EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D – Nuclear Energy
D4 - Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

HUELVA sites: Phosphogypsum piles and CRI-9

SPAIN

14 to 17 September 2009

Reference: ES-09/08

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES: Further to parliamentary questions and petitions, a team of four inspectors from DG TREN H4 visited the Huelva sites on 14 September after having been fully informed of the current situation by the site operator and by the regulatory authority. The goal of this verification was to obtain complete information and to verify certain monitoring installations implied in the environmental radioactivity monitoring of the Huelva sites. The laboratories performing the measurements (University of Huelva, University of Seville, *CIEMAT*, *GEOCISA*) were also included in this verification.

SITE: Huelva, Spain

DATE: 14 to 17 September 2009

REFERENCE: ES-09/08

INSPECTORS: C. Gitzinger (Head of team)
E. Henrich
J-L. Frichet (national expert on secondment from France)
P. Vallet

DATE OF REPORT: 2009-12-23

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[signed]

P. Vallet

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ABBREVIATIONS AND ACRONYMS

ACERINOX	*ACERo INOXidable* (stainless steel factory in Los Barrios, Algeciras, Cádiz)
ACS Group	*Grupo Actividades de Construcción y Servicios*
AVRA	*Área de Vigilancia Radiológica Ambiental* (Environmental Radiological Surveillance Area; unit at *CSN*)
AEIR	*Área de Evaluación del Impacto Radiológico* (Radiological Impact Evaluation Area; unit at *CSN*)
BOE	*Boletín Oficial del Estado* (Official Gazette)
CD-ROM	Compact Disk – Read Only Memory
CIEMAT	*Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas* (Public Research Institution attached to the Ministry of Science and Education)
CITI	*Área de Ciencias de la Tierra* (Earth Sciences Area; unit at *CSN*)
CITIUS	*Centro de Investigación, Tecnología e Innovación – Universidad de Sevilla* (Research, Technology and Innovation Centre of the University of Seville)
CLOR	*Centralne Laboratorium Ochrony Radiologicznej*, Warsaw, Poland
CRI	*Centro de Recuperación de Inertes* (Inert Materials Recovery Centre)
CSN	*Consejo de Seguridad Nuclear* (Nuclear Safety Council)
DG ENER	Directorate-General for Energy (European Commission)
DG TREN	(former) Directorate-General for Energy and Transport (European Commission)
DGPEM	*Dirección General de Política Energética y Minas* (Directorate General for Energy Policy and Mines of the Ministry of Industry, Tourism and Trade)
DPR	*Dirección Técnica de Protección Radiológica* (Technical Directorate Radiation Protection; at *CSN*)
EC	European Commission
EGMASA	*Empresa de Gestión Medioambiental S.A.* (public sector company attached to the Environmental Agency of the Andalusian government *Junta de Andalucía*)
ENAC	*Entidad Nacional de ACcreditación* (National Accreditation Organisation)
ENRESA	*Empresa Nacional de Residuos Radiactivos* (Spanish radioactive waste Management agency)
FEDER	*Fonds Européen de Développement Régional* (European Funds for Regional Development)
FERTIBERIA	*Fertiliser production plant at Huelva*
GM	Geiger-Müller (radiation detector)
HPGe	High Purity Germanium (radiation detector)
IAEA	International Atomic Energy Agency
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
ICRP	International Commission on Radiological Protection
IPPC	Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
LEGe	Low Energy Germanium (radiation detector)
LSC	Liquid Scintillation Counting (radiation measurement)
MITYC	*Ministerio de Industria, Turismo Y Comercio* (Ministry of Industry, Tourism and Trade)
MS-DOS	Microsoft Disk Operating System

NaI(Tl)	Sodium Iodide, Thallium activated (radiation detector)
NPL	National Physics Laboratory, England)
NIM	Nuclear Instrumentation Module
NORM	Naturally Occurring Radioactive Material
NPP	Nuclear Power Plant
PC	Personal Computer
PDF	Portable Document Format (descriptive language for printing, created by *Adobe Systems*)
PIPS	Passivated Implanted Planar Silicon (radiation detector)
PTB	*Physikalisch-Technische Prüfanstalt, Braunschweig*
PVRA	*Programa de Vigilancia Radiológica Ambiental* (Environmental Radiological Monitoring Programme)
PVRAIN	*CSN's* independent environmental monitoring programme established as a control of the *PVRA* implemented by licensees
QA/QC/QM	Quality Assurance / Quality Control / Quality Management
REA	*Red de Estaciones Automáticas de Vigilancia Radiológica Ambiental del CSN* (Automatic Station Network)
ReGe	Reversed Germanium (radiation detector)
REM	*Red de Estaciones de Muestreo* (Sampling Station Network)
REVIRA	*Red de Vigilancia Radiologica Ambiental* (Environmental Radiological Monitoring Network – not associated with installations)
RPSRI	*Reglamento de protección sanitaria contra radiaciones ionizantes* (Health regulation on ionising radiation)
SAJ	*Servicio Asesoría Jurídica* (Juridical Counseling Service; at CSN)
SALEM	*Sala de emergencias del CSN* (*CSN's* Emergency Centre)
UPS	Uninterruptible Power Supply
U.T.P.R.	*Unidad Técnica de Protección Radiológica* (Technical Unit Radiation Protection; unit at *ENRESA*)
UV/VIS	UltraViolet-VIsible Spectroscopy (analytical device)
WHO	World Health Organisation

1. INTRODUCTION

Article 35 of the EURATOM Treaty requires that each Member State shall establish 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 in order that it may verify their operation and efficiency.

For the EC, the Directorate-General for Energy (DG ENER; formerly Directorate-General for Energy and Transport - DG TREN) and in particular its Radiation Protection Unit (at the time of the visit: TREN.H.4) is responsible for undertaking these verifications.

Further to parliamentary questions and petitions, a team of four inspectors from DG TREN H4 visited the Huelva sites on 14 September after having been fully informed of the current situation by the site operator, by the regulatory authorities and by other actors. The goal of this verification was to obtain complete information and to verify a number of monitoring installations involved in the environmental radioactivity monitoring of the Huelva sites. The laboratories performing the measurements were also included into this verification.

The visit to the Huelva sites included also meetings with the Spanish competent authorities, *Consejo de Seguridad Nuclear* (*CSN*) ([2]), *CIEMAT* and Directorate General for Energy Policy and Mines (*DGPEM*) of the Ministry of Industry, Tourism and Trade, as well as with *Junta de Andalucía*, Directorate General of Sustainability of the Coasts and the Sea of the Ministry of the Environment and Rural and Marine Affairs and with *FERTIBERIA*, *EGMASA*, *ENRESA* and *GEOCISA* and with representatives of the analytical laboratories of the universities of Huelva and Seville. A summary overview of the programme of verification activities is provided in Appendix 1. The verifications were carried out in accordance with the programme.

The present report contains the results of the discussions with the site operator, other actors and the Spanish competent authority *CSN*, as well as results of the verification team's review of some aspects of the environmental surveillance at and around the Huelva sites in relation with the NORM issue and an accidental contamination with the artificial radionuclide Cs-137.

Specifically, reference is made to the accidental presence of the contamination with caesium-137 at the Inert Materials Recovery Centre (*Centro de Recuperación de Inertes, CRI*) in *Las Marismas de Mendaña* and to the alleged existence of radiological levels due to emissions of uranium, radon-222 and other radioactive components from the phosphogypsum ponds. The first issue refers to the existence of radioactive material of an artificial origin (caesium-137), and the second one to the existence of naturally-occurring radioactive material (NORM).

The purpose of the review was to acquire full information both from the operator and from the regulator concerning both issues relevant to the Huelva sites and to get state of the art information on the monitoring and remedial measures put in place till now.

With regard to general radiological and environmental radioactivity and discharge monitoring aspects the present report is also based on information collected during the recent verifications of the NPPs Trillo, Cofrentes and Ascó in Spain.

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1 Directive 96/29/Euratom, Council Directive of 13 May 1996 laying down basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation (OJ L 159, 29.6.1996, p. 1).

2 *Consejo de Seguridad Nuclear* /Nuclear Safety Council, Justo Dorado 11, 28040 Madrid.

2. PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 INTRODUCTION

The Commission's decision to conduct an urgent mission under the scope of Article 35 EURATOM was discussed with the Spanish authorities in August 2009. Beginning of September 2009 the Spanish competent authority invited the Commission services to come to Spain from 14 to 17 September in order to verify the Huelva NORM and Cs-137 issues and the relevant environmental radioactivity monitoring programmes. All practical arrangements for the implementation of this mission were made with the persons designated at the *Consejo de Seguridad Nuclear*, in particular with Ms. Lucila Ramos Salvador, Deputy Director for Environmental Radiological Protection.

2.2 DOCUMENTATION

In order to facilitate the work of the verification team, a package of information was supplied in advance by *CSN*. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 2 to this report. The information thus provided has been extensively used for drawing up the descriptive sections of this report.

2.3 REPRESENTATIVES OF THE COMPETENT AUTHORITIES, THE HUELVA SITE OPERATOR AND OTHER ORGANISATIONS INVOLVED IN THE SITE RELATED ENVIRONMENTAL RADIOACTIVITY MONITORING

During the visit the following representatives of the national authorities, the operator and other parties involved were met:

Nuclear Safety Council (*CSN*)

Juan Carlos LENTIJO LENTIJO	Radiological Protection Department, Technical Director
Lucila RAMOS SALVADOR	Environmental Radiological Protection Department, Deputy Director
Rosario SALAS COLLANTES	Head of Environmental Radiological Surveillance Area (*AVRA*)
Antonio JIMÉNEZ JUAN	Head of Geosciences Branch (*CITI*)
José Luis MARTÍN MATARRANZ	Technical Adviser of Environmental Radiological Surveillance Area (*AVRA*)
Carmen REY DEL CASTILLO	Scientist, *AVRA*
Natalia MUÑOZ MARTÍNEZ	Head of Communication, Cabinet of Presidency
Inés URBANO POLLATO	Institutional Relations. Technical Cabinet of the President

Ministry of the Environment and Rural and Marine Affairs; Directorate General of Sustainability of the Coasts and the Sea

Pablo MARTÍN HUERTA	Land-Maritime Public Domain, Deputy Director General
Gabriel Jesús CUENA LÓPEZ	Head of Huelva Coast Service

Ministry of Industry, Tourism and Trade; Directorate General for Energy Policy and Mines

Elvira HERNANDO VELASCO	Head of Nuclear and Radioactive facilities Area

Junta de Andalucía

Andres LEAL	Coordinator General Deputy of Environment Quality

José Antonio CANDELA	Head of Environment Protection Service

EGMASA

Pedro SILVERIO CÓRDOBA	Director of Environmental Infrastructures

ENRESA

Maria TERESA ORTIZ	Head of Technical Unit of Radiological Protection (U.T.P.R.)

FERTIBERIA

José GARRALDA BENAJES	Head of Environment and Quality Department

CIEMAT

David CANCIO	Head Radiation Protection Public & Environment
María Antonia SIMÓN	Head Environmental Laboratory Unit (URA and VR)
Ana María SUAÑEZ	Scientist (URA and VR)

University of Huelva (UHU)

Juan Pedro BOLÍVAR RAYA	*Vicerrector; Grupo de Investigación Física de Radiaciones y Medio Ambiente*
Federico VACA GALÁN	Dr./Scientist
Fernando MOSQUEDA PEÑA	Dr./Scientist
Rafael LOZANO BERMEJO	MSc/ /Scientist
Antonio PADILLA OLLERO	Lab Technician

University of Seville

Rafael GARCÍA-TENORIO GARCÍA-BALMASEDA	Professor; Scientific Advisor at *CITIUS,* Head of Research Group "Applied Nuclear Physics"
Maria VILLA	Dra./Scientist
Ana CALLEJA	Contracted Agent
Juan MONTERO	MSc
Inmaculada DIAZ	Postgraduate Scholarship
José DIAZ	Technician

GEOCISA

Anselmo SETO	Service Director
Maria MADRID	Quality Assurance Manager
Adela ALONSO	Radiological, Radiochemistry and Chemistry Division Manager
Marta GOMEZ DE GRACIA	Radiological Technical Unit Manager
Eva NAVARRO	Radiochemistry Lab Manager
Verónica VIDAL	Technician I+D+I

3. COMPETENT AUTHORITIES & LEGAL BACKGROUND

3.1 INTRODUCTION

In Spain, generally, facilities liable to generate radioactive effluents and/or waste must have proper control storage, treatment and removal systems. Radiological monitoring programmes must be based on site and discharge characteristics. For installations of the nuclear fuel cycle site related

environmental radiological monitoring programmes have to be implemented by the operators. Site-specific control programmes are implemented by the *Consejo de Seguridad Nuclear* (*CSN*). Nation wide monitoring networks for environmental radioactivity are set up and managed by *CSN*.

For NORM industries decisions with regard to any environmental radioactivity monitoring programme have to be made, case by case, by the relevant competent authority, based on advice by *CSN*. With regard to the phosphate industry at Huelva it is made up by the companies *Fertiberia* and *FMC Foret S.A.* The phosphogypsum piles administrative concession is the responsibility of *Fertiberia*. The *Junta de Andalucía* acts as competent authority.

The nation-wide radiological monitoring network established and managed by *CSN* is operational since 1992 (except for rivers, which are surveyed since 1984) and is independent from the network associated with nuclear facilities. It includes an Automatic Station Network (*REA*) for real-time measurement of ambient gamma dose rate and atmospheric radioactivity and a Sampling Station Network (*REM*) for sampling and analysis programmes for air, soil, rivers, coastal water, drinking water, milk and mixed diet.

3.2 COMPETENT SPANISH AUTHORITIES

An organizational overview over the administrative structures dealing with the Huelva sites (NORM and Cs-137 contamination at *CRI-9*) is shown in figure 1.

