Report of the International Expert Appraisal on Application of International Radiation Protection Standards for members of the public in the area of the Ezeiza Atomic Centre

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1. Introduction

1.1. Purpose

This report describes the background information, development and conclusions of an *International Expert Appraisal* (hereinafter referred to as 'the IEA')[1] of the radiological protection of the population surrounding the Ezeiza Atomic Centre (CAE), located in Buenos Aires province, Argentina. The IEA was carried out by relevant organizations in the United Nations system and competent non-governmental international professional organizations, following a request of the Government of Argentina. The International Atomic Energy Agency (IAEA) organized the IEA in accordance with the functions established in Article III.A.6 of the IAEA Statute, namely to provide for the application of its international safety standards for radiation protection of the public and the environment.

1.2. Background

The Government of Argentina requested the IEA within the framework of a lawsuit in the Argentine Federal Justice system that alleged contamination of the environment around CAE with anthropogenic radioactive substances, including anthropogenic enriched and depleted uranium, which — according to the allegations — is affecting the population living in the surroundings of the CAE. The IEA team understood that, as a result of the publicity given to the allegations made in the judicial case, a stressful situation, mainly in terms of the level of social disruption, arose for the local population in the surroundings of the CAE. This situation reached a climax when an expert appraisal report for the judicial case (*Expert Appraisal Report No. 6*) was made public in early 2005. The report implied that the drinking water for the population in the area surrounding the CAE was contaminated with human-made radioactive material and that, in particular, it contained enriched uranium and depleted uranium. It appeared that this information had major public repercussions and caused great anxiety for the population, giving rise to hundreds of public meetings, not only involving official Argentinian organizations and non-governmental organizations, but also at the Pan American Health Organization (PAHO) office in Buenos Aires.

In the light of this situation, the Argentinian Nuclear Regulatory Authority (ARN) prepared a *Rebuttal to Expert Appraisal Report No. 6* [1] and, on 15 April 2005, requested the IAEA to undertake an evaluation of the ARN rebuttal. In response to this formal request, on 28 April 2005 the IAEA issued an initial report [2] analyzing ARN rebuttal with respect to international safety standards for ensuring radiation protection of the public from exposure to radiation. The IAEA's evaluation concluded that the ARN report was technically sound and presented credible conclusions relating to the radiological protection of the public and the environment.

After finalization of this initial consideration of the situation by the IAEA, the Government of Argentina requested the IAEA and PAHO to undertake a fact finding mission, which took place from 1 to 3 June 2005. This mission was to meet with the interested parties, to resolve technical issues, to evaluate the ARN's monitoring programme and its capabilities for its implementation, and to provide an opinion on the need for and conduct of an international appraisal of the situation. The fact finding mission performed by the IAEA and PAHO initially involved comprehensive discussions on the general situation and the exchange of relevant documentation with ARN. The team also undertook inspections at the ARN laboratories, at some of the water sampling sites, at the Radioactive Waste Management Area at the Ezeiza Atomic Centre (CAE) and at installations belonging to the Argentine Nuclear Fuels Ltd. Company, CONUAR (the only industrial plant at the CAE where uranium is stored and handled for the fabrication of fuel). The fact finding mission had discussions with those immediately responsible for the technical aspects and procedures for environmental monitoring, laboratory measurements, and waste and effluent management. The fact finding mission team also received a detailed explanation of the region's hydrogeological system from the National Institute for Water (INA).

The conclusions of the fact finding mission confirmed the results of the initial assessment, whereby the assessment of radiological safety of the population carried out by the ARN was consistent with the

[1] This international expert appraisal is considered by the Argentine Government to be a 'Peritaje' which is the official term in the Spanish language to denote an expert appraisal with judicial status.

relevant international standards, and thus that the affirmation that there was no radiological risk to the population was credible. The fact finding mission team also concluded that there was no need for an international expert appraisal, given that there was no evidence that international standards for radiation protection of the public had been violated and the ARN has the technical capability to make its own independent assessments.

Nevertheless, the Argentine federal judicial authority (Justicia Fedérale Argentina) requested through the Argentine Government that the IAEA, by virtue of the statutory power vested in it, organize a independent and definitive expert appraisal by means of an international mission with the participation of competent bodies: the World Health Organization (WHO), the Pan American Health Organization (PAHO) and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)., The Food and Agriculture Organization of the United Nations (FAO), the International Commission on Radiation Protection (ICRP) and the International Radiation Protection Association (IRPA).

In this context, the IAEA agreed to coordinate the International Expert Appraisal requested by the Argentine government. The particulars of the terms of reference for the International Expert Appraisal were discussed with Argentine government representatives and took into account the entirety of the questions raised by the Argentine federal judicial authority.

2. The International Expert Appraisal

2.1. Objectives

On the basis of the request of the International Expert Appraisal (IEA) stipulated by the Argentine federal judicial authority to the Nuclear Regulatory Authority in its note dated 18 May 2005 (Annex 1), the IEA adopted the following objectives:

1. To determine whether there is any contamination[2] due to the presence of radioactive elements in the topsoil, in the under-soil, in the surface waters and groundwater, or in the air, in the area encompassing the districts of Ezeiza, Esteban Echeverría and La Matanza in the province of Buenos Aires, Republic of Argentina, in such a way that a health hazard has been generated and, if so, the nature of the hazard caused.
2. To verify whether the water for consumption (human and/or industrial) supplied to the population of the aforementioned localities has been contaminated with radioactive elements and thereby rendered harmful to health.
3. If contamination is present, to determine whether it could be attributed to activities that have been and/or are being carried out on the site of Ezeiza Atomic Centre and whether they have been carried out in such a way as to have generated a health risk. In the event that contamination under the given circumstances is detected and it cannot be attributed to the activities at the atomic centre, its origin should be investigated.
4. To evaluate the work done by Argentina's Nuclear Regulatory Authority, in relation to the case in question, as regards the international best practices in protection from exposure to ionizing radiation and the current international safety standards.

2.2. Framework

The reference framework that governed the implementation of the IEA was the international standards applicable to radiation protection and safety — that is, the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS), jointly sponsored by the WHO, PAHO, the International Labour Organization (ILO), the Food and Agriculture

[2] In the Glossary of the International Basic Safety Standards [3], Contamination is defined as "*The presence of radioactive substances in or on a material or the human body or other place where they are undesirable or could be harmful*"

Organization of the United Nations (FAO), the Nuclear Energy Agency of the Organization for Economic Cooperation and Development(OECD/NEA) and the IAEA [3].

The BSS provide generic action levels[3] for radioactivity in foodstuffs as established by the Joint FAO/WHO Codex Alimentarius Commission. Guidance levels for radionuclides in drinking water are established in the WHO Guidelines for Drinking-Water Quality [4].

For evaluation of the Argentinian programme for environmental radiation monitoring implemented by the ARN, the reference used was the IAEA Safety Guide on environmental monitoring and source monitoring [5].

2.3. Participants

By agreement with the Argentinian Government, experts from the following organizations of the United Nations system and non-governmental organizations were nominated to participate as their representatives:

- International Atomic Energy Agency (IAEA): Didier LOUVAT, coordinator of the IEA;
- IAEA Seibersdorf Physics, Chemistry and Instrumentation (PCI) Laboratory: Paul MARTIN, Head of the Laboratory;
- World Health Organization (WHO): Zhanat CARR, Medical Officer, Radiation and Environmental Health Program, Department of Public Health and Environment;
- Food and Agriculture Organization of the United Nations (FAO): David BYRON, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture;
- United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR): Malcolm CRICK, Scientific Secretary;
- Pan American Health Organization (PAHO): Pablo JIMENEZ, Regional Advisor on Radiological Health;
- International Radiation Protection Association (IRPA): Phil METCALF, President;
- International Commission on Radiological Protection (ICRP): Annie SUGIER, Chairwoman of the ICRP Committee on Application of the Commission's Recommendations.

