



**EUROPEAN COMMISSION**  
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D – Nuclear Energy  
**D.4 Radiation Protection**

# **TECHNICAL REPORT**

## **VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY**

**Plutonium contaminated sites in the PALOMARES region**

**SPAIN**

**19 to 22 April 2010**



**Reference: ES-10/01**

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## VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

FACILITIES: Further to parliamentary questions and petitions, a team of two inspectors from DG TREN H.4 visited the *Palomares* sites on 20 and 21 April 2010 after having been fully informed of the current situation by the regional authorities and by *CSN* (Spanish 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 *Palomares* sites. The laboratory of *CIEMAT* was not included in this verification.

SITE: *Palomares*, Spain

DATE: 19 to 22 April 2010

REFERENCE: ES-10/01

INSPECTORS: C. Gitzinger (Head of team)  
E. Henrich

DATE OF REPORT: 20/08/2010

SIGNATURES:

*[signed]*

**C. Gitzinger**

*[signed]*

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## TECHNICAL REPORT

### ABBREVIATIONS AND ACRONYMS

|                |                                                                                                                                                                           |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>AVRA</i>    | <i>Área de Vigilancia Radiológica Ambiental</i> (Environmental Radiological Surveillance Unit; CSN)                                                                       |
| <i>AEIR</i>    | <i>Área de Evaluación del Impacto Radiológico</i> (Radiological Impact Evaluation Unit; CSN)                                                                              |
| <i>BOE</i>     | <i>Boletín Oficial del Estado</i> (Official Gazette)                                                                                                                      |
| <i>CIEMAT</i>  | <i>Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas</i> (Energy, Environment and Technology Research Centre)                                        |
| <i>CSN</i>     | <i>Consejo de Seguridad Nuclear</i> (Nuclear Safety Council)                                                                                                              |
| DG ENER        | Directorate-General for Energy (of the EC)                                                                                                                                |
| DG TREN        | (former) Directorate-General for Energy and Transport (of the EC)                                                                                                         |
| DOE            | United States' Department of Energy                                                                                                                                       |
| EC             | European Commission                                                                                                                                                       |
| IAEA           | International Atomic Energy Agency                                                                                                                                        |
| ICRP           | International Commission on Radiological Protection                                                                                                                       |
| JEN            | <i>Junta Energía Nuclear</i> (Nuclear Energy Board; now CIEMAT)                                                                                                           |
| <i>MITYC</i>   | <i>Ministerio de Industria, Turismo y Comercio</i> (Ministry of Industry, Tourism and Trade)                                                                              |
| NORM           | Naturally Occurring Radioactive Material                                                                                                                                  |
| NPP            | Nuclear Power Plant                                                                                                                                                       |
| <i>PIEM-VR</i> | <i>Plan de Investigación Energética y Medioambiental en Materia de Vigilancia Radiológica</i> (Energy and Environmental Research Plan for Radiological Monitoring - 2004) |
| <i>PVRA</i>    | <i>Programa de Vigilancia Radiológica Ambiental</i> (Environmental Radiological Monitoring Programme)                                                                     |
| <i>PVRP</i>    | <i>Programa de Vigilancia Radiológica Palomares</i> (Palomares Radiological Monitoring Programme)                                                                         |
| <i>REA</i>     | <i>Red de Estaciones Automáticas de Vigilancia Radiológica Ambiental del CSN</i> (Automatic Station Network)                                                              |
| <i>REM</i>     | <i>Red de Estaciones de Muestreo</i> (Sampling Station Network)                                                                                                           |
| <i>RPSRI</i>   | <i>Reglamento sobre protección sanitaria contra radiaciones ionizantes</i> (Health regulation on ionising radiation)                                                      |
| 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 <sup>(1)</sup>.

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 two inspectors from DG TREN.H.4 visited the *Palomares* sites on 20 and 21 April 2010. At different meetings the team met:

1. The sub delegation of the Spanish government in *Almería* (*Subdelegación del Gobierno en Almería*), headed by Mr. Andrés Heras.
2. The Senator for the region of *Almería* in the Spanish government and Mayor of the district town *Cuevas del Almanzora*, Mr. Jesús Caicedo.
3. The Mayor of the village of *Palomares*, Mr. Juan José Perez-Celdrán.
4. Representatives from *Consejo de Seguridad Nuclear* (CSN) which is the Spanish nuclear authority. This delegation was headed by Deputy Director Mrs. Lucila Ramos.
5. Representatives from *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas* (CIEMAT; Energy, Environment and Technology Research Centre; a public research institution attached to the Ministry of Science and Innovation), headed by Secretary General, Mrs. Teresa Mendizábal.

After having been fully informed of the past and current situation at this opening meeting, the team visited the contaminated sites. The goal of this verification was to obtain up to date information on the monitoring of the environmental radioactivity in the concerned areas around *Palomares* and to get knowledge of any remedial measures put in place till now or foreseen for the future. The verification included measures taken to prevent access to these areas, as well as efforts to get knowledge of any issues still needing a solution.

A summary overview of the programme of verification activities is provided in Appendix 1. The verifications were carried out in accordance with this programme.

The present report contains the results of the discussions with the Spanish competent authority CSN and all other actors, as well as the results of the verification team's review of some aspects of the environmental surveillance at and around the *Palomares* sites in relation with the plutonium contaminated soil stemming from the accident of two US military airplanes in the late sixties in the region of *Palomares*.

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 in Spain of the NPPs *Trillo*, *Cofrentes* and *Ascó* as well as of the phosphogypsum sites (NORM) around *Huelva*.

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<sup>1</sup> 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. PREPARATION AND CONDUCT OF THE VERIFICATION

### 2.1 INTRODUCTION

The Commission's decision to conduct a mission under the scope of Article 35 EURATOM was discussed with the Spanish authorities end of 2009. The Spanish competent authority (*Consejo de Seguridad Nuclear - CSN*) agreed to a verification visit of the Commission services in Spain from 19 to 22 April 2010 in order to verify the radiological monitoring of the *Palomares* region (issue of plutonium contamination) and of the underlying 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 AND OTHER ORGANISATIONS INVOLVED IN THE SITE RELATED ENVIRONMENTAL RADIOACTIVITY MONITORING

During the visit the following representatives of the national authorities and other bodies involved were met:

#### Nuclear Safety Council (CSN)

|                              |                                                                          |
|------------------------------|--------------------------------------------------------------------------|
| Mrs. Lucila RAMOS SALVADOR   | Deputy Director for Environmental Radiological Protection                |
| Mrs. Rosario SALAS COLLANTES | Head of the Environmental Radiological Surveillance Unit ( <i>AVRA</i> ) |
| Mr. José Ignacio SERRANO     | Head of the Radiological Impact Evaluation Unit ( <i>AEIR</i> )          |
| Mrs. Carmen REY DEL CASTILLO | Scientist, <i>AVRA</i>                                                   |
| Mrs. Inés URBANO             | Institutional Relations, Technical Cabinet of Presidency                 |
| Mrs. Vanessa LORENZO         | Communication adviser, Technical Cabinet of Presidency                   |

