



MINISTERIO
DE CIENCIA
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Ciemat Centro de Investigaciones
Energéticas, Medioambientales
y Tecnológicas

PROJECT INDALO

ANNUAL WORK PROPOSAL FOR THE YEAR 2000

Annual Work Proposal
Office of International Health Programs (EH-63)
U.S. Department of Energy

Project Indalo

Centro de Investigaciones Energeticas Medioambientales y Tecnologicas (CIEMAT)

Purpose: In 2000, we will continue to perform the radiological medical surveillance and environmental monitoring in the area of Palomares (Almería – Spain). In addition it is intended to continue activities included in the recommendations made by the expert panel in its 1998 report, mainly related to soil studies, calculational assessments and risk studies. Given the geographical distribution of the residual contamination and the potential existence of a burial pit, the emphasis will be again put on the soil studies in zone 2.0, where the highest levels of contaminants exist. Also, Pu analysis in different types of soils and conditions, including greenhouses, of zone 3 (cultivated area) will be continued to investigate potential differences. An important topic to start during 2000 will be a risk assessment in the area. Also, specific research concerning the study of Pu hot particles in soils will be initiated in 2000. The following is a general description of work to be performed.

General Description of Work to be Performed:

I. Concise Statement of Goals

The goals remain unchanged since the signing of the Hall-Otero Agreement. They are:

- To determine the magnitude of the risk of internal contamination in the inhabitants of the zone during the period immediately following the accident and the subsequent emergency phase.
- To assess the short, medium, and long-term risk of internal contamination for those people living in and around Palomares, those who cultivate the contaminated land and those who consume vegetable products grown in this area, as well as products from animals which have been given cereals and other vegetables grown in the area as fodder.

II. Background (includes relevance to DOE programs)

As a consequence of the accident which occurred on January 17, 1966, a radiological medical surveillance and environmental monitoring program has been conducted in Palomares, Spain. This work has been performed pursuant to the Hall-Otero Agreement of February 25, 1966. In Spain, the Centro de Investigaciones Energeticas Medioambientales y Tecnologicas (CIEMAT; Center for Energy, Environmental, and Technological Investigations) is the organization responsible for all technical aspects of this project. CIEMAT provides semi-annual reports to the Spanish Consejo de Seguridad Nuclear (CSN; Nuclear Safety Board), which, in turn, provides summaries of the activities in Palomares to the Spanish Parliament. The CSN is the Spanish organization responsible for radiation protection in general.

III. Methods and Approach

The medical monitoring program consists of clinical examinations and radiobioassays of plutonium and americium collected from 24-hour urine samples of 150 residents from Palomares. The individuals examined differ each year unless some plutonium in urine was detected from the previous year's examination. In addition to these tests, those individuals with the highest potential internal contamination are examined by CIEMAT's whole body counter. They number approximately 5 to 10 individuals per year. The details of the clinical examinations are on record at DOE. The examinations are performed during the spring and autumn of each year. Approximately 10 individuals are examined each week.

The environmental monitoring program consists of sampling, analysis, and measurements of plutonium and americium in air, soil, food crops, wild vegetation, milk, and other products. For example, the air is

sampled continuously by high volume samplers equipped with a PM-10 inlet. The filters are changed weekly. There are four air high volume continuous samplers in the area. Soils are sampled with a frequency depending on the characteristics of the experiment to be performed. For example, the frequency of deep soil samples is less than surface soil samples. The frequency of samples in vegetables depends on the growing season and the vegetable species cultivated each year.

Air and urine samples are analyzed by sequential radiochemistry methods for Pu and Am. On separate planchets, Am and Pu are then measured by alpha spectrometry. Other samples, such as soils and vegetation, are analyzed for Pu by radiochemistry and then measured by alpha spectrometry. However, Am is measured directly (in ashes for vegetables and with previous drying and removal of organic matter for soils) by gamma spectrometry without previous radiochemistry. All radiochemical analyses and measurements are performed according to established procedures at CIEMAT.

The specific sampling and analysis plan for 2000 is presented below:

Air Samples:

In an optimal way, about 200 samples from 4 stations will be collected. However, a lower number of samples are normally obtained due to unexpected stops of the samplers. During 2000 the samples corresponding to 1999 sampling will be analyzed for Pu and Am by radiochemistry and measured by alpha spectrometry. The samples are analyzed individually and accumulated in a monthly basis for measurement.