A brief description of the fields of competence of these organizations and the professional backgrounds of the nominated experts representing them were provided to the Argentine Government (Annex 2).

2.4. IEA Mission to Argentina

The planned activities relating to the IEA were officially notified in advance to the Argentine Government. The first stage of the IEA consisted of a mission to Argentina. This mission was aimed at assessing the information already available, including the evaluation of the health related information; measuring activity levels of selected samples in the environment; comparing analytical measurements of environmental activity levels made by the ARN and IAEA laboratories; and reviewing the ARN programme on environmental surveillance.

2.4.1. Information provided by the Republic of Argentina prior to the mission

Before the IEA started its mission to Argentina, the Argentine government submitted advance information to the IEA coordinator relating to the IEA objectives. This information included:

[3] In the Glossary of the International Basic Safety Standards [3], action level is defined as *"The level of dose rate or activity concentration above which remedial actions or protective actions should be carried out in chronic exposure or emergency exposure situations."*

- a precise definition of the region to be covered by the expert appraisal;
- a geographical and geological characterization of the region defined;
- a description of the demography of the region defined (including the identification of the critical population groups from the point of view of radiological protection);
- a description of the hydrogeology of the region defined (including water resources and water use and a characterization of the water wells);
- a complete description of the Ezeiza Atomic Centre and of the activities carried out there;
- the location of all the existing water sampling points in the region;
- the results of analyses of radionuclides in environmental samples;
- environmental radiological assessment reports for the defined region;
- a list of the sampling equipment of the Argentinian Regulatory Authority that would be available for the sampling programme of the IEA.

2.4.2. IEA Mission

The IEA mission to Argentina took place from 4 to 9 December 2005. The list of the persons met by the IEA during the mission is given in Annex 3.

On 4 December, a preparatory meeting was held between mission participants and the Argentine Government liaison officer to agree on the mission programme and on the arrangements for undertaking the technical work.

On 5 December, an initial meeting was held at the Argentinian Ministry of Foreign Affairs to make an introductory presentation of the appraisal and the IEA mission to the Argentinian Government.

On the same day, a technical meeting took place at the ARN headquarters to present to the IEA mission all the data gathered up to that time through regular and specific monitoring programmes for the possible radioactive contamination of groundwater in the Buenos Aires province. On the basis of the presentations made by the ARN, the mission team decided to divide into three groups to implement the appraisal objectives, as follows:

- The first group, Group A, was dedicated to environmental sampling for purposes of evaluation and comparison. The samples taken during the mission were to be analysed independently both by the Seibersdorf Laboratory and by the ARN.
- The second group, Group B, was to review the ARN's environmental monitoring programme.
- The third group, Group C, was to review the available data on health and their possible relation to any radionuclides in the environment.

On 6 and 7 December the three groups undertook their work in the environs of the Ezeiza Atomic Centre and in the ARN laboratories at the Ezeiza Atomic Centre.

On 8 December the three groups met to share results, draw preliminary conclusions, draft the mission report and develop the content and the timetable for the measurements, the assessment and the preparation of the final appraisal report.

On 9 December an outline of the mission report and some initial conclusions were presented to the Government of Argentina at a final meeting at the Ministry of Foreign Affairs. The IEA coordinator and the WHO and PAHO representatives visited the country office of PAHO/WHO in Buenos Aires, where they met the PAHO/WHO Representative and reported on the results of the IEA mission.

On 11 December, the subsamples for analyses at the IAEA laboratory were transported and transferred to the PCI Seibersdorf Laboratory under the surveillance of the Argentine National Gendarmerie (acts

in Annex 4). The samples were analysed by both the ARN laboratory and the PCI laboratory and the results were sent separately to the IEA coordinator for comparison and inclusion in the IEA reports.

2.5. Preparation of the IEA Report

The measurement results were evaluated and the final assessment and conclusions of the IEA were developed by the participants in January–February 2006, and the final report of the IEA was discussed at a meeting of the participants held at the Vienna International Centre on 27 and 28 March 2006.

3. IEA Groups' activities

3.1. Group for environmental measurements

The focus of Group A was to undertake independent measurements of environmental radioactivity levels, and in addition to validate the sampling programme and the measurement techniques of ARN by mean of an intercomparison exercise. In line with the first three objectives of the IEA, a sampling programme was developed to collect samples of topsoil, under-soil, surface water and groundwater, and airborne particulates (Tables 1 and 2 in Annex 5). For the collection of the samples, standard procedures were followed.

3.1.1. Strategy for collecting groundwater

The sampling strategy was based on existing data provided by the Argentine Government either before the mission or at the presentation on the first day. The Sampling Group therefore decided:

1. To sample the deeper aquifer (Puelche), which is the aquifer generally used for public water supply in the region and therefore the most important source in terms of possible implications for human health;
2. To cover the three districts under investigation — Ezeiza, La Matanza and Esteban Echeverría;
3. To include a borehole expected to contain water with a low concentration of uranium to check the ability of the laboratories to measure this element;
4. To include samples from upstream and downstream of the hydrogeological position of the Ezeiza Atomic Centre;
5. To include a public water supply close to the Ezeiza Atomic Centre that has been under public discussion (a school water supply).

As a result, seven sampling points were selected:

- one borehole tapping the Puelche aquifer in the Esteban Echeverría district, to serve as a low uranium content reference;
- one borehole providing the water supply to the fuel fabrication plant operated by CONUAR S.A. of the National Atomic Energy Commission (CNEA) to serve as a test for the $^{235}U/^{238}U$ isotopic ratio;
- two boreholes downstream of the Ezeiza Atomic Centre, tapping the Puelche aquifer, including the public water supply close to the Ezeiza Atomic Centre in the Ezeiza district, which had previously indicated values exceeding the guideline values for screening in accordance with international standards;
- two boreholes upstream of the Ezeiza Atomic Centre, one in the Esteban Echevaria district and one in the Ezeiza district, which had previously indicated values exceeding the guideline values for screening in accordance with international standards;

- one borehole tapping the Puelche aquifer in the La Matanza district, which previously indicated values exceeding the guideline values for screening in accordance with international standards (this region is not in the same hydrogeological area as the rest of the set).

The physico-chemical parameters measured and recorded by Group A are presented in Table 3 in Annex 5.

3.1.2. Strategy for collecting surface water

Sampling of surface water was considered only for purposes of comparison with the results of the ARN surveillance monitoring of the Aguirre Creek, a tributary of the Matanza River. The ARN surveillance network includes four sampling points:

- For the Aguirre Creek, one point upstream and one point downstream of the Ezeiza Atomic Centre;
- For the Matanza River, one point upstream and one point downstream of the confluence with the Aguirre Creek.

The measurements of physico-chemical parameters for surface waters made and recorded by the Group are presented in Table 3 in Annex 5.

3.1.3. Strategy for collecting air and soil samples

In addition to water samples, samples of soil and air particulates were collected.

Reference samples of air particulates and soil were taken at the ARN permanent air sampling station at the Ezeiza Atomic Centre. The station is located so as to detect environmental discharges from the Ezeiza Atomic Centre. The air sample was collected using a portable air sampler. The soil was sampled four times at 10 cm intervals up to a depth of 40 cm to account for any surface deposition and migration through the soil profile.