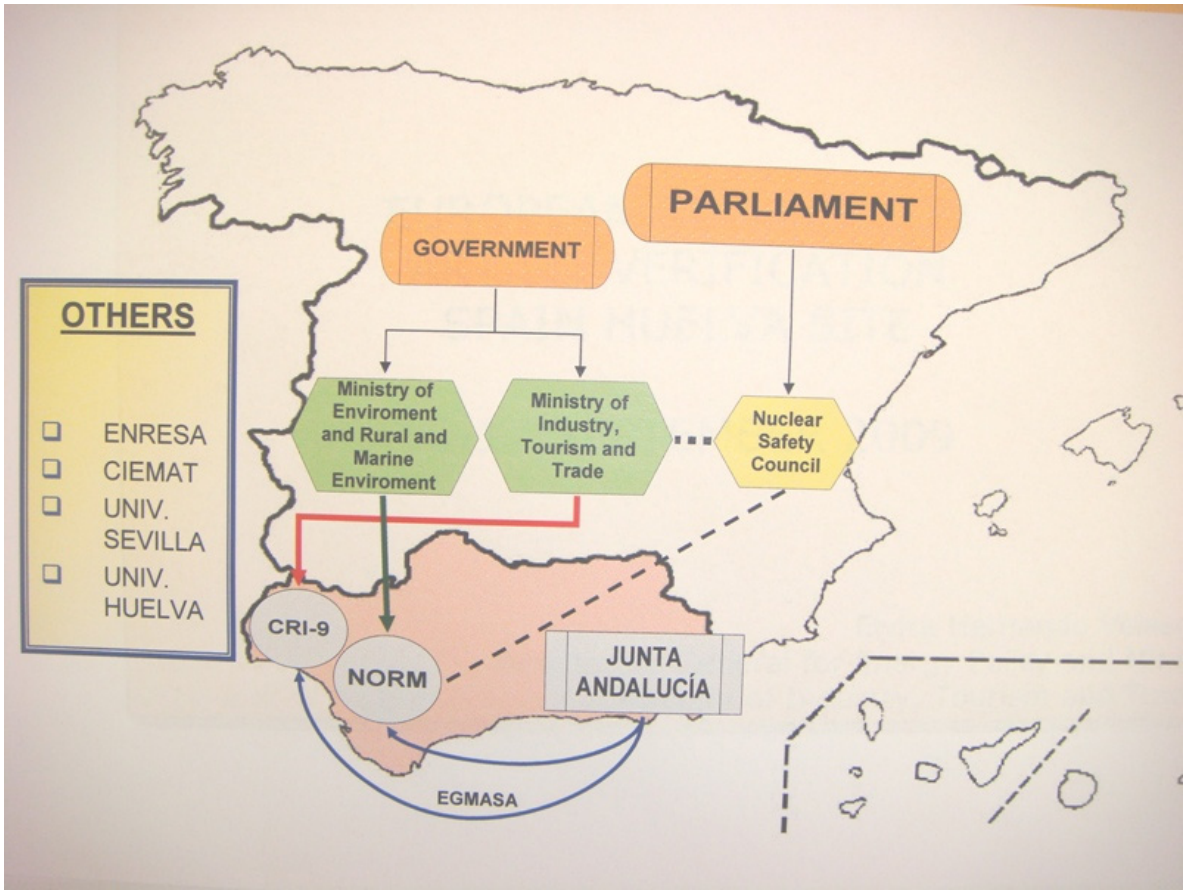

Figure 1: Spanish Administrative Organisation with regard to the Huelva sites

3.2.1 *Consejo de Seguridad Nuclear* (Nuclear Safety Council)

The *Consejo de Seguridad Nuclear* (*CSN*), established in 1980, is the Spanish organisation responsible for nuclear safety and radiological protection. It is independent from the Government and reports to the Spanish Parliament. *CSN* issues reports with binding content prior to the awarding of authorisations to regulated facilities (either "nuclear" and/or "radioactive") by the Ministry of

Industry, Tourism and Trade and proposes regulations on nuclear safety and radiation protection nation wide.

CSN is an associated body formed by 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, *CSN* is organised in two Technical Directorates, Nuclear Safety and Radiation Protection. The latter includes three Deputy Directorates: Emergencies, Operational Protection and Environmental Radiological Protection.

CSN maintains a strict control and monitoring programme for nuclear installations and facilities related to medical, industrial or research activities that are using radioactive substances. *CSN* has also to provide mandatory and binding documents for any modifications of such installations and facilities. On average, *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 Ministry of Industry concerning radiological protection of workers and members of the public and safety criteria for waste management.

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

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

CSN also promotes research programmes in matters related to its competencies. It proposes regulations and informs the public through direct contact with the media, diffusion of publications, an internet web page and an information centre. *CSN*'s annual report to Spain's Congress and Senate provides information on the results of the monitoring programmes; more detailed information about these results is published in an annual specific report and a summary of the results is posted on *CSN*'s internet site to provide information to the public.

National responsibilities in relation to the protection against natural radiation exposure are included in Royal Decree 783/2001, of 6th of July, approving the Regulation for Health Protection against Ionizing Radiations (*RPSRI*). According to this:

The competent authority advised by the Nuclear Safety Council, will require the owners of work activities within which there is an increased exposure to natural radiation sources, to carry out the necessary studies, in order to assess the existence of a significant increase in the exposure of workers or of members of the public which cannot be disregarded from the radiation protection point of view.The studies are to be performed according to recommendations from *CSN*.

With the study results, *CSN* identifies those work activities that must be subjected to control and defines those activities that need to be provided with adequate exposure monitoring devices; establishing, if the case arises, the need of corrective actions or radiation protection measures.

CSN informs the competent authorities about the conclusions and measures needed, to be required of the party responsible for the work place.

3.2.2 Ministry of the Environment and Rural and Marine Affairs; Directorate General of Sustainability of the Coast and the Sea

Among the competences of the Directorate General of Sustainability of the Coast and the Sea of the Ministry of the Environment and Rural and Marine Affairs, are the management, protection and preservation of the land-maritime public domain, where the Huelva phosphogypsum area is located.

The competent authority advised by the Nuclear Safety Council, shall require the owners of work activities within which there is a increased exposure to natural radiation sources, to carry out the

necessary studies, in order to assess the existence of a significant increase in the exposure of workers or of members of the public which cannot be disregarded from the radiation protection point of view.

The studies shall be performed following instructions from the competent authorities in agreement with *CSN* recommendations.

The competent authorities shall require the application of the conclusions and measures established by *CSN*, if the case arises.

3.2.3 Ministry of Industry, Tourism and Trade; Directorate General for Energy Policy and Mines

The Nuclear Energy Act defines radioactive waste as any residual material for which no use is foreseen that contains radioactivity above certain levels that need to be defined by the Ministry of Industry (*MITYC*) with a previous binding report of *CSN*.

3.2.4 "*Junta* de Andalucía"; Department of the Environment

With regard to effects of discharges from NORM activities, the Regional government is the competent authority on regional level. For the case of Huelva, this is the Department of the Environment of the *Junta de Andalucía*. The competence is related to the implementation of Directive 96/61 (IPPC).

The competent authority advised by the Nuclear Safety Council, shall require the owners of work activities within which there is a increased exposure to natural radiation sources, to carry out the necessary studies, in order to assess the existence of a significant increase in the exposure of workers or of members of the public which cannot be disregarded from the radiation protection point of view.

The studies shall be performed following instructions from the competent authorities in agreement with *CSN* recommendations.

The competent authorities shall require the application of the conclusions and measures established by *CSN*, if the case arises.

3.2.5 Ministry of Health and Consumer Affairs (Radiological surveillance of food stuffs)

The body responsible for the radiological monitoring of foodstuffs is the Ministry of Health and Consumer Affairs.

Radiological monitoring of water for human consumption, including bottled water, is required by *Real Decreto* [Royal Decree] *140/2003*, establishing the health criteria for the quality of water for human consumption and *Real Decreto 1744/2003*, amending *Real Decreto 1074/2002*, regulating the procedure for the preparation, transport and sale of bottled drinking waters.

The Ministry of Health and Consumer Affairs through the *Centro Nacional de Sanidad Ambiental* [National Centre for Environmental Health] analyses the radioactive content of imported food products and issues export certificates.

Radiological monitoring of foodstuffs in areas around installations which emit discharges externally is required of the proprietor of these installations in the corresponding regulations and directives.

In compliance with Articles 35 and 36 of the EURATOM treaty, *CSN* has established and manages the national Environmental Radiological Monitoring Network, which includes the sampling of foodstuffs (milk and mixed diet). The design and development of this network follows EC recommendations.

3.3 EMERGENCY PREPAREDNESS

In Spain, planning and preparation for nuclear emergency situations are governed by the Basic Nuclear Emergency Plan and by the regulations governing nuclear and radiological facilities. In addition, there are general provisions on nuclear emergencies in the law creating *CSN* (as amended by the law on public prices and tariffs for services rendered by *CSN*), in the Regulation on Protection against Ionising Radiations, in the Agreement of the Cabinet of Ministers on public information on healthcare measures and actions in the event of radiological emergency.

3.4 LEGAL PROVISIONS FOR ENVIRONMENTAL RADIOACTIVITY MONITORING

With regard to legal provisions reference is also made to the reports of the Article 35 EURATOM verifications to the NPPs at Trillo (2004), Cofrentes (2007) and Ascó (2008).

3.4.1 Legislative acts regulating environmental radioactivity monitoring

- 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 15/1980, of 22 April, on the creation of CSN. Published in BOE nº 100 of 25 April 1980. Partially amended by Law 14/1999 and Law 33/2007 of 7 November 2007
- 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 and amended in BOE nº 131 of 2 June 1999.
- *Real Decreto* 783/2001, of 6 July, adopting the regulations on health protection against ionising radiations. Published in BOE nº 178, of 26 July 2001.
- *Real Decreto* 1836/1999, of 3 December, adopting the regulations on nuclear and radiological installations. Published in BOE nº 313, of 31 December 1999. This regulation was modified by the *Real Decreto* 35/2008, of 18 January.

3.4.2 Legislative acts regulating the radiological surveillance of foodstuffs

- *Real Decreto* 140/2003, of 7 February, establishing the health criteria for water quality for human consumption. Published in BOE nº 45 of 21 February 2003.

There are no other specific regulations regarding the radiological surveillance of foodstuffs.

3.4.3 Guidance documents

- ICRP Publication 60. Recommendations of the International Commission on Radiological Protection 1990.
- IAEA International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. Safety Series Nº 115, 1996.
- Council Directive 96/29/Euratom of 13 May 1996 laying down basic standards for the protection of the health of workers and the general public against the damages arising from ionising radiation.
- Commission Recommendation 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 populations as a whole. (2004/473/Euratom).
- Council Regulation (EC) n° 737/90 of 22 March 1990, on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station [Official Journal L 82 of 29.3.1990].

- WHO Codex Alimentarius Commission Guideline 5-1989: Guideline levels for radionuclides in foods following accidental nuclear contamination for use in international trade.

3.5 RADIOACTIVE DISCHARGE AUTHORISATIONS FOR NORM FACILITIES

The current regulation *"Reglamento de protección sanitaria contra radiaciones ionizantes"*, which was published in July 2001, establishes 1 mSv per year as the effective dose limit for the protection of the public.

The competent authorities have to require studies with regard to the operation of NORM industries to assess its radiological impact. *CSN* is playing an advisory role.

Discharge surveillance and control will be considered, if necessary, in the specific studies.

4. HUELVA PHOSPHOGYPSUM-PILES, PONDS AND *CRI-9*

At the opening meeting and during the course of the verification, the team of Commission experts received extensive information concerning the Huelva phosphogypsum piles and ponds as well as concerning the *CRI-9* site (Inert Materials Recovery Centre No. 9). This information is detailed below.

4.1 INTRODUCTION

The marshlands (*las marismas*) used by the local phosphate fertilizer industry for stocking phosphogypsum are located to the south of the city of Huelva, in the estuary of the river *Tinto*, before its junction with the river *Odiel*. This is a great span of land that faces the sea and has marshland vegetation subject to tidal movements of the estuary. The area in figure 2 called "*Balsas restauradas*" has been completely restored and below is referred to as Zone 1 (Marshes of *El Pinar*). The area called "*Balsas activas*" represents Zones 2 (Marshes of *El Rincón*; operative ponds; lower part in the picture) and 3 (Marshes of *El Rincón*; auxiliary pond; upper part in the picture). The Cs-137 accidentally contaminated area is located in the "old pond 9" (= *CRI-9)* in Zone 4 (Marshes of *Mendaña*).

Since the nineteen-sixties phosphate industry has been operating close to Huelva city.

The *FERTIBERIA* industrial plant in Huelva (marked 'Fábrica' in figure 2) produces fertilisers using phosphate rock as a raw material for the production of phosphoric acid, various phosphates and fertilisers. This phosphate rock is a sedimentary rock that contains natural concentrations of uranium and thorium. In relation to unperturbed typical soils, these concentrations are relatively high for U-238 (1500 Bq/kg), which is usually found in radioactive equilibrium with its decay products, including Ra-226.

In the process of manufacturing phosphoric acid, the rock is ground to the proper grain size and then treated with sulphuric acid. Phosphoric acid and gypsum (phosphogypsum) are produced in the reaction; the greatest part of the radium contained in the phosphate rock usually co-precipitates with gypsum. Most of the uranium and thorium remains with the phosphorus in the phosphoric acid.

The redistribution of these natural radionuclides - present in the original rock - to the various products, by-products, solid wastes, and effluents obtained in the industrial process may lead to an exposure of workers and members of the public.

Fig. 2: *Marismas de la Ría del Tinto (Marismas del Pinar, Marismas del Rincón and Marismas de Mendaña*' areas); the city of Huelva is located in the upper left quarter of the photo (provided to the verification team at the opening meeting). Description; see text.

