EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D – Nuclear energy, safety and ITER
D.3 – Radiation protection and nuclear safety

Verification under the terms of Article 35 of the Euratom Treaty

Technical Report

SPAIN

Garoña Nuclear Power Plant

Discharge and environmental monitoring and national environmental radioactivity monitoring network in the vicinity

19 – 21 October 2021

Reference: ES 21-06

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35

OF THE EURATOM TREATY

FACILITIES	- Facilities for monitoring discharges of gaseous and liquid radioactive effluents into the environment at the Garoña nuclear power plant - Facilities for monitoring environmental radioactivity in the vicinity of the Garoña nuclear power plant - Associated analytical laboratories
LOCATIONS	- Garoña NPP and the surrounding area - Medina de Pomar
DATES	19 – 21 October 2021
REFERENCE	ES 21-06
TEAM MEMBERS	Mr Vesa Tanner, DG ENER (team leader) Mr Simon Murphy, DG ENER
REPORT DATE	2 March 2022
SIGNATURES	

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Legend

ATI	Almacén Temporal Individualizado (Individualised temporary storage facility)
BOE	Boletín Oficial del Estado (Spanish Official Gazette)
CC	Operator's Analytical Quality Control Programme
CEDEX	Center for Research and Experimentation of Public Works
CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (Centre for Energy, Environmental and Technological Research)
CSN	Consejo de Seguridad Nuclear (Nuclear Safety Council)
ERA	Network of automatic stations of the Basque Government
ETF	Operation Technical Specifications at NPP
EURDEP	EUropean Radioactivity Data Exchange Platform
MASL	Laboratorio de Medidas Ambientales S.L. at Medina de Pomar / Laboratory for Environmental Radiological Monitoring
MCDEP	Shutdown Offsite Dose Calculation Manual
MINETAD	Ministry for Energy, Tourism and Digital Agenda
MTE	Ministry for the Ecological Transition (previous MINETAD)
ODCM/MCDE	Offsite Doses Calculation Manual of Garoña nuclear power plant
PVRA	Radiological Environmental Monitoring Programme
PVRAIN	Independent Radiological Environmental Monitoring Programme (CSN)
RAE	Operator's Off-site Alert Network
RAI	Operator's On-site Alert Network
RAR	Radioactivity Alert Network of Directorate-General of Civil Protection
REA	Network of automatic stations (CSN)
REM	Network of sampling stations (CSN)
REVIRA	National Environmental Radiological Monitoring Network (CSN)
SALEM	Emergency Room of CSN
ULE	Laboratorio de Radiactividad Ambiental de la Universidad de León - Environmental Radioactivity Laboratory at University of Leon
URAyVR	Unit of Environmental Radiology and Radiation Monitoring (CIEMAT)

TECHNICAL REPORT

1 INTRODUCTION

Under Article 35 of the Euratom Treaty, all Member States must establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic safety standards[1]. Article 35 also gives the European Commission (EC) the right of access to such facilities to verify their operation and efficiency. The radiation protection and nuclear safety unit of the European Commission's Directorate-General for Energy is responsible for undertaking these verifications. The EC's Joint Research Centre provides technical support during the verification visits and in drawing up the reports.

The main purpose of the verifications under Article 35 of the Euratom Treaty is to provide an independent assessment of the adequacy of monitoring facilities for:

- liquid and airborne discharges of radioactivity from a site into the environment;
- levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant exposure pathways;
- levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[2] describing practical arrangements for Article 35 verification visits in Member States was published in the *Official Journal of the European Union* on 4 July 2006.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The Commission notified Spain of its decision to conduct an Article 35 verification in a letter addressed to the Permanent Representation of Spain to the European Union. The Spanish Government subsequently designated the Nuclear Safety Council (CSN) to lead the preparations for this visit. There has been no previous verification under Article 35 at the Garoña NPP.

2.2 DOCUMENTS

To assist the verification team in its work, the Spanish national authorities supplied an information package in advance[3]. Additional documentation was provided during and after the visit. The information provided was used extensively in drawing up the descriptive sections of this report.

2.3 PROGRAMME OF THE VISIT

The EC and CSN agreed on a programme of verification activities in line with the Commission Communication of 4 July 2006 (Annex 1).

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1 Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation; repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom with effect from 6 February 2018 (OJ L 13 of 17.1.2014)

2 Commission Communication *Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty — Practical arrangements for the conduct of verification visits in Member States* (OJ C 155, 4.7.2006, pp. 2-5)

3 Replies to the preliminary information questionnaire addressed to the national competent authority, received on 22 September 2021

The opening meeting held at the Garoña NPP included presentations on the following:

- Commission Article 35 verification programme
- Garoña NPP introduction
- Environmental radioactivity monitoring in Spain
- Garoña NPP on- and off-site monitoring programmes

The verification team pointed to the quality and comprehensiveness of all the presentations and documentation. The team carried out the verifications in accordance with the programme in Annex 1. It met the following representatives of the national authorities and other parties involved:

Garoña NPP (Nuclenor S.A.)

- Gerardo Gutiérrez Simón – Licensing manager of Garoña NPP
- Ángel Félez Justes – Head of Radiation Protection and Environment
- José Fernando Sánchez Marcos – Technical manager of Radiation Protection and Environment
- Pedro Romón Moquillas – Head of Operation and Nuclear

Nuclear Safety Council (CSN)

- Inmaculada Simón Cirujano – Deputy Director for Environmental Radiation Protection (acting as)
- José Ignacio Serrano Renedo – Head of the Radiological Impact Assessment Department.
- Carmen Rey Del Castillo – Head of the Radioactivity Environmental Monitoring Department
- Sofía Luque Heredia – Deputy Direction for Environmental Radiological Protection
- José Antonio Trinidad Ruiz – Deputy Direction for Environmental Radiological Protection. Radioactivity Environmental Monitoring Expert
- Pablo Martínez Vivas – Deputy Direction for Environmental Radiological Protection Radioactivity Environmental Monitoring Expert
- Elena López Vingolea – Deputy Direction for Environmental Radiological Protection Radiological Impact Assessment Department Expert
- Cristina Parages Perez del Yerro – Deputy Direction for Emergencies and Security Emergencies Expert
- Marcos Nieto Jimenez – Resident Inspector

Laboratorio de Medidas Ambientales S.L. at Medina de Pomar (MASL)

- Maria José de Lucas de Rose – Technical Director
- Lidia Encarnacion Alonso Heras – Quality Director
- Ramon Torre Díez – Laboratory technician

Directorate General for Civil Protection and Emergencies

- Carlos García Vegas – Head of Technological Risk Department

3 LEGAL FRAMEWORK FOR RADIOACTIVITY MONITORING

3.1 NATIONAL LEGISLATION IN SPAIN

3.1.1 Legislative acts establishing the responsibilities of the various actors

The following legal texts establish the responsibilities in Spain:

- Law 15/1980 of 22 April, on the creation of CSN. Published in BOE nº 100 of 25 April 1980.

3.1.2 Legislative acts regulating environmental radioactivity monitoring

The following legal texts regulate the environmental radioactivity monitoring in Spain:

- Law 25/1964 of 29 April, on nuclear energy. Published in the Boletín Oficial del Estado [Official Gazette] (BOE) nº 107 of 4 May 1964.
- Law 14/1999 of 4 May, on rates and public charges for services provided by the Nuclear Safety Council. Published in BOE nº 107 of 5 May 1999.
- Royal Decree 783/2001 of 6 July, adopting the regulations on health protection against ionising radiations. Published in BOE nº 178 of 26 July 2001.
- Royal Decree 1836/1999 of 3 December, adopting the regulations on nuclear and radiological installations. Published in BOE nº 313 of 31 December 1999.
- Royal Decree 1400/2018 of 23 November, adopting the regulations on nuclear safety in nuclear installations. Published in BOE nº 284, of 24 November 2018.
- Royal Decree 314/2016 of 29 July, adopting the regulations the sanitary criteria of the water for human consumption. Published in BOE nº 183, of 30 July 2016.

3.1.3 Legislative acts regulating discharge radioactivity monitoring

The following legal texts and instructions regulate the monitoring of radioactive discharges in Spain:

National Legislation

- Law 25/1964 of 29 April, on nuclear energy. Published in BOE nº 107 of 4 May 1964.
- Royal Decree 783/2001 of 6 July, adopting the regulations on health protection against ionising radiations. Published in BOE nº 178 of 26 July 2001.
- Royal Decree 1836/1999 of 3 December, adopting the regulations on nuclear and radiological installations. Published in BOE nº 313 of 31 December 1999.
- Royal Decree 1400/2018 of 23 November, adopting the regulations on nuclear safety in nuclear installations. Published in BOE nº 284, of 24 November 2018.

CSN Technical Instructions

CSN has the competence to prepare and approve technical standards on nuclear safety and radiological protection issues, which are binding for the parties affected by their scope of application.

- CSN-IT-DSN-08-25: Technical instruction on standardized information on radioactive airborne and liquid discharges into the environment from nuclear power reactors in normal operation.

CSN Safety Guides

CSN has the competence to prepare and approve guides that are technical documents of recommendatory nature, which provide guidance to the affected parties in relation to the regulations currently in force for nuclear safety and radiological protection issues.

- CSN Safety Guide 1.4: Control and radiological surveillance of radioactive liquid and gaseous effluents released by nuclear power plants, partially modified by Technical Instruction CSN-IT-DSN-08-25.
- CSN Safety Guide 1.7: Information to be sent to the CSN by the licensees on the operation of nuclear power plants, partially modified by Technical Instruction CSN-IT-DSN-08-25.
- CSN Safety Guide 4.1.: Design and development of the Environmental Radiation Monitoring Programme for Nuclear Power Plants, CSN, 1993.
- CSN Safety Guide 7.9: Offsite dose calculation manual of nuclear installations.

3.2 INTERNATIONAL LEGISLATION AND GUIDANCE DOCUMENTS

The list below includes the main international legislative and guidance documents issued by the European Union (EU) and the International Atomic Energy Agency (IAEA), that form the basis for environmental radioactivity monitoring, radiological surveillance of foodstuffs and surveillance of radioactive discharges.