An additional two soil samples of the top soil (0 to 10 cm) were taken on agricultural land, one in an area under the greatest potential influence of any atmospheric discharge and one in an area not influenced by any possible atmospheric releases.

3.1.4. Implementation of the analytical intercomparison

All samples collected during the field mission were split into three subsamples. Each subsample was sealed with a numbered seal by the Argentine National Gendarmerie, which monitored all the process of sampling as representatives of the Argentine judicial authority, and the numbers from these seals were used for identification purposes (Tables 1 and 2 in Annex 5).

One set of subsamples was transported under the surveillance the Argentine National Gendarmerie and was delivered, accompanied, to the PCI Seibersdorf Laboratory, which is the reference laboratory for international appraisals of this type, and analysed according to the PCI Laboratory's routine protocol.

One set of subsamples was analysed by the ARN following their routine measurement protocol.

The last set was kept by the Argentine National Gendarmerie as reference samples.

Group A was adequately provided with data, site access, technical assistance and resources to implement the sampling programme. No major difficulties or constraints were encountered during the sampling programme.

3.1.4.1 Sample preparation and analyses by the IEA: water samples

Eleven water samples were collected as part of the sampling campaign. On the same day that they were collected, the waters were filtered through a fast filter paper and poured into three separate 1 L plastic bottles, and each subsample was acidified with 2 mL of 50% nitric acid. The caps of the bottles were closed with numbered seals of the Argentine National Gendarmerie. One set of subsamples was supplied to the PCI Laboratory. The process of acidification of the samples was carried out in order to

preserve the sample and in particular to prevent the adsorption of trace metals (including uranium) onto the walls of the container. This is a standard procedure for sample preparation for such analyses, and was carried out under the surveillance of the Argentine National Gendarmerie.

Upon opening the bottles at the PCI Laboratory in Seibersdorf, it was found that in the case of the surface water samples there was visible precipitate and turbidity. These samples were filtered again at PCI Laboratory through mixed cellulose ester membrane filters, to separate the dissolved and the particulate fractions. The filters with the residues were dried at 60°C for a few hours and then weighed to give a measure of the amount of precipitate present. The dissolved fraction (the filtered waters) and the particulate fraction (the filters with the precipitate) were analysed separately. The sum of these analyses then gave the result for the total water, which was compared with the results provided by the ARN Laboratory.

Analyses for uranium isotopes ^{234}U and ^{238}U were performed by isotope dilution alpha spectrometry after radiochemical separation. This technique gives reliable measurements of the activity concentrations of these uranium isotopes. An artificial isotope of uranium (^{232}U) is used as an internal yield tracer of the chemical recovery during the measurement process. This technique also gives an estimate of activity concentrations for ^{235}U; however the resulting uncertainties for this isotope are relatively high. The reasons for this are that, firstly, the activity concentrations for ^{235}U in environmental samples are much lower than those of ^{234}U and ^{238}U (i.e. the signal is relatively weak), and secondly, because approximately 15% of the signal is not measured as it consists of a number of small peaks lying under or close to the ^{234}U and ^{238}U peaks.

For measurement of the isotope ^{235}U, mass spectrometry techniques are more sensitive than alpha spectrometry, and they are the only definitive method to assess whether uranium is depleted or enriched with respect to natural uranium (with $^{235}U/^{238}U$ isotopic ratio = 0.0072). Consequently, $^{235}U/^{238}U$ atom and activity ratios in the water samples were determined separately by means of inductively coupled plasma mass spectrometry (ICP-MS) at the PCI Laboratory. However, ICP-MS is a less sensitive method for the measurement of ^{234}U than alpha spectrometry because of the higher specific activity of ^{234}U due to its relatively short half-life. Consequently, the two techniques are complementary, and both were used.

3.1.4.2 Sample preparation and analyses by the IEA: soil samples

At the PCI Laboratory, soil samples were air dried for approximately 65 h and then sieved with a sieve of mesh size 2 mm. This resulted in a fine fraction and a coarse fraction of the soil material. The coarse fraction was predominantly 'gravel' with occasional pieces of other material, e.g. pieces of bone.

High resolution gamma spectrometry was used for analysis of the soil samples. This technique is a suitable technique for soil. In addition, it does not require chemical dissolution of the sample as does alpha spectrometry. This is advantageous as chemical dissolution procedures can in some cases be difficult and can result in artificially low results if the dissolution is not complete. For gamma spectrometry counting, the samples were prepared in Marinelli beakers of nominal volume 450 cm^3.

The gamma peaks available for measurement of ^{238}U (such as the 1001 keV peak of the ^{238}U daughter product ^{234m}Pa) are relatively weak. However, there is a peak at 186 keV that has contributions from both ^{235}U and ^{226}Ra. By using other peaks in the spectrum, the ^{226}Ra was measured using the peak from radium progeny and its contribution to the 186 keV peak was subtracted, giving a measurement of ^{235}U. From the ^{235}U results, an estimate of ^{238}U was obtained on the assumption that the uranium has the $^{235}U/^{238}U$ activity ratio normally observed for environmental samples.

3.1.4.3 Sample preparation and analyses by the IEA: air filter samples

Air filters were measured 'as received' (in original plastic bags) using high resolution gamma spectrometry. The results were based on spectral lines at 144 keV of ^{235}U and 1001 keV of the ^{238}U daughter product ^{234m}Pa. Although the analytical peaks were detected, the results were below the detection limit (MDA = minimum detectable activity). During the sampling, the flow rate through the filter system was maintained at around 120 $m^3.h^{-1}$ and the total volume of air filtered was 960 m^3.

3.1.4.4 Intercomparison of PCIL and ARN Results

Water samples

Table 4 in Annex 5 shows the results obtained for 234 and 238 uranium isotopes in groundwater, as determined by alpha spectrometry. IAEA-381 is a reference material (seawater), used here for quality control purposes. The results obtained for IAEA-381 were in good agreement with the information values within a 95% confidence interval. Tables 5 and 6 in Annex 5 show the results for the same isotopes for surface water samples obtained using alpha spectrometry. Table 7 in Annex 5 shows the activity ratios of 235 and 238 uranium isotopes obtained by ICP-MS. From the data in Tables 4, 5, 6 and 7, the total uranium concentration in $\mu g.L^{-1}$ was derived, and these results are compared in Table A below for the groundwater and surface water samples with the results obtained for the same samples by the ARN using its routine fluorimetry technique. The derivation of water uranium content in $\mu g.L^{-1}$ is also explained in Table 7 in Annex 5.