#### Sub-delegation of the Spanish government in Almería

|                    |                                |
|--------------------|--------------------------------|
| Mr. Andrés HERAS   | Subdelegate of the Government  |
| Mr. Luís HERNÁNDEZ | Secretary of the Subdelegation |

#### Representatives of the Spanish senate, of regional and local authorities

|                             |                                                                                                                         |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Mr. Jesús CAICEDO           | Senator for the region of <i>Almería</i> in the Spanish Parliament and Mayor of the town of <i>Cuevas del Almanzora</i> |
| Mr. Juan José PÉREZ-CELDRÁN | Mayor of the village of <i>Palomares</i>                                                                                |

#### CIEMAT

|                        |                                                                                         |
|------------------------|-----------------------------------------------------------------------------------------|
| Mrs. Teresa MENDIZÁBAL | Secretary General of <i>CIEMAT</i>                                                      |
| Mr. Carlos SANCHO      | Head of <i>Unidad de Recuperación de Terrenos Radiologicamente Contaminados (URTRC)</i> |

|                              |                                   |
|------------------------------|-----------------------------------|
| Mrs. Asunción ESPINOSA       | Project responsible               |
| Mr. José Carlos SÁEZ VERGARA | Sénior Technician at <i>URTRC</i> |
| Mr. Diego MORENO             | Local aide                        |

### 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*.

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

*CSN* is also the Spanish authority competent in the follow up of the case of the accident of two aircraft of the United States Airforce which collided in mid-flight over the district of *Palomares, Cuevas del Almanzora (Almería)* in 1966.

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

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 6<sup>th</sup> of July, approving the Regulation for Health Protection against Ionizing Radiations (*RPSRI*).

### **3.2.2 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.

### **3.2.3 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.

### **3.2.4 Ministry of Science and Innovation; Energy, Environment and Technology Research Centre (CIEMAT)**

The Energy, Environment and Technology Research Centre (*Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, CIEMAT*) is a public research body that reports to the Ministry of Science and Innovation through the State Secretariat for Research and whose activities are carried out

in the areas of energy and environment, various cutting edge technologies and important fields of basic research.

*CIEMAT* is responsible for the Energy and Environment Research Plan in matters of Radiological Monitoring of soils affected by residual contamination in *Palomares (Almería)*.

### **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) and to *Huelva* (2009).

#### **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 Relevant incident related legislation and resulting initiatives**

- Chapter VI (Interventions) of the Regulation on Health Protection against Ionising Radiation;
- Law of 16 December 1954 on forced expropriation (BOE nº 351 of 17 of December of 1954);
- Law 62/2003 of 30 December 2003 on fiscal, administrative and social measures to meet the economic policy objectives of the law on general state budgets for the year 2004 (this law included, under Article 130, provisions relating to the 'Energy and Environmental Research Plan for Radiological Monitoring of the land in *Palomares* requiring special environmental radiological monitoring');
- Agreement of the Cabinet of Ministers of 17 December 2004, by approving Energy and Environmental Research Plan for Radiological Monitoring and the expropriation certain land in *Palomares*;
- Agreement of the Cabinet of Ministers of 28 September 2007, by approving the expansion of Energy and Environmental Research Plan for Radiological Monitoring and the temporary occupation of affected lands.

### 3.4.3 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 n° 45 of 21 February 2003.

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

### 3.4.4 International legislation and 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 N° 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 sobre 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. PALOMARES SITES – DESCRIPTION AND VERIFICATION

At the opening meeting and during the course of the verification, the team of Commission experts received extensive information concerning the issue of the release and dispersion of the fissile material of nuclear weapons into the terrestrial Mediterranean ecosystem in the surroundings of the village of *Palomares* (district of *Cuevas del Almanzora*; *Almería*) further to an accident of two US military airplanes in 1966. Although the contaminated areas were cleaned immediately after the accident, substantial contamination remained, as has been proved by subsequent studies, which focussed on the distribution, characterisation and behaviour of transuranium elements (Am-241 and Pu-239+240) in the affected ecosystems.

The information received is detailed below in chronological order.

## 4.1 INTRODUCTION

On 17 January 1966 two aircraft of the United States Airforce (a B-52G bomber and a KC-135 tanker airplane) collided during the refuelling process of the bomber at 9450 metres above ground over the village of *Palomares* in the municipality of *Cuevas del Almanzora* (province of *Almería* in *Andalucía*). As a result of this accident the four nuclear bombs (Mk28 type hydrogen bombs) being transported by the bomber were dropped. The non-nuclear explosives in two of the weapons detonated when impacting the ground without setting off a nuclear explosion; however, a quantity of plutonium was released which contaminated a large area of *Palomares*. The other bombs remained intact: one was later found in a river bed, one in the sea. During the accident seven American soldiers died, but nobody was hurt or injured amongst the Spanish population.

On account of the radioactive nature of the contamination, immediate action was taken by specialist United States personnel in conjunction with Spanish personnel. This action basically consisted of removing a layer of contaminated earth and vegetation over a large area which had been affected.

Once the emergency action had been completed a radiological monitoring programme was started which consisted of monitoring the population potentially affected by the plutonium and analysing the residual soil, animal and vegetation contamination. Responsibility for this monitoring programme was given, from the start, to the *Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas* (*CIEMAT*; Energy, Environment and Technology Research Centre), formerly the *JEN* (Nuclear Energy Board), on account of its technical capacities, and it received American financing. This was agreed by means of letters of agreement between the president of *JEN* and the person responsible for the international activities of the Atomic Energy Commission of the U.S.A. within the framework of the Cooperation Agreement for civil uses of 1957 between the two countries (Otero-Hall Agreement).

The monitoring programme has been maintained since then, even if the cooperation framework has altered, and in 1997 a new agreement was signed between the Ministry for Industry and the United States' Department of Energy (DOE) for a period of 10 years under the new framework for the Intergovernmental Agreement on Scientific and Technological Cooperation of 10 June 1994.

The team was informed that since 1986 it has been within the Nuclear Safety Council's remit (*Consejo de Seguridad Nuclear - CSN*) to supervise the activities carried out by *CIEMAT* from a radiological protection point of view.

During the forty-four years that the *Palomares* Radiological Monitoring Programme (*PVRP*) has been in force the relationship with the various American parties involved has always been one of scientific cooperation. Studies carried out on the population and the surroundings of the area affected by the accident have been of great scientific significance, in that it has been possible to study the behaviour of plutonium of military origin on the affected population and on the land, crops and animals in a rural environment.