European Union

- Euratom Treaty (1957)
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation; repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom with effect from 6 February 2018 (OJ L 13 of 17.1.2014)
- Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption (OJ L 296 of 7.11.2013)
- Commission Recommendation 2000/473/Euratom of 8 June 2000 on the application of Article 36 of the Euratom Treaty concerning the monitoring of the levels of radioactivity in the environment for the purpose of assessing the exposure of the population as a whole (OJ L191 of 27.7.2000)
- Commission Recommendation 2004/2/Euratom of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation (OJ L36 of 6.1.2004)

International Atomic Energy Agency (IAEA)

- *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, IAEA Safety Standards Series No. GSR Part 3, IAEA, Vienna, 2014
- *Clearance of materials resulting from the use of radionuclides in medicine, industry and research*, IAEA-TECDOC-1000, IAEA, Vienna, 1998
- *Generic models for use in assessing the impact of discharges of radioactive substances to the environment*, Safety Reports Series No 19, IAEA, Vienna, 2001
- *Handbook of parameter values for the prediction of radionuclide transfer in temperate environments*, Technical Reports Series No 364, IAEA, Vienna, 1994
- *Regulatory control of radioactive discharges to the environment: Safety Guide*, Safety Standards Series No. WS-G-2.3, IAEA, Vienna, 2000

4 BODIES HAVING COMPETENCE IN THE FIELD OF ENVIRONMENTAL AND DISCHARGE RADIOACTIVITY MONITORING

4.1 MINISTRY FOR THE ECOLOGICAL TRANSITION AND DEMOGRAPHIC CHALLENGE

The Ministry for the Ecological Transition and Demographic Challenge (MITERD) is responsible for the granting of the necessary permits for the different stages of the lifecycle of the Spanish nuclear power plants and facilities using radioactive substances, following a mandatory and binding report of the CSN. This system of authorizations includes also approval of the environmental radioactivity monitoring programmes and the discharge radioactivity monitoring programmes of the facilities.

4.2 NUCLEAR SAFETY COUNCIL

The Nuclear Safety Council (CSN), established in 1980, is the Spanish competent authority for nuclear safety and radiological protection. It is independent from the Government and reports directly to the Spanish Parliament. CSN is a collegiate body consisting of five members (a president/chairman and four commissioners) proposed by the Government and endorsed by the Congress of Deputies. Under the overall responsibility of the Secretary-General, the CSN is organised in two technical directorates: Nuclear Safety and Radiation Protection. The latter includes three sub-directorates: Emergencies and Physical Protection, Operational Protection and Environmental Radiological Protection.

CSN issues mandatory and binding reports prior to the authorisation for nuclear facilities by the MITERD and proposes regulations on nuclear safety and radiation protection.

CSN conducts inspections to control the different phases of the life of the installations (project, construction, operation and decommissioning) and any other activity that may have a radiological risk. CSN also provides mandatory and binding reports for modifications of the authorizations of such installations and facilities. On average, the CSN carries out around 200 control inspections per year in nuclear power plants operating in Spain. It is also responsible for proposing regulations to the MITERD concerning radiological protection of workers and members of the public.

With respect to the environment, the CSN has the following regulatory functions:

- To assess the radiological impact of nuclear facilities and installations using radioactive substances on the environment, especially concerning radioactive discharges (aerial/liquid) into the environment, their accumulation in the vicinity of such installations and the evaluation of the resulting radiological impact.
- To run its own programmes of environmental radiological monitoring (both in the vicinity of nuclear installations and at national level) and to supervise all environmental radiological protection activities conducted by nuclear installations and by facilities using radioactive substances.

The CSN also has regulatory functions concerning emergencies. It is responsible for the immediate response to any nuclear or radiological incident. Its 24h emergency room SALEM is fitted with redundant communication systems, collecting information in real time and thus facilitating CSN's advisory role in the event of an emergency. The emergency room has permanent automatic communications with all Spanish nuclear power plants.

4.3 CENTRE FOR ENERGY, ENVIRONMENTAL AND TECHNOLOGICAL RESEARCH

The Centre for Energy, Environmental and Technological Research (CIEMAT) is a public research body assigned to the Ministry of Economy and Enterprise, focusing on energy and environment and the technologies related to them. It has offices in several different regions of Spain. Its activity is structured around projects that form a bridge between R&D&I and social interest goals. At present, the main lines of action are the study, development, promotion and optimisation of various sources as: renewable energies, nuclear fusion, nuclear fission and fossil fuels; the study of their impact on the environment,

development of new technologies; not forgetting areas of basic research such as high-energy physics and molecular and cellular biology.

CIEMAT has an advanced radiological laboratory in Madrid, which has a key role on the monitoring of radioactivity in the environment in Spain[4].

4.4 Directorate-General for Civil Protection and Emergencies

The Directorate-General for Civil Protection and Emergencies under the Ministry of Internal Affairs is responsible for the management, operation and maintenance of the Radioactivity Alert Network (RAR). This nationwide network of some 800 stations measures dose rate with the aim of detecting, in real time, abnormal levels of radiation that may pose a radiological risk.

4.5 Gobierno Vasco

Gobierno Vasco (Basque Government – Autonomous Community of Basque Country) is responsible for the Basque Country network of automatic stations, in collaboration with the University of Basque Country. Under agreement among CSN, Basque Government and University of Basque Country, data of this network is shared with CSN.

4.6 Centre for Research and Experimentation of Public Works

The Center for Research and Experimentation of Public Works (CEDEX) is a public research institution, organically attached to the Ministry of Transport, Mobility and Urban Agenda, and functionally to the Ministry for Ecological Transition and Demographic Challenge, responsible for the determination of the radiological quality of the Spanish continental and coastal waters.

[4] CIEMAT radiological laboratory has been verified as a part of the Art. 35 verifications in the Trillo NPP (ES 04-02), the Huelva site (ES 09-08) and the Palomares site (ES 19-01).

5 GAROÑA NPP ENVIRONMENTAL RADIATION MONITORING PROGRAMMES

5.1 SITE INTRODUCTION

Garoña Nuclear Power Plant (Fig. 1) is operated by Nuclenor S.A. It began commercial operation on 11 May 1971; the alternator was connected to the grid for the first time on 2 March 1971. The plant was built in accordance with the permit granted by the General Directorate of the Energy on 2 May 1966. The first provisional operation licence was granted by the Ministry of Industry on 30 October 1970, including the initial loading of the reactor. The operation licence was extended for the last time on 3 July 2009, establishing the date of definitive cessation of exploitation on 6 July 2013.

The plant has a nuclear steam production system consisting of a boiling water reactor of the BWR 3 type designed and supplied by General Electric. Containment type is Mark I with pressure suppression. Thermal power was 1,381 MW in the initial design of the plant, equivalent to a gross electrical power of 460 MW. Cycle performance improvements were subsequently made, resulting in an increase in gross electrical power to 466 MW.

Today the Garoña NPP is in a permanent shutdown, with the irradiated fuel in the fuel pool, and in the phase prior to dismantling. The definitive shutdown of the plant, following the refusal by the competent ministry to renew its operating permit, is dated in August 2017. The main activities at the site today relate to maintaining the safe storage of spent fuel and preparing the plant for dismantling. A temporary spent fuel storage area (ATI) has been constructed at the site to receive the spent fuel in Castor containers. Monitoring of the environment and discharges continue with minor modifications to the monitoring programme of an operational plant.

The Garoña NPP site covers an area of 37 hectares, forming a peninsula surrounded by a meander of the Ebro River. This peninsula belongs to the municipalities of Garoña and Santa María de Garoña at the Tobalina valley (Burgos province). The Ebro River surrounds the peninsula, leaving a narrow neck in the extreme southwest. The meander of the river is part of the Sobrón reservoir, owned by Iberdrola. The boundaries to the southwest are privately owned land. The plant is located approximately in the geometric centre of the peninsula, with the intake channel from the Ebro River to the west and the discharge channel to the Ebro River to the south (see Fig. 5 on page 24).

5.2 SURVEILLANCE PROGRAMMES

The radiation surveillance around the Garoña NPP is carried out by the CSN, the Directorate General for Civil Protection and Emergencies, the Basque Government and the site operator. Table I summarises the surveillance programmes. The on-line radiation monitoring capabilities around the Garoña NPP include the CSN automatic stations network (REA), the Directorate General for Civil Protection and Emergencies Radioactivity Alert Network (RAR) and the Basque Government network (ERA). The site-related sampling and measuring programmes around the Garoña NPP include the Operator's Environmental Radioactivity Monitoring Programme (PVRA), the Operator's Quality Control Programme (CC) and the regulator's Independent Environmental Radioactivity Monitoring Programme (PVRAIN and REM). Additionally, the Garoña NPP is currently performing a preoperational surveillance program in the close surroundings of the future Temporary Spent Fuel Storage Facility (ATI). This programme started in 2015.

Table I. Summary of environmental surveillance around the Garoña NPP

Responsible	Network name	Type of measurement
CSN	REA	On line gamma dose rate
Basque Government	ERA	On line gamma dose rate
Directorate General for Civil Protection and Emergencies	RAR	On line gamma dose rate
Operator Garoña NPP		On site gamma dose rate and air sampling
Operator Garoña NPP	PVRA	Analysis in different types of samples and TLDs
Operator Garoña NPP	CC-PVRA	Quality control analysis
CSN	PVRAIN	Analysis in different types of samples
CSN	REM-Dense	Air, Drinking Water, Soil, Milk, Mixed Diet, Surface Continental Water
CSN	REM-Sparse	Air, Drinking Water, Mixed Diet, Milk, Surface Continental Water

Figure 1. Garoña nuclear power plant

5.3 OPERATORS ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMME

5.3.1 On-site monitoring

Garoña NPP has an on-site radiation monitoring network with three dose rate monitoring locations with air samplers for emergency purposes (Fig. 2). These provide continuous information on the site area dose rate. Each station has a gamma radiation probe for the environmental radiation measurement and a pen recorder. They have also small-volume air samplers with similar characteristics to the PVRA equipment. These stations are not on-line; the data is recorded on paper charts.