Table A: Comparison of results obtained by PCI and ARN for Uranium content in water

	IEA Sample code	PCIL U ($\mu g.L^{-1}$)	ARN U ($\mu g.L^{-1}$)	ARN Sample code
Agua Potable Pozo EEN007, Aguas Argentinas, M. Grande	AA0019	10.8 ± 0.4	<10	AA0020
Agua Potable Ag. Argentinas Pozo EE001 Monte Grande	AA0022	16.3 ± 0.6	<10	AA0023
Agua Potable hidrante Aguas Arg., T. Suárez	AA0025	19.7 ± 0.7	14.2±1.4	AA0026
Agua Potable EGB N° 12 Ezeiza	AA0028	33.3 ± 1.1	27.2±3.0	AA0029
Club Empleados de Comercio, Ezeiza	AA0031	35.2 ± 1.2	35.0±3.3	AA0032
Agua Industrial, Fábrica de mosaicos, Laferrere	AA0052	8.9 ± 0.3	<10	AA0053
Agua Potable, Pozo N°2, CONUAR	AA0055	16.9 ± 0.6	12.3±1.3	AA0056
Arroyo Aguirre, Punto N°1	AA0010	12.4 ± 0.4	14.2±1.5	AA0011
Río Matanza, Punto N°8	AA0013	8.7 ± 0.3	8.8±1.2	AA0014
Arroyo Aguirre, Punto N°6	AA0016	11.6 ± 0.4	9.4±1.3	AA0017
Río Matanza Punto N° 9	AA0058	11.1 ± 0.3	10.9±1.2	AA0059

The results presented in Table A are from two laboratories using two independent but comparable techniques and calibrations. The results are given with estimates of the statistical uncertainties in the measurements. The ARN technique of fluorimetry has a higher quantification limit (in this case 10 $\mu g.L^{-1}$) than the alpha spectrometry technique used by the PCI Laboratory. This is reflected in the magnitude of the analytical uncertainties.

The results obtained are comparable. The differences observed between the results are normal in such intercomparison exercises, and arise from a number of factors, including statistical variability in the

measurement signal, the use of different calibration solutions, and chemical or physical artefacts in the measurement process.

Soil samples

Table 9 in Annex 5 shows the results obtained for radionuclides in soil samples, determined by gamma spectrometry at the PCI laboratory. The results for U-238 activity concentration may be converted to mass concentration of total uranium, and this conversion for the total soil sample has been performed and the results shown in Table B, where these results are compared with the results of the ARN laboratory analysis for uranium.

As can be seen, the results obtained by PCIL were higher than those obtained by ARN. On average, the difference is that the PCIL results are approximately twice those of the ARN results for Uranium. PCIL results were confirmed by separate analysis of three samples by alpha spectrometry (Table 14 in Annex 5).

Table B: comparison of results obtained by PCIL and ARN for U content in soil

Location & depth (cm)	IEA Sample code	PCIL ^{238}U (Bq kg^{-1})	PCIL U (μg g^{-1})	ARN U (μg g^{-1})	ARN Sample code
1. 0-10	AA0049	25.7±2.4	2.1±0.2	0,72±0,15	AA0050
1. 10-20	AA0046	21.8±2.6	1.8±0.2	0,72±0,15	AA0047
1. 20-30	AA0043	23.2±2.1	1.9±0.2	1,0±0,2	AA0044
1. 30-40	AA0040	22.1±3.2	1.8±0.3	1,2±0,4	AA0041
2. 0-10	AA0037	39.3±4.0	3.2±0.3	1,8±0,4	AA0038
3. 0-10	AA0034	39.0±3.1	3.2±0.3	1,4±0,3	AA0035

From Tables 9 and 13 in Annex 5, it can be said that ^{137}Cs obtained by the two laboratories compared favourably. The discrepancy in the uranium measurements can be explained by the use of less precise technique by the ARN. However for monitoring purposes, the technique used by ARN is sufficiently sensitive.

The IEA concluded that the results obtained by PCI and ARN are acceptably consistent and demonstrate that the ARN is capable of measuring uranium in environmental samples to a level of accuracy that is fit for the required monitoring purposes.

3.1.5. Findings

The IEA was able to measure environmental level of uranium in surface water and groundwater, soil and air. These data were comparable with those previously reported by ARN.

The IEA found from the intercomparison exercise that the ARN laboratory produces reliable results for the analysis of uranium content in both surface water and groundwater. The team considers that this gives credence to the data gathered by the ARN on the uranium content in waters in Buenos Aires province.

The conclusions drawn from this material are reported in Section 6.

3.2. ARN Environmental Monitoring Programme Review Group

The focus of Group B was to appraise the ARN environmental monitoring programme in relation to the CAE. The review team was adequately provided with data and site access to implement its work programme. No difficulties or constraints were encountered during the review.

3.2.1. Approach

The approach Group B adopted for appraising the ARN programme of environmental monitoring was to review the strategy used by ARN, to visit their various analytical facilities and laboratories at the

site of the Ezeiza Atomic Centre and to review related documentation. A visit was also made to one of the licensed facilities on the site, the fuel fabrication plant operated by CONUAR S.A., to review the controls in place on the management of radioactive waste at the facility. Group B was informed that this facility is the only one on the site where uraniferous material is at present being stored, handled and treated.

With regard to the monitoring strategy, the Group considered both the normal ongoing programme of environmental monitoring conducted for the Ezeiza Site and the additional programme that was implemented in response to the issue of uranium in groundwater. It also considered the management system that was in place for providing for assurance of the quality of analytical services provided by ARN. Staff members of ARN made a number of presentations on the subjects of interest and extensive discussions took place to obtain the necessary insight and clarity on the basis for the monitoring programme and on its implementation.

Visits were conducted to the various laboratories and facilities relating to the environmental monitoring programme, during which the various items of equipment were shown to Group B and explanations were provided of the approach to the various analyses carried out. A list of the facilities visited and personnel met during the visits is attached as Annex 6.

A number of documents were provided to Group B during the presentations and discussion. A list of the documents is attached as Annex 7.

3.2.2. Presentation of the ARN Programme

3.2.2.1 The Work of the Scientific and Technical Support Branch

Group B was informed that the structure of the ARN has four main branches — one dealing with licensing and regulatory matters, one providing scientific and technical support, a third dealing with safeguards and institutional control, and the fourth being an administrative branch. The scientific and technical support branch has three divisions, one dealing with environmental control, a second with safety assessment and a third dealing with dosimetry and radiobiological control. The ARN was established as an independent regulatory authority around 1995 and a number of services such as dosimetry and environmental monitoring, which had previously been common with the CNEA, were assigned to the ARN.

The prime responsibility of the ARN environmental monitoring programme is to provide independent assurance of the control over releases of radionuclides from licensed facilities.

Group B was told that ARN participates in an active programme of international intercomparison studies organized under the leadership of the United States Department of the Environment's Environmental Measurement Laboratory, and that it had consistently achieved better than average results, providing a high level of confidence in the analytical services provided by ARN. ISO accreditation of the laboratory is at present under way and a number of sample lines have all the necessary provisions in place for accreditation.

3.2.2.2 The Environmental Monitoring Programme for the Ezeiza Nuclear Centre

- **Routine environmental monitoring**

The programme is largely reported in the annual ARN reports (from 1995 to 2004; see http://www.arn.gov.ar). The Nuclear Centre of Ezeiza is considered as a whole with sampling points corresponding to different media (river water, drinking water from wells, grass, milk, food and vegetables). Group B was informed that the rationale behind the geographical location of the sampling points is based on the following:

- Meteorological conditions
- Presence of drinking water wells

– A hydrogeological study.

The dose to the critical group from the site is calculated on the basis of the monitored release of the plants operated on the Ezeiza Nuclear Centre. They are compared with a dose constraint of 0.1 $mSv.a^{-1}$, which is 1/10 of the dose limit established in international standards.

- **Non-routine environmental monitoring**

Group B was informed that, owing to existing concern over the presence of uranium in drinking water in three districts of the Buenos Aires area, ARN had taken additional samples in the three districts as well as complementary samples taken as controls in more remote areas, and it had found that the results of monitoring for artificial radionuclides in drinking water were that levels were all below the detection limits. It detected uranium in drinking water samples, but found that all the values were below the levels of concern as provided in international radiation protection guidance.