At present, *FERTIBERIA's* activities in Huelva's industrial area generate around 2,5 million tonnes of phosphogypsum per year and 0,5 million tonnes more are produced by *FMC Foret S.A*. All of this phosphogypsum is transported from the production plants into the decantation ponds by pumping in a suspension of water, with a maximum suspension of 20% phosphogypsum. Once the phosphogypsum has decanted, the pumped water circulates back to the plant in a closed circuit and is re-used for the process.

This system of recirculation with water – installed in 1997 - represents a notable environmental improvement over the previous transportation process since, up until then, the pumped water - which was taken from the estuary - was later dumped back into the same body, carrying a significant fraction of the radioactivity originally present in the phosphogypsum in dissolution and suspension. Moreover, until 1997, the phosphogypsum generated by *FMC Foret S.A*. (approximately 20% of the total amount) was dumped directly into the *Odie*l River estuary and the phosphogypsum from *Fertiberia* overflowed from the ponds, into the Tinto River.

The verification team was informed that today the phosphogypsum piles and ponds in *Las Marismas* cover an area of approximately 850 hectares and it is estimated that the total amount accumulated during the nearly 40 years of operation of this fertiliser factory is 70 million tonnes.

The team was also informed that it is planned to close the *FERTIBERIA* production plant by 2012.

4.2 FIRST EVALUATIONS OF THE RADIOLOGICAL SITUATION OF THE HUELVA SITES; FIRST REMEDIAL MEASURES

In 1989, *CSN* commissioned the Energy, Environment and Technology Research Centre *CIEMAT* to do first studies on the radiological situation resulting from the operation of the phosphate industry. In 1998 further studies have been performed by *CIEMAT* at the request of the Environmental Agency of the *Junta de Andalucía*.

As a result of the 1989 study, *CSN* sent a series of suggestions to the *Junta de Andalucía* on the waste management and restoration of the phosphogypsum ponds, among which was the attenuation of the emissions of radon gas (decay product of Ra-226) using an appropriate cover for the phosphogypsum deposits, including restoring of vegetation.

Between 1991 and 1993 the restoration of some 400 ha of ponds (Zone 1 of the site) was carried out by the Environmental Agency.

In 1997, the direct dumping of phosphogypsum into the *Odiel* River estuary ceased. In the same year a new process of recirculation of waters was implemented (this process is still in use).

Phosphogypsum is transported from the production plants to the settling ponds in the marsh lands of "El Rincón" by pumping it in a suspension of water (maximum 20% phosphogypsum). Once the phosphogypsum has settled, the seeping water which is collected in a channel, is pumped back to the plant, and re-used in the process, thus forming a closed circuit.

In September of 1997, *Empresa de Gestión Medioambiental S.A*. (*EGMASA* – a public sector company attached to the Environmental Agency of the Andalusian government), *FERTIBERIA* and the Huelva Town Council signed a cooperation agreement for the environmental recovery of the phosphogypsum ponds numbers 6, 7, 8, and 9 in Zone 4 (*Las Marismas de Mendaña*). *FERTIBERIA* at that time held an administrative concession on that land granted by the Directorate General of Coasts of the Ministry of the Environment. This cooperation agreement built the basis for The Inert Materials Recovery Centre (*Centro de Recuperación de Inertes*, *CRI*), the project which dealt with the recovery of *FERTIBERIA's* phosphogypsum ponds in that area.

The second study in 1998 showed that the restoration of some 400 ha of ponds (Zone 1 of the site) carried out by the Environmental Agency between 1991 and 1993 and the restoration of phosphogypsum dumps that had begun in 1997 (which included stopping dumping into the estuary) had generated a clear improvement in the radiological situation in the area. The activity concentrations of natural radionuclides measured in the restored areas were found to be lower than the background levels in the unaffected marshlands.

At the time of these first studies (1989 and 1998), according to the regulations then in force, this industrial activity was exempt from specific regulation on radiation.

4.3 RELEVANT NORM RELATED LEGISLATION AND RESULTING INITIATIVES

Before 2001, NORM activities were not specifically regulated in Spanish radiological legislation.

Since 2001, the Spanish regulation covering NORM issues (which includes phosphogypsum piles and ponds) is the Health regulation on ionising radiation (*Reglamento de protección sanitaria contra radiaciones ionizantes – RPSRI*), approved by Royal Decree 783/2001 (BOE 26-7-01). This regulation transposes Council Directive 96/29/Euratom (the Basic Safety Standards Directive).

Title VII of this Regulation refers to "Natural sources of radiation"; in Article 62 it is established that the competent authority has to follow advice of *CSN*. It requires responsible parties to carry out the necessary studies to determine whether work activities with natural radiation sources leads to a significant increase in the exposure of workers or of members of the public which cannot be disregarded from the radiation protection point of view.

In accordance with the said Title VII, the mission of *CSN* is to advise the competent authority for the relevant industrial sector. In line with this mission, in 2004 *CSN* financed a research project with the University of Seville and the University of Huelva to assess the impact of radiation caused by the activities of several non-nuclear industries in southern Spain, including the industrial area of Huelva.

The objective of the research project was to compile information on these industries in order to, if necessary, bring their activities into compliance with the aforementioned rules with respect to both occupational safety and environmental protection.

This four-year-long project concluded that the workers involved in stacking, distribution and maintenance of the phosphogypsum ponds do not have a significant increase in exposure, as the increase in the effective dose received (taking into account the various exposure pathways) is less than 1 mSv/year (the dose limit for members of the public). *CSN*'s summary of this study with according conclusions translated into English is contained in Appendix 3.

In addition, this project clearly showed the virtues of the changed phosphogypsum management policy, with a notable decrease in the radioactive impact on the surrounding environment.

In summary, the authorities concluded that the potential radiological impact caused by the piles and ponds on workers and the public is very small with regards to the limits imposed by law. Thus, no additional remedial action would be necessary in the areas that are already covered with protective material. For the ponds and piles still operating restoration is envisaged.

4.4 VERIFICATION ACTIVITIES AT NORM SITES

The verification team was given a general overview of the phosphogypsum storage sites (Zones 1 to 4) which cover surface areas of 400 ha (Zone 1) and 720 ha (Zones 2 to 4; plus Zone 5 which has never been used for phosphogypsum storage and is relatively small - it expands to the North of Zones 3 and 4).

The team could see that Zone 1 was remediated (1991 to 1993) and is covered by vegetation. It was informed that both, ambient gamma dose rate and radon levels in that area, currently are comparable to such in non-affected "background" areas. The team questioned the high values for annual ambient dose in Zone 1 that were reported in several documents transmitted to the verification team. The team was informed that these values were wrong by a factor of hundred than the values actually determined; they were erroneously cited in these documents. Thus, it was confirmed that Zone 1 in its current state does not pose any radiological risk to the population.

The verification team was informed that the IPPC permit (AAI/HU/039) issued by the *Junta de Andalucía* on 29 April 2008 governs the actual industrial utilisation of the phosphogypsum stacking piles (Zones 2 and 3) of the Huelva site. Currently the phosphogypsum is pumped from the fertiliser plant to Zone 2, containing the "Stacking Pile". Zone 3, which contains the "Safety raft" or "Security reservoir", is a reserve area to be used to collect water in case of emergency, produced by high rainfalls, avoiding the overflow of phosphogypsum, to the Tinto River.

The verification team entered Zone 2 through Zone 3, and saw the two settling ("decantation") ponds, one in the south, one in the north of the zone, separated by a narrow partition wall of phosphogypsum. Phosphogypsum containing sludge is piped from the fertiliser factory to these ponds, where solid matter gradually settles. Some of the water seeps through the pile and is collected in the "perimetral leaching channel" that leads around the settling ponds. The "regulator reservoir" which is located between the pile and the city of Huelva collects the "clean" water; the pumping station in the south of Zone 2 pumps the "clean" water back to the fertiliser plant for re-use. Thus, the system forms a closed loop of water to avoid discharges into the estuary.

The team was told that a control system is installed. It focuses on:

- controls of the receiving water (with annual reports on surveillance and control of the receiving environment);
- structural control of the discharge pipes (with annual reports);
- structural control of the pile.

Currently, the rim of the south-pond is at a height of 24 m. It will gradually be increased to a height of 30 m which is the technical limit. The water volume in the ponds is some 800 000 m^3.

During the visit a few ambient gamma dose rate measurements were taken using an *EG&G Berthold UMO* device equipped with a probe type *Berthold LB 1236*. No measurement showed values that would have to be considered as posing an unacceptable radiation risk for the workers.

The verification team was shown the outlets of the pipes for discharging the phosphogypsum sludge near the south border of the south-pond (Zone 2). One of them was operating. The team observed ongoing consolidation work at the east rim of the pile using a dredger. It also observed the process of seeping from the pile to the leaching channel, from where the water (which contains large amounts of phosphoric acid) is pumped back to the fertiliser factory.

At Zone 3 the team could observe trucks loading phosphogypsum to be transported off-site. The team was told that to some extent the material is used for improving certain soils following national regulations in place.

With regard to the development of the site the verification team was informed that production has been reduced to some 50%. A complete stopping of fertiliser production is discussed, however, social arguments regarding the labour situation in the Huelva area have been raised. The Directorate General for Marine and Coastal Sustainability of the environment Ministry has initiated a "Study for the Recovery of the Phosphogypsum Ponds in the Marshes of Huelva; Diagnosis Phase and Regeneration Proposal". In June 2009, the *Junta de Andalucía* has established a committee of five experts for the evaluation of the restoration plan for the entire site.

> *Taking into account the very long half lives of some of the natural radioactive contaminants in Zones 1 to 4, the verification team recommends developing also administrative solutions for the very long term that avoid any future uses of the affected areas that could lead to an unacceptable population exposure. In the extremely long term the possible destruction of the surface layer could become an issue. Thus, measures such as prohibition of soil removing construction, of re-forestation with deep rooting trees, or of agricultural methods using deep ploughing should be considered.*

The team was informed that the University of Huelva - within a project of the Ministry of Science and Innovation- continues monitoring of NORM issues.

> *The verification team endorses the continuation of the environmental radioactivity monitoring currently performed by the University of Huelva.*

4.5 ACCIDENTAL CONTAMINATION BY CS-137 IN ZONE 4 (*CRI-9*)

Further to the cooperation agreement between *EGMASA*, *FERTIBERIA* and the Huelva City Council from 1997 remedial work was ongoing in Zone 4, in particular dumping of inert material into the phosphogypsum ponds. Some such material stemmed from the *ACERINOX* steel factory in Los Barrios (Algeciras, Cádiz). Exhaust dust from this factory was treated by an inertisation plant belonging to *EGMASA* with a view to be used for dumping. The inertisation plant is located at Palos de la Frontera. Its task is the inertisation (i.e. the stabilisation and solidification) of various inorganic industrial wastes from several industrial factories in Andalucía. The inertisation process consists of a physico-chemical treatment of the waste (in this case exhaust dust) including addition of approximately 20% weight of concrete. The result is a low hardening product called "*inertizado*".

On 30 May 1998, in the *ACERINOX* factory a radioactive caesium-137 source that was inadvertently mixed in with scrap metal the company uses as raw material was accidentally melted in one of its electric arc ovens used to produce stainless steel.

Subsequently, caesium-137-contaminated exhaust dust was transported to the inertisation plant.

The resulting neutralised material of this process was used in the customary manner as filler for the phosphogypsum pond restoration plan at the Inert Materials Recovery Centre. Obviously at that time nobody realized the Cs-137 contamination; thus, the material was dumped in pond number 9 (*CRI-9*).

A total of 5198 t of that caesium-137 contaminated material was dumped into sites named front 1 to front 4 of that pond (see figure 3). Fronts 3 and 4 were identified to have received the material with the highest contamination.

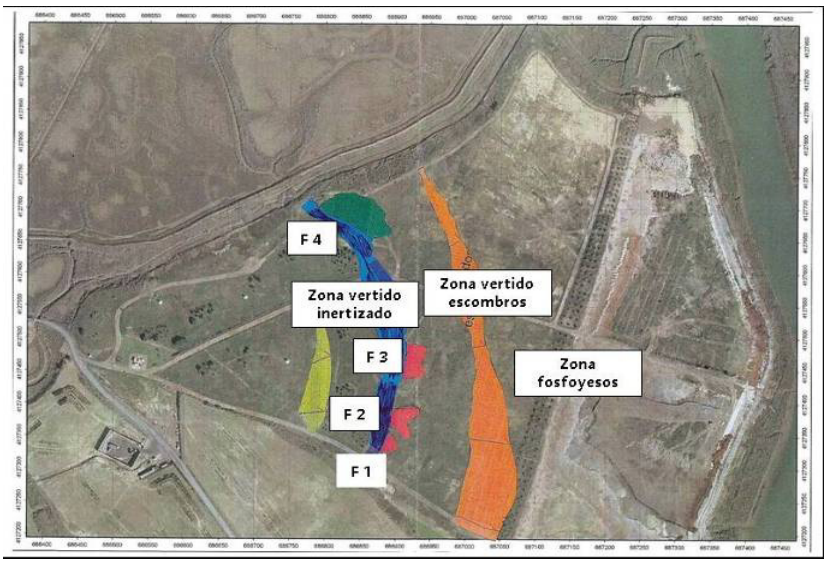

Fig. 3: *CRI-9* area in Zone 4 with identification of the dumping areas, fronts 1 to 4 (F1 to F4)

4.6 CONTAMINATION AT *CRI-9*: EVALUATION OF THE RADIOLOGICAL SITUATION AND FIRST MEASURES

Further to the dumping of the contaminated material in *CRI-9* and having realised the contamination issue with Cs-137 of the *CRI-9* site, the Directorate General for Energy Policy and Mines (*DGPEM*) issued its Decision of 22 June 1998, on the adoption of protective measures in relation to the radioactive contamination incident. This decision required that *EGMASA*, the company in charge of the remediation work conducted at *CRI-9*, present an action plan for the normalisation of that site to *CSN*. To get approval of the implementation of this action plan *EGMASA* would have to obtain a favourable evaluation by *CSN*.