Figure 2. On-site dose rate monitoring network station

5.3.2 Off-site monitoring

In Spain the operator of the nuclear power plant has to run a sampling, analysis and measurement programmes of radiation levels and radionuclides present in the environment within a 30 km radius (PVRA) and a quality control monitoring programme to verify the analytical quality of the measurements (CC-PVRA). The main pathways of human exposure to radiation have to be monitored, as well as those ecosystem elements, which are good indicators of the behaviour of radionuclides in the environment.

In the Operator's Analytical Quality Control Program (CC) between 5% and 10% of PVRA samples are taken and analysed by a different laboratory than the one responsible for the PVRA program. The sampling locations change every year to obtain samples in all the points included in the main programme.

Sampling and measuring programme details are included in the documents: MCDEP "Manual de Cálculo de Dosis al Exterior en Parada" (Shutdown Offsite Dose Calculation Manual) and PVRA "Programa de Vigilancia de Radiación Ambiental" (Environmental Radiological Surveillance Program).

Ambient radiation dose

The Garoña NPP off-site monitoring programme includes monitoring of ambient radiation dose using TLD dosimeters. The dosimeters are placed in small locked wooden boxes at about 1.3 m height (Fig. 3). Every TLD is composed of a card, which has assembled four thermoluminescent detectors and a holder. The detector material is LiF:Mg, Cu, P. The detectors are calibrated in a Cs-137 irradiation unit (traceable to a national standard body) to calculate their element correction coefficients (ECC).

There are altogether 19 TLD monitoring locations in the plant vicinity. The TLDs are identical to the ones used for personnel radiation monitoring at the plant; they are changed monthly. Dose readings are carried out by the MASL laboratory.

The preoperational surveillance program in the surroundings of the future Temporary Spent Fuel Storage Facility (ATI) (Fig. 4) includes four TLD locations next to the storage area (one on each side). The TLDs are read monthly.

Figure 3. Off-site monitoring box for the TLD

Figure 4. Future Temporary Spent Fuel Storage Facility (ATI)

Air sampling

The operator's environmental sampling programme includes six air sampling stations (plus three additional on-site stations for emergency purposes). The filters used are made of cellulose nitrate. Suction pumps are rotary vane type pumps, providing a constant flow of 30 l/min in order to sample a total air volume of about 300 m^3 over a week. The system includes a flow meter and a total flow counter, but no electrical back-up. Filters are analysed weekly.

Environmental sampling

The operator's environmental sampling programme includes the following components:

- Soil yearly from 6 locations
- Rain water monthly from 6 locations
- Milk monthly from 4 locations
- Sugar three times a year from 1 location
- Agricultural products yearly from 14 locations
- Meat and eggs yearly from 5 locations
- Fish half yearly from 3 locations
- Drinking water monthly from 7 locations
- Ground water quarterly from 2 locations
- Surface water monthly from 4 locations
- Indicator organisms (vegetables) yearly from 4 locations
- Indicator organisms (animals) yearly from 7 locations
- Sediment half-yearly from 8 locations

The samples are analysed by the MASL laboratory. Table in Annex 2 describes the programme details.

5.4 AUTHORITIES' INDEPENDENT ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

5.4.1 Automatic radiation dose rate monitoring networks

The following automatic dose rate monitoring networks are present in the vicinity of the Garoña NPP:

- REA network, owned and managed by the CSN, which has 185 advanced monitoring stations nationwide (one spectroscopic station in the vicinity of the Garoña NPP).

- Basque Government network of on-line monitoring stations (ERA), which is managed by the University of the Basque Country. The CSN has signed an agreement with the Basque Government for the consultation and public use of these data.
- Directorate General for Civil Protection and Emergencies Radioactivity Network (RAR) with 13 stations for gamma dose rate measurement around the Garoña NPP. In total this nationwide network comprises over 800 monitoring stations. In the vicinity of the Garoña NPP the municipalities where the stations are located are Bóveda, Trespaderne, Villaescusa de Tobalina, Villanueva de Valdegovia, Zuazo de Cartango, La Puebla de Arganzón, Salinas de Añana, Puentelarrá, Tobalinilla, San Martín de Don, Barcina del Barco and Pangusión y Gabanes.

5.4.2 Air sampling

University of Leon

In Leon, there is an air sampling system located in a weather cabin for measuring meteorological variables in a space belonging to the Department of Applied Physics, located in the School of Industrial, Computer and Aerospace Engineers of the University of Leon. Sampler is type S.A.I.C. Radeco Aerosol and radioiodine collector, model AVS-28A. Millipore AAWP04700 membrane filters are used (Mixed cellulose ester). Additionally, gaseous iodine is sampled using an impregnated active charcoal cartridge placed after the particulate aerosol filter. Frequency of filter change is weekly.

University of Basque Country

The UPV/EHU LMBA (Low Activity Measurements Laboratory, Department of Energy Engineering) belongs to both REM networks (sparse & dense). For this reason, two different aerosol samples are used: low volume and high volume samplers. Both air samplers are located at the roof of the building G in the Engineering School of the UPV in Bilbao.

The low volume sample is a SAIC RADECO Model LN-28A Constant Flow Air Sampler. Aerosol samples (particulate) are collected using a 47 mm diameter, 0.8 µm pore size, nitrocellulose filters for one week. Additionally, gaseous iodine is sampled by using a Radeco type Cp-100 impregnated active charcoal cartridge placed after the particulate aerosol filter. Cartridges are 57.5 mm in diameter. Frequency of filter change is weekly. Typical air flow is 30±5 L/min; volume of air sampled is 250 – 350 m^3/week. Gross alpha counting is performed on the weekly filter. In addition, gamma spectrometry and Sr-89/90 analysis is performed on 13 accumulated filters. The charcoal filter is analysed for I-131 radioiodine uptake weekly.

The high volume sampler is a Physik-Technik-Innovation (PTI) Aerosol Sampling Station ASS-500. The station is a stand-alone, all-weather instrument for continuous air aerosols collection with high air flow rate up to 950 m^3/h. Polypropylene filter with a surface of 47x47 cm is used. Frequency of filter change is weekly. Typical air flow is 11600±500 L/min; volume of air sampled is about 111 000 – 130 000 m^3/week. Gamma spectrometry is performed on the weekly filter.

5.4.3 Environmental sampling

PVRAIN programme

The PVRAIN programme conducted by the CSN is a nationwide sampling programme, which acts as a control of the Garoña NPP operator's programme. It collects some 5-50 % of the samples taken by the operator for an independent analysis. Table II illustrates the programme.

Table II. PVRAIN control sampling programme at the Garoña NPP vicinity

SAMPLE	NUMBER	FREQUENCY	ANALYSIS
Soil	1	Yearly	Gamma emitters, Sr-89/90
Surface Water	3	Monthly	Gamma emitters, H-3, Beta T/R
Sediments	1	Yearly	Gamma emitters, Sr-89/90
Shore sediments	1	Yearly	Gamma emitters
Drinking water	6	Monthly	Gamma emitters, H-3, Sr-89/90, Beta T/R
Groundwater	1	Yearly	Gamma emitters, H-3, Beta T/R
Milk	3	Monthly	Gamma emitters, Sr-89/90, I-131
Crops	2	Yearly	Gamma emitters, Sr-89/90, I-131
Fish	1	Yearly	Gamma emitters
Eggs and Meat	1	Yearly	Gamma emitters
Fauna and flora	2	Yearly	Gamma emitters, Sr-89/90

REM surface water sampling

As a part of the REM programme for monitoring Spanish rivers and coastal waters, there are 11 dense network and one sparse network sampling stations on the river Ebro. The Ebro River Basin Authority collects water samples (5 litres for dense network and 350 litres for sparse network) manually and sends them to the CEDEX laboratory for analysis together with a filled-in sampling sheet. Water sampling follows a protocol valid for all surface waters under control of the river authority. The frequency of the sampling is defined with the aim of obtaining the best representative information about a specific radiological situation (quarterly or monthly). The analysis includes gross alpha activity, gross beta activity, residual beta activity, tritium activity, gamma spectrometry (artificial radionuclides) and radiocesium (Cs-134 and 137).

Other sampling

As a part of the REM programme, the University of Leon and the University of the Basque Country carry out the following sampling and analysis:

- Soil annually in Leon (site cleared of vegetation located around the university campus) Quantities: 10 – 25 kg. Natural radionuclides, artificial radionuclides, Sr-90, Total Beta index.
- Soil annually in Bilbao (site located on the top of a hill in the outskirts of Bilbao, without vegetation and away from buildings and high-traffic roads). Gamma spectrometry, Sr-90 and gross beta. Mass sampled approximately 500 g.
- Milk from three points in the community of Castilla y León (León, Zamora and Palencia). Natural radionuclides, artificial radionuclides, Sr-90.
- Mixed diet sampling at the University of Leon cafeteria and the Bilbao School of Engineering canteen. Gamma spectrometry, Sr-90 and C-14.

5.5 MOBILE MONITORING SYSTEMS

5.5.1 Nuclear Safety Council

The CSN has signed collaboration agreements with the following specialized public entities, whose mobile radiological characterization units are available in case of emergency:

- Mobile unit for radiological characterization of the Centre for Energy, Environmental and Technological Research (CIEMAT), equipped with the following:
  - Measurement of external radiation (GAMMATRACER Geiger-Muller tube, Reuter Stokes RSS112 ionization chamber)
  - Air activity concentration measurement (high flow suction pump and solid scintillation detector (NaI(Tl))
  - Surface contamination measurement (two NaI(Tl) scintillation detectors)
- Extremadura Board mobile monitoring unit. The Extremadura Board and CSN have signed an agreement for planning, preparation and response to radiological emergency situations, in which the Extremadura Board undertakes to send its mobile emergency unit (CBRN) to any place in the Spanish territory where a radiological incident or accident occurred, in order to carry out a radiological characterization of the event.