Group B also considered the results obtained by ARN since 1998 by means of non-routine environmental monitoring of the concentrations in groundwater of natural radionuclides in the country as a whole. The concentration of uranium in the aquifers of Argentina exhibits significant variability (between a few $\mu g.L^{-1}$ to around 250 $\mu g.L^{-1}$). ARN also carried out soil measurements in different areas.).

- **The Management System**

Group B was informed that historically ARN had had in operation a system for quality assurance relating to sampling and measurement, including for example intercomparison exercises. At the end of 2003 the ARN Directorate decided that the laboratories should develop a quality management system for accreditation to ISO 17025. The scope of the accreditation project (ACX-AL-1) is (1) sampling; (2) gamma spectrometry; (3) uranium measurement by fluorimetry; and (4) tritium measurement by direct scintillation — all for water.

3.2.3. Visits

3.2.3.1 Sample reception

Group B visited the sample reception area and noted the sample reception, recording, separation and preparation processes carried out. The arrangements put in place for the three lines undergoing preparation for the ISO accreditation process were explained to the team and the record keeping system in place was demonstrated. The arrangements in place were observed to be systematic and competent. Hard copy records of information were stored in the sample reception area.

3.2.3.2 Analytical laboratories

The Group visited the following laboratories: alpha-beta measurements and also alpha spectroscopy laboratory; ^{90}Sr and ^{14}C laboratory; Kinetic Phosphorescence Analysis laboratory; ^{3}H laboratory; ultra low level measurement laboratory; radon gas measurement laboratory.

The curricula vitae of the 12 analytical scientists interviewed were presented to the IEA mission, giving a good presentation of their capabilities (background, training, previous positions, publications).

In-depth discussions were held regarding the methodology for measurement of uranium isotopes in groundwater samples by alpha particle spectrometry, with a particular focus on spectrum interpretation and calculation of results. It was apparent to the review team members present at these discussions that the ARN staff carrying out this work had a good understanding of the method and utilized an appropriate and correct approach.

3.2.3.3 Fuel fabrication

The company CONUAR S.A operates a fuel fabrication plant on the Ezeiza site. This plant primarily produces fuel pellets for the two Argentinian nuclear power plants: Atucha-1 NPP (using slightly enriched uranium fuel — 0.85%) and Embalse NPP (using natural uranium). Other facilities operated at the Ezeiza site are: a Co-60 radioactive source production plant; I-131 radioisotope production plant; Mo-99 production plant; fuel fabrication for two research reactors; a 10 MW research and isotope production reactor; and a cyclotron and laboratories. The Group visited the NPP fuel fabrication plant. Uranium oxide (UO_2) powder is converted into pellet form. Slightly enriched uranium (U_3O_8) is blended with natural uranium to produce fuel for the Atucha-1 NPP. The pellets are then fired in a high temperature sintering furnace to create hard, ceramic pellets of uranium dioxide. The cylindrical pellets then undergo a grinding process to achieve a uniform pellet size. There are no chemical processes involved. Discharges are to the air coming from the building's main ventilation stack, which is filtered and equipped with in situ monitoring. Other ventilation channels from specific equipment (e.g. grinding equipment) allow discharge to the atmosphere. These routes have high efficiency particulate air (HEPA) filters, whose efficiency is monitored by measuring pressure differences. Water from cleaning of the facility is collected, filtered and treated before discharge. The team examined the discharge reports made to ARN and noted that the facility was accredited by ISO in the 9000 and 14000 series.

3.2.4. Findings

Group B found that the environmental monitoring programme for the Ezeiza site has a logical basis and makes use of sound scientific principles and methodology. Arrangements for the management of radioactive waste at the fuel fabrication plant appear to be effective and discharges are controlled and monitored.

The quality of the results from the environmental monitoring programme is assured by a number of provisions:

- The staff employed are well qualified and trained;
- Good quality modern equipment is available;
- The supporting infrastructure is also of a good quality;
- A quality assurance programme is in place;
- The laboratory regularly takes part in international analytical intercomparison programmes and has consistently achieved good results.

Overall, the programme appears to be of a good standard producing credible results.

3.3. Health Group

3.3.1. Specific tasks for Group C

The focus of Group C was to review available information on demographic and health statistics with regard to possible health risks attributable to exposure to ionizing radiation. In addition the Group also compared the data assessed by the IEA and the methodology applied for assessing radionuclides in drinking water on the basis of the WHO Guidelines for Drinking Water Quality (Annex 8).

3.3.2. Approach

The key concern of the Argentinian Government was the possible health hazard from radionuclides in drinking water. The IEA therefore considered it appropriate to request access to such information. With this in mind, IEA requested the information on demographic statistics and selected health statistics for the population in the districts of Buenos Aires province, including Ezeiza, Esteban

Echeverría and La Matanza (Annex 9). Health statistics data included cancer mortality rates for the given region (Tables B and C).

Group C visited the Radiopathology Laboratory of the ARN, where the following documents were provided for review:

- The letter from the Minister of Health and Environment sent to the Secretary of Environment and Sustainable Development (Ref. No 3907/05) dated 27.10.2005 including the annexed report entitled *Cancer Mortality in Ezeiza, Buenos Aires Province, August 2005.* The report contains information on the socio-demographic profile of the Ezeiza population and an analysis of statistical data on cancer mortality rates by sex for all ages combined, comparing mortality rates for Ezeiza with the rates for Argentina, Buenos Aires province, and other districts of the Sanitary Region VI (Annex 9).
- The letter from the Director, Ministry of Health of the Buenos Aires province (dated 03.05.2005), in response to the Judiciary request (Ref. 2900-5506/05). The letter includes information on cancer mortality rates for 1997–2003 by age, sex and tumour site for the districts of Ezeiza, Esteban Echeverría and La Matanza.
- Comments on the aforementioned documents prepared for the Judiciary by the ARN.

3.3.3. Cancer mortality statistics

Reports of the Epidemiology Department of the National Ministry of Health submitted to the General Secretary of the President of Argentina demonstrate that cancer mortality rates for the areas in question (in 2001–2003) were within the range of national and provincial mortality ratios due to spontaneous cancer (Tables C and D).

Table C. Standardized Cancer Mortality Ratio (SMR) for Selected Districts of the Buenos Aires Province (all cancers, both sexes)*

Population	Year	Observed deaths #	Expected deaths** #	SMR	95% CI
Ezeiza	2001	115	117	97.9	80.0–115.8
	2002	89	118	75.2	59.6–90.8
	2003	92	126	73.3	58.3–88.2
Esteban Echeverria	2001	274	277	99.1	87.4–110.8
	2002	260	276	94.4	82.9–105.9
	2003	260	290	89.6	78.7–100.5
La Matanza	2001	1413	1736	81.4	77.2–85.7
	2002	1444	1712	84.4	80.0–88.7
	2003	1445	1739	80.6	76.4–84.7

* Provincial Ministry of Public Health, Department of Informatics

** The values of the expected spontaneous cancer mortality were assessed by the Provincial Ministry of Public Health (Buenos Aires province) by taking into account the population in each district and the average value of the spontaneous cancer mortality rate in the whole province.