During July-August 1998, the authorities ordered *EGMASA* to interrupt the operation (NORM related remediation activities) at *CRI-9* and to implement the above mentioned action plan with clear radiological objectives (the resulting dose to individuals must be smaller than 1 mSv/year).

As a first step of the implementation of the action plan for the normalisation and remediation of the *CRI*-9 site and under the control of the CSN, *Empresa Nacional de Residuos Radiactivos* (*ENRESA*), the company contracted by *EGMASA*, performed two actions to remove 341 tonnes of the most contaminated material from "fronts" 3 and 4 in *CRI-9* and to transport such materials to the *ENRESA's* medium and low-level radioactive waste centre at El Cabril, Cordoba, for final disposal. The rest (less-contaminated material; 4857 t) is currently still in *CRI-9*.

4.6.1 Legal considerations with respect to the situation at *CRI-9*

Due to the fact that the events at *CRI-9* had potentially led to a lasting exposure situation any legal instruments transposing Title IX (intervention) of the European Basic Safety Standards had to be applied.

With regard to Spanish Law, Title VI, “Interventions”, Royal Decree 783/2001 on Health Protection against Ionizing Radiation, is applicable. At the time of the accident the former Royal Decree 53/1992 on Health Protection against Ionizing Radiation was applicable, its Title VI referring to interventions. The Royal Decree 783/2001 updated the Decree from 1992, transposing Council Directive 96/29/Euratom, mainly to include Title VII “Natural sources of radiation”. Title VI was not modified.

In particular,

- The competent authority, after a report by *CSN*, had to:
  - Set the limits of the affected zone;
  - Establish a system to monitor exposures;

- Carry out the necessary activities according to the situation;
- Control the access and uses of the affected areas.

- *CSN* had an advisory role.

4.6.2 Approaches for the normalisation of activities in *CRI-9*

After *ENRESA* had carried out the two actions to remove the most contaminated material at the inert material dump sites (see above), on 14 September 1998, *EGMASA* requested an authorisation from *CSN* for the normalisation of the *CRI-9* site.

Further to this, in September 1998, *CSN* requested from *EGMASA* a respective proposal.

In July 1999, the company presented a technical document in which four alternatives for the normalisation of the activities in *CRI-9* were proposed and analysed.

Of the four alternatives, the first three proposed leaving the contaminated material in the ground at the site of *CRI-9*; whereas the fourth alternative proposed that the contaminated material should be removed from the area and be transferred to the radioactive waste storage centre in El Cabril.

CSN drew attention to the fact that, in the event of any future use of the dump site land or consumption of water from that zone, the application of any of the first three options would lead to an unacceptable long-term radiological impact. For many other reasons such water cannot be used as drinking water.

The application of any of the first three options would have to be accompanied by an absolute prohibition on any future use of *CRI-9* land and water. In addition to this, the relevant administrative safeguards would have to be put in place to ensure that these restrictions are duly registered, effectively publicised, and implemented through the relevant legal instruments and physical actions. Furthermore, a long-term radioactive monitoring programme for the contaminated area would have to be established.

CSN informed the Directorate General for Energy Policy and Mines of the Ministry of Industry, Tourism and Trade, that both **Alternative number 2** - including the restrictions on use and a long-term monitoring programme - and **Alternative number 4** were acceptable in terms of radiation protection.

Alternative number 2 entailed laying a cover of clay on top of the contaminated dump sites. Advantages of this alternative were reported to consist in a double effect of diminishing permeability, and the delay of Cs-137 migration.

Alternative number 4, which proposed the removal and transport of the contaminated material to the El Cabril radioactive waste disposal facility, was seen to entail a higher overall radiological risk due to excavation, removal and transport activities. In addition, the implementation of this alternative would have generated great technical difficulties that, in practical terms, would have prevented the total removal of the contaminated material.

4.6.3 Decided actions

4.6.3.1 First decision of the Directorate General for Energy Policy and Mines

On 15 January 2001, the Directorate General for Energy Policy and Mines (*DGEPM*), taking into account *CSN*'s report of 3 November 2000, issued a Decision to inform *EGMASA* that the normalisation of *CRI-9* was to be carried out following Alternative 2, which was to be complemented by certain limits and conditions. Normal operations were not to be resumed in that particular part of the centre until these were approved by *CSN*. Alternative 4 was discarded for the reasons outlined above.

The selection of Alternative 2 of the action plan meant that access restrictions would still have to be defined on the use of the area. In addition to impose laying a cover of clay on top of the contaminated dump sites, the Decision required *EGMASA* to establish the necessary means to effectively guarantee

that the use of the land and of the area's water resources would be carried out in accordance with the radiological situation.

Work was to be carried out in accordance with limits and conditions established:

- requirements for the layer of clay to be met in order to guarantee adequate containment of the radioactive material;
- establishment of an environmental radioactivity monitoring programme to specify the boundaries of the affected area, to monitor its evolution, and to determine the effectiveness of the remedial measures that have been implemented.

This monitoring would be supervised and controlled by *CSN* and would have to remain in operation for no less than 30 years. Special attention would be given by *CSN* to the control of the effectiveness of the clay covering to prevent migration of the contamination.

4.6.3.2 Monitoring of the *CRI-9* area

In late 2001, the conditioning works (i.e. covering of the *CRI-9* area with a clay layer) were reported to be finished.

In 2002, *EGMASA* submitted a radiological surveillance programme to the authorities (*"Plan de Normalización del CRI-9"* - "Normalisation Plan for *CRI-9*") including a radiometric control of the area, the monitoring of ground water by taking borehole samples from around the two contaminated dump sites and the establishment of a programme for the measurement and analysis of samples of water, sediment and indicator organisms at these points. *EGMASA* requested technical assistance from *ENRESA* for the implementation (August 2002).

This surveillance programme was initiated in November 2002. Surface waters from three sampling points and groundwater from twenty boreholes were analysed for total beta and rest beta activity and underwent gamma spectrometry for determination of Cs-137.

In June 2004, indicator organisms (sediments and plants) were included. In Sept. 2004, two additional groundwater sites and in October 2005, two sediment sampling points were added. In the first year the sampling frequency was monthly and afterwards quarterly.

Later, further adjustments of the programme were demanded.

4.6.3.3 Control of work at *CRI-9*

CSN has been controlling the developments at *CRI-9* through the evaluation of the information provided by *EGMASA* and by conducting periodic inspections.

After the works envisaged in the *DGPEM* decision of 15 January 2001 were reported to be completed, according to that decision, *EGMASA* had to draw up a final report that, in addition to describing the characteristics of the materials used in the covering, was to describe the geometry of the existing materials and a detailed flow chart of surface and underground waters.

In August 2002, *EGMASA* sent *CSN* the report "*Normalización del CRI de las Marismas de Mendaña. Informe Final"* ("Normalisation of *CRI* in *Las Marismas de Mendaña* – Final Report"), describing the conditioning works carried out. This report included the assessment reports and inspection certificates issued.

The assessment of this 2002 report (as well as the subsequent documents provided by *EGMASA*, together with the results of the inspections that took place between 2003 and 2007) have revealed a significant lack of information and some severe shortcomings, e.g. insufficiency of the clay layer to prevent migration of caesium-137. (Details with regard to the evaluation state of 2007 can be found in Appendix 4). As a consequence, additional information was supplied to CSN. Thus, in 2009 CSN could deliver a summary report (see Appendix 5 for the English translation).

The implementation phase of the ambient radiation monitoring plan began in November 2002. During this phase, the programme included the monthly collection of samples in three points for surface water

and in 20 bore holes for ground water. Total and residual beta activity measurements and gamma spectrometry (providing results for Cs-137, K-40, Bi-214 and Pb-214) were performed on all samples. In addition, in the bore holes, also the bore depth and its radiometric profile were measured.

The evaluation of the results obtained during the first twelve months of this programme, delivered to *CSN* in quarterly reports, concluded, among other aspects, that the analytical results for surface waters did not show that the remedial actions carried out were effective in confining the Cs-137.

As a consequence of this evaluation and in order to draw conclusions, it was found to be necessary to complement the ongoing programme, e.g. with the collection of sediment samples and of indicator organisms (vegetation that grows in the canals and on its slopes) in all sampling points, as well as by the establishment of a sampling point outside of the contaminated area of *CRI-9* (thus defining a "natural background").

In the ensuing monitoring phase, ongoing since January 2004, the sampling frequency has been quarterly at all the points; analysis and measurement tasks did not change.

In August 2007, *EGMASA* issued a report summarising the information related to the documents *"Vigilancia Radiológica Ambiental (PVRA) del CRI-9"* (Environmental Radiological Monitoring of *CRI-9*) and *"Estudio Hidrogeológico del comportamiento del Cs-137 en los frentes 3 y 4 del CRI-9"* ("Hydrogeological study of the behaviour of Cs-137 in sites 3 and 4 of *CRI-9*"). The two documents had been finalised in July 2007. The information in that report was required by the *DGPEM* Decision of 15 October 2001.

The results of the monitoring plan were evaluated by the Spanish authorities in relation to the degree of compliance of the work conducted with the requirements stated in the *"Plan de Normalización del CRI-9"* ("Normalisation Plan of *CRI-9*"). This evaluation took into account all the information provided by *EGMASA* and the inspections carried out (October 2007). The Earth Sciences unit at *CSN (CITI)* evaluated all aspects related to the behaviour of the clay cover; *AVRA* assessed the programme for monitoring surface water, sediment, and indicator organisms in order to determine the possible radiological impact; and *AEIR* managed *CRI-9* as a project. The results seem to indicate that the clay layer has not proven to be an effective barrier for isolating the contaminated materials, as it is not preventing the migration of caesium through the ground. However, the measurements suggest that the area affected by this migration remains confined to the proximities of the clay covered site, without reaching the *areas* outside of *CRI-9*.

Thus, according to the values seen, the Spanish authorities assumed that the radiological impact on workers, the population and the environment continued to be not significant.

In July 2007, the Technical Directorate Radiation Protection at *CSN* (*DPR*) sent a letter to the Huelva Town Council, *FERTIBERIA* and *EGMASA* informing *FERTIBERIA* that, as holder of the administrative concession of the ponds (including site *CRI-9*), among other actions, it must restrict access to the sites for all persons not involved in the Environmental Radiological Monitoring Plan underway.

As a result of the evaluation of the findings from the monitoring plan, on 16 January 2008 *CSN* decided to propose to the Directorate General for Energy Policy and Mines (*DGPEM*) that a new decision be issued requiring *EGMASA* to present to *CSN*, within a period of three months, a proposal for reinforcing the containment system in order to ensure the immobilisation of the contaminated material and prevent water from reaching it.

Thus, on 30 January 2008 *DGPEM* issued a new decision requiring *EGMASA* to carry out a series of additional reinforcing actions at *CRI-9* to ensure an adequate level of long-term radiological protection of the population, workers and the environment.

Taking into account that *CRI-9* is located in a land-maritime public domain area, the implementation of these actions had to include the relevant authorisation from the Directorate General of Coasts of the Ministry of the Environment and Rural and Marine Affairs.

On 25 March 2008 a meeting was held at the Ministry of Industry, Tourism and Trade with representatives of *DGPEM*, of the Directorate General of Coasts of the Ministry of the Environment and Rural and Marine Affairs, of *CSN* and of the company *EGMASA*, in order to address the different

questions (administrative, technical, etc.) relating to *EGMASA's* execution of the actions required in the Decision of 30 January 2008.

The new Decision of 30 January 2008, took into account that seepage of water was observed in the perimeter channel of fronts 3 and 4, with concentrations of Cs-137 higher than those observed in the radiological surveillance boreholes.

In their decision, the authorities requested *EGMASA* to perform complementary activities in order to fulfil the normalisation objectives established (February 2008).

In May 2008*, EGMASA* submitted a technical study on alternatives for the reinforcement of the confinement prepared with the technical assistance of *ENRESA*. In February 2009, the authorities approved the confinement reinforcement actions to be carried out and requested the performance of additional tasks for the radiological characterisation of the current situation in order to be able to provide a better basis for the design to be submitted six months later.

In September 2009, *EGMASA* submitted the results of a complementary radiological characterisation performed with the technical advice of *ENRESA* to support the design of the corresponding confinement reinforcement works.

4.6.3.4 Verification at *CRI-9*

After having received full information at the opening meeting the verification team visited the *CRI-9* site. It was informed that the part of the area holding old piles of phosphogypsum with a height of some 7 m, particularly the old piles identified as number 6, part of the number 7 and number 8-West located in the Marisma of Mendaña were evenly covered with 3,6 metres of material (1 m of excavation mud, then 2 m of rubble and 0,60 m of natural soil). Thus, the orographic structure of the site is kept. This restoration plan was carried out by the City Council of the Huelva.

The team verified a selection of the installed environmental radioactivity monitoring facilities, e.g. the boreholes coded S3-1, S3-6, S3-7, S4-1, S4-2, CA09-2, CA09-19, CA09-20 and CA09-21. The team was explained that the boreholes marked "S" are old ones, the ones marked "CA0" are from the series demanded in 2008 and later. Both types are key locked to prevent vandalism.

The verification team was shown several marked locations of seepage, surface water and sediment sampling. For the collection of seepage water in the morning a hole is dug; after several hours the water seeping into that hole is taken as sample. The team noted that the "canal" bordering *CRI-9* in the north-west was containing water only to a very limited degree, in several puddles, the water level generally depending on the tide. The background sampling point outside *CRI-9* at *Rio Tinto* was shown to the team. With regard to soil sampling, the team was told that such sampling only was done in the beginning in order to allow a site characterization; it is not performed anymore.