The team was informed that currently an area of 40 ha is still affected by residual contamination at different levels of concentration. However, there has been economic development in the affected area over time which means that the possible uses of the land have been changing. Environmental awareness has also grown and there are other potential actors in the area, such as environmental groups, and lastly socio-political changes that have taken place in Spain since the time of the accident mean that other factors such as public opinion or pressure on the part of the affected local authorities are of great significance.

These changes mean that a new focus is required for the affected area of *Palomares*. Independently of continuing the radiological monitoring programme to check the continuing contaminating effects of the plutonium and its descendents on the land and the population, it is now necessary to provide another type of palliative or corrective response to the contaminating effects of the accident. Knowledge of intervention models after accidents and reparation methods allow active reparation actions to be carried out.

## 4.2 MONITORING PROGRAMMES AND CHRONOLOGY OF IMPORTANT MONITORING EVENTS

Monitoring programmes were implemented since 1966 by *CIEMAT* with financial support from the United States Department of Energy (DOE), including the surveillance of the population and of the environment.

Since the control of this monitoring was taken up by *CSN* in 1986 (see also Appendix 3) the scope of this Radiological Monitoring was specified as follows and *CIEMAT* was requested to report on a semi-annual basis to *CSN* and annually to DOE:

### 4.2.1 Monitoring Programmes

- **Programme for radiological and health monitoring of the inhabitants of Palomares**

This programme includes the medical screening of approximately 150 people per year, comprising among others the collection of urine samples over 24 hours in order to determine the radioactivity levels of Pu-239+240 and Am-241. The total number of tests carried out to determine the levels of plutonium in urine to date is 4 860, from a total of 1 096 persons.

- **Programme for radiological monitoring of the environment in the district of Palomares, Cuevas del Almanzora (Almería)**

This programme had a variable scope based on the results obtained and the situations which occurred, in terms of the type of samples, places and frequency of their collection, and the extension of the area. The types of analysis carried out on the samples have also changed with initially the concentration of total alpha activity being analysed and subsequently radiochemical tests being carried out to determine the content of Pu-239+240 and Am-241.

This environmental radiological monitoring programme included the radiological control of:

#### **Soils:**

The team was informed that originally six areas were delineated and two control points away from the affected areas were selected. Soil samples were taken from the surface and from different depths in different areas, and their radioactive content analysed, initially in terms of the total amount of alpha activity and subsequently determining the levels of Pu-239+240 and Am-241. This radiological soil control formed part of the *PVRP* until 2007.

Starting in 2007, a surface radiological characterisation was carried out as part of the Energy and Environmental Research Plan for Radiological Monitoring (*PIEM-VR*) approved by the Spanish Government in 2004. This investigation was carried out over an area of 660 ha, with an intensive radiological surface characterisation being performed over the 40 ha which were most affected. This comprised a below the surface radiological characterisation in these areas (details see chapter 4.3), which allowed the creation of tridimensional radiological maps (Appendix 4). This provided the basic information needed to draw up a recovery plan for the area.

Therefore, given the exhaustive radiological control of the affected soils which has been carried out and which offers adequate and sufficient information on the state of radioactive contamination in this component of the environment in the area, currently it is not considered necessary to include the radiological control of the soils as part of a routine radiological environmental monitoring under the *PVRP* until the recovery plan for the area has been implemented and thus the situation has changed.

#### **Aerosols:**

The control of air contamination is being carried out at four stations using continuous sampling of air with high flow equipment (approximately 10 000 m<sup>3</sup> a week), which have been maintained continuously at two of the stations and with interruptions and changes in the other two. The stations have been sited to find out the representative levels of inhalation in the urban area and in various rural areas (areas with agricultural practices and areas that could be influenced by work to be carried out in the occupied area). The filters are changed weekly and transported to *CIEMAT*'s laboratory for analysis.

**Vegetation:**

The control includes both wild and cultivated vegetation, with analyses being carried out on different parts of the plant (edible and other) or after different processes (washed, peeled, etc.) to evaluate the distribution of the contamination and its potential effect on the population. The type and number of samples of crops to be obtained meets the criteria of representativeness both in terms of the level of production and consumption and the siting of the sampling points can vary in accordance with the area cultivated in each season, although priority is always given to those zones which may be influenced by air contamination. The frequency of sampling depends on the time when the main crops are harvested (generally in spring and autumn) and the number of crops per year.

**Animal products:**

The programme includes, on a more sporadic basis, sampling of goat's and cow's milk, and occasionally the meat from goats and sheep or gastropods, as their characteristics act as bio-indicators.

Additionally, *CIEMAT*'s aquatic radioecology laboratory carried out a series of studies between 1985 and 1992, financed by the European Union, to evaluate the transfer to the marine environments of the contamination dispersed as a result of the accident. Plutonium levels were basically measured in sediments, but also in sea water, biota, fish and crustaceans.

This programme is being reviewed by *CIEMAT*, taking into account the information obtained from the characterisation programme which was carried out and which is described below.

In addition to the monitoring carried out by *CIEMAT*, within the national network of coastal monitoring a new sampling point for collecting samples of seawater was incorporated in 2006. This point is located at *Garrucha*, an area close to *Palomares*. In these samples Pu-239+240 and Am-241 are analysed besides the standard tests performed in the programme.

**4.2.2 Chronology of important monitoring events**

The team was informed that in October 2001 *CIEMAT* informed the Nuclear Safety Council that important changes were taking place in the region of *Palomares* that could lead to extensive and intensive use of the soils, leading to significant soil movements and a de-localisation of the residual contamination in them. It also stated that the latest studies had shown that the residual contamination was greater than initially estimated. Both findings required new control measures and an intervention by authorities.

In the light of this, in December 2001 *CSN* carried out a detailed evaluation of all the available information on the radiological situation in *Palomares*, defining some radiological criteria in order to determine the need to control the use of the land, taking into account the laws concerning radiological protection and international practice.

|                                                                                                                                                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p align="center"><b>Criteria set up by CSN for the protection of the population in the<br/><i>Palomares</i> region:</b></p>                                                                                                                                                     |
| <ul style="list-style-type: none"> <li><b>To totally restrict</b> activities that could lead to a residual dose level equal to or greater than 5 mSv/year. The derived soil concentration for 5 mSv/year is 25 Bq.g<sup>-1</sup> Pu-239.</li> </ul>                              |
| <ul style="list-style-type: none"> <li><b>To partially restrict</b> areas and carry out additional studies when activities may give rise to a residual dose of between 1 and 5 mSv/year. The derived soil concentration for 1 mSv/year is 5 Bq.g<sup>-1</sup> Pu-239.</li> </ul> |

The ultimate objective of the criteria implemented by *CSN* is to ensure that the impact on the population due to the exposure by any residual contamination does not exceed an annual average dose of 1 mSv.

