormes River is 23,2 m^3/s.

AII-1.1.6. Production

The annual capacity is 500 tonnes since 2010 but it was 400 tonnes during the period of time considered in the present report. The production, expressed as amount of processed Uranium, is given in Table AII-1.1

AII-1.1.7. Other relevant information

There is no other relevant information.

AII-1.2. Discharges

AII-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 sample 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 large contribution to the releases, particularly from those areas where non-encapsulated material is managed. In Juzbado fuel fabrication plant 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 high efficiency particulate filters (HEPA filters) to remove the suspended particles from the air.

AII-1.2.2. Efficiency of abatement systems

This information is shown in Table AII-1.2

AII-1.2.3. Annual liquid discharges

The policy to minimise the production of waste is explained in the report (3.2.2). Besides that, some changes have been introduced in the radioactive liquid discharge system between 2003 and 2009 such as the partial replacement of outdoor pipes or a level sensor installation in the discharge tank. But the target of these changes has been to reduce the probability of uncontrolled releases more than to minimise the normal releases.

Information on annual alpha activity and percentage of the limit is given in Table AII-1.3, while a semi-logarithmic representation of data is given in Figure AII-1.1.

For Juzbado FFP, discharges have remained reasonably constant over this period. The range for total alpha activity in the discharges is 1,74E-2 – 3,70E-2 GBq/y. There is no clear trend. As no reference data are published for fuel fabrication plant, normalised discharged data have not been calculated.

Total alpha activity in gaseous effluents shows a slight upward trend due to a higher production in the facility during 2008 and 2009. The range for total alpha activity in the discharges is 1,68E-5 – 7,38E-5 GBq/y.

AII-1.3. Environmental Impact

AII-1.3.1. Concentrations of radionuclides of concern in representative samples of water, sediment, and fish.

In tables AII-1.4, AII-1.5, and AII-1.6 are presented respectively the ^{238}U, ^{234}U and ^{235}U mean activity concentrations in river water, sediments and fish in the area surveyed around Juzbado FFP.

AII-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. The Table AII-1.7 details the type of samples, the sampling frequency and the analyses included in the programme.

AII-1.4. Radiation Doses to the Public

Information on annual effective dose to the most exposure member of the public is given in Table AII-1.8 and Figure AII-1.2.

The exposure pathways considered in these calculations are:

- Liquids: Exposure to river shoreline deposits, and ingestion of potable water, vegetables, milk, meat and fish.
- Gases: Inhalation, Exposure to deposits on the ground surface, and ingestion of vegetables, meat and milk.

Critical group / Main exposure pathways:

- Liquids: Children (1-2 years) / Potable water (65,07%) and Vegetables (32,59%)
- Gases: Adults (>17 years) / Inhalation (88,80%) and Vegetables (10,74%)

Effective doses are well below the present authorised limit. Taking into account liquid and gaseous effluents, the average dose in the considered period of time is 1,06E-5 mSv that represents a 0,01% of the present release limit. There is a slight increasing trend along the considered period of time.
The critical group is the children being the main exposure pathways inhalation and vegetable ingestion.

Table AII-1.1: Juzbado FFP. Annual production (t/y)

Year	2003	2004	2005	2006	2007	2008	2009
Production	204	314	280	267	302	364	369

Table AII-1.2: 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: ▪ Coarse filters	> 99,95% (0,3µm)		
▪ HEPA filters	> 99,97 % (0,3µm)		

Table AII-1.3: Juzbado FFP. Total Alpha activity (GBq/y)

Year	2003	2004	2005	2006	2007	2008	2009
Liquid effluents	2,83E-02	1,74E-02	2,88E-02	3,70E-02	2,92E-02	3,00E-02	2,09E-02
Gaseous effluents	2,31E-05	3,28E-05	1,97E-05	1,68E-05	1,86E-05	4,11E-05	7,38E-05

Table AII-1.4: Juzbado FFP. ^{238}U, ^{234}U and ^{235}U concentrations in river water (Bq/m^3)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{238}U	7,90	9,90	9,25	9,67	10,5	8,82	4,12
^{234}U	13,3	13,1	15,2	17,2	10,5	11,3	6,1
^{235}U	<1,44	0,93	<1,85	<1,98	<2,59	3,60	<0,80

Table AII-1.5: Juzbado FFP. ^{238}U, ^{234}U and ^{235}U concentrations in sediments (Bq/kg.dry.wt.)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{238}U	37,4	45,2	51,2	42,0	61,5	34,7	53,5
^{234}U	55,3	71,9	82,7	65,6	91,5	53,2	82,2
^{235}U	2,95	2,25	2,38	1,91	2,79	2,39	2,49

Table AII-1.6: Juzbado FFP. ^{238}U, ^{234}U and ^{235}U concentrations in fishes (Bq/kg.wet.wt.)