At borehole S3-1 a staff member from *GEOCISA* demonstrated the sampling of borehole waters. At the time of the visit the ground water level was at 4,80 metres below "surface". This value includes 1 m for the above-surface part of the bore tube, protected by a brick construction. Borehole bottom was at 15 metres. Samples of two litres are taken using a special device. The sample container is marked with the sample site code (on flask and on cap).

The team was informed about the methods of sampling other media such as indicator organisms.

The locations of the various sampling points are shown in figure 4.

During the visit a few ambient gamma dose rate measurements were taken. No measurement showed values that would have to be considered as posing an unacceptable radiation risk for the workers.

The verification team witnessed the presence of a fence of some three metres height surrounding approximately one third of the *CRI-9* site, in particular in the road access area. The team was informed that full fencing-in of the site was not foreseen as access in the non-fenced parts is not easy. The fence gate on the road was key-locked; it had to be opened to allow the access of the verification team and the accompanying persons. The team was informed that before installation of the fence guards were securing the site.

During the verification, the team was informed that the study scheduled for September 2009 was submitted by *EGMASA* to *CSN* on 14 September. *CSN* still had to analyse the results before informing the verification team of the outcome of this study.

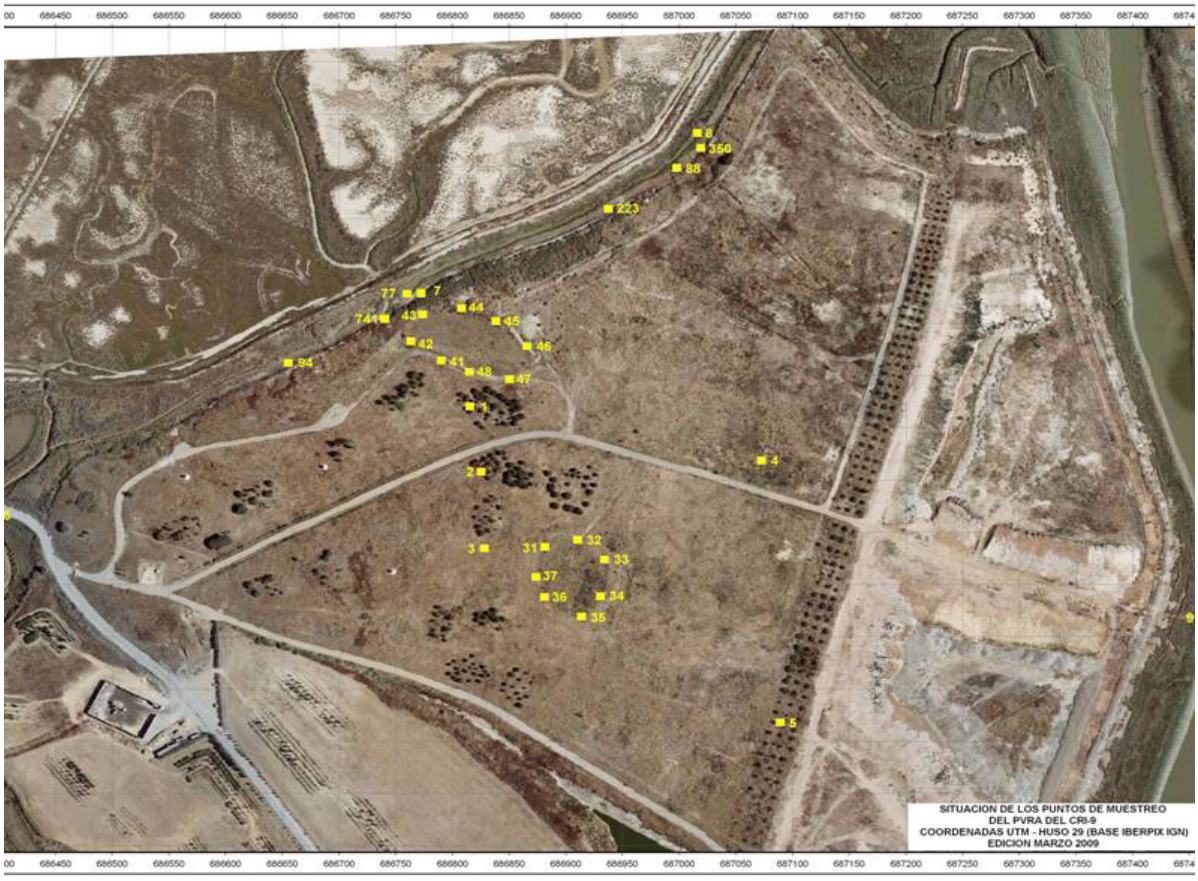

Figure 4: Location of all sampling points (status at time of the verification) at *CRI-9*

The verification team was informed about the main results of the environmental radiological programme, in particular that.

- All analysed samples showed low activity values; these results were considered to be without radiological significance.
- Most of the borehole water samples did not show any Cs-137 activity.
- Activity levels generally were far below limiting values from the Regulation on Radiological Protection.
- At front 3 of the *CRI-9* site, activity continues to be detected only in one borehole and, spuriously in another one.
- At front 4 of the *CRI-9* site, activity is detected in four boreholes, in two of those with decreasing values.
- Low activity has been detected in the surface waters from two sampling points; in 2009 all values were below the detection limit.
- In the samples of sediments and plants a decrease of activity was observed.

The team was informed that – after taking into account the different issues affecting the implementation of these actions by *EGMASA*, once *CSN* has studied the reports delivered in September 2009 by *EGMASA* on the radiological situation of the contaminated area – *CSN* will propose definitive actions and the measures to be implemented in the contaminated area.

Having received all information included in this report and after verification of the *CRI-9* site, the verification team considers that the environmental radiological monitoring as currently performed on behalf of the regulator is adequate.

The verification team endorses a thorough verification (after finishing the remediation work according to plan) of the effectiveness of the clay cover to prevent migration of the contamination. It also endorses a continuing monitoring of environmental radioactivity in the area. The team suggests reconsidering the total fencing of CRI-9 in order to completely prevent access by unauthorised persons.

5. VERIFICATION OF LABORATORIES

The following chapters describe the verification activities performed in the laboratories involved in environmental radioactivity monitoring (studies and routine programmes) at the Huelva NORM sites including *CRI-9*.

5.1 UNIVERSITY OF HUELVA

The verification team visited the analytical laboratory of the University of Huelva, belonging to the "*Grupo de investigación: Física de Radiaciones y Medio Ambiente*" of the Applied Physics Department.

A first room is dedicated to the reception of samples. Samples are stored in a separate room for a period of 3 to 4 years.

In another room the equipment for sampling soil (sampler tubes) is stored; a chemical laboratory with a decontamination tank is situated there as well. The room is also used for sample preparation; it contains among others a *P-Selecta Vibromatic* mechanical arm shaker that is used for liquid samples. The verification team noticed that sample preparation methods are well documented (e.g. document of methodology FRYMA01 - "*Metodo de extracción secuencial para aislamiento de isótopos de Po, U, Th y R*a").

A drying oven is housed in a separate room.

A liquid scintillation counter *Tri-Carb 3170 TR/SL* is used for tritium analysis and a 10 channel low level counter *Berthold LB 770* with a *Berthold LB 530* low radioactivity data system for gross alpha and gross beta analysis.

Canberra detectors for gamma spectrometry (among them one HPGe with 30% relative efficiency and 2,1 keV resolution, one with 35% relative efficiency and 1,9 keV resolution) are associated with electronic systems from *Canberra* and *Ortec*. Spectrum analysis is done with the software *Genie 2000* from *Canberra/Areva*. One detector is housed in a cylindrical shield formed of lead rings (during the visit this detector was out of operation), another in a 10 cm lead cubic castle. Another detector with L-shaped cryostat is installed in a special lead shield with copper liner. The verification team observed that one of the detector end caps was protected with cling film to avoid contamination.

For alpha spectrometry a complex setup of *Ortec* chambers (four *Soloist* single chamber alpha spectrometers and a *576A* double chamber alpha spectrometer in a NIM frame, together with an *Ortec 920-8 Spectrum Master* module) with *EG&G ORTEC 576 Vacuum Manifold*, an *Ortec Octete* alpha spectrometer, and an additional *Ortec Soloist* device are used. Spectrum analysis is done with *Ortec Maestro* software. For uranium determinations the laboratory uses U-232 as tracer. The verification team was told that this laboratory is the only one in Spain to be able to measure Ra-226 by alpha spectrometry, a methodology which was developed in Australia, then adapted in Spain. The main advantage is the very low limit of detection.

The verification team observed a radon chamber with *Pylon* equipment; a *Genitron AlphaGuard* device for Rn measurement, financed with funds from the EU FEDER programme; and a *Durridge RAD7* radon detector.

Calibrations are performed according to a Quality Control manual.

The team was also shown the results of the last inter-comparison in which the laboratory had participated ("Individual Evaluation Report for Laboratory N° 133"), in the frame of a "world-wide open proficiency test on the determination of natural radionuclides in phosphogypsum and spiked water", organized by IAEA.

Verification does not give rise to recommendations.

5.2 UNIVERSITY OF SEVILLE

5.2.1 *CITIUS*

CITIUS (*Centro de Investigación, Tecnología e Innovación – Universidad de Sevilla*) is part of the University of Seville. Together with the University of Huelva it performed a study with regard to the environmental impact and possible exposures by the Huelva phosphogypsum sites. The verification team was informed that within the study the *servicio de radioisótopos* of *CITIUS* dealt mainly with the aspects of surface water, sediments and phosphogypsum. Collaboration exists with *CSN* regarding NORM industries in general and with regard to the national environmental radioactivity monitoring network.

At the *servicio de radioisótopos* the verification team received detailed explanations from the scientific advisor (who is also professor and head of the research group “Applied Nuclear physics" from the University of Seville). Two persons are employed full time, one of them – a physicist specialised on liquid scintillation counting and alpha spectrometric measurements) could be interviewed by the team. The second one – a physicist specialised on gamma spectrometry and Monte Carlo simulation techniques – was not available during the visit. One staff member (doing work with the inductively coupled plasma mass spectrometer) works on contract basis.

The team was told that some 30-50 % of the *CITIUS* premises (including the laboratory equipment) were financed by the European FEDER programme.

The service also works on a commercial basis for industry, receiving samples as "black boxes" and returning analysis results.

The service started preparations for receiving ISO 17025 accreditation for its measuring tasks. *CITIUS* as a whole is ISO 9001 certified.

Radiochemistry laboratory

Sample registration is done in the radiochemistry laboratory. Generally the client's sample code is kept, with an internal number added. The registry is on paper using measurement specific sheets with the measuring tasks to be performed added to the sample description.

The radiochemistry lab is also responsible for the preparation of the tritium samples (including tritium enrichment by electrolysis). Control of the electrolysis process is done using tritium spiked water. As background water for tritium determinations *Solar de Cabras* mineral water is used. (The owner of the source himself does tritium measurements within its water quality control programme.) The overall limit of detection for H-3 achieved at the *servicio de radioisótopos* is some 0.2 Bq/l.

Gamma spectrometry

The verification team visited the gamma spectrometry laboratory. This lab houses a special Anti-Compton gamma spectrometry system with a well type HPGe detector (*Canberra*, horizontal cryostat), a large, horizontal, cylindrical lead shield, and a 5" well type NaI(Tl) detector with six photomultiplier tubes for anti-coincidence counting. At the time of the visit the system was still in its installation/fine tuning phase and not yet completely operational. It uses *Canberra* electronic NIM devices and *Canberra Genie 2000* as data acquisition and analysis software. The system will be mainly used for determination of Pb-210 for dating.

The verification team observed also a mobile gamma spectrometry system based on a *Canberra Inspector 2000* device, set up in the same room. The device is motor driven and contains a dismountable lead shield and a notebook PC for the data management programs. This equipment was used for tests at the Huelva phosphogypsum site (Zone 3).

The team was told that the reason for choosing *Canberra* was that this firm offers a very efficient service from its Spanish branch at Madrid.

With a view to avoid any disturbances in the measurements all PCs for handling the systems including gamma spectrometry software have been set up in the anteroom (with large a connecting window to the measuring room for easy observation).

Alpha, beta laboratory

The verification team observed that the laboratory houses two LSC devices of the type *Quantulus 1220*, an old one (supplied by *LKB Wallac*) and a newer one (supplied by *Perkin Elmer Wallac*). Staff remarked that the new device has the better operating characteristics.

For alpha spectrometry, a *Canberra Alpha Analyst* device with 12 chambers is used. The chambers house 450 mm^2 PIPS detectors. A low noise *Edwards* vacuum pump is used for building up the necessary vacuum. The verification team was shown a spectrum of a North Atlantic water sample, prepared for analysis of Po-210 using Po-209 as tracer. The sample stemmed from a project with UK partners.

For total alpha and total beta measurements as well as for the determination of Sr-90 in radiochemically prepared samples a gas proportional counter type *Berthold LB770 10 channel low level counter* with a PC interface *Berthold low radioactivity data system LB 530 PC* is used. Calibration is done with Pu-239 for alpha measurements and with Sr-90 for beta measurements. The laboratory uses Argon Methane as counting gas, supplied by *Alphagas* (subsidiary of *Air Liquide*).

ICP-MS

For the analysis of stable heavy metal isotopes, uranium and thorium in water and in biological samples an *Agilent 7500 Series* single quadrupole ICP-MS device is available, allowing a detection limit of some 100 ppt (parts per trillion). A sample changer for up to 50 samples is included. Main area is the determination of isotopic ratios for lead and mercury. An expansion of the range of analysis to include determination of Tc-99 is foreseen. For this device *CITIUS* has a service contract with *Agilent*, Barcelona.