In addition, the CSN has 15 portable autonomous monitoring stations available to deploy locally in the event of a radiological or nuclear accident. These stations measure gamma dose rate in air with a 10-minutes timeframe; they have two Geiger-Müller detectors to cover a wide measurement range from 10 nSv/h to 10 Sv/h and an integrated GPS receiver, which enables the automatic recognition of their location. The stations are stored in the CSN with the batteries fully charged to be used at any time when an emergency arises. The CSN emergency room (SALEM) has access in real-time to the data provided by these stations through the Network Monitoring Centre (NMC).

In the CSN Emergency Room the data recorded by the radiological mobile units described above are received in real time. These data are shown on the map of the area that is being characterized. Operation of these mobile monitoring systems and the transmission of radiological and positioning variables is periodically exercised as part of the CSN's emergency planning.

5.5.2 Garoña NPP

Garoña NPP has one monitoring vehicle, which can be equipped with portable monitoring and sampling equipment in order to carry out local environmental monitoring in the event of an emergency.

6 GAROÑA NPP LIQUID AND GASEOUS RADIOACTIVE DISCHARGE MONITORING PROGRAMMES

6.1 INTRODUCTION

Garoña NPP is equipped for carrying out both continuous and batch wise monitoring of radioactivity in gaseous and liquid discharges. While the operator is responsible for performing the discharge monitoring programme, the regulator verifies, on a monthly basis, that the sampling programme and the analytical assessment performed fulfil the requirements established in the Offsite Dose Calculation Manual, as well as that the radioactive effluent monitoring instrumentation has been operable and their alarm and/or trip set points have not been exceeded.

Additionally, during the inspections carried out on a biennial basis, the regulator verifies that the radioactive effluent monitoring instrumentation calibration and maintenance programmes have been performed. The regulator also checks chosen samples in order to verify the data transmission chain between initial measurements of the sample and the final reporting to the CSN. It is also verifies the samples preparation and measurement, the calibration of the laboratory equipment and the management of the samples (identification, storage and traceability).

6.2 DISCHARGE REGULATION

The Royal Decree 783/2001 specifies the maximum dose limits for the members of the public. The effective dose limit for members of the public shall be 1 mSv per year and an equivalent dose to the skin 50 mSv per year. In the Garoña NPP the discharge limit is established on 0,1 mSv/y (operational restriction), distributed in 0,08 mSv/y and 0,02 mSv/y for gaseous and liquid effluents respectively.

Surveillance for protection of the public is based on evaluating the cumulative dose in 12 consecutive months that could potentially be received by members of the public as a consequence of the emissions of radioactive material into the environment. In order to facilitate continuous surveillance and control, instantaneous limits are established, which provide a sufficient margin to guarantee that the annual dose limit will not be exceeded, while at the same time providing the facility with operational flexibility.

The Garoña NPP Technical Specification for Shutdown 5.6.2.2 (ETP) contains the Radioactive Effluent Control Program with the limits above indicated. The Radioactive Effluent Control Program procedural details are developed by the document “Manual de Cálculo de Dosis al Exterior en Parada” (MCDEP) (Shutdown Offsite Dose Calculation Manual). The MCDEP contains the methodology and parameters to be used to calculate dose to the public resulting from the emission of liquid and gaseous effluents, and to calculate the alarm/trip set points of the effluent monitors. It also contains a list of the procedures applicable to the discharges, and a summary of the discharge routes and the structure of the liquid and gaseous effluents. The MCDEP is based on international guidelines[5].

6.3 MONITORING OF GASEOUS DISCHARGES

6.3.1 Monitoring points

The quantitative analysis of the radioactivity content of the gaseous discharges is based on sampling of the outflow through the plant discharge chimney. In addition, gaseous discharge monitoring is

[5] - NUREG-0133 “Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants”
- NUREG-1302 "Offsite dose calculation manual guidance: Standard radiological effluents controls for Boiling Water Reactors"
- NUREG-0473 “Standard Radiological Effluent Technical Specifications for Boiling Water Reactors”
- Regulatory Guide 1.109 “Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50”, Appendix I

carried out at the waste material storage building and the temporary storage facility for solid radioactive waste (Fig. 5).

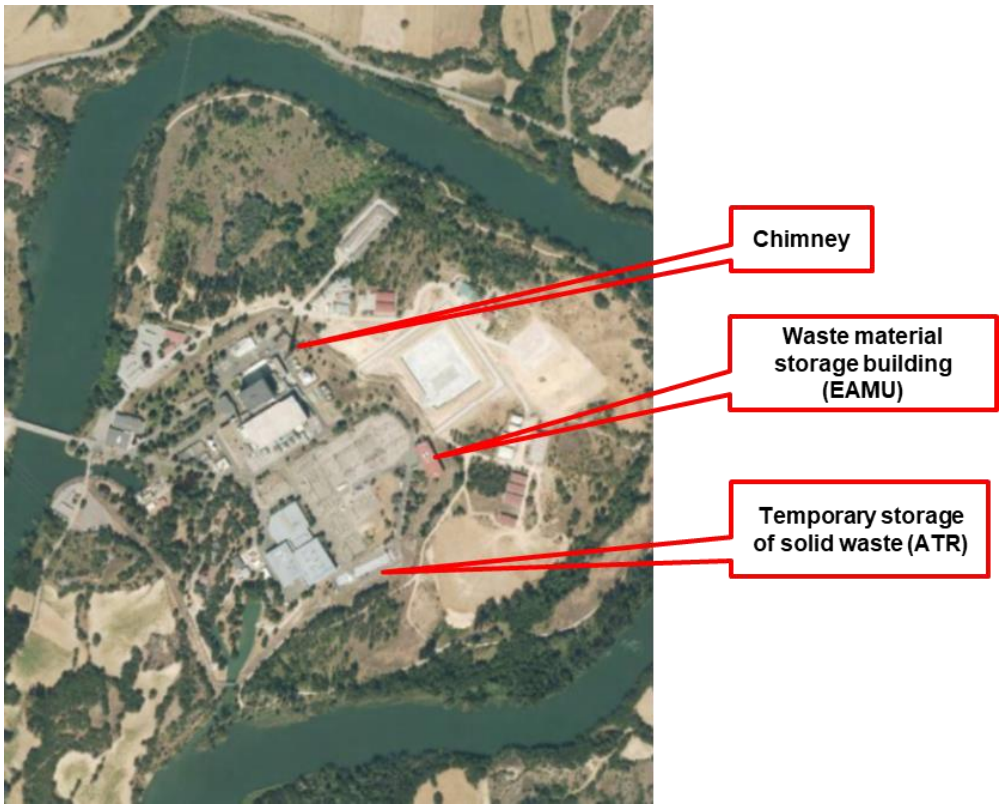

Figure 5. Gaseous discharge monitoring points

6.3.2 Chimney monitoring

The instantaneous dose rate limits ensure at all times that discharge rates of radioactive materials in gaseous effluents in the chimney will be such that the corresponding doses above the background level, to the members of the public at points located at or beyond the site boundary, will not exceed the values specified above.

To ensure that these limits are met, the following surveillance actions are performed:

- It is determined periodically that the dose rate due to noble gases in gaseous effluents is within the stated limits.
- It is determined periodically that the dose rate due to tritium, Kr-85 and all particulate radionuclides with a half-life of more than 8 days in gaseous effluents, is within the stated limits, and representative samples and analyses are performed according to the sampling and analysis programme.

The chimney gas is made up of the contribution of the ventilation units of the plant buildings. There is a loop for continuous measurement of the stack flow. A sample is continuously drawn by means of an isokinetic probe located at a height of 2/3 of the total stack height. The sample passes through two shielded chambers for detecting the radioactivity of the gas, and from there back to the chimney after passing through a motorized valve and two pumps. A gamma-sensitive scintillation detector (NaI) and a check source are located in each shielded chamber.

The gaseous effluent control system in the chimney has two instrumentation channels, each of which includes a scintillation detector (NaI) sensitive to gamma radiation, a pulse preamplifier and a process radiation monitor that receives the signal from the detector. The radiation meters send their output signal to a 2-pen recorder and to auxiliary trip circuits, in charge of activating the corresponding alarms.

6.4 MONITORING OF LIQUID DISCHARGES

6.4.1 Monitoring points

The quantitative analysis of the radioactivity content of the liquid discharges is based on sampling the NPP waste water tanks before discharges. The online monitoring of the liquid discharges consists of monitoring the service water discharge and the wastewater discharge in order to detect any abnormal activity in the discharge flow – these do not contribute to the calculation of the total discharge.

In order to facilitate continuous surveillance and control, instantaneous limits are established that provide a sufficient margin to guarantee that the annual dose limit will not be compromised, while at the same time providing operational flexibility for the facility.

The following surveillance requirements are performed to ensure that established limits are met:

- Samples of radioactive liquid waste are taken and analysed according to the sampling and analysis programme.
- The results of the radioactivity analyses are used to ensure that concentrations at the point of emission remain within the established limits in the Shutdown Technical Specifications.

6.4.2 Liquid waste discharge monitoring

In order to carry out monitoring of the tank discharges, there is a process monitor with alarm/trip settings in the Control Room. This radiation monitor is off-line with a pump. The detector is a sodium iodide crystal (NaI), inserted in a chamber containing the liquid to be controlled, and located in the discharge line of the liquid waste treatment system before the discharge union with circulating water. The detector assembly is lead-shielded.

The detector signal is sent to a pulse preamplifier and from there to the radiation monitor. These send signal to an auxiliary trip unit, which triggers the corresponding alarms, to a 2-pen recorder on the control room panel 902, and to the recorder in the Radwaste control room (which activates a high radiation alarm from the discharge to the channel in the Radwaste control room).

6.4.3 Service water discharge monitoring

The continuous discharge (service water system) is controlled by the service water process monitor with alarm settings in the control room. This radiation monitor is off-line pump type. The detector is a sodium iodide crystal (NaI), inserted in a chamber containing the liquid to be controlled. The detector assembly is lead-shielded.