Isotope	2003	2004	2005	2006	2007	2008	2009
^{238}U	0,08	0,20	0,08	0,67	0,08	0,08	0,06
^{234}U	0,11	0,32	0,14	1,13	0,15	0,14	0,08
^{235}U	<0,02	<0,04	<0,01	<0,04	<0,008	<0,008	<0,01

Table AII-1.7: Environmental monitoring programme around Juzbado FFP

Sample	Frequency	Measurement/analysis
Air (Aerosols)	Continuous -Weekly	Gross-α. Uranium α.-spectrometry
Gamma radiation (TLD)	Continuous (quarterly)	Dose rate
Rain water	Continuous (quarterly)	Gross-α.
Soil	Yearly	Gross-α. Uranium α.-spectrometry
Drinking water	Monthly	Gross-β Residual β Gross-α. Uranium α-spectrometry
Ground water	Quarterly	Gross-α. Uranium α.-spectrometry
Surface water	Continuous-Monthly	Gross- β Residual β Gross-α. Uranium α-spectrometry
Sediment	Yearly	Gross-α. Uranium α-spectrometry
Milk[1]	Quarterly	Gross-α. Uranium α-spectrometry
Crops[2]	Harvest season	Gross-α. Uranium α-spectrometry
Meat[3] .	Yearly	Gross-α. Uranium α-spectrometry
Fishes.[4]	Yearly	Gross-α. Uranium α-spectrometry

1 Cow milk samples **// 2** Cabbage, corn, potatoes **// 3** Sheep and pig meat samples// 4. Barbel.

Table AII-1.8: Juzbado FFP. Annual effective dose to the critical group (mSv/y)

Year	2003	2004	2005	2006	2007	2008	2009
Liquids	2,51E-06	4,53E-06	1,29E-05	5,71E-06	3,33E-06	4,99E-06	5,82E-06
Gases	3,95E-06	4,86E-06	3,22E-06	2,57E-06	3,76E-06	8,64E-06	1,12E-05
Total	5, 28E-06	8,91E-06	1,59E-05	8,09E-06	6,63E-06	1,28E-05	1,66E-05

Figure AII-1.1: Juzbado FFP. Annual total alpha activity (GBq/y)

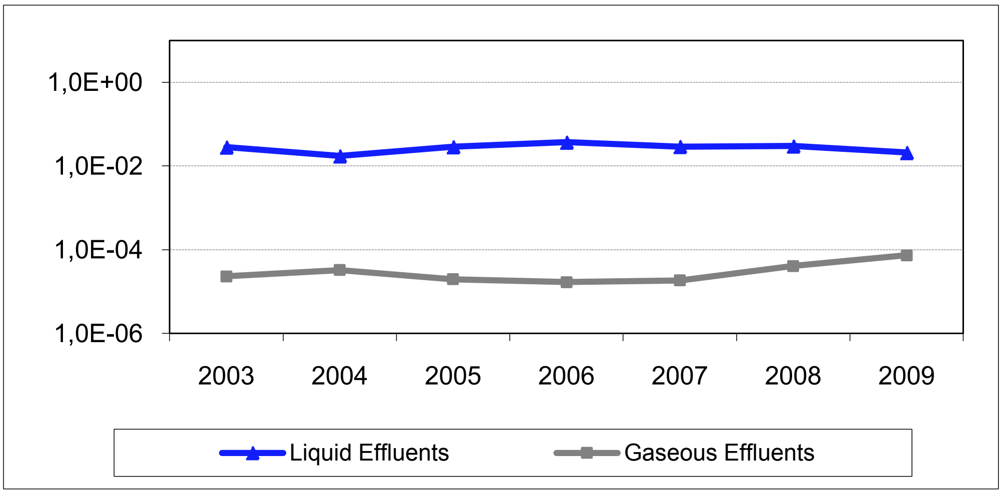
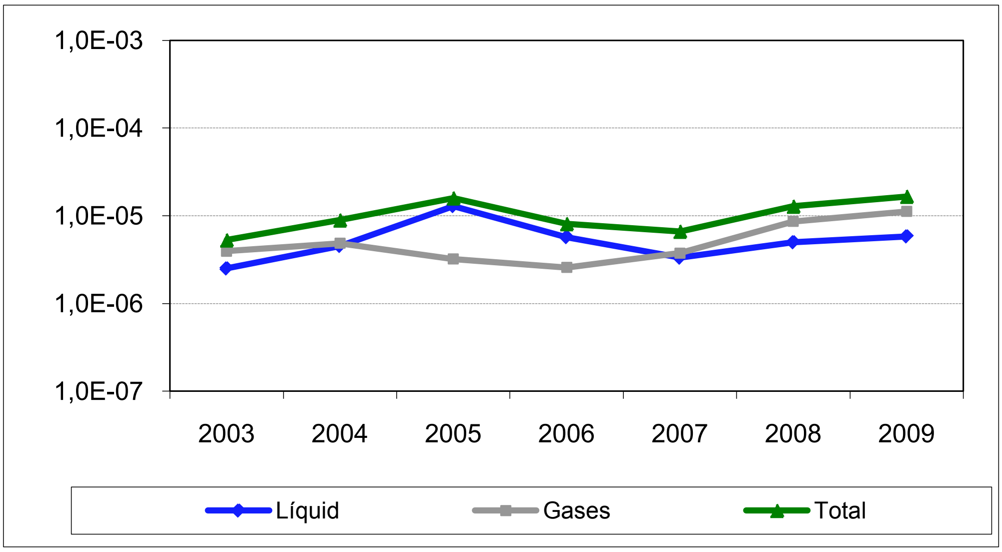


Figure AII-1.2: Juzbado FFP. Annual effective dose to the critical group (mSv/y)



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