Clean cell lab

Sample preparation for ICP-MS is done in the "clean cell laboratory". This room also houses the cooled device that contains eight cells for electrolytically enriching tritium, a *Cecil CE4004* spectro photometer for potassium measurement in water (for the determination of the K-40 content) and various sample preparation devices (furnaces *J.P. Selecta*, centrifuge *Hettich Universal 32*).

Other rooms

The verification team was shown a series of rooms belonging to the *servicio de radioisótopos* such as a special storage room for acids and chemicals, a balance room (the balance available is not yet calibrated but will be for accreditation), and a – key locked – room for radioactive sources.

QM/QC

The service is in the process of applying for ISO 17025 accreditation for its measurement work and already uses standard operating procedures. Annually, it participates in inter-comparison exercises organised by *CSN*, the last one involving measurement of a phosphogypsum sample. It also takes part in international inter-comparisons, e.g. for U-238, U-234 and Ra-226 by IAEA.

The verification team was shown the procedures for measuring uranium, thorium, polonium, Pb-210 and Ra-226. As general practise, a copy of the relevant procedure is used as a template for the measurement log; the individual sample data are added.

Most of the radioactive sources are from *CIEMAT*; others are from *PTB*, Braunschweig, Germany, and NPL (National Physics laboratory, England).

The verification team encourages all efforts with regard to receiving ISO 17025 accreditation for the measuring tasks performed by the servicio de radioisótopos of CITIUS.

5.2.2 Nuclear physics department

The *Departamento fisica atomica molecular y nuclear* of the Physics faculty of the University of Seville, through the research group "Applied Nuclear Physics group", participates in the national environmental radioactivity monitoring programme set up by CSN. It also does annual sampling in relation to the radioactive waste disposal site El Cabril and old uranium processing plant. This work is performed on the basis of an internal quality control programme developed by CSN with a view to controlling an other laboratory that performs measurements on a monthly sampling basis.

The verification team received detailed explanations of the work of the department by the head of the "Applied Nuclear Physics Group" of the University (who is also scientific advisor at *CITIUS*, verification see chapter 5.2.1). Three persons of this group are permanently employed, one works on basis of a scholarship. If needed, students are assigned to specific tasks. They receive according training and are supplied with the necessary documentation of procedures.

Roof area

On the roof of the Physics faculty building several devices are installed, belonging to the national radioactivity monitoring programme.

A high volume aerosol sampler type *ASS 500* (serial number 4/00) has been purchased from *CLOR*, Warsaw, Poland, via *Canberra*, Spain. The air flow measuring device is type *DPFA95*, serial number 95021, from *Physik Technik Innovation*, Erlangen, Germany, giving data on air flow rate, flow since last start, integrated flow, and operating hours. The flow rate is checked every two years by the supplier. Weekly air flow is 40000 to 90000 m^3. Similar devices are set up in Bilbao, Barcelona, Madrid and Cáceres. Above the filter holder a heater is installed to avoid clogging of the filter in winter. The heating device consists of a quartz tube heater, triggered during night time by an electronic clock. Filters are 44 cm x 44 cm; they are changed each Monday.

A low volume air sampler with *Millipore* paper filter and charcoal cartridge (weekly filter change) is operated as well. The paper filters are used for total alpha and total beta activity determinations in air and – three months composite samples – for Sr-90 analysis. The device is based on a pump from *Busch*, Chevenex, Jura, CH, and a gas counter from *Kronschroeder SA*, Barcelona. The flow rate is controlled every year.

The verification team noted also a precipitation collector with a sampling area of 1 m^2. Until 2000 it was part of the national system.

Radiochemistry lab

The team was informed that laboratory staff prepare samples for gross alpha, gross beta analysis and for determination of Sr-90 and actinides. However, sample measurement is performed at *CITIUS*. About ten samples are prepared per month.

The team observed preparation of a sample for Sr-90 analysis. It was shown the corresponding protocol with all relevant data being introduced (check marks are used for control). Sample preparation sheets were shown for Sr-90 determination in air, mixed diet and milk. Checks are performed by the technician and the head of the research group, however these are not signed off on the sample preparation sheets.

Spectrometry lab

The verification team visited the spectrometry lab that houses both, the alpha and the gamma spectrometry systems.

For alpha spectrometry a *Canberra Alpha Analyst* device with eight chambers is available: four are reserved for uranium, two for thorium and two for polonium determinations. A *Canberra DSA 1000* device interfaces to a PC.

For gamma spectrometry three detectors are available:

- Detector 'A', the 'extra system', a *Canberra* HPGe of 30% relative efficiency, with L-shaped cryostat, a shield made of "very old" lead (lead from the inner part of an old palace roof having a low content in Pb-210), and a *Canberra Bicron* active shield;
- Detector 'B', a *Canberra* ReGe (reversed germanium) detector in a Pb and Cu shield, with *Canberra* NIM equipment;
- Detector 'C', a *Canberra* LEGe (low energy germanium) detector used for Pb-210 and Am-241 determinations.

For data acquisition and evaluation *Canberra Genie* is available. However, this system is usually not used for evaluations in the automatic mode; the interactive peak fit contained in *Genie* is preferred, in particular for research tasks with low sample numbers.

Two PCs are used for controlling the devices.

At the time of the visit detector 'B' was measuring a milk powder sample, produced in the laboratory from fresh milk.

Air filters, after changing, are folded in cling film to approximately 10 cm x 10 cm and pressed at 2 tons. Then, "immediately" a first gamma spectrometric measurement is performed to guarantee detection of any elevated gamma activities. A second long term gamma spectrometric analysis is done after two to three days to allow to a certain extent the decay of radon daughter products.

The devices are calibrated when purchased using mixed radionuclide sources. Energy checks are done with the peaks in the samples ("self calibration", in particular for the LEGe detector). Efficiency controls are performed once every two months using an IAEA reference sample. Calibration of the ReGe detector is based on modelling using a Monte Carlo method, verified by measurements.

Background is measured once per month (minimum two days, usually during weekends or holidays); generally the last measurement is taken as being representative.

Fine tuning of the gamma spectrometry system is done using an oscilloscope.

Several UPS's with holding times of approximately ½ hour are in operation. Electric power generation by a diesel generator is available at the faculty, but not available for this lab.

Liquid nitrogen for cooling the detectors is filled into the dewars each Monday or Tuesday. A large LN_2 storage tank is installed at the faculty premises.

QM/QC

The verification team was shown the quality manual for the Nuclear Physics department and for *CITIUS* (defining among others the responsibilities) with regard to the tasks for the national monitoring systems: *Manual de la calidad de laboratorio de radiactividad ambiental (Programa REVIRA REM y PVRAIN) - Departamento de Física Aplicada*. The team was also shown various written procedures for sample preparation.

> *The verification team recommends securing electric power, in particular for gamma spectrometry, by connecting to an electric power system that is secured by the diesel generator of the faculty (in addition to operating the available UPS's for short power failures). With regard to sample preparation it recommends signing the data checks on the sample preparation sheets.*

5.3 *CIEMAT*

CIEMAT (*Centro de Investigationes Energeticas MedioAmbiantales y Tecnologicas*), the Research Centre for Energy, Environment and Technology, in Madrid, is a public organisation for research and technological development. It works under the Ministry of Education and Science. Its main objectives are to develop alternative energy sources, to find solutions to improve the use of resources and energy generation systems and to solve the problems of the Spanish companies regarding energy and its effects on the environment.

Some of the laboratory measurement procedures (tritium in liquid, alpha/beta total and Sr-90) are accredited to comply with the ISO 17025 quality standard.

The verification team visited the unit of Environmental Radioactivity and Radiological Surveillance (*Radiactividad Ambiental y Vigilancia Radiológica*) of the *División de Medio Ambiente Radiológico* (Division of Radiation in the Environment), which is part of the Environmental Department (*Departamento de Medio Ambiente*) of *CIEMAT*.

The technological capabilities of the unit include:

- Radiochemical analyses of natural and artificial isotopes in all kind of environmental sample matrices;
- High resolution gamma spectrometry;
- Alpha spectrometry;
- Low background liquid scintillation counting;
- Gas flow proportional counting;
- ZnS solid scintillation counting;
- Design and performance of monitoring programmes;
- Design and performance of radioecological studies.

In 1989 *CIEMAT* was asked by *CSN* to develop a study to assess the radiological situation in the vicinity of Huelva city as a consequence of the phosphate industry. A second study was performed by *CIEMAT* in 1998 after *Junta de Andalucía* request to verify the radiological impact of the phosphate industry following the implementation of a recovery plan.

Some of the laboratory measurement procedures (e.g. tritium and alpha total in waters) are accredited to comply with the ISO 17025 quality standard.

A room in the laboratory is dedicated to the arrival and registration of samples. For each sample, an electronic document containing all information is generated. In this room the team noticed a drying chamber (*Digitheat*, *p-Selecta*, Barcelona).

Samples are prepared in a second room.

In the lab gross beta measurements are done with a gas proportional counter.

Another room houses devices for measuring gross alpha and for the preparation of analysis of thorium and uranium by electrodeposition.

The alpha spectrometry device is a *Canberra Alpha Analyst* with 36 detectors of which 6 are dedicated to research.

Several HPGe detectors in lead shields are used for gamma spectrometric measurements. After amplification using NIM electronics (e.g. from *Canberra*), the signals are sent to computers situated one floor above.

The team noticed UPS devices with 3 to 4 hours battery capacity in case of power cuts.

Strontium is analysed in a separate room.

The room with the computers for gamma-spectrometric analysis is located on the first floor. *Canberra Genie 2000* is used for the calculations.

The following room is the laboratory for analysis of tritium and carbon-14. Several distillation devices for tritium are available. In addition, tritium is enriched by electrolysis. Measurements are done using a *TriCarb 3100 TR* liquid scintillation analyser. The sources for calibration are purchased from the US. The team was informed that this laboratory was the very first one accredited in Spain.

One specific laboratory prepares the samples for detection of Pu, Am, Po-210 and Pb-210.

Three low-level counters (10 channels) a *Berthold LB 770-2* is available for (gross) alpha and (gross) beta measurement; ZnS solid scintillation counting is used for alpha counting as well.

Radioactive sources are stored in a separate room.

The verification team was shown procedures and quality management documents, such as the "*Manual de Calidad*" (RA/MC-GC01; Ed. 4). The team received a demonstration of the data base on the central computer and performed a tracing of sample measurements. All data were found to be in order.

The laboratory routinely participates in inter-comparison exercises.

Verification does not give rise to recommendations.

5.4 GEOCISA - LABORATORIO DE VIGILANCIA AMBIENTAL Y ESTUDIOS RADIOMETRICOS

Introduction

The team verified the radiological laboratory at *GEOCISA* in Madrid that has been charged with performing the monitoring of the *CRI-9* site at Huelva.

Geotecnia y Cimientos S.A. (*GEOCISA*) was founded in 1968; originally it was based on construction related research and management. It has developed step by step and now performs technical studies, it operates laboratories, and performs specific work tasks. The verification team was told that generally the way forward was to study a problematic issue, develop appropriate methods for problem solving, and then offer the implementation of the corresponding work including the quality control.

Studies cover the following areas: geotechnics and technical assistance, (construction) structure, environment, roadway management, computer development, monitoring, site management and supervision, technical supervision of tunnels.

Laboratories have been set up with regard to construction, new instrumentation systems, radiochemistry and radiometry, environment, and quality control for works.

Highly specific approaches developed by *GEOCISA* are implemented in the areas of foundation construction, ground treatments, monument restoration, infrastructure restoration, and surface pollution remediation.

GEOCISA is organized as a main office in Madrid and six regional offices covering various areas. In case a task develops in a certain region to a considerable extent, this may form a new regional office. For quality control purposes, *GEOCISA* runs 50 QC laboratories in Spain. Currently, it is part of the large Spanish *ACS* group *(grupo Actividades de Construcción y Servicios)*.

The geographical area of work is not restricted to Spain. It operates all over the world.

Currently *GEOCISA* has some 1200 employees, 600 of them in Madrid.

GEOCISA has quality certification in compliance with the ISO 9002:94 standard. It uses the quality management systems ISO 9001, ISO 17020, ISO 17025 and the environment management system ISO 14001. In particular, the "Chemistry laboratory" is accredited to ISO 17025 by the Spanish accreditation authority *ENAC*. The verification team was informed that internal audits are performed twice a year in each department, on all levels. An award system in the areas of quality and security is seen as an important incentive to maintain the interest of staff in such issues.

Laboratory management

The verification team visited the *Laboratorio de Vigilancia Ambiental y Estudios Radiometricos* that is responsible for the radiological monitoring tasks associated with the *CRI-9* site at Huelva.

The team received an on-line presentation of the *LabWindows* system (*National Instruments Corp.*, Austin, TX, USA), which is used as a tool for creating test and control applications and the system *HCLab®* (*HCSoft*, Murcia, Spain), which is used for managing quality control in the laboratory. All relevant documents (such as the laboratory management document that contains all tasks, the organizational structure etc.; descriptions of control tasks for various persons; certification and accreditation details) are contained in PDF files.

This laboratory employs some 20 persons in Madrid. Together with several local laboratories (e.g. at El Cabril and Cordoba) some 40 staff are working in the area of radiological tasks.

Sampling, sample registration

Generally, the client is involved in all steps of the contracted programme, including technical aspects such as calibration. If sampling is done by *GEOCISA* staff, the client may be present. Written procedures exist for all types of sampling *GEOCISA* performs. At the sampling site a form is filled in with relevant sampling details; this form is signed by the sampler. The verification team had witnessed such sampling and the filling-in of the sampling form at *CRI-9* in Huelva.

A chain of custody form accompanies the samples when they arrive at the laboratory (one form may contain information on several samples). This form includes information on the physical condition of the samples at the different (transport) stages.