Vegetation Samples:

About 30 samples of different vegetable species will be collected during 2000. Taking into account that the samples are further divided in several parts (plants, leaves, edible parts, etc.) for analysis a higher number of analyses is foreseen. 110 samples will be analyzed for Pu and Am: 50 by radiochemistry followed by alpha spectrometry and 60 by gamma spectrometry. In addition 10 selected samples will be analysed for Am by radiochemistry followed by alpha spectrometry.

Soil Samples:

Approximately 50 samples of surface soil from zones 2 and 5 will be collected. 200 samples will be analyzed for Pu and Am, 100 samples by radiochemistry followed by alpha spectrometry and 100 by gamma spectrometry. The samples to be analyzed will be surface and profile soil samples, some of them collected during 1999

Urine samples:

300 samples analyzed for Pu and Am: 150 for Pu and the same 150 for Am by radiochemistry followed by alpha spectrometry.

Snail Samples:

4 samples, collected in previous years, will be analyzed for Pu and Am: 4 from the shell and 4 from the meat; all the samples will be analyzed by radiochemistry and alpha spectrometry.

Honey Samples:

1 sample collected in 1998 will be analyzed for Pu by radiochemistry and by alpha spectrometry.

Rain Water Samples:

If there were enough rain water, samples would be analyzed by radiochemical procedures and measured by alpha spectrometry.

Concerning the **risk assessment**, the tasks will be addressed to estimate the current annual doses under the present conditions and under potential future use of the area. The dose assessment will be based on the

most recent international recommendations and will focus the hypothetical critical group and other realistic groups. Specifically, committed effective doses integrated for 70 years will be assessed for at least two age groups: adults and children. The most important pathways (inhalation, ingestion of locally produced foods and external irradiation from the soil) and radionuclides (at least Pu-239, Pu-240 and Am-241) in the area will be considered for this study, leading to the identification of the major (pathways and radionuclides) contributors to the annual committed effective doses. On the basis of the dose estimations, the excess of fatal risk to an individual of the hypothetical critical group will be calculated. Information concerning potential remedial actions will also be reviewed in order to estimate the potential averted doses by the applicable countermeasures jointly with their associated consequences. The study is expected to be performed from April 2000 to October 2001.

In relation to the **research on Pu hot particles in soils**, the following tasks are planned:

- Pu hot particles separation in the soil particle size fraction of 125-250 microns, with higher density and less magnetic susceptibility.
- Study of this Pu particles by electronic microscopy; determination of color, different morphological aspects and chemical elements.
- Characterization of the Pu particles' compounds solubility by sequential leaching techniques.
- Assessment of its isotopic composition by radiochemical methods and verification of the Pu weapon grade's isotopic composition previously evaluated.

The first and second tasks are expected to be completed during 2000 and the remaining in 2001.

IV. Milestones and Deliverables (include dates)

By December 31, 2000, we intend to achieve the following Milestones:

- Perform clinical examinations and radiobioassays of plutonium and americium collected from 24-hour urine samples of 150 residents from Palomares.
- Perform sampling, analysis, and measurements of plutonium and americium in air, soil, food crops, wild vegetation, milk, and other products. The number of analyses are listed above in Section III.
- Perform a first estimation of doses to people living and working in Palomares, as a part of the risk assessment.
- Perform separation and identification of Pu hot particles in soils.

By April 15, 2000, we will provide the semi-annual progress reports for the first and second halves of 1999. By October 15, 2000, we will provide the semi-annual progress report for the first half of 2000.

V. Suggested Performance Indicators

- Provide the personal results from clinical examinations and radiobioassays of plutonium and americium collected from 24-hour urine samples to the 150 residents from Palomares who were examined during the year, by April 2001.
- Provide the results from the sampling, analysis, and measurements of plutonium and americium in air, soil, food crops, wild vegetation, milk, and other samples to CSN by September 2000 (semi-annual report for the first half of 2000) and by March 2001 (semi-annual report for the second half of 2000). These reports will also be provided to DOE. The number of analysis are listed above in Section III.
- Provide the first results concerning the dose estimation study to CSN and DOE by April 2001.
- Provide the results concerning the separation and identification of Pu hot particles in soils to CSN and DOE by April 2001.