As a result of the application of these criteria, *CSN* recommended that restrictions on land use should be imposed in certain areas and that for this, a special plan should be prepared by *CIEMAT* including the precise characterisation of the radiological situation and proposing possible remedial measures.

On 4 December 2003, *CIEMAT* submitted to *CSN* the document titled: "*Research plan on the land in Palomares requiring special environmental radiological monitoring*". Subject to approval by *CSN*, this plan was to be implemented by *CIEMAT* in the *Palomares* area. The proposed plan took into account the radiological criteria defined by *CSN*. In its meeting of 10 December 2003, *CSN* gave a favourable opinion to this document.

Article 130 of Law 62/2003 of 30 December 2003 required the Spanish Government to approve within six months an "Energy and Environmental Research Plan for Radiological Monitoring" (*PIEM-VR*) of the concerned land in *Palomares*, which would then be carried out by *CIEMAT*. Prior advice concerning this plan had to be given by *CSN*.

The actions included in the plan were declared to be of general interest. This implied the land to be declared 'public utility' (according to the Law on forced expropriation).

On 15 March 2004 *CIEMAT* sent to the Ministry of Science and Technology the Research Plan (including the approval by *CSN*) to be carried out on the land considered to need special environmental radiological monitoring in accordance with the provisions of Article 130 of Law 62/2003. The plan was approved by the Spanish Government on 17 December 2004.

This plan included:

- The expropriation/occupation of areas affected by restrictions (2006 to 2007);
- The radiological characterisation of the affected areas with the setting up of a tridimensional map (until 2009);
- US DOE technical and financial support.

In 2005 the procedure to expropriate the affected land was implemented and in 2006 *CIEMAT* occupied the expropriated farms, launching the research plan with radiological characterisation actions on and below the surface.

The surface radiological characterisation (details in chapter 4.3) covered an area of approximately 660 ha and was finished in 2007 (see Appendix 4, 'topsoil').

*CIEMAT*, considering the radiological information obtained from this characterisation, the update on the surface radiological situation, the reactivation of the agricultural and urban sectors and the activities necessary to carry out the research plan approved by the Council of Ministers, submitted a proposal for temporary occupation of the zones bordering on those already expropriated, which on 2 July 2007 received a favourable opinion from *CSN*.

The Council of Ministers, in its meeting of 28 September 2007, agreed to extend the "research plan" to include the temporary occupation of 30 ha of land affected by residual radioactive contamination in order to environmentally reclaim that land.

In 2008 the activities for the radiological characterisation of the land below the surface (details see chapter 4.4; see also Appendix 4, 'subsoil') were completed, the final report having been presented to the Nuclear Safety Council in April 2009. The investigation demonstrated significant residual contamination by plutonium and americium in the area and it was reported that the inventory of plutonium was five times higher than had been estimated before.

A Cooperation Agreement between the United States' Department of Energy and the Spanish Ministry for Industry and Energy, was drawn up with the aim of establishing a framework for scientific and technical cooperation between the parties (DOE and *CIEMAT*) in radiological studies to be carried out further to the *Palomares* accident. The Agreement was signed on 15 September 1997 and was valid for ten years. It could be renewed automatically for periods of five years.

As a main objective the Cooperation Agreement fixed the cooperation of DOE and *CIEMAT* for the research on radiological evaluations. It indicated that *CIEMAT* would have the main responsibility for carrying out these research activities and that the DOE would support *CIEMAT*, where necessary, in managing the activities determined. The DOE and *CIEMAT* would share the costs.

*CIEMAT*, and previously the Nuclear Energy Board, have maintained continuous communication with the DOE during the past 44 years since the accident which, amongst other things, has taken the form of sending mandatory yearly reports and co-financing part of the activities.

During the period 2005-2009 these relations had a special relevance based on the scientific and technical support offered by the DOE to *CIEMAT* in the implementation of the *PIEM-VR* as part of which a tridimensional radiological characterisation was carried out on the land affected by residual contamination.

### 4.3 SURFACE RADIOLOGICAL CHARACTERISATION

An extensive radiological characterisation was carried out (grid size approximately 25 m x 25 m), covering approximately 660 ha, including the 'base line of the initial contamination' (220 ha) and a detailed radiological characterisation (grid size approximately 1 m x 1 m). The latter included 40 ha of zones 2, 3 (i.e. the impact zones of bombs 2 and 3) and a later discovered contaminated zone in the *Sierra Almagrera* (zone 6), identified as being affected in the 'rough' characterisation of the surface soil (top 15 cm).

More than 325 000 gamma spectrometric measurements were recorded with geographical references. Gamma dose rates were measured in contact with the soil as well as at 1 m above ground. In addition, 'in situ' gamma spectra were obtained in 619 points in zones 2, 3 and 6 and a total of 1 848 soil profile samples were collected and evaluated. The results were expressed in concentrations of americium-241, a decay product of plutonium-241 (a beta emitter, which in the contamination is also present, together with other isotopes of plutonium). Since the ratio between Pu and Am had already been evaluated as practically constant and because the measurement of Am-241 is much easier than the one of plutonium Am-241 was chosen as 'indicator' nuclide.

The results of the extensive radiological characterisation confirmed the presence of concentrations of transuranium elements in the surface soil in excess of the criteria for restrictions on land-use near the points of impact of bombs 2 and 3 (named zones 2 and 3 respectively) and in an area of the *Sierra Almagrera* (zone 6). Some of these elevated concentrations were found in land which was not included in the 10 ha originally expropriated (zones 2 and 3; Appendix 5); this led to the assignation of an additional 30 hectares, for which an extension of the scope of the *PIEM-VR* was proposed in order to temporarily occupy the land (see also Appendix 6).

At its Plenary Session of 2 July 2007, CSN analysed the *CIEMAT* report. A letter was sent to *CIEMAT* expressing the following opinions:

- the radiological criteria established previously by the Nuclear Safety Council (see chapter 4.2.2) continue to apply;
- *CIEMAT* should therefore proceed to restrict land use in those geographical areas in which radioactive contamination levels in excess of these criteria had been detected;
- when determining the size of these areas, *CIEMAT* should include sufficient safety margins to guarantee the radiological protection of the population and the environment.

The Council of Ministers, meeting on 28 September 2007, agreed to extend the *PIEM-VR* to include the temporary occupation of 30 ha of land affected by the plutonium contamination in order to environmentally reclaim that land.

Additionally, two trenches were detected in zone 2, the contents of which still need to be identified, although it is believed that possibly they include contaminated plant material and fragments of equipment used in remediation work in 1966.