The detector signal is sent to a pulse preamplifier and from there to the radiation monitor. These send signal to an auxiliary trip unit, which triggers the corresponding alarms, to a 2-pen recorder in the control room and to a recorder in the Radwaste control room, which activates an alarm.

7 LABORATORIES PARTICIPATING IN THE GAROÑA NPP DISCHARGE AND ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

7.1 OPERATORS LABORATORIES FOR DISCHARGE SAMPLES

7.1.1 Garoña NPP laboratory

Garoña NPP has a well-equipped radiological laboratory for analysing the radioactivity content of gaseous and liquid samples for discharge monitoring and operational purposes. The laboratory is available on 24/7 basis with a staff of 21. Samples are taken and/or received by the laboratory, examined and identified for their control and subsequent analysis. Once the samples have been received at the laboratory, every sample is examined, identified by a standardised reference code and recorded in a sample file of the computer application specifically designed for radiological analysis. The reference code is recorded in the sample file and on all the sample containers. Sample preparation differs depending on the sample matrix, the analysis to be performed and the measurement technique.

Radiochemical measurements are recorded in measurement control books (gamma spectrometry, total gamma counting, liquid scintillation, total alpha counting). Measurement times are established to meet the detection limits specified in Commission Recommendation 2004/2/Euratom and in the Offsite Dose Control Manual (ODCM).

Calculations of specific activities and characteristic limits are performed by applying the ISO-11929 standard using the Genie2K application for gamma spectrometry and spreadsheets validated for this purpose for the other determinations.

The laboratory is not accredited. It takes part in national intercomparisons organized by the CSN.

7.2 OPERATORS LABORATORIES FOR ENVIRONMENTAL SAMPLES

7.2.1 MASL

The Garoña NPP has contracted the MASL (Laboratorio de Medidas Ambientales S.L. at Medina de Pomar) laboratory in Medina de Pomar to analyse the environmental samples. It carries out the analysis of the PVRA programme on behalf of the operator.

Once the samples have been received at the laboratory, every sample is examined, identified by a standardised reference code and recorded in a sample file of the computer application specifically designed for radiological analysis. The reference code is recorded in the sample file and on all the sample containers. The sample preparation, which takes place prior to the measurement, differs depending on the matrixes and analysis to be performed. Table III below details the sample measurements and table IV the laboratory equipment.

Table III. MASL laboratory sample measurements

MEASUREMENT	MEASUREMENT DEVICE	COUNTING TIME
Sr-90	Alpha - beta low level counter	Air: 300 minutes Liquid food: 180 minutes Solid food: 300 minutes Water: 180 minutes Soil/sediment: 800 minutes Vegetable (non-edible) and indicator organisms (animals): 300 - 800 minutes
H-3	Ultra low level liquid scintillation spectrometer	Water: 70 minutes
Ba-140, Be-7, Bi-214, ~~Ce-141~~, Ce-144, Co-58, Co-60, Cs-134, Cs-137, Fe-59, K-40, La-140, Mn-54, Nb-95, Pb-212, Pb-214, Tl-208, Zn-65, Zr-95, Ac-228	Gamma detector	Air: 20000 seconds Liquid food: 20000 seconds Solid food: 25000 seconds Water: 50000 seconds Soil/sediment: 30000 seconds Vegetable (non-edible) and indicator organisms (animals) : 50000 seconds
Gross beta/gross beta without potassium contribution	Alpha-beta low level counter	Air: 300 minutes Water: 300 minutes

MEASUREMENT	MEASUREMENT DEVICE	COUNTING TIME
Radiation dose	TLDs and TLD reader	Non applicable

Table IV. MASL laboratory measurement devices

MEASUREMENT DEVICE	MANUFACTURER	TYPE	CALIBRATION AND MAINTENANCE	STANDARD USED	CALCULATION OF RESULTS
Gamma detector (8)	CANBERRA	HPGe detector	Energy and efficiency calibration Efficiency checks Background measurements Liquid nitrogen charge MASL Lab. procedures ref. MLPMA-208 and MLPMA-253	Mixed gamma ray sources traceable to a national standard body	Computer application for radiological analysis
Alpha - beta low level counter (4 devices and 40 detectors)	BERTHOLD	Gas filled proportional counter	Efficiency calibration Efficiency checks Background measurements PR gas charge MASL Lab. procedure ref. MLPMA-205 and MLPMA-206	Sr-89/ Sr-90 – Y-90/ I-131/ Am-241 sources traceable to a national standard body	Computer application for radiological analysis
Ultra low level liquid scintillation spectrometer (1)	PERKIN-ELMER	Liquid scintillation counter	Efficiency calibration Efficiency checks Background measurements MASL Lab. procedure ref. MLPMA-204	H-3 source traceable to a national standard body	Spreadsheets
TLDs and TLD reader (1)	HARSHAW – BICRON	Thermolu minescence dosimetry (material - LiF:Mg, Cu, P)	Calculation of reader calibration factor (RCF) and element correction coefficients (ECC) MASL Lab. procedure ref.: MLPMA-209	Cs-137 irradiation unit traceable to a national standard body	Spreadsheets

Data are printed on paper, as well as stored in a database on the MASL intranet. A validated computer application is used for the calculation of the activity results (except for tritium and radiation dose). Validated spreadsheets are used for the calculation of the radiation dose and tritium activity results.

MASL laboratory reports the results to the Garoña NPP. The analysis are performed according to established detection limits. Moreover, there are notification levels established for the activity results. In the case that such notification levels are exceeded, the MASL laboratory notifies the corresponding results immediately to the nuclear power plant.

After the analysis, the sample is stored to verify any result if required. Every analytical result is subject to quality assurance checks by the MASL laboratory staff. Various methods are applied in connection with quality assurance, such as

- Comparison of the calibration checking results
- Comparison of the background measurements
- Control of blank samples
- Analysis of unknown and duplicated samples
- Comparison of the measurements carried out by two different laboratories on the same sample

- Participation in national and international proficiency tests
- Weekly control of the detection limits and notification levels
- Control of process indicators
- Systematic comparison between the analytical results and the historical values of activity and detection limits
- Inspection of every analytical process

The samples are stored until the final results report is approved and sent to the CSN (the quality control samples are kept 1 additional year) in a warehouse protected from light. Results are stored electronically on shared hard drives that are regularly backed up. From preparation to delivery and from reception to readout, TLD dosimeters are stored inside a 10 cm thick lead shielding to minimize natural background radiation. While not in use, TLDs are safely stored in the laboratory.

The MASL laboratory quality assurance system is certified by DNV (Det Norske Veritas) according to the international standard ISO 9001. Every three years, the Evaluation Group of Suppliers of Spanish Nuclear Power Plants audits MASL Laboratory in accordance with the requirements of the UNE 73401 standard. The laboratory is undergoing accreditation for radioactivity measurements (gross beta, gross beta without potassium contribution, gross alpha and tritium) according to the international standard ISO 17025. It takes part in national intercomparisons organized by the CSN and international proficiency tests prepared by the IAEA and the EC (DG JRC).

7.2.2 CIEMAT

The CIEMAT laboratory is located in Madrid. Unit of Environmental Radiology and Radiation Monitoring (URAyVR) carries out the analysis of the Garoña NPP quality control programme. The unit is accredited by ENAC (UNE EN ISO/IEC 17025; accreditation number ENAC 144/LE471).

URAyVR/CIEMAT have a quality assurance department that performs internal audits, reviews the procedures and maintains the quality system. Table V details the analyses carried out and Table VI the laboratory equipment. URAyVR retains the samples and reports in electronic format at least for 5 years after analysis and reporting.

Table V. CIEMAT sample measurements

SAMPLE	RADIONUCLIDE	DEVICE	COUNTING TIME
Air, water, soil, sediments and biota	Gross beta activities	Proportional counters	1 000 min
Water	Gross beta activities excluding potassium	Atomic emission spectrometry	1 000 min
Air, water, soil, sediments and biota	Gamma emitters	Gamma spectrometry	60 000 s
Water	H-3	Scintillation counters	300 min
Air, water, soil, sediments and biota	Sr-90	Proportional counters	2 000 min

Table VI. CIEMAT measurement devices

DEVICE	MANUFACTURER	TYPE OR MODEL	NUMBER
HPGe detectors	Canberra	GR2920, GR3321, GR4022, GX3519, BE5030, GC2518, GC3251, BE5030, GX4020, X10022 and GCW3521	11 detectors
Proportional counters	Berthold	LB-770 B	3 devices (30 detectors)
	Canberra	LB4200-8	1 device (8 detectors)
Scintillation counters	Packard	Tricarb 2750 TR/SL, Tricarb 2770, Tricarb 3100 and Tricarb 3110 TR	4 detectors

Reports are regularly submitted to the Garoña NPP when samples are analysed. All reports submitted to the client are digitally signed and stored on a group hard disk, which is only accessible by the persons responsible of the analysis. Back-up copies of this hard disk are done daily.

7.3 REGULATORS LABORATORIES FOR SITE-RELATED ENVIRONMENTAL SAMPLES

7.3.1 Department of chemistry and applied physics of the University of Leon

The regulator's laboratory for the Garoña NPP site-related environmental samples is the environmental laboratory of the Department of chemistry and applied physics of the University of Leon. It carries out the measurements of the CSN control samples taken in the framework of the Garoña NPP environmental sampling programme (PVRAIN). The laboratory has the following counting equipment:

- High resolution gamma spectrometer (HPGe)
  - Natural radionuclides: Be-7, K-40, Tl-208, Pb-212, Bi-214, Pb-214, Ra-226, Ac-228
  - Man-made radionuclides: Cr-51, Mn-54, Co-58, Co-60, Fe-59, Zn-65, Nb-95, Zr-95, Ru-103, Ru-106, I-131, Cs-134, Cs-137, Ba-140, La-140, Ce-144
- Low Background Alpha-Beta Proportional Counter
  - Sr-90, total alpha and beta indexes
- Atomic absorption spectrophotometer
  - K-40
- Liquid scintillation counter
  - H-3

The data are included into a database (Keeper-file) following the indications provided by the CSN. The final results for the determinations are performed using Excel-sheets, which are independent of the measurement equipment.