Table D. Standardized Cancer Mortality Ratio (SMR) for Selected Districts of the Buenos Aires Province (all cancers combined)*

Districts of the Region VI	Mortality rate per 100,000 people	SMR	95% CI
Females			
Almirante Brown	110.3	90.0	90–100
Avellaneda	524.2	580	550–620
Berazategui	109.9	100	90–100
Esteban Echeverria	92.2	90	80–100
Ezezia	77.3	90	70–100
Florencio Varela	85.6	100	90–110
Lanas	148.4	80	80–90
Lomas de Zamora	125.1	80	80–90
Quilmas	142.7	100	90–100
Region VI	132.1	130	120–130
Males			
Almirante Brown	136.8	90	90–100
Avellaneda	630.7	560	530–590
Berazategui	150.0	100	100–110
Esteban Echeverria	116.8	90	80–100
Ezezia	92.3	80	70–90
Florencio Varela	104.8	100	90–110
Lanas	186.4	80	80–90
Lomas de Zamora	153.5	90	80–90
Quilmas	180.2	100	100–100
Region VI	147.9	70	60–70

* Provincial Ministry of Health, Department of Informatics.

3.3.4. Findings

From the information reviewed, there has been no apparent increase in cancer mortality among the population in the area of investigation as compared with cancer mortality rates in other national/provincial data.

4. Radiological situation of the studied area

To assess the radiological situation, the IEA reviewed existing data provided by the government on the radionuclide content of water from the area studied and from other locations in Argentina. The IEA also considered the data on surface water and groundwater that were obtained in the intercomparison exercise as well as the data obtained on soil samples and airborne particle samples.

4.1. Surface water

The samples collected by the IEA from the rivers Matanza and Aguirre do not contain artificial radionuclides (of Cs, Sr, Co and H) in any detectable amount (Table 11, Annex 5). The samples contain uranium at the same level regardless of the sampling location, either upstream or downstream of the CAE site. The $^{234}U/^{238}U$ activity ratios range from 1.30 to 1.40, which represents the average value for natural surface water owing to the generally higher availability to dissolution of ^{234}U due to recoil of the atom following alpha decay of ^{238}U [6]. The $^{235}U/^{238}U$ atomic concentration and activity concentration ratios obtained using ICP-MS for the surface water samples (Table 7 in Annex 5) are in good agreement with published data for natural abundance [7]. Hence there is no evidence for the presence of depleted or enriched uranium in these samples.

The uranium content of these river waters (Table A) is higher than the global average value for surface water but within the range of global reported values [6]. The relatively high content of uranium in the water of the rivers Matanza and Aguirre cannot be explained by a point discharge from the CAE as the uranium content is equivalent upstream and downstream of the existing point of effluent discharges from the CAE. On the basis of the regional hydrogeology, it cannot be caused either by releases of uranium into the phreatic aquifer from the CAE centre as any such uranium releases could not extend to the upper part of the catchment basin of the Rio Matanza (see 4.2). The river waters were not contaminated by airborne fallout at the time of the sampling as the concentration of radionuclides in air recorded for the sampling days does not show the presence of uranium (see 4.4). The uranium is unlikely to originate solely from the drainage of high uranium content water in the topsoil of the area studied as the soil samples collected exhibit similar uranium contents to those commonly observed for environmental soil samples (see 4.3).

The process of uranium loading appears to be a natural continuous process taking place in the phreatic aquifer where groundwater recharge rich in oxygen with high pH and high carbonate content leaches the geological substrate along underground water pathways and then discharges into the rivers. This type of natural process could explain the significant content of uranium in river water and probably the content of other heavy metal elements common in the detritic geological horizons of the Rio de La Plata delta [8].

From the evidence mentioned above it can be concluded that the uranium content of surface water is of natural origin.

From the radiological point of view, the measured natural uranium content of surface waters does not pose any risk with respect to the use of the river water by the public. These waters are anyway not usable at all for public consumption as the rivers are already heavily polluted by domestic and industrial effluents of organic origin.

4.2. Groundwater

The groundwater samples collected for the IEA in the three districts of interest do not contain artificial radionuclides (of Cs, Sr, Co and H) in any detectable amount (Table 11, Annex 5). The uranium content is between 10 and 35 $\mu g.L^{-1}$, which is above the global average value for groundwater. These values are, however, well in the range of reported values for natural groundwater (from 0.01 to 700 $\mu g.L^{-1}$) [9] and drinking water [10]. The $^{234}U/^{238}U$ activity ratios obtained for the groundwater samples ranged from 1.20 to 1.37. Such values are commonly observed for groundwater, where this activity ratio usually ranges between 1.1 and 3 (but sometimes up to 30)[9]. The reason is the generally higher availability to dissolution of ^{234}U due to recoil of the atom following alpha decay of the ^{238}U. The $^{235}U/^{238}U$ atom and activity concentration ratios obtained using ICP-MS for the groundwater samples (Table 7 in Annex 5) are in good agreement with published data for natural abundance [7]. Hence there is no evidence for the presence of depleted or enriched uranium in these samples.

The IEA samples were collected from selected wells to be representative of the Puelche aquifer, which is the aquifer used for drinking water supply in these districts, by way of both public and private wells. The data obtained by the IEA do not differ from those obtained in previous analyses made by the ARN or other sources of information on the same sampling points. On considering all the existing data together, no trend with respect to groundwater flow lines, aquifer boundary or location of industrial facilities, including the CAE, can be evidenced. Differences observed from one well to another are explained by temporal and spatial hydrogeological features influenced by the water extraction mechanisms. In addition, in the major part of these districts, the Puelche aquifer is captive and flow gradients are turned toward the surface, preventing any possibility of pollution descending from rivers or phreatic aquifers to the Puelche aquifer.

Uranium levels comparable with those in groundwater of the Puelche aquifer have also been recorded in other districts of Gran Buenos Aires as well as other parts of the Buenos Aires province and also in aquifers of other regions of Argentine [11]. These observations, together with the natural isotopic labelling of the dissolved uranium, confirm the natural origin of the dissolved uranium in the groundwater pumped from the Puelche aquifer in the area studied. In this case, again, the leaching process takes place along the groundwater flow lines and reaches different degrees depending on the water transit time and the mineralogy of the geological horizons leached. In addition to the geological characteristics of each area, there are several factors, such as pH, carbonate content and redox condition, that could cause variations in the level of uranium in groundwater.

In accordance with the methodology described in the Radiological Aspects Chapter of the 3rd Edition of the WHO Guidelines for Drinking Water Quality [2], the IEA concluded that the levels of radioactivity of the groundwater sampled for the IEA or previously collected by other interested parties meet international radiation protection standards [2; 3] and therefore do not represent a radiological hazard to human health.

In addition to a radiological hazard, uranium can also present a chemical hazard. The scientific basis for evaluating this hazard is still developing and at this stage only a provisional guideline level is available from WHO [4]. While the remit of the IEA was limited to radiological aspects, it notes that in some water samples the concentration of natural uranium exceeds the WHO provisional guideline values of 15 $\mu g.L^{-1}$ established for naturally occurring uranium on the basis of its chemical toxicity [2]. WHO indicates that "this guideline value is provisional because of outstanding uncertainties regarding the toxicology and epidemiology of uranium as well as difficulties concerning its technical achievability in smaller supplies (private wells)" (see Annex 8). Some of the groundwater samples collected from the Puelche aquifers exhibit a uranium content above the WHO provisional guideline level but comply with the reference level established in the relevant Argentinian regulations [12; 13].

4.3. Soil samples

Tables 8, 9 and 14 in Annex 5 show the results obtained for soil samples. In all cases most of the soil passed through the 2 mm sieve. In the case of AA0037 only a small amount of coarse fraction material was obtained and so the resulting uncertainties for the radionuclide activity concentrations in the coarse fraction were very high; results are therefore not reported for this subsample.