The surface characterisation concluded that the land which has concentrations of Am-241 in excess of any of the criteria for restrictions on land use is located in the expropriated land in zones 2 and 3, and

confirms that the contamination extends to 10 additional hectares and an area of 20 ha in the *Sierra Almagrera* (zone 6).

The areas with restrictions on land use proposed by *CIEMAT* were considered sufficient by the Nuclear Security Council, as its assessment met the requirements on concentrations of plutonium and americium established by the latter.

#### 4.4 RADIOLOGICAL CHARACTERISATION BELOW THE SURFACE

For the below surface radiological characterisation 321 probes were placed at depths between 0.5 and 6 m in zones 2, 3 and 6, which recorded in full the radiological profile along the length of the sample cores (more than 7 500 recordings). Additionally, 734 soil profile samples were extracted and analysed using gamma spectrometry.

Using the soil profile samples and information from measuring probes, 879 thin samples were prepared which allowed to determine the ratio Pu-239+240/Am-241 by low energy gamma spectrometry. In addition, 300 of these samples were distributed between four collaborating laboratories (75 per laboratory) in order to validate the results using independent analyses based on radiochemical methods and alpha, beta and gamma spectrometry. The results of both methods matched well, which enabled the ratio of Pu-239+240/Am-241 = 4 to be considered as constant for all the land in *Palomares*.

Using these results a tridimensional model was drawn up demonstrating the activity concentrations of Pu-239+240/Am-241 (see also Appendix 4). This makes it possible to show the location of soil with levels higher than the reference values and to estimate its volume.

From the results of the characterisation below the surface the following conclusions were reached:

- "The contamination below the surface has very variable distributions and levels which depend not only on the zone in question, but also on the land use and changes which occurred in the various plots of which they consist.
- The observed distributions range from being strictly superficial in the zones for which use has not changed since 1966 (the whole of zone 6 and the hills of zone 2), to complex profiles like those observed in the troughs of zone 2 and which faithfully reflect the filling process followed by the initial remedial activities, and from various profiles based on agricultural production and the movement of soil in zones 2 and 3 to surface distributions typical of the superficial dislodging in the run-off in zone 2.
- In general, in zones 2 and 2-bis no deep contamination was observed in areas which were not already contaminated on the surface. Given that the locations for the probes were decided in a very random way, it could be concluded that, with one exception, in these areas it is not very probable that there is contamination below the surface which has not been detected on the surface.
- Although strictly speaking the previous conclusion could not be extended to zone 6 due to the limited number of probes which could be placed on account of the orographical difficulties posed by the *Sierra Almagrera*, the whole of zone 6 has remained unchanged since 1966 and the contamination detected in soil samples did not exceed a depth of 20 cm. Consequently, it may be considered that the contaminated land is limited to that identified in the surface characterisations."

In March 2009, *CIEMAT* published the report SG-PIEM-VR-01/09: "Tri-dimensional radiological map of Palomares, Final report" with the results of the updated radiological characterisation. In it, the land affected by values exceeding the criteria for restriction on use established by *CSN* is identified, comprising an evaluation of the volume of contaminated soil. This report was sent to *CSN* and to the DOE. It was also submitted for peer review to the experts of the International Atomic Energy Agency (IAEA). This review process ended in November 2009.

The evaluation was very positive and the panel of experts noted that *CIEMAT* had carried out its work in accordance with international recommendations and by supplying rigorous information on the limits of the basic residual source in order to establish the recovery methods for the land affected by the accident in 1966 and to optimise the balance of materials to be managed as radioactive waste.

## **4.5 FINAL ACTIONS**

### **4.5.1 Restrictions on land use**

In the light of the results of the radiological characterisation *CIEMAT* was sent a letter in which it was requested by *CSN* to notify the land-use planning authorities of the concerned zones of *Palomares* in which restrictions on use apply and inform them of the exact geographical location of these zones. The land-use planning authorities would have to take these notifications into account when carrying out the land-use planning for which they were responsible.

### **4.5.2 Rehabilitation plan for the affected zones**

*CIEMAT* has prepared a preliminary version of a rehabilitation plan for the affected zones and has sent this mandatory report mid March 2010 to *CSN*. This rehabilitation plan requires a favourable assessment from *CSN* in accordance with Chapter VI (Interventions) of the Regulation on Health Protection against Ionising Radiation and its approval by the Spanish Government.

The plan provides for installing 'on site' soil treatment plants with the objective of minimising the volume of waste produced so that it is plausible to transfer it to the United States for its final storage. The plan also provides for the adaptation of the monitoring programme to include these activities.

A first problem which was to decrease the volume of contaminated soil could be solved by applying granulometric technologies. At present with these technologies, 50 000 m<sup>3</sup> of contaminated soil may be reduced to about 6 000 m<sup>3</sup>.

This rehabilitation plan includes a new environmental monitoring plan appropriate to the new situation.

### **4.5.3 Negotiations with the U.S.A.**

For Spain, the remaining issue is to achieve an agreement with the U.S.A. to take charge of the generated waste, since Spain does not have facilities for the storage of this material. At the time of the verification contacts with the US Departments of State, Defense and DOE were scheduled with the aim of reaching an agreement on the removal of this waste.

## **4.6 MEETING WITH SENATOR JESÚS CAICEDO AND VERIFICATION ACTIVITIES AT THE VARIOUS *PALOMARES* SITES**

### **Senator Jesús Caicedo: Townhall of *Las Cuevas del Almanzora***

The team met Mr. Jesús Caicedo, Senator, member of the Spanish Popular Party and Mayor of *Cuevas del Almanzora* and Mr. Juan José Pérez-Celdrán, the Mayor of *Palomares*. Senator Caicedo stressed the fact that the population of the entire region suffers already since 44 years from the consequences of this accident and the resulting radioactive contamination. He asked the team members to try to understand the total dimension of this distress and to inform EC hierarchy accordingly and ask their assistance to Spain in the ongoing negotiations with the U.S.A. to overcome the issue of storage of the radioactively contaminated soil. He stressed that "High Level" support from the European Commission in this issue of negotiations could be very useful for Spain.

The verification team highlighted the importance of protecting the population by effective fencing of the contaminated zones (to prohibit the access) and said that this would be an important part of the verification.

The verification team was given a general overview of the plutonium contaminated sites (zones 2, 3 and 6). The covered surface areas are detailed in Appendix 6. All three zones are located in a seismically active area of Spain.