This laboratory is not accredited. It has participated in national intercomparison exercises organized by the CSN during the last 10 years.

8 VERIFICATIONS

8.1 INTRODUCTION

Verifications were carried out in accordance with the agreed programme (Annex 1). This chapter summarises the verifications carried out the by the verification team. The team has assessed the monitoring arrangements based on their own expertise and comparison with similar arrangements in other Member States.

The outcome of the verification is expressed as follows:

- A '*Recommendation*' is made when there is a clear need for improvement in implementing Art. 35. These are included in the main conclusions of the verification. The Commission requests a report on the implementation of the recommendations – lacking implementation of a recommendation can lead to a reverification.
- A '*Suggestion*' is made when the verification team identifies an action, which would further improve the quality of the monitoring.

In addition, the team may '*commend*' particularly good arrangements, which could serve as a best practice indicator for the other EU Member States.

8.2 OPERATOR ON-SITE ENVIRONMENTAL RADIOACTIVITY MONITORING STATIONS

8.2.1 Monitoring location 1

The verification team verified the monitoring systems at the on-site monitoring station 1. There are three identical stations on the Garoña NPP site. The station includes the following:

- Small volume particle air sampler (filter at 2 meter height, total flow counter and flow meter, flow 55 l/min)
- Radiation dose rate meter at 3 meter height (local display, paper recorder, no alarm)

The equipment is old, but functional. There is no data connection to the plant, so receiving the radiation dose rate information from these systems requires the plant personnel to visit the station to collect the paper record.

No remarks.

8.2.2 Monitoring location 3

The verification team verified the monitoring systems at the on-site monitoring station 3 (Fig. 6 and 7). The station includes the following:

- Small volume particle air sampler (filter at 2 meter height, total flow counter and flow meter, flow 35 l/min)
- Radiation dose rate meter at 3 meter height (local display, paper recorder, no alarm)

The equipment is old, but functional. There is no data connection to the plant, so receiving the radiation dose information from these systems requires the plant personnel to visit the station to collect the paper record.

No remarks.

Figure 6. On-site monitoring location 3

Figure 7. On-site dose rate monitor and paper chart recorder at monitoring location 3

8.3 OPERATOR OFF-SITE ENVIRONMENTAL RADIOACTIVITY MONITORING STATIONS

8.3.1 Santa Maria de Garoña

The operator's off-site monitoring station at the village Santa Maria de Garoña is located at a small old tower structure, which houses the pump and flow meter of an air sampler. The filter is placed outside the tower. At the time of the verification, the flow was 32 l/min. The filter is changed weekly and analysed at the plant laboratory. The sample data sheet was presented to the team. The system has no back-up power source.

On top of the tower there is a 1 m^2 dry/wet deposition collector; the sample container is inside.

On the other side of road on a hilltop, there is a TLD monitoring location. The TLD is placed in a locked wooden box at 1.5 m height.

The verification team commends the very good tamper-proof arrangement for placing the TLDs.

8.3.2 San Martin de Don

The operator's off-site monitoring station at the village San Martin de Don is located in the garden of one of the houses in the village. There is a concrete hut, which houses the pump and the flow meter of the air sampler. The filter is placed outside the hut.[6] The filter is changed weekly and analysed at the plant laboratory. There is also an iodine filter (charcoal) available, but this is no longer needed, since the Garoña plant is on permanent shutdown. The system has no back-up power source.

On top of the hut there is a 1 m^2 dry/wet deposition collector; the sample container is inside.

In the vicinity there is also a TLD monitoring location. The TLD is placed in a locked wooden box at 1.5 m height.

[6] At the time of the verification, the filter was blocked and there was no flow. Apparently, this was due to recent burning of branches next door. After the filter change the flow was restored to 25 l/min.

In the centre of the village there is a drinking water well, which is used to sample ground water.

In the communal building in the centre of the village there is the RAR dose rate monitoring station (number 00645), which displayed a dose rate 0,117 µSv/h. This station is equipped with a 72h back-up battery. The date on the station display was incorrect. It was later confirmed by CSN, that this date was not reflected in the EURDEP data from this station, but that the correct date was reported.

No remarks.

8.3.3 Barcina del Barco

The monitoring location at the village Barcina del Barco has a drinking water tap and a private vegetable garden, which are used for sampling ground water and agricultural products within the operators motoring programme. In addition, there is a RAR dose rate monitoring station (number 00649), which displayed a dose rate 0,083 µSv/h. This station is equipped with a 72h back-up battery. The date on the station display was incorrect here too.

Next to the village there is an air sampling station and a dry/wet deposition sampler, which are identical to the other operator's stations. Filter airflow during the verification was 40 l/min.

No remarks.

8.3.4 Medina de Pomar

The verification team verified the TLD, the air filter station and the dry/wet deposition sampler, which are located at the MASL laboratory facility yard in Medina de Pomar. These stations are some 30 km from the Garoña NPP, so they are regarded as 'clean' area stations used as a reference for the other stations located in the vicinity of the nuclear plant.

The verification team noted that the dry/wet deposition collector is placed very close to the building wall. This may affect the representativeness of the sample (Fig. 8).

The verification team suggest placing the dry/wet deposition collector in an open area.

Figure 8. Dry/wet deposition sampler at the MASL laboratory in Medina de Pomar

8.4 OTHER MONITORING LOCATIONS

8.4.1 Quintana Martín Galíndez

The verification team verified the REA monitoring station at Quintana Martín Galíndez, about 5 km from the site. This is a new Envinet SARA spectroscopic ($LaBr_3$) gamma radiation monitor, which is part of the REA network operated by the CSN (Fig. 9). It is the only one of such stations on this area.[7] It has a back-up battery for one week. The station is located inside the fence of a Guardia Civil office, so it is well protected from tampering and intrusion.

No remarks.

Figure 9. REA automatic spectroscopic radiation monitoring station at Quintana Martín Galíndez

8.4.2 Soil sampling

The verification team visited the site at about 1 km distance from the plant, where soil samples are taken as a part of the operator monitoring programme. Five 11×11 cm samples are taken from undisturbed soil to about 5 cm depth.

No remarks.

8.5 OPERATORS MOBILE MONITORING EQUIPMENT

The operator of the Garoña NPP has no mobile laboratory, but there is a set of portable equipment, which can be used to carry out radiation dose rate monitoring and environmental sampling in the plant vicinity in the event of an emergency. The equipment (Fig. 10) includes the following:

[7] Verification team was informed, that the operational NPPs in Spain typically have a ring of 15-20 such stations around the plant, but since the Garona NPP is in permanent shutdown, no such ring was constructed here.

- Portable air sampler (F&J Products, particulate filter, no charcoal filter)
- Smear test sampling equipment
- Water sampling equipment
- Dose rate monitor
- Contamination monitor
- Personal dosimeters and protective equipment

In addition, the equipment kit contains the relevant monitoring instructions (checklists) and sampling sheets for sample documentation. Altogether 25 staff members have been trained to use the equipment, five of them are on duty at all times. Monitoring is carried out using a dedicated 4x4 vehicle (Toyota Land Cruiser).

No remarks.

Figure 10. Operator's portable monitoring equipment

8.6 MONITORING OF GASEOUS RADIOACTIVE DISCHARGES AT THE GAROÑA NPP

8.6.1 NPP stack

Gaseous radioactive discharges are released to the environment via a single stack. The stack is equipped with routine and emergency monitoring systems (Fig. 11 and 12). Isokinetic sample from the outflow gas is taken at 2/3 height of the stack. The system is used to take a continuous sample of the outflowing air using a particulate filter and a noble gas monitor, and to monitor outgoing activity with an on-line detector, which provides an alarm on high values. In addition, there is a bubble sampler (MARC 7000) for monitoring tritium. There is also a possibility to use charcoal filters for iodine monitoring, but since the plant is in permanent shutdown since 2012, this monitoring is no longer needed.

No remarks.

Figure 11. Garoña NPP stack routine gaseous discharge monitoring system

Figure 12. Garoña NPP stack emergency discharge monitoring system

8.6.2 Temporary waste storage facility

The verification team verified the availability of the gaseous discharge monitoring equipment at the temporary waste storage facility. This facility (Fig. 13) is located outside the plant controlled area. The purpose of the system is to detect possible releases from the radioactive waste drums stored on-site. There are altogether six sampling cabinets, which house particulate air filter collectors. Each cabinet receives a sample from three underground waste drum storage cells. The equipment consist of a pump, filter and a flow meter. The filters are changed monthly.

No remarks.

Figure 13. Temporary waste storage facility

8.6.3 Waste treatment building

The verification team verified the availability of the gaseous discharge monitoring system located on the roof the of waste treatment building. The purpose of the system is to detect possible radioactive releases from waste treatment operations passing through the HEPA filters at the building roof (Fig. 14 and 15). The system consists of a pump and a particulate filter.

The system is available, but not continuously operational since there is currently no activity in the building. It is tested monthly to ensure it remains functional.

No remarks.

Figure 14. Gaseous discharge monitoring cabinet of the waste treatment building ventilation

Figure 15. HEPA filters on the waste treatment building roof

8.6.4 Reactor building ventilation

The verification team verified the availability of the reactor building ventilation system monitors. The system outlet duct is equipped with two GM-tubes to detect leaks of radioactive material in the ventilation air as quickly as possible.

No remarks.

8.7 MONITORING OF LIQUID RADIOACTIVE DISCHARGES AT THE GAROÑA NPP

8.7.1 Service water discharge

In normal circumstances, the plant service water is discharged to the river. It is not radioactive. The discharge facility includes a shielded monitoring system (pump, bypass flow-through sample tank and a detector) (Fig. 16), which provides an alarm to the control room if the outgoing service water discharge activity limit is exceeded.

No remarks.

Figure 16. Service water discharge radioactivity monitor

8.7.2 Liquid waste discharge

The liquid waste discharge facility comprises a shielded monitoring system (pump, bypass flow-through sample tank and a detector), which provides an alarm to the control room if the outgoing waste water discharge activity limit is exceeded. The system controls also an automatic shut-off valve, which closes on detection of high activity on the discharge line. (Fig. 17 and 18)

No remarks.

Figure 17. Liquid waste discharge monitor

Figure 18. Liquid waste discharge shut-off valve

8.7.3 Waste treatment building tanks

Radioactive discharge from the NPP liquid waste treatment facility is collected in four tanks, which are discharged to the Ebro River after analysis of the radioactivity content. Sample homogeneity is ensured by recirculating the tank content before sampling. Sampling takes place in a sampling cabinet (Fig. 19). Samples are analysed in the plant laboratory before a discharge permission is given to the plant operations staff.

No remarks.

Figure 19. Liquid waste tank sampling cabinet

8.8 ASSOCIATED ANALYTICAL LABORATORIES

8.8.1 Operator laboratory at the Garoña NPP

The Garoña NPP laboratory carries out the analysis of the air filters and liquid waste samples. The laboratory is not accredited. It is located in the plant controlled area. It comprises a facility for sample preparation (weighting, filtering, labelling) and a counting room (gamma spectrometry, alpha/beta counting and liquid scintillation counting). The main laboratory equipment is the following:

- 4 HPGe-detectors (Canberra) with Genie 2000 counting software
- 2 Liquid scintillation counters (Tri-Carb 1600 and 2610TR)
- 1 Berthold LR-720 Low-level counter (10 counting chambers)
- 2 Alpha-total counters

Counting equipment calibration is based on commercial activity standards. These standards are used regularly to control equipment stability (in particular the HPGe-detectors).

The laboratory participates annually in the intercomparison exercises organised by CIEMAT (involving all Spanish nuclear plant laboratories). The 2020 results of these intercomparison exercises were presented to the verification team.

The laboratory is very clean and well organised. No staff shortage was reported to the verification team.

No remarks.

8.8.2 MASL laboratory

The verification team visited the Laboratorio de Medidas Ambientales S.L. laboratory (MASL) in Medina de Pomar[8]. This is a private laboratory, which has a contract to carry out the analytical work of the environmental surveillance programmes of all Spanish nuclear power plants.[9] Laboratory staff consists of 16 persons.

The verification team verified the following facilities of the MASL laboratory:

- **Sample receipt and preparation**

  Sample receipt area includes the necessary equipment for labelling the incoming samples and including them in the laboratory database. In addition, there are the furnaces and ovens needed for sample drying and ashing, and sieves for soil samples and sediments.

- **Sample storage**

  Samples are stored in the basement of the building. All samples are kept until the corresponding report is approved. The large storage area is very well organised.

- **TLD reader**

  TLD dosimeters are read using a Harshaw 4500 TLD reader. The reader is old, but functional. MASL can use a replacement TLD reader in case of 4500 TLD device is out of operation. Altogether, more than 300 TLDs are read annually as a part of the environmental monitoring programmes. MASL laboratory does not carry out personnel dose monitoring.

[8] Lugar, Bo. Villacomparada, S N, 09500 Medina de Pomar, Burgos, Spain

[9] The MASL laboratory was verified by the Commission also in 2004, as a part of the verification ES 04-02 (Trillo NPP).

- **Gamma spectrometry**

  The laboratory has eight HPGe-detectors (Canberra) for gamma spectroscopy. Calibration of the detectors is based on commercial standards on different geometries (for example, Marinelli and air filter geometries). LABSOCS software is available for density corrections if it is needed.

  The verification team noted, that although the routine HPGe-calibration procedure includes control the system resolution (FWHM of the Co-60 peak at 1332 keV), the laboratory does not record a long-term trend of this parameter.

- **Alpha/beta counting**

  The MASL laboratory has ~~a~~ 4 Berthold alpha/beta counters for performing total beta measurements.

- **Liquid scintillation counting**

  For liquid scintillation counting the laboratory has Quantulus 1220 and Tri-Carb 5110TR counters. The latter one is brand new and was not yet operational during the verification.

- **Chemical preparation facility**

  The chemical preparation facility includes the equipment for radiochemical separation, distillation, etc. before counting.

The MASL laboratory is accredited according to ISO 17025 (process and physico-chemical analysis); accreditation of radiological analysis is currently being applied for (target 2023). It receives some 9500 environmental samples each year. The process includes control measurements by other laboratories (such as CIEMAT) of some 5-15% of all samples.

The laboratory is clean and well organised. No staff shortage was reported to the verification team.

The MASL laboratory annually participates in Spanish national intercomparison exercises organised by the CSN (CIEMAT) and international exercises organised by the IAEA and the EC (DG JRC).

The verification team suggests that the MASL laboratory maintain long-term trend graphs of the HPGe-detector calibration parameters (FWHM resolution).

The verification team suggests renewal of the TLD reader in the near future.

The verification team commends the well-organised sample storage at the MASL laboratory.

9 CONCLUSIONS

All planned verification activities were completed successfully. The information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, proved very useful.

The information provided and the verification findings lead to the following observations:

(1) The verification activities that were performed demonstrated that the facilities necessary to carry out monitoring of levels of radioactivity in air, water and soil at the Garoña nuclear power plant and in its vicinity are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(2) The verification activities that were performed demonstrated that the facilities necessary to carry out monitoring of levels of radioactivity in air, water and soil at the Garoña nuclear power plant and in its vicinity in the event of a radiological emergency are adequate. The Commission could verify the availability of a representative part of these facilities.

(3) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the gaseous and liquid discharges at the Garoña nuclear power plant are adequate. The Commission could verify the operation and efficiency of a representative part of these facilities.

(4) The verification summary is presented in the 'Main Conclusions' document that is addressed to the Spanish competent authority through the Permanent Representative of Spain to the European Union.

(5) The Commission services request a report on any significant changes in the set-up of the monitoring arrangements, in particular with regard to the future temporary spent nuclear fuel storage facility (ATI). Based on this report the Commission will consider the need for a follow-up verification.

(6) The verification team acknowledges the excellent co-operation it received from all persons involved in the activities it performed.

ANNEX 1

VERIFICATION PROGRAMME

Garoña NPP 19-21 October 2021

Tuesday 19 October

09.30 Opening meeting
(Garoña NPP)

- Welcome address
- European Commission Art. 35 verification programme introduction
- Verification planning
- Introduction (CSN) + Communication to the public
- Introduction (Garoña NPP)

11:00 Verification of gaseous and liquid discharge monitoring arrangements
(Garoña NPP)

- Gaseous discharge monitoring systems (Instrumentation and sampling)
  - NPP chimney
  - Reactor building ventilation
  - Solid waste temporary storage building
  - Waste material storage building
- Liquid discharge monitoring systems (Instrumentation and sampling)
  - Liquid radioactive waste treatment system
  - Service water discharge
- Emergency discharge monitoring systems

Wednesday 20 October

09:00 Verification of environmental radioactivity monitoring systems
(Garoña NPP and its surrounding area)

- TLD programme
- Air sampling
- Dry/wet deposition sampling
- REA system
- RAR system

14.00 Verification of the Garoña NPP laboratory for discharge monitoring
(Garoña NPP)

- Discharge laboratory
- Data handling and reporting
- Quality control

Thursday 21 October

09.30 Verification of the Garoña NPP laboratory for environmental monitoring
(Laboratorio de Medidas Ambientales S.L. at Medina de Pomar (Burgos))

- Environmental laboratory
- Data handling and reporting
- Quality control
- Mobile systems

15.00 Verification of emergency monitoring arrangements
(Garoña NPP)

- Mobile monitoring vehicles
- On-site radiation monitors
- Emergency sampling arrangements

ANNEX 2

GAROÑA NPP OFF-SITE ENVIRONMENTAL SAMPLING AND ANALYSIS PROGRAMME (PVRA & CC)

SAMPLE	SAMPLING FREQUENCY	LOCATIONS (SITE CODE)	ANALYSIS	ANALYSIS FREQUENCY	LOWER LIMITS OF DETECTION
Radiation (DM)	Monthly Change of TLD dosimeters every month	01-Santa María de Garoña 02-Tobalinilla 03-San Martín de Don 05-Mijaralengua 06-Medina de Pomar 14-Quintana Martín Galíndez 26-La Aldea del Portillo de Busto 27-Extramiana 28-Bóveda 29-Moriana 30-Cubo de Bureba 31-Pancorbo 32-Berberana 33-Cereceda 34-Miranda de Ebro 35-Briviesca 60-Gabanes 61-Montejo de Cebas 62-Bachicabo	Gamma integrated exposure	Monthly	Non applicable
Air particles (PP)	Weekly	01-Santa María de Garoña 02-Tobalinilla 03-San Martín de Don 04-Barcina del Barco 05-Mijaralengua 06-Medina de Pomar	Gross beta activity	Weekly	**(Bq/m³)** 2.0E-04
			Gamma spectrometry	Three months composite	**Co-58-** 8.0E-05 **Co-60-** 8.0E-05 **Mn-54-** 6.5E-05 **Fe-59-** 2.0E-04 **Zn-65-** 2.0E-04 **Nb-95-** 1.5E-04 **Zr-95-** 2.0E-04 **Cs-134-** 7.4E-05 **Cs-137-** 7.4E-05 **Ba-140** 8.0E-03 **La-140-** 3.0E-03 **Ce-144-** 3.0E-04
			Sr-90	Three months composite	2.0E-05

SAMPLE	SAMPLING FREQUENCY	LOCATIONS (SITE CODE)	ANALYSIS	ANALYSIS FREQUENCY	LOWER LIMITS OF DETECTION
Soil (S)	Yearly	01-Santa María de Garoña 02-Tobalinilla 03-San Martín de Don 04-Barcina del Barco 05-Mijaralengua 06-Medina de Pomar	Gamma spectrometry	Yearly	**(Bq/kg dry mass)** **Co-58-** 1.0 **Co-60-** 1.0 **Mn-54-** 1.0 **Fe-59-** 2.0 **Zn-65-** 2.0 **Nb-95-** 1.5 **Zr-95-** 2.0 **Cs-134-** 1.0 **Cs-137-** 1.0 **Ba-140-** 8.0 **La-140-** 2.0 **Ce-144-** 5.0
			Sr-90	Yearly	1.0
Rain water/wet deposition (LL/DES)	Monthly	01-Santa María de Garoña 02-Tobalinilla 03-San Martín de Don 04-Barcina del Barco 05-Mijaralengua 06-Medina de Pomar	Gamma spectrometry	Monthly	**(Bq/m³)** **(Not applicable to wet deposition)** **Co-58-** 300 **Co-60-** 300 **Mn-54-** 200 **Fe-59-** 500 **Zn-65-** 500 **Nb-95-** 400 **Zr-95-** 500 **Cs-134-** 200 **Cs-137-** 200 **Ba-140-** 600 **La-140-** 300 **Ce-144-** 500
			Sr-90	Monthly	25
Milk (LV/LO)	Monthly	06- Medina de Pomar 11- La Revilla de Herrán 68- Barcina de los Montes 77- Angosto	Gamma spectrometry	Monthly	**(Bq/m³)** **Co-58-** 300 **Co-60-** 300 **Mn-54-** 250 **Fe-59-** 500 **Zn-65-** 500 **Nb-95-** 300 **Zr-95-** 400 **Cs-134-** 250 **Cs-137-** 250 **Ba-140-** 600 **La-140-** 500 **Ce-144-** 800
			Sr-90	Monthly	55

SAMPLE	SAMPLING FREQUENCY	LOCATIONS (SITE CODE)	ANALYSIS	ANALYSIS FREQUENCY	LOWER LIMITS OF DETECTION
					(Bq/kg wet mass)
Sugar (AZR)	Three times per year (While season)	73-Miranda-Azucarera	Gamma spectrometry	Three times per year (While season)	**Co-58-** 1.0 **Co-60-** 1.0 **Mn-54-** 0.8 **Fe-59-** 1.4 **Zn-65-** 1.8 **Nb-95-** 1.0 **Zr-95-** 1.7 **Cs-134-** 0.8 **Cs-137-** 0.8 **Ba-140-** 5.0 **La-140-** 1.5 **Ce-144-** 2.5
			Sr-90	Three times per year (While season)	0.1
					(Bq/kg wet mass)
Agricultural products (COL, ACG, PAT, TRG, RCH, GIR)	Yearly (While season)	01-Santa María de Garoña 02-Tobalinilla 03-San Martín de Don 04-Barcina del Barco 05- Mijaralengua 06-Medina de Pomar 24-Orbañanos 25-Fontecha 65-Comunión 60-Gabanes 70-Sobrón 71-Barrio 76-Cuezva 78-Villaescusa de Tobalina	Gamma spectrometry	Yearly (While season)	**LW/HW*** **Co-58** 1.0/0.3 **Co-60** 1.0/0.3 **Mn-54** 0.8/0.4 **Fe-59** 1.4/0.5 **Zn-65** 1.8/0.5 **Nb-95** 1.0/0.3 **Zr-95** 1.7/0.4 **Cs-134** 0.8/0.3 **Cs-137** 0.8/0.3 **Ba-140** 5.0/2.0 **La-140** 1.5/0.4 **Ce-144** 2.5/1.0
			Sr-90	Yearly (While season)	0.1
					(Bq/kg wet mass)
Meat and eggs (CO, CJ, GA, HV)	Yearly	01-Santa María de Garoña 03-San Martín de Don 04-Barcina del Barco 06-Medina de Pomar 68-Barcina de los Montes	Gamma spectrometry	Yearly	**Co-58-** 1.0 **Co-60-** 1.0 **Mn-54-** 0.8 **Fe-59-** 1.5 **Zn-65-** 1.5 **Nb-95-** 1.0 **Zr-95-** 1.5 **Cs-134-** 0.8 **Cs-137-** 0.8 **Ba-140-** 4.0 **La-140-** 1.5 **Ce-144-** 2.5

SAMPLE	SAMPLING FREQUENCY	LOCATIONS (SITE CODE)	ANALYSIS	ANALYSIS FREQUENCY	LOWER LIMITS OF DETECTION
Fish (PM)	Half-yearly	18- Km 22 Trespaderne-Puentelarrá carretera 20- Montejo de Cebas 21- Canal de descarga unión río Ebro	Gamma spectrometry	Half-yearly	**(Bq/kg wet mass)** **Co-58-** 1.0 **Co-60-** 1.0 **Mn-54-** 0.8 **Fe-59-** 1.5 **Zn-65-** 1.5 **Nb-95-** 1.0 **Zr-95-** 1.5 **Cs-134-** 0.8 **Cs-137-** 0.8 **Ba-140-** 4.0 **La-140-** 1.5 **Ce-144-** 2.5
Drinking water (PO)	Monthly	01-Santa María de Garoña 02-Tobalinilla 03-San Martín de Don 04-Barcina del Barco 05-Mijaralengua 06-Medina de Pomar 63-Zambrana	Gamma spectrometry	Monthly	**(Bq/m³)** **Co-58-** 300 **Co-60-** 300 **Mn-54-** 200 **Fe-59-** 500 **Zn-65-** 500 **Nb-95-** 400 **Zr-95-** 500 **Cs-134-** 200 **Cs-137-** 200 **Ba-140-** 600 **La-140-** 300 **Ce-144-** 500
			H-3	Three months composite	6000
			Gross beta/gross beta excluding potassium activities	Three months composite	50
			Sr-90	Three months composite	25

SAMPLE	SAMPLING FREQUENCY	LOCATIONS (SITE CODE)	ANALYSIS	ANALYSIS FREQUENCY	LOWER LIMITS OF DETECTION
Ground water (SB)	Quarterly	03- San Martín de Don 05- Mijaralengua	Gamma spectrometry	Quarterly	**(Bq/m³)** **Co-58-** 300 **Co-60-** 300 **Mn-54-** 200 **Fe-59-** 500 **Zn-65-** 500 **Nb-95-** 400 **Zr-95-** 500 **Cs-134-** 200 **Cs-137-** 200 **Ba-140-** 600 **La-140-** 300 **Ce-144-** 500
			H-3	Quarterly	6000
			Gross beta/gross beta excluding potassium activities	Quarterly	50
Surface water (SP)	Monthly	15- Canal de descarga 18-Km 22 Trespaderne-Puentelarrá carretera 20-Montejo de Cebas 57-Km 20.5 Trespaderne-Puentelarrá carretera	Gamma spectrometry	Monthly	**(Bq/m³)** **Co-58-** 300 **Co-60-** 300 **Mn-54-** 200 **Fe-59-** 500 **Zn-65-** 500 **Nb-95-** 400 **Zr-95-** 500 **Cs-134-** 200 **Cs-137-** 200 **Ba-140-** 600 **La-140-** 300 **Ce-144-** 500
			H-3	Monthly	6000
			Gross beta/gross beta excluding potassium activities	Three months composite	50

SAMPLE	SAMPLING FREQUENCY	LOCATIONS (SITE CODE)	ANALYSIS	ANALYSIS FREQUENCY	LOWER LIMITS OF DETECTION
Indicator organisms-vegetables (FAN, CTG, MGO)	Yearly	20 –Montejo de Cebas 21- Canal descarga unión con el río Ebro 22 – Km 19-20 Trespaderne-Puentelarrá carretera 23- Km 30 Trespaderne-Puentelarrá carretera	Gamma spectrometry	Yearly	**(Bq/kg wet mass)** **Co-58-**0.3 **Co-60-**0.3 **Mn-54-** 0.4 **Fe-59-**0.5 **Zn-65-** 0.5 **Nb-95-**0.3 **Zr-95-**0.4 **Cs-134-** 0.3 **Cs-137-** 0.3 **Ba-140-**2.0 **La-140-**0.4 **Ce-144-** 1.0
			Sr-90	Yearly	0.1
Indicator organisms-animals (MJC, GTT, GTC)	Yearly	20 –Montejo de Cebas 21- Canal de descarga unión con el río Ebro 22 – Km 19-20 Trespaderne-Puentelarrá carretera Montejo 23- Km 30 Trespaderne-Puentelarrá carretera 18- Km 22 Trespaderne-Puentelarrá carretera 19- Km 27 Trespaderne-Puentelarrá carretera 69- Estructura de toma	Gamma spectrometry	Yearly	**(Bq/kg wet mass)** **Co-58-** 1.0 **Co-60-** 1.0 **Mn-54-** 0.8 **Fe-59-** 1.5 **Zn-65-** 1.5 **Nb-95-** 1.0 **Zr-95-** 1.5 **Cs-134-** 0.8 **Cs-137-** 0.8 **Ba-140-** 4.0 **La-140-** 1.5 **Ce-144-** 2.5
			Sr-90	Yearly	0.2
Sediment (SDF)	Half-yearly	15- Canal de descarga 16-Km 18 Trespaderne-Puentelarrá carretera 17-Km 20.5 Trespaderne-Puentelarrá carretera 18-Km 22 Trespaderne-Puentelarrá carretera 19-Km 27 Trespaderne-Puentelarrá carretera 20-Montejo de Cebas 67- Canal de descarga-B 74-Embarcadero	Gamma spectrometry	Half-yearly	**(Bq/kg dry mass)** **Co-58-** 1.0 **Co-60-** 1.0 **Mn-54-** 1.0 **Fe59-** 2.0 **Zn-65-** 2.0 **Nb-95-** 1.5 **Zr-95-** 2.0 **Cs-134-** 1.0 **Cs-137-** 1.0 **Ba-140-** 8.0 **La-140-** 2.0 **Ce-144-** 5.0
			Sr-90	Half-yearly	1.0