VI. References

Radiochemical analytical procedures were provided to DOE in 1992. Please see Annex I, Methodologies for Analysis and Measurements in "Summary Report on the Palomares Surveillance Program," July, 1992.

VII. CV's of Investigators (short 1-2 pages, if possible, including only relevant publications for the last 5-10 years)

Short CV's of José Gutiérrez, Asunción Espinosa, Antonio Aragón and Javier Martínez were submitted the past year.

VIII. Budget Request (see attached form)

IX. Addendum Containing Relevant Publication Preprints, etc

A. Espinosa et al. "Palomares experience in Pu environmental behaviour". IAEA International workshop. Rfo de Janeiro. April 1999. (Presently included in the IAEA-TECDOC-1148, "Site Characterization Techniques used in Environmental Restoration Activities" May 2000).

A. Espinosa et al. "Composición isotópica del plutonio grado bomba procedente del accidente de Palomares". 25 Reunión Anual de la SNE. Granada. Noviembre de 1999.

J. Martínez, A. Espinosa, A. Aragón "Determinación de la variación en la concentración de partículas en aire a causa de las labores que implican movilización de suelos contaminados" 25 Reunión Anual de la Sociedad Nuclear Española. Granada (España). Nov. 1999.

C. Gascó and M.P. Antón. "Radionuclides sequential extraction: a method review". Workshop on Speciation of Radionuclides. Edimburgo, Sept. 1999.

C. Gascó et al. "Distribution of Pu, Am and Cs in margin sediments from the western Mediterranean (Spanish coast)". Science of the Total Environment (sent for publication).

C. Gascó and M.P. Antón. "Estudios de radiecología marina en ecosistemas europeos". Publicación Técnica ENRESA

Vigilancia Radiológica en la Zona de Palomares. Informe al Consejo de Seguridad Nuclear. (Primer Semestre del Año 1999). CIEMAT/DIAE/PPRI/51100/3/99

Vigilancia Radiológica en la Zona de Palomares. Informe al Consejo de Seguridad Nuclear. (Segundo Semestre del Año 1999). CIEMAT/DIAE/PPRI/51100/2/00

Informe de la Estación Meteorológica de Palomares (Almería) 1998. CIEMAT/DIAE/552/55260/05/99

Inhalation of Radionuclides. Final Report for the CEC FOURTH FRAMEWORK PROGRAMME. CONTRACT N° F14-CT95-0026- July 1999

X. Other Sources of Funding

Title of Project: Intake of Radionuclides

Funding Organization: European Commission (DG XII) and ENRESA (Spanish National Company for the Management of Radioactive Wastes)

Funding Level: During 1999, last year of the project, a funding level of 1.5 million pesetas by the EC and 0.45 million pesetas by ENRESA was obtained.

Project Description: The project is to improve the dosimetric assessment of potential inhaled radioactivity by the public in general. CIEMAT is participating by providing specific data from Palomares. The main CIEMAT objective is to investigate the biokinetics of plutonium and americium associated with soil particles able to be resuspended and to use the respirable fraction to estimate the dose per unit of intake and to establish specific limits of intake of the above mentioned radionuclides in the Palomares area. Also, it is intended to implement and validate the last version of the ICRP lung model (LUDEP 3.0) and to apply it to two specific population groups in Palomares (urban and agricultural).

The project finished in 1999.

Title of Project: ARMARA ("Radioecological assessment of the consequences of contamination of marine waters: modelling the key processes controlling radionuclides behaviour under extreme conditions").

Funding Organization: European Commission (DG XII) and ENRESA (Spanish National Company for the Management of Radioactive Wastes).

Funding Level: During 1999, last year of the project, a funding level of 1.0 million pesetas by the EC and also 1.0 million pesetas by ENRESA was obtained.

Project Description: CIEMAT's contribution to the ARMARA Project has been largely focused on a study of the geochemical association of transuranics with marine sediments and the evaluation of transuranic behavioural similarities in two extreme marine ecosystems (desertic and polar) following episodic events such as floods and ice melting.

The project finished in 1999.