## **Visit and verification of zone 2**

The team witnessed that access to zone 2 was restricted (registration of all persons accessing the site). The entire zone is surrounded by two 2 m high fences (double fenced). The team visited the site and noted that the drillings are not marked (numbered) individually but complete geographic position is kept in a database based on DGPS measurements. The team verified an air sampler, which was additionally fenced in a cage. On the day of the verification the device did not function since it broke down on Friday of the week before and waited to be repaired. The team witnessed "pit A" (additionally fenced) and "pit B", which was the storage area for the drums with contaminated soil during the first cleaning up of the area by US specialists. Later, after the completion of the remediation activities, high contamination was found in that area. During the visit the team noted that the first (inner) fence around zone 2 was partially open. The second outer fence was closed.

Apparently, sometimes some persons (illegal hunters) enter the fenced area to hunt rabbits. The team was told that rabbit meat was never analysed for contamination because this pathway was thought to have no relevance in the consumption habits of the population.

The team was told that according to rumours immediately after the accident 'souvenir hunting' took place and accident debris were collected. However such rumours were not officially confirmed.

At the time of the accident zone 2 was not used. Apparently, now it would be interesting to use the site for agriculture and partly for tourism (e.g. the construction of 'aparthotels' is discussed).

Plastic mostly in form of decomposing sheets is abundant at the site due to the temporary usage of zone 2 for agricultural purposes. It was used for keeping condensation water to irrigate plants. Now, the remaining plastic is feared to become an issue in the proposed soil granulometric approach to minimise the volume of contaminated soil (such plastic sheet parts would have to be removed before processing the soil).

Outside of zone 2 an air sampler was operative in a locked cage. The team was informed that the device works since 1983 without any problems. The filter (glass fibre) is changed weekly.

## **Visit and verification of zone 3**

Outside, between zone 2 and 3, two water-reservoirs are located, which were built in 1986 and 1988. In the beginning they were used to irrigate watermelons. The commercialisation of these fruit was forbidden because they were grown in zone 2. Nowadays water to fill the reservoirs comes from ca. 100 km away and can be used for irrigation purposes.

The team witnessed that zone 3 is also fenced in and has access control (registration of all persons accessing the site).

A house is situated in zone 3 adjacent to the (highly contaminated) impact zone of bomb 3. The house is used by *CIEMAT* as garage and for equipment, but it is not inhabited. *CIEMAT* made drillings inside the house in order to define what contamination could be below it.

The verification team observed that around zone 3 land use for agriculture and housing is gradually approaching the fenced area.

## **Visit and verification of zone 6**

Zone 6 is a hilly area without agricultural or housing use situated north-east of *Palomares*. Rabbits populate the area leading to some hunting in the restricted zone that until now is fenced only by a barbed wire (at a height of 1 metre above ground) on which at certain points (close to access roads) panels "prohibiting access" are attached. The texts on the panels say: "*Gobierno de España / Ministerio de Ciencia e Innovación / CIEMAT - PLAN DE INVESTIGACIÓN ENERGÉTICA Y MEDIOAMBIENTAL EN MATERIA DE VIGILANCIA RADIOLÓGICA*" and "*Ministerio de Ciencia e Innovación / CIEMAT – ACCESO PROHIBIDO salvo personal autorizado*". The team was informed that *CIEMAT* does not own the land in this zone, but has the land use right for it.

The team observed that the barbed wire fence can easily be crossed by animals and illegal hunters since the site is not really closed. Within zone 6 an area of about ½ ha has higher contamination. The team was told that *CIEMAT* intends to put a better fence around at least that area. However, any action in that area would have to involve the land owner and would have to allow access to the land e.g. to

existing facilities (electric power station) on the site. In addition *CIEMAT* intends to place more warning signs on the outer fence (about every 100 metres)

The Dutch pharmaceutical company (*DERETIL*) has a production site adjacent to the South side of zone 6. In terms of employment this company is important for labour in the *Palomares* region. In this factory it produces some 40% of the chemical basis for its *Amoxicillin* production. The team witnessed the same signs attached to the barbed wire (fence) as on the other side of zone 6.

A UK firm plans to build houses on the top of the hills of zone 6 because of the very nice view of the sea on one side and to the "hinterland" on the other side. Formerly this area was used for silver mining.

The team witnessed a '*Puesto de caza*' (a stand for waiting for birds when hunting) situated on the top of one of the hills, showing that there is still access at least by hunters to these parts of zone 6.

### **CIEMAT**

The *CIEMAT* laboratories in Madrid were not subject of this verification due to the travelling modifications imposed by the eruption of the Eyjafjallajökull volcano in Iceland and the resulting closure of part of the European airspace. Two specialised laboratories of *CIEMAT* have already been verified in Madrid within the Article 35 verifications conducted in *Trillo* (2004) and in *Huelva* (2009).

### **Statement by the EC inspectors further to the verification mission**

*Taking into account the very long half lives of the radioactive contaminants in Zones 2, 3 and 6, the verification team recommends the remediation of the contaminated land.*

*Considering that within the contaminated areas, some locations give rise to potential radiation exposures for members of the public of more than 1 mSv per year, exceeding in certain zones 5 mSv per year, the team recommends applying the Spanish rehabilitation plan and cleaning up the concerned land to avoid any unacceptable radiological risks including those in the distant future: The Pu contaminated soil should be removed and safely deposited for long term storage. The team stresses the high importance of the cooperation of the US government with Spain to overcome the socio-economic consequences of the disaster.*

*The assistance of the U.S.A. to Spain for the management of the radioactive wastes generated by the remediation of the contaminated land is judged to be of primordial importance in order to provide a final solution to this problem knowing that Spain has no facilities for the final storage of these Pu contaminated materials.*

*For the remaining areas with soils contaminated to a lower degree the development of administrative solutions for the very long term is recommended in order to avoid any future uses of the affected areas that could lead to an unacceptable population exposure.*

*For the short term, the verification team encourages installing improved fences with more warning signs, in particular in zone 6.*

*With a view to improve the radiation exposure estimates for the most affected members of the local population the team suggests to widen the surveillance programme to include rabbit meat (e.g. bought from local hunters).*

*The verification team endorses the continuation of the environmental radioactivity monitoring currently performed by CIEMAT.*

### **Palomares - CIEMAT building - Closing Meeting**

At the closing meeting *CIEMAT* informed the verification team that the sum of 30 Mio. Euro was estimated as being necessary to conduct the actions foreseen in the rehabilitation plan. These costs are exclusively the costs for transport of the contaminated soil to a safe deposit (very likely this would have to be in the U.S.A., since in Europe there is no area with a legal basis to take this type of Pu contaminated waste and deposit it safely). *CSN* informed the verification team that in the U.S.A., a lot

of information concerning *Palomares* is still classified "top secret" and that for this reason the exact details of the accident are still not known by Spain.

The verification team was informed that the preferred solution for Spain would be that the U.S.A. take care of the contaminated soil i.e. by depositing it on a repository within the U.S.A.. The theoretical option of depositing this soil within Spain, e.g. at *El Cabril*, does not exist for the moment, because it would imply a change of authorisation for this site. For political and cost reasons this seems very unlikely.