The radionuclide activity concentrations obtained for the soil samples were within the range of values commonly observed for environmental soil samples [10]. For site 1, there is no strong evidence for an increase in uranium concentrations moving up the soil profile. This means that if there is deposition of uranium to the soil from the atmosphere, then the amounts must be small in comparison with the amount of naturally occurring uranium in the soil. For the majority of samples, and on taking into account the uncertainties in the results, ^{226}Ra appears to be in or close to secular equilibrium with its progenitor ^{238}U. This result also implies that there is only negligible deposition of uranium to the surface of the soil from the atmosphere.

Table 14 in Annex 5 shows results for the fine fraction from surface layer of soil at the three sampling sites. These results, obtained by alpha spectrometry, are for the 234 and 238 isotopes of uranium. Using results of Tables 9 and 14 for uranium-series radionuclides, ^{238}U-^{234}U-^{226}Ra, it can be said that for these three soil samples, the three radionuclides are in secular equilibrium, within the analytical uncertainties, and therefore are from natural undisturbed origin.

4.4. Air filter samples

The results obtained for the air filter samples are given in Table 10. For the air filter samples, only the naturally occurring radionuclides ^{226}Ra and ^{40}K were present at levels above the minimum detectable activity level. It must be noted that the sample sizes of the air filters measured were different. The amount of blank filter paper material was greater for the blank than for the sample. It appears that 4

complete filters were supplied for the blank, whereas the sample filter was only one filter. This did not impact the interpretation of the measurements.

5. Conclusion

With reference to its objectives, the International Expert Appraisal concluded with a high degree of confidence that:

- There is no anthropogenic (i.e. human made) contamination with radioactive elements in the topsoil, or in the undersoil, or in the surface waters and groundwaters used for drinking water supply in the area encompassing the districts of Ezeiza, Esteban Echeverría and La Matanza, of the province of Buenos Aires, Argentina. In particular, there is no presence of either enriched uranium or depleted uranium.
- Natural uranium is present in the Puelche aquifer as a result of natural geochemical processes.
- The measured levels of radioactivity of the groundwater meet the international radiation protection standards [2; 3] and therefore do not represent a radiological hazard to human health.
- The water for consumption supplied to the population of the aforementioned localities does not contain radioactive elements at levels that would cause harm to health.
- In view of the results of water sampling measurements, no adverse health effects due to exposure to ionizing radiation are expected. Health statistics data are in support of this.
- As there is no anthropogenic contamination with radioactive elements, no such contamination could be attributed to activities that have been and/or are being carried out on the site of the CAE.
- The Argentinian Nuclear Regulatory Authority is adequately regulating the activities of the Ezeiza Atomic Centre.

In addition to radiological hazard, uranium can also present a chemical hazard. The scientific basis for evaluating this hazard is still developing and at this stage only a provisional guideline level is available from WHO. While the IEA was limited to radiological aspects, it notes that in some water samples the concentration of natural uranium exceeds the WHO provisional guideline values established for naturally occurring uranium on the basis of its chemical toxicity. Some of the groundwater samples collected from the Puelche aquifers exhibit a uranium content exceeding the WHO provisional guideline level, but they comply with the reference level established in the relevant Argentinian regulations.

Acknowledgement

IEA participants wish to express their appreciation for the constructive, open and transparent discussions that took place with all Argentinian counterparts throughout the field mission.

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Annex 1: Request from the Argentine Federal Justice

(Translated from Spanish)

National Judiciary
[Stamp of the Lomas de Zamora Federal Criminal and Correctional Court No. 1, Buenos Aires province]

To: Dr. Raúl Oscar Racana
President of the Nuclear Regulatory Authority Board of Directors

VERY URGENT

Lomas de Zamora, 18 May 2005

I am writing to you in connection with case No. 5452, entitled "Proceedings instituted to inquire into presumed infringement of articles 200 and 207 of the Penal Code", brought before this Lomas de Zamora Federal Criminal and Correctional Court of First Instance No. 1, Alem 180, Lomas de Zamora, under my charge, court office No. 1 registry (Dr. Gustavo F. González), to inform you that, pursuant to Nuclear Regulatory Authority letters Nos 766/05 and 870/05, the intervention of the International Atomic Energy Agency (IAEA) will have to be requested, through the appropriate consultative channels, for the organization of an independent group of international peer experts, with the participation of the relevant supranational organizations — such as the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the World Health Organization (WHO), the Pan American Health Organization (PAHO), the International Radiation Protection Association (IRPA) and the International Commission on Radiological Protection (ICRP) — to carry out an expert appraisal, in accordance with the nature of the procedural purpose of this case, which makes it necessary to answer, as accurately as demanded by modern standards, the following substantive questions:

A) Whether there is any contamination due to the presence of radioactive elements in the topsoil, in the undersoil, in the surface waters and groundwaters, or in the air, in the area encompassing the districts of Ezeiza, Esteban Echeverría and La Matanza in the province of Buenos Aires.

   If so, the nature of the hazard caused should be determined, and it should be determined whether the contamination could be attributable to activities that have been and/or are being carried out on the site of the Ezeiza Atomic Centre, which comes under the National Atomic Energy Commission, in such a way as to have generated a health risk.

B) Checks should be made to find out whether the water for consumption (human and/or industrial) supplied to the population of the aforementioned localities is contaminated with radionuclides and thereby rendered harmful to health.

C) In the event that contamination under the given circumstances is detected and it cannot be attributed to the activities at the aforementioned atomic centre, its possible origin should be determined.

To that end, an appropriate work plan should be prepared, as soon as possible, covering the aforementioned questions, specifying in particular the activities foreseen to meet the probative requests and expressly mentioning the laboratories abroad where the radiochemical analytical determinations will be made. Once this information has been gathered, it should be submitted immediately to these law courts.

Yours, etc.,
(signed) Alberto P. Santa Marina
Federal Judge
[Stamp: Federal Criminal and Correctional Court ...]

Annex 2: Description of organizations participating in the IEA and resume of the experts involved

As provided to the Government of Argentina (original Spanish version)

Organismo Internacional de Energía Atómica (IAEA): Se creó en el año 1957. Es un organismo de la familia de la Organización de las Naciones Unidas que basa su accionar en tres pilares, la verificación, la cooperación y la seguridad. En el marco de la seguridad, se destaca su propósito de proteger a las personas y al ambiente de los efectos nocivos de la exposición a las radiaciones ionizantes. Su Estatuto le asigna el objetivo de procurar acelerar y aumentar la contribución de la energía atómica a la paz, la salud y la prosperidad en el mundo entero. Una de las funciones del IAEA es "establecer o adoptar, en consulta, y cuando proceda, en colaboración con los órganos competentes de las Naciones Unidas y con los organismos especializados interesados, normas de seguridad para proteger la salud y reducir al mínimo el peligro para la vida y la propiedad (inclusive normas de seguridad sobre las condiciones de trabajo), y proveer a la aplicación de estas normas a sus propias operaciones, así como a las operaciones en las que se utilicen los materiales, servicios, equipo, instalaciones e información suministrados por el Organismo, o a petición suya o bajo su control o dirección; y a proveer a la aplicación de estas normas, a petición de las partes, a las operaciones que se efectúen en virtud de cualquier arreglo bilateral o multilateral, o, a petición de un Estado, a cualquiera de las actividades de ese Estado en el campo de la energía atómica". Además, con respecto a cualquier proyecto del IAEA, o a otro arreglo en el cual las partes interesadas soliciten de él que aplique salvaguardias, el IAEA tiene el derecho y la responsabilidad, en cuanto se relacione con el proyecto o arreglo, de "exigir la observancia de cualquier medida de protección de la salud y de seguridad prescritas por el Organismo" y "enviar al territorio del Estado o de los Estados beneficiarios a inspectores. La finalidad de las normas internacionales que desarrolla es, entre otras, facilitar al IAEA el cumplimiento de estas funciones, derechos y responsabilidades para determinar si se observan dichas medidas de protección de la salud y de seguridad".

Organización Mundial de la Salud (WHO): Es un organismo especializado de las Naciones Unidas, tuvo su origen en una propuesta formulada en la Conferencia de las Naciones Unidas, celebrada en San Francisco en 1945, pidiendo la creación de un organismo especializado encargado de todas las cuestiones relativas a la salud. La Constitución de la WHO entró en vigor el 7 de abril de 1948, la primera Asamblea Mundial de la Salud se reunió en Ginebra en junio de 1948, y la organización quedó establecida con carácter permanente el 1 de septiembre de 1948. Sus actividades se realizan por medio de tres órganos: la Asamblea Mundial de la Salud, instancia suprema a la que todos los Estados Miembros envían delegados; el Consejo Ejecutivo, órgano ejecutivo de la Asamblea de la Salud; la Secretaría, encabezada por el Director General. Por medio de esta organización, los profesionales de la salud de casi 180 países intercambian conocimientos y experiencia con el fin de hacer posible que todos los ciudadanos del mundo consigan un grado de salud que les permita llevar una vida social y económicamente productiva. La WHO desarrolla su labor con una estructura orgánica descentralizada; tiene su sede en Ginebra y seis oficinas regionales —África, América, Europa, Mediterráneo oriental, Pacífico occidental y sudeste de Asia — más oficinas locales en muchos países. Para cumplir su misión, la WHO cuenta con su plantilla multinacional de funcionarios y, además, recurre a actividades de cooperación con otras organizaciones internacionales, a sus centros colaboradores, sus grupos de expertos asesores y diversas organizaciones científicas y profesionales no gubernamentales entre las que figuran la Sociedad Internacional de Radiología, la Sociedad Internacional de Radiógrafos y Técnicos de Radiología y la Organización Internacional de Física Médica. Por medio de la cooperación técnica directa con sus Estados Miembros, e impulsando dicha cooperación entre ellos, la WHO fomenta el desarrollo de amplios servicios de sanidad, la prevención y control de las enfermedades, la mejora de las condiciones ambientales, el perfeccionamiento de los recursos de personal en la esfera de la salud, la coordinación y desarrollo de las investigaciones sobre biomedicina

y servicios sanitarios, y la elaboración y ejecución de programas de sanidad. En la esfera radiológica, los temas de interés para la WHO son las aplicaciones de la radiación en medicina y la higiene radiológica.

Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO): Fue creada en 1945 en sustitución del Instituto Internacional de Agricultura. Uno de sus objetivos es asegurar mayor eficacia en la producción y distribución de productos alimenticios y agrícolas. Las principales funciones de la FAO son: ejecutar grandes programas de asesoramiento y asistencia técnicos al mundo de la agricultura; acopiar, analizar y difundir información; asesorar a los Gobiernos en cuestiones de política y planificación; finalmente, ofrecer a los Gobiernos y expertos ocasiones de reunirse y analizar temas relativos a la agricultura y la alimentación. Por diversos conductos oficiales y extraoficiales, la FAO presta a los Gobiernos de sus Estados Miembros asesoramiento y asistencia sobre todos los aspectos de la producción, distribución y consumo de alimentos y productos agrícolas en consonancia con las necesidades existentes. En 1962, la FAO y la WHO constituyeron la Comisión del *Codex Alimentarius*, con los siguientes objetivos: proteger la salud de los consumidores y velar por la existencia de prácticas satisfactorias en el comercio de alimentos, promover la coordinación de todos los trabajos e iniciativas en materia de normas alimentarias que realicen las organizaciones internacionales gubernamentales y no gubernamentales, establecer prioridades y emprender y orientar la elaboración de un proyecto de normas con la colaboración y ayuda de las organizaciones apropiadas y publicar esas normas en forma de Codex Alimentarius, así como enmendar las normas publicadas tras examinar atentamente la evolución de la situación. En el año 1964 la FAO impulsó la creación del Programa Conjunto FAO/IAEA, uno de cuyos objetivos es la conservación de los recursos naturales y la protección del medio ambiente.

Organización Panamericana de la Salud (OPS): Fundada en 1902, es un organismo internacional de salud pública dedicado a mejorar la salud y las condiciones de vida de los pueblos de las Américas. Goza de reconocimiento internacional como parte del Sistema de las Naciones Unidas, y actúa como Oficina Regional para las Américas de la Organización Mundial de la Salud. Dentro del Sistema Interamericano, es el organismo especializado en salud. El personal de la institución comprende a científicos y técnicos expertos que, ya sea en su sede, sus oficinas representativas en 27 países o sus ocho centros científicos, trabajan con los países de América Latina y el Caribe para abordar temas prioritarios de salud. Las autoridades sanitarias de los Gobiernos Miembros de la OPS fijan las políticas técnicas y administrativas de la Organización por medio de sus Cuerpos Directivos. Los Gobiernos Miembros de la OPS son los 35 países de las Américas; Puerto Rico es un Miembro Asociado. Francia, el Reino de los Países Bajos y el Reino Unido de Gran Bretaña e Irlanda del Norte son Estados Participantes, y España y Portugal son Estados Observadores. La OPS inició sus actividades de salud radiológica en los años del decenio de 1950, prestando especial atención a los aspectos de la radiación relacionados con la salud pública. Actualmente el Programa Regional de Salud Radiológica tiene como finalidad principal asesorar en el campo de la salud radiológica haciendo hincapié en la orientación de las políticas y los programas para fortalecer los procesos de desarrollo, producción, evaluación, incorporación y utilización de las tecnologías apropiadas en las áreas del diagnóstico por imagen y radioterapia, en la seguridad radiológica del publico, el paciente, los trabajadores y el medioambiente, y en la preparación y respuesta a emergencias radiológicas.

Comité Científico de la Naciones Unidas para el Estudio de los Efectos de las Radiaciones Atómicas (UNSCEAR): En 1955 la Asamblea General de las Naciones Unidas estableció por Resolución 913 (X) un Comité Científico en respuesta a ciertas preocupaciones en cuanto a los efectos de la radiación en la salud y el ambiente. Entonces, se realizaban ensayos nucleares cuyos desechos se dispersaban por la atmósfera y el ambiente, alcanzando el cuerpo humano a través de su absorción por aire, agua y alimentos. Por esta razón se le solicitó al Comité que, reúna y evalúe la información científica sobre los niveles de radiación ionizante y radionucleidos de todas las fuentes (naturales y producidas por el hombre) y estudie sus posibles efectos en el hombre y el ambiente. Los tratados

internacionales actuales prohíben este tipo de ensayos con armas nucleares en la atmósfera, pero aún ciertas exposiciones mínimas a la radiación se originan en otras fuentes y prácticas. Entre las fuentes artificiales se encuentran: Los reactores nucleares, que son usados en muchos países para producir energía eléctrica y los exámenes médicos con rayos X, que son muy comunes en todo el mundo. Entre las fuentes más significativas de exposición, está la radiación natural, que siempre existió en la tierra y a la que todos estamos expuestos. La radiación natural incluye los rayos cósmicos que entran en la atmósfera desde el espacio exterior y las provenientes del potasio, uranio, radio, radón y otros isótopos radiactivos naturales presentes en suelo, agua, alimentos y el cuerpo humano. El Comité consiste