The verification team was shown the software used as laboratory information tool, *GEOPRA V5.0*, an MS-DOS application. This tool is used for sample registration, sample data input, etc. It contains information on all projects and generates analysis demands (including – as a link – information on the measurement method).

A preliminary data form is produced containing sample number, type of analysis foreseen etc.

Sample preparation

The verification team was shown the laboratory that prepares all samples for measurement, including (for some customers) radiochemical separation for strontium analysis or alpha spectrometry. The team saw various tools for evaporating water and (in a separate room) three muffle ovens for ashing samples. Electrodeposition for alpha spectrometry is on platinum disks.

Gamma spectrometry

For gamma spectrometry the laboratory has five coaxial HPGe detectors (four from *Canberra*, one from *Harshaw*); analogue NIM modules are from *Canberra*, *Bertan Associates S.A.* and *Nuclear Data*. One detector has digital data transfer via a *Canberra DSA 1000* device. For spectrum acquisition and analysis all systems use *Canberra Genie 2000*. Shields are made of 11.5 cm lead; there are no copper or cadmium liners.

Calibration is done every two years using a mixed radionuclide source and single nuclides (e.g. Cs-137 for samples where only a Cs-137 determination is demanded). The standards are coming from *QSA Global GmbH*, Braunschweig, Germany, certified by *DKD Deutscher Kalibrierdienst*; and from *Nucliber S.A.,* Madrid, traceable to *PTB*). The verification team observed that all detectors were marked with green labels signifying that the device was calibrated and operational. Weekly efficiency checks are performed.

Background is measured weekly.

LN_2 filling for detector cooling is performed every two to three days.

Electric power is assured for one hour by a UPS. After power failures a security officer has to call a staff member that subsequently turns off all critical equipment.

Alpha and beta activity measurements

The verification team was shown the devices used for gross beta measurements, one *Berthold LB 770* and two *Berthold LB 770-2* 10 channel low-level counters (with *Berthold LB 530 PC* low radioactivity data system). Two PCs are available for data handling. The counting gas (Argon-Methane) is delivered

by *AlphaGaz* (subsidiary of *Air Liquide*). Calibration for artificial beta emitters is done with Sr-90, for natural beta emitters with K-40 (the planchets being kept in an dessicator).

The laboratory operates three Liquid scintillation counters, one *Packard TriCarb 2900 TR*, one *TriCarb 1500* and one *TriCarb 3100TR*

All devices were marked with green labels to show operability.

Alpha spectrometry

Three *Canberra Alpha Analyst* devices are available (one with ten, the others with 12 chambers each), connected to two PCs. Three low noise vacuum pumps produce the necessary vacuum for the detectors (all 350 mm^2 PIPS). Spectrum analysis is done with *Canberra Genie*. A UPS device is available in the alpha spectrometry room to guarantee electric power. The room is temperature and humidity controlled.

Other measuring equipment

The verification team also saw a *Perkin Elmer* UV/VIS device.

QC/QM

The laboratory has ISO 17025 accreditation for all measurement tasks it offers. It routinely participates in inter-comparison exercises organised by *CSN*/*CIEMAT* and by IAEA.

Reporting

The client receives a written report in a format decided by him. With regard to measurements for *CRI-9* quarterly reports are produced, always using the same structure (introduction; tables and figures on total beta, rest beta and Cs-137 activity concentration). The text is written manually, data are taken from the database via an *EXCEL* application. The reports are sent to *EGMASA* and to *CSN* on hard copy and on CD-ROM, two weeks after the last measurement of the reporting period.

Archiving

The team was informed that record registries have to be kept 15 years. Samples are kept for two years; subsequently they are handled as decided by the client.

> *The verification team recommends securing electric power, in particular for gamma spectrometry, by connecting to an electric power system that is secured by a diesel generator (in addition to operating the available UPS's for short power failures).*

6. CONCLUSIONS

Further to parliamentary questions and petitions, a team of four inspectors of DG TREN H4 visited the Huelva sites on 14 September after having been fully informed of the actual situation by the site operator, by the regulatory authorities and by other actors. The goal of this verification was to obtain complete information and to verify a number of monitoring installations implied in the environmental radioactivity monitoring of the Huelva sites. The laboratories performing the measurements were also included in this verification. The verification did not touch any non-radiological aspects of the site.

All verifications that had been planned by the verification team were completed successfully. In this regard, the information supplied in advance of the visit, as well as the additional documentation received before the start and during the verification, was useful.

The information provided and the outcome of the verification activities led to the following observations:

(1) The information provided and the verification activities that were performed demonstrated that the radiological studies and surveillance programmes established for the concerned area are appropriate and efficient.

(2) With regard to the impact from the phosphate fertiliser production (NORM industry) the work conducted showed that the potential radiological impact caused by the phopshogypsum piles and ponds on workers and the public is very small with regards to the limits imposed by law. No additional remedial action seems to be necessary in the areas that are already covered with protective material. For the ponds and piles still operating restoration is envisaged.

With regard to monitoring, the verification team endorses the continuation of the environmental radioactivity monitoring currently performed by the University of Huelva.

The team points to the very long half lives of the substances involved and thus the necessity of an extremely long persistence of any measures that are taken.

(3) Concerning the contamination with Cs-137 at *CRI-9*, the verification team endorses a thorough verification (after finishing the remedial work according to plan) of the effectiveness of the clay cover to prevent migration of the contamination. It also endorses continuing monitoring of environmental radioactivity in the area. The team suggests reconsidering the total fencing of *CRI-9* in order to completely prevent access by unauthorised persons.

(4) A few topical suggestions are formulated. These aim at improving some aspects of the environmental radiological surveillance of the sites. They do not discredit the fact that environmental radioactivity monitoring of the phosphogypsum sites in the Huelva area is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.

(5) The verification findings and ensuing recommendations are compiled in the 'Main Findings' document that is addressed to the competent authority in Spain through the Permanent Representative of Spain to the European Union.

(6) The present Technical Report is to be enclosed with the Main Findings.

(7) The Commission Services ask the Spanish competent authority to inform them of any implementation achievements with regard to the situation at the time of the verification.

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

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APPENDIX 1

THE VERIFICATION PROGRAMME – SUMMARY

Tuesday 15/9/2009

1. Huelva: Opening meeting: introductions / presentations / programme of the visit. In particular: legal background, studies, sampling and measuring programme, plans for future developments.
2. Team-1: Verification of the provisions for any access restrictions, access control, monitoring/sampling (Cs-137 site *CRI-9*).
3. Team-2: Verification of the provisions for any access restrictions, access control, monitoring/sampling (NORM sites zones 1, 2, 3, 4).

Wednesday 16/9/2009

4. Verification of the local laboratories involved in monitoring/sampling; Team-1: Seville University; Team-2: University Huelva.

Thursday 17/9/2009

5. Madrid: Verification of laboratories involved in *CRI-9* monitoring: Team-1: *GEOCISA* and Team-2: *CIEMAT*
6. Closing meeting at the *CSN* headquarters. Presentation of preliminary verification findings.

Team 1 Mr Eberhardt Henrich
Mr.Constant Gitzinger (team leader)

Team 2 Mr Patrick Vallet
Mr Jean-Loup Frichet

APPENDIX 2

REFERENCES AND DOCUMENTATION

European Parliament	Petition 631/2007
European Parliament	Petition 1458/2007
European Parliament	Written Question E-3253/2007
European Parliament	Written Question E-0713/2008
European Parliament	Written Question E-4676/2008
Nuclear Safety Council (*CSN*)	*Solicitud sobre las balsas de fosfoyesos y el centro de recuperación de inertes (CRI-9) de las Marismas de Mendaña (Huelva); 3 Marzo 2008; CSN-C-RI-08/62*
Nuclear Safety Council (*CSN*)	*Centro de recuperación de inertes (CRI-9)* (Inert Material Recovery Centre *CRI-9*; document of 27 July 2009)
Nuclear Safety Council (*CSN*); *Vigilancia radiológica ambiental*	Tables and Figures with regard to the *CRI-9* site; 28 July 2009
Nuclear Safety Council (*CSN*)	*Situación del Centro de Recuperación de Inertes (CRI-9) de las Marismas de Mendaña. Propuesta de actuación; CSN/IEV/CTPA/CRI-9/0712/06, Rev. 1; 14 de Enero de 2008*; with annexes
Nuclear Safety Council (*CSN*)	*Revisón de la situación radiológica en la zona de vertidos de la industria de fosfatos de Huelva; junio 1998*
Ministerio de industria, turismo y comercio; Dirección General de politica energetica y minas	*Informa en relación con la carta de la Comisión Europea, de fecha 12-2-08, relativa a la existencia de residuos en el estuario de Huelva; 27-3-08*
Ministerio de industria, turismo y comercio; Dirección General de politica energetica y minas	*Resolución por la que se requiere a la empresa EGMASA para que lleve a cabo en el Centro de Recuperación de Inertes (CRI-9) de las Marismas de Mendaña (Huelva), una serie de actuaciones con el fin de asegurar, desde el punto de vista de la protección radiológica, un adecuado nivel de protección a la población y al medio ambiente a largo plazo; 30 ENE 2008*; with annex
Ministerio de Economia; Dirección General de politica energetica y minas	*Normalización del Centro de Recuperación de Inertas de las Marismas de Mendaña, resolución, 15 de enero de 2001;* with annexes
Junta de Andalucía	*Contestación de la Junta de Andalucía a la carta de emplazamiento complementaria 226 2448/2007. Actividades fabricantes de fertilizantes. Industrias Fertiberia y FMC-Foret en el polígono industrial de Punta Sebo*; 2009; with annexes
EGMASA	*Plan de vigilancia radiológica ambiental del CRI-9, rev. 2, Marzo 2009*
Consejería de Medio Ambiente de la Junta de Andalucía y Consejo Superior de	*Diagnóstico de la calidad ambiental de la Ría de Huelva. Evaluación radiológica de las balsas de fosfoyesos de Huelva.. 2007*

Investigaciones Científicas	
Centro Superior de Investigaciones Científicas (CSIC)	*6º informe Ría de Huelva – conclusiones y recomendaciones*
Juan Pedro Bolivar, Rafael García –Tenorio, José Luís M. Matarranz	*Evaluación radiológica del apilamiento de fosfoyesos de las marismas del río Tinto (Huelva)*
Comisión de Investigación e Información Independientes sobre la Radiactividad (CRIIRAD)	*Control radiológico de las balsas de fosfoyesos y del vertido de cesio 137 del CRI-9 - Informe CRIIRAD No07-117 Huelva (fosfoyesos y vertido Cs 137)*
CIEMAT	*Radiological Considerations Related with the Restoration of a Phosphogypsum Disposal Site in Spain. 1993*

PowerPoint Presentations

Elvira Hernando Velasco *(Ministerio de industria, turismo y comercio)*	"European Commission Art. 35 Verification - Spain Huelva Site"
Lucila Mª Ramos *(CSN)*	"Marismas de Mendaña. Huelva Verification under Art. 35 Euratom"
Andres Leal *(Junta de Andalucía)*	
Pablo Martín Huerta(Ministry of the Environment and Rural and Marine Affairs)	
Mª Teresa Ortiz *(ENRESA)*	"Presentation to Verification of Environmental Radioactivity – Article 35 – *CRI-9*"
David Cancio *(CIEMAT)*	"Radiological Assessment of Phosphate Industry in Huelva – Old Studies Performed for CSN and Junta de Andalucía"
Juan Pedro Bolivar, Rafael García –Tenório Garcia-Balmaseda	Phosphogypsum Piles from Huelva: Radiological Evaluation
CIEMAT	"Division of Radiations in the Environment"
GEOCISA	"General Presentation"
GEOCISA	"Quality and Environment" – Management

Web sites consulted

CSN	http://www.csn.es/
CIEMAT	http://www.ciemat.es/
Junta de Andalucía - EGMASA	http://www.egmasa.es/

APPENDIX 3

Summary and conclusions of *CSN*'s report on the study on NORM issues at Huelva

The following text is the translation of the summary and the conclusions of *CSN*'s report on the study on NORM issues at Huelva, performed in 2004 to 2007.

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Conclusions

Depending on the results of the radiological evaluation performed and summarized above, we can conclude the following:

- The occupational radiological impact associated with work activities carried out concerning the management, storage in ponds and maintenance of phosphogypsum generated at the phosphoric acid production factories (bare piles areas 2 and 3), is very limited, found an increase in effective doses that can be received by the workers considering all exposure pathways below 1 mSv / year, dose limit for members of the public. In this sense, increases in effective doses likely to be received by workers via external irradiation, do not exceed 0.30 mSv / year; even under conservative assumptions, the increase in effective doses by inhalation of particulate material potentially received by these workers does not exceed 10 micro Sv / year, and the concentrations of 222 Rn above the phosphogypsum piles and surroundings are quite low and indistinguishable from background values obtained in coastal environments (15-30 Bq / m 3).

- The occupational radiological impact associated with work activities carried out concerning maintenance of restored piles (areas 1 and 4) can be estimated as practically zero. Given the results of the assessment in the bare piles, the only possible way of impact that would need to be evaluated is the external irradiation pathway. Experimental measurements carried out indicate that soil and / or inert waste covers act as perfect shielding of the radiation emitted from phosphogypsum, obtaining values indistinguishable from background values for the external irradiation dose rate.

- The radiological impact on the public, caused by phosphogypsum piles can also be evaluated as negligible or nil. The values of external irradiation dose rates and the concentrations of 222 Rn in the city of Huelva correspond to background values."

"Main results

… the main results in the study and assessment of the radiological impact associated with the activities of the phosphoric acid production plants, situated in Huelva These conclusions are:

- The occupational radiological impact associated with development of work activities within these industries, under normal operating conditions is quite limited, being the increase in effective doses likely to be received by the workers below 1 mSv / year.