The team was informed that *CIEMAT* continues monitoring of the concerned *Palomares* sites.

## 5. CONCLUSIONS

Further to parliamentary questions and petitions, a team of two inspectors from DG ENER D.4 (then DG TREN H.4) visited the *Palomares* sites on 20 and 21 April 2010.

After having been fully informed of the past and current situation at several meetings, the team witnessed the contaminated sites (zones 2, 3 and 6).

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

- (1) The radiological studies and surveillance programmes established for the concerned area are appropriate and efficient.
- (2) Due to the effective fencing of zones 2 and 3 currently the potential radiological impact by the plutonium contamination on the public appears to be very small. However, the verification team strongly recommends proceeding also to an effective fencing of zone 6, at least of the areas in this zone with the highest contamination. The team stresses the high importance of the cooperation of the US government with Spain to overcome the socio-economic consequences of the disaster. The Pu contaminated soil should be removed and safely deposited for long term storage. Thus the team recommends implementing the rehabilitation plan that was developed by Spain, i.e. the volume of the contaminated soil should be reduced using the developed approach (estimated 6000 tons) and this soil should be removed and safely deposited.

The assistance of the U.S.A. to Spain for the management of the radioactive wastes generated by the remediation of the contaminated land is judged to be of primordial importance in order to provide a final solution to this problem knowing that Spain has no facilities for the final storage of these Pu contaminated materials.

- (3) With regard to monitoring, the verification team endorses the continuation of the environmental radioactivity monitoring currently performed by *CIEMAT*. 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.
- (4) A few topical suggestions are formulated. These do not discredit the fact that environmental radioactivity monitoring in the *Palomares* area is in conformity with the provisions laid down under Article 35 of the Euratom Treaty.
- (5) The present Technical Report is addressed to the competent authority in Spain through the Permanent Representative of Spain to the European Union.
- (6) The Commission Services ask the Spanish competent authority to inform them of any achievements with regard to the situation at the time of the verification.
- (7) 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**

|                                             |
|---------------------------------------------|
| <b>THE VERIFICATION PROGRAMME – SUMMARY</b> |
|---------------------------------------------|

**Art. 35 verification Spain – 19 to 22 April 2010****Palomares site****PROGRAMME OF ACTIVITIES****Monday 19/4**

EC party travelled from Luxembourg to Almería (Spain) by rented car (due to the eruption of the Icelandic volcano Eyjafjallajökull and the subsequent closing of European airspace).

**Tuesday 20/4**

1. 05:30 Arrival at Almería.
2. 09:00: Meeting with representatives, the sub-delegation of the national government to Almería, CSN and CIEMAT.
3. 11:00: Travel to Palomares.
4. 12:15: Opening meeting: introductions / presentations / programme of the visit. In particular: legal background, studies, sampling and measuring programme, plans for future developments.
5. 15:00: Verification of the provisions for access restrictions, access control, monitoring/sampling at zones 2 and 3.

**Wednesday 21/4**

6. 09:00: Meeting with the Mayor of Cuevas del Almanzora (and Senator to the Spanish Parliament), the Mayor of Palomares, and representatives of CSN and CIEMAT.
7. 12:30: Verification of the provisions for access restrictions, access control, monitoring/sampling at zone 6.
8. 15:00: Closing meeting with representatives of CSN and CIEMAT.
9. 16:00: Travel from Palomares to Jávea (rented car).

**Thursday 22/4**

10. 07:30: Travel from Jávea to Luxembourg (rented car).

European Commission team: Constant Gitzinger, Eberhardt Henrich

Leader: Constant Gitzinger

**APPENDIX 2****REFERENCES AND DOCUMENTATION**

|                              |                                                                                                                                                 |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| European Parliament          | Written Question E-6271/08                                                                                                                      |
| Nuclear Safety Council (CSN) | Summary document named " <i>CONTAMINACIÓN RADIATIVA EN EL ENTORNO DE PALOMARES</i> " (radioactive contamination in the <i>Palomares</i> region) |

**PowerPoint Presentations**

|                                    |                                                                           |
|------------------------------------|---------------------------------------------------------------------------|
| Lucila Ramos (CSN)                 | "European Commission Art. 35 Verification in Spain <i>Palomares</i> Site" |
| Teresa Mendizábal Aracama (CIEMAT) | <i>Palomares</i> radiological surveillance programme                      |
| José Carlos Sáez Vergara (CIEMAT)  | <i>Palomares</i> 3D radiological characterisation                         |
| Carlos Sancho Llerandi (CIEMAT)    | <i>Palomares</i> remediation programme (PRP), a preliminary approach      |

**Web sites consulted**

|        |                                                           |
|--------|-----------------------------------------------------------|
| CSN    | <a href="http://www.csn.es/">http://www.csn.es/</a>       |
| CIEMAT | <a href="http://www.ciemat.es/">http://www.ciemat.es/</a> |

**APPENDIX 3**

| <b>PALOMARES RADIOLOGICAL SURVEILLANCE PROGRAMME<br/>(summary 1986 to 2009)</b>        |                                      |                      |
|----------------------------------------------------------------------------------------|--------------------------------------|----------------------|
| <b>Type</b>                                                                            | <b>Frequency</b>                     | <b>N° of samples</b> |
| <b>Population internal dosimetry<br/>(urine bioassay) and medical<br/>examinations</b> | <b>Yearly</b>                        | <b>4 949</b>         |
| <b>Air monitoring</b>                                                                  | <b>Weekly</b>                        | <b>3 000</b>         |
| <b>Soil monitoring</b>                                                                 | <b>Yearly</b>                        | <b>1 870</b>         |
| <b>Control of foods (snails, goat<br/>and cow milk, honey and other<br/>products</b>   | <b>Yearly</b>                        | <b>3 500</b>         |
| <b>Control of wild plants and<br/>crops</b>                                            | <b>Biannual</b>                      | <b>1 602</b>         |
| <b>Marine sediments</b>                                                                | <b>1985 to 1991 and 1992 to 2005</b> | <b>48</b>            |
| <b>Water resources</b>                                                                 | <b>Occasionally</b>                  | <b>19 wells</b>      |

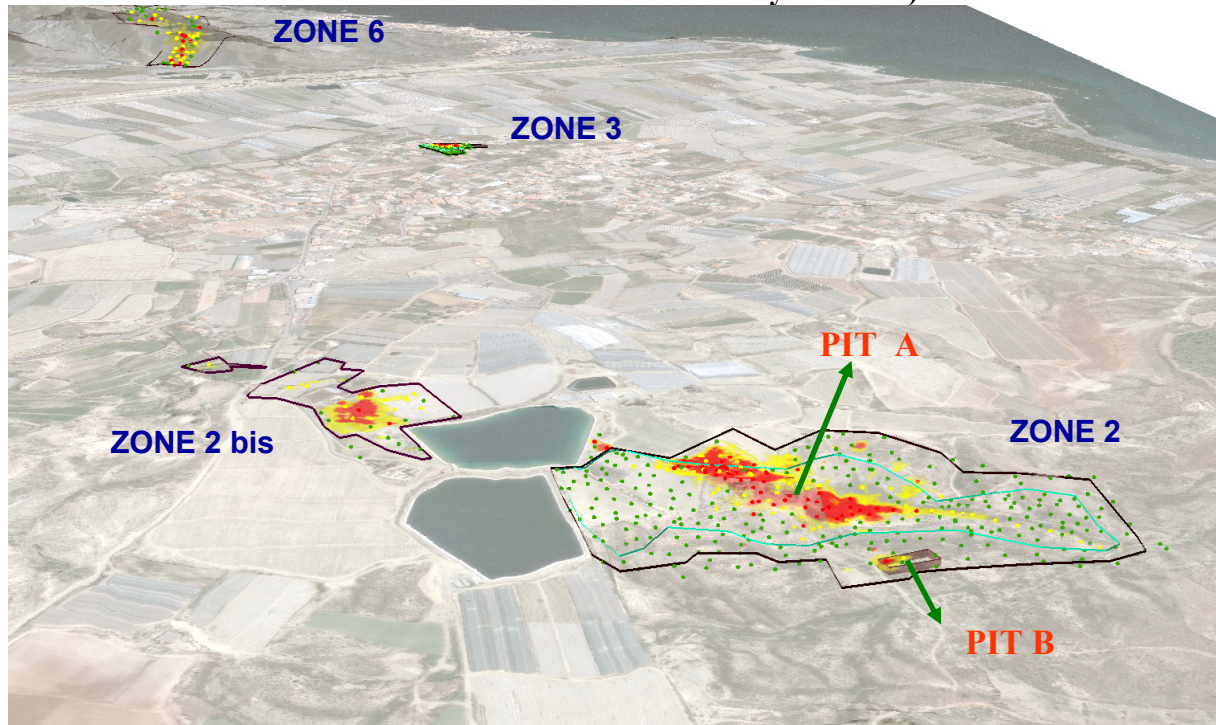
## APPENDIX 4

**3D MODELS OF SOIL CONTAMINATION IN THE DIFFERENT ZONES AFFECTED WITH PU  
CONTAMINATION**

Source: CIEMAT

**3D Model of Topsoil contamination (0-15 cm)**

(Allows to estimate the topsoil volume that is affected with contamination over the land use restriction levels established by the CSN)

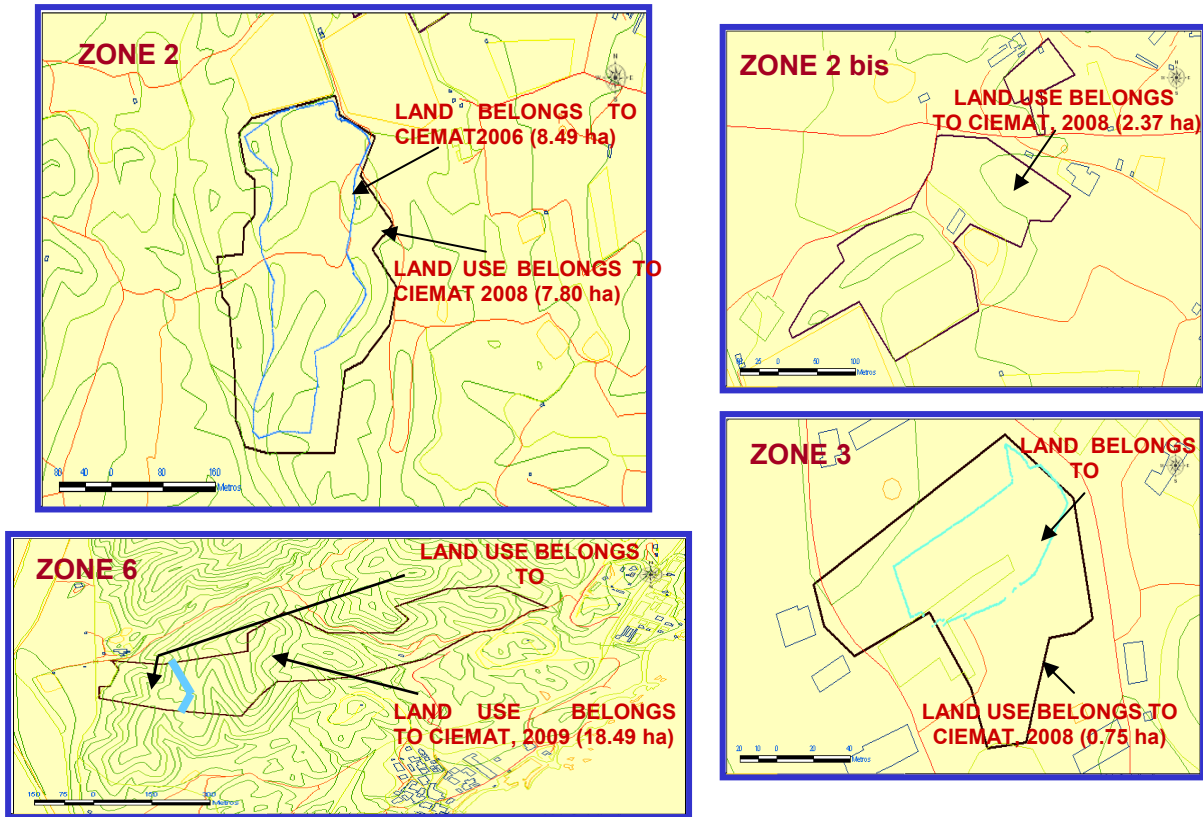




## APPENDIX 5

### PROPERTY OF LAND IN ZONE 2 AND 3 (PALOMARES 2009)

Source: CIEMAT



**APPENDIX 6**

|                                                   |
|---------------------------------------------------|
| <b>SURFACE OF AFFECTED LANDS AROUND PALOMARES</b> |
|---------------------------------------------------|

|                   |                       |
|-------------------|-----------------------|
| <b>Zone 2</b>     | <b>16.29 ha</b>       |
| <b>Zone 2 bis</b> | <b>2.37 ha</b>        |
| <b>Zone 3</b>     | <b>1.17 ha</b>        |
| <b>Zone 6</b>     | <b>21.39 ha</b>       |
|                   | <b>TOTAL 41.22 ha</b> |