- The occupational radiological impact associated with work activities carried out in connection with the management, storage and maintenance of phosphogypsum generated in phosphoric acid production factories, is also quite limited, being the increase in effective doses likely to be received by workers also below 1 mSv / year.

- The radiological impact on the public caused by the activities associated with the production of phosphoric acid in Huelva and the management of the by-product that generates which is stored in the marshes of the Tinto, is close to zero.

- The new management policy of phosphogypsum, conducted since 1998 has led to the cessation of contributions of radioactive elements to the estuary of Huelva. The estuary, on the other hand, has experienced since the change in management policy of phosphogypsum regeneration from a

radioactive point of view, having now practically recovered the situation prior to the beginning of the activities of phosphoric acid production industries, dating from 1968.

In view of these findings, we estimate that the industry should not be under supervision, and is not necessary to take corrective measures to reduce exposures and / or implementation of radiation protection measures.

Only, as stated in the report, during maintenance work in plants is recommended to take precautionary measures to minimize inhalation doses likely to be received by workers (through the use of masks) and at least until obtaining a meaningful set of data, to perform a workers control with personal dosimeters. In addition, in areas where external irradiation exposures are higher under normal operating conditions, the necessary steps must be taken by the company to ensure that in future there is not a radical increase in present occupational factors, which are very low, as this could result in an increase of the external irradiation effective doses likely to be received by workers."

APPENDIX 4

Detailed analyses and conclusions concerning the plan of action for *CRI-9* (Decision of 15.01.01) and proposal for additional actions (2007)

The following text is the translation of an extract from document CSN/IEV/CTPA/CRI-9/0712/06, Rev. 1, transmitted by *CSN* to the EC on 14 January 2008.

"The overall evaluation of the data obtained to date in the current Monitoring Plan and the data collected in the inspections carried out appear to indicate a lack of effectiveness of the containment of the contaminated material. There are underground water flows that appear to enter into contact with the contaminated material of sites 3 and 4. These flows, in the form of small streams or seepage, surface in the water intake channel (marsh) and have the highest concentrations measured in the area. The possibility has not been ruled out of finding other locations where waste contamination may have accumulated outside of sites 3 and 4 and which could contribute to these high concentrations.

In addition, according to the information provided by *EGMASA's* representatives, the neutralised material was not completely covered, as the clay layer is not anchored in perimeter trenches around the contaminated materials, and, therefore, Alternative 2 proposed by *EGMASA* and approved in the Decision of 15.01.01 has not been carried out in full.

Despite *EGMASA's* completion of the documentation required by the Decision in question (August 2007), there are still shortcomings in aspects such as the hydrogeological operation and structural characteristics of the containment layers. Due to these insufficiencies, and to the incomplete execution of Alternative 2, it is not possible to consider the Decision properly fulfilled, nor is it possible for *CSN* to give a positive evaluation of the conclusion of the normalisation works at *CRI*.

Although the clay layer has not proven to be an effective barrier for isolating the contaminated materials by not preventing the migration of the caesium through the ground, from the information available, it can be concluded that the area affected by this migration remains confined to the vicinity of the neutralised sites, and does not reach the areas outside of *CRI-9*. Therefore, the radiological impact on the population and the environment are negligible, according to the values as presently measured. However, measures must be taken to ensure the containment of the contaminated material in order to guarantee adequate long-term protection of the population and the environment.

Considering all the foregoing, the following conclusions have been made:

1. It is not possible to give a favourable report on the conclusion of the normalisation works at *CRI-9* required by the *DGPEM* Decision of 15.01.01, which would allow the total covering of the affected areas with material from a borrow pit. *DGPEM* is to be notified of this.

2. It is considered necessary to propose to *DGPEM* that it issue a new Decision, requiring *EGMASA*, as the party currently responsible for the fulfilment of the aforementioned Decision, to carry out the following actions:

a. Submit to *CSN,* within a period of three months, a proposal for reinforcing the containment system to ensure the immobilisation of the contaminated material and prevent water from reaching them, in accordance with the objectives set forth in Alternative 2, selected in the *DGPEM* Decision of 15 January 2001. The proposal must consider the current situation of the recovery works and the results of the monitoring plan that is being carried out.

   This proposal must include an itemisation of the works and actions to be carried out and the plan for their execution, as well as the relevant supporting study, which must consider the long-term evolution of the concentrations of Cs-137 in the area possibly affected outside of *CRI-9*. The proposal must be approved by *CSN* before its execution.

b. Continue the execution of the Monitoring Plan without reducing the frequency of the sample taking and analyses. The design of the Plan must be modified to include a monitoring of the seepage, with the aim of determining the direction of preferential flow from the dump sites and the origin of the Cs-137 detected in sediment samples from the runoff areas in proximity to

CRI-9 but further from the neutralising sites. The plan must also include an additional sampling point in the area of the river *Tinto*, upstream and at a distance far enough away from the effluence of the *CRI-9* marshes so that reference values can be obtained that are not influenced by this effluence.

Within a period of six months, submit a proposal for modifying the monitoring plan that considers the results to date of the programme carried out and the actions required in the previous section, and that permits the carrying out of adequate monitoring of the effectiveness of the measures implemented for the containment of Cs-137 in the neutralising sites.

c. Immediately and effectively restrict access to the affected areas for all persons not involved in the current environmental radiological monitoring plan, and submit a proposal to *CSN* as to how to enforce this restriction and how the control of the land and water use required in the second condition of the *DGPEM* Decision of 15 January 2001 will be carried out. This proposal is to be submitted within a period of three months and must be approved by *CSN*.

d. Submit a final report to *CSN* on the execution of the reinforcement of the containment system, which must be approved by *CSN*.

e. Those conditions laid down in the *DGPEM* Decision of 15 January 2001 which have not been amended by the present Decision and that are still pending shall remain in force.

C) Request a report from *SAJ* on the administrative situation of *CRI-9* to respond to the communication from the Director of *FERTIBERIA* of 21.12.07."

APPENDIX 5

CSN summary report on _CRI-9_ (2009)

The following text is the translation of *CSN*'s summary report on the state of the actions at *CRI-9* as of September 2009.

"In September 1997 the Environmental Management Company S.A. (EGMASA), Fertiberia and the City Council of Huelva signed a collaboration agreement for environmental restoration of phosphogypsum ponds 6, 7, 8 and 9 of the Marshes of Mendaña FERTIBERIA holds an administrative concession over the land of the Marshes of Mendaña granted by the Directorate General of Coasts (Currently DGSCM).

On 30 May 1998 a radioactive source of cesium-137 was melted in the facilities that Acerinox has at its factory in Los Barrios (Algeciras, Cádiz) in one of its electric arc ovens, for the production of stainless steel. The smoke dust contaminated with cesium-137, was treated by an inertisation plant owned by EGMASA in the usual way, which was the use of inertized material as fill material for the restoration plan of the phosphogypsum ponds, dumping the material on the pond No 9 (CRI-9).

As a result of the dumping of contaminated material in the CRI-9, the Directorate General for Energy, Policy and Mines (DGPEM), of the then Ministry of Economy (now Ministry of Industry, Tourism and Trade), requested EGMASA in June 1998 to submit an Action Plan for the normalization of the CRI-9.

Within the implementation of this Action Plan, the National Radioactive Waste Company (ENRESA) removed 341 metric tons of the most contaminated radioactive material of the CRI-9 in two interventions. The remaining less contaminated material (4857 t) is currently in the CRI-9.

In September 1998, EGMASA requested approval for the normalization of the denominated dumping fronts. As technical support to this request, and given that in the dumping area persisted contaminated material, EGMASA submitted in July 1999 a document in which they formulated and analyzed four alternatives for normalization activities in the CRI-9. Of the four alternatives the first three entailed the permanence of the contaminated material in the CRI-9.

The DGPEM, with the previous report of the Nuclear Safety Council of 3 November 2000, issued a resolution, dated 15 January 2001, requiring EGMASA to proceed to the normalization of CRI-9 according to one of the alternatives, supplemented with the limits and conditions set out in Annexes 1 and 2 of the resolution, and not allowing to resume normal operations at the Center until the CSN reported favorably.

Additionally, the resolution required EGMASA to establish the means to effectively guarantee that the uses of land and water in the affected area were conducted in a manner consistent with the radiological situation and the need to implement a monitoring of radioactive contamination plan in the long term, supervised and controlled by the CSN, whose continuity must be guaranteed at least 30 years.

In late 2001 the restoration activities were completed and EGMASA started the monitoring plan in the area. The radiation monitoring plan consists in the realization of a radiometric control, monitoring of groundwater with boreholes around the two contaminated fronts, and establishment of a program for measuring and analyzing water samples, sediments and organisms indicators in those sections. This monitoring plan is conducted quarterly and the results are evaluated by the CSN in order to verify that the confinement provided by the clay

layer is sufficient to ensure that the long-term radiological impact is acceptable in the area potentially affected out of CRI -9.

The environmental radiation monitoring plan had an implementation phase, which ran from December 2002 until November 2003. At this stage the program included the collection of monthly samples at three points of surface water and 20 water points in boreholes. All samples were analyzed for the levels of total beta and beta rest activity and gamma spectrometry, providing results of Cs-137 and also of natural isotopes K-40, Bi-214 and Pb-214. The surveys also carried out measures of the boring level and the radiometric profile.

The evaluation of the results obtained during the first twelve months of the program development, submitted to the CSN in quarterly reports, concluded, among other aspects, that the analytical results for surface water monitoring plan of the CRI-9 did not show that remedial actions performed had been effective to ensure the containment of inertized products contaminated with Cs-137, being necessary therefore to have the results of a larger number of samples to reach conclusions about it. These surveys could be carried out quarterly, as EGMASA had reported to do during the next stage of program development, but maintaining this quarterly frequency for several years. In addition, it was considered necessary to have new sampling points, including some in natural river areas outside the CRI-9, which could eventually receive contamination of Cs-137 which is trying to be confined in the CRI-9 and it was required to complete the program with the sampling of sediments and indicator organisms (vegetation that grows in the channels and on their slopes) at all sampling points.

In the next phase, of follow-up, ongoing since 2004, the sampling frequency has been done quarterly in all points, as noted above, carrying out the same analysis and measurements. The water monitoring boreholes have been the same throughout the whole program, but in respect of surface water, taking into account the findings of successive evaluations and inspections in the affected areas of the CRI-9, the program has been completed, increasing the sampling points.

While the results of the monitoring program suggest that the clay layer is not proving an effective barrier to isolate the contaminated materials, for failing to prevent the migration of cesium through the ground, information available indicates that the area affected by this migration is restricted to the vicinity of the contaminated fronts, not reaching the areas outside the CRI-9, as shown by the higher values obtained in the samples of water and sediment of the river's natural areas to which contamination could reach. In those outside areas the highest values measured in sediments are of the order of 10 Bq/kg dry, against maximum values of the order of 10^3 Bq/kg dry in sediments obtained in the vicinity of fronts. Measures of water samples of the outside areas have lower or similar values to the limits of detection. It follows, therefore, that the radiological impact on the population and the environment is not significant, according to the currently measured values. However additional measures must be implemented, to contain the contaminated materials and ensure adequate protecting people and the environment over time.

Besides that, measures of environmental radiation rate made at 1 m distance over each of the fronts are less than 0.2 μSv / h.

Following the results of the monitoring program the CSN agreed, dated 16 January 2008, to propose that the General Directorate for Energy, Policy and Mines issues a new resolution requiring EGMASA to present to the CSN, within three months, a proposal for reinforcing the containment system in order to ensure the immobilization of the contaminated material and prevent water from reaching it.

The General Directorate for Energy Policy and Mines issued, dated 30 January 2008, a resolution requiring EGMASA to carry out in the CRI-9 a set of actions to ensure, from the standpoint of radiation protection, an adequate level of protection of the public, workers and the environment in the long term.

Among these actions there is one asking to present the CSN a proposal for reinforcing the containment system for the immobilization of contaminated materials and prevention of access of water to them and to continue the implementation of the surveillance program without reducing the sampling and analysis frequency, presenting also a proposal to amend the program to take into account the results of the program up to date and to allow proper monitoring of the effectiveness of the measures implemented for the confinement of Cs - 137 inertized fronts.

EGMASA, with the collaboration of ENRESA, carried out a number of additional studies including a special campaign of radiological characterization of the CRI-9 held in February 2008, and finally submitted a proposal to strengthen the confinement system, which has been appreciated by the CSN as well as the proposed amendment of the monitoring program.

In the proposed modification of the monitoring program the scope is completed as requested in the resolution, including new sampling points and sample types incorporated as a result of evaluation of results observed in annual inspections of the CSN and the new data obtained in the radiological characterization of February 2008.

In any case, further studies requested by the CSN to determine the disposition and characteristics of existing materials are pending completion, hydro geological performance of the area, preferred directions of flow and discharge zones from the areas affected by pollution, which may lead to other changes in the monitoring program to ensure that potentially covers the entire affected area and meets all its targets for surveillance so there is no radiation risk to people and the environment, while determining the effectiveness of the remedial actions carried out.

Results of these studies were expected in September 2009[3] according to the conditional approval of the technical study. However, EGMASA/ENRESA has submitted supplementary information on the monitoring program that provides information on activities carried out and preliminary results, which include among others the drilling of new boreholes that, as noted above, may be used to establish a new revision of the monitoring program.

The laboratory responsible for carrying out this monitoring program is the one of environmental measures of Geocisa, company which is based in Madrid.

The CSN performs its control functions approving the programs to be carried out, verifying their compliance through annual inspections and evaluating the results of these programs. CSN inspectors conduct an independent control with samples which are analyzed by the laboratories of CIEMAT and, occasionally, the CEDEX, both in Madrid."

[3] Received by CSN on 7 September 2009: “Resultados de la Caracterización del Centro de Recuperación de Inertes (CRI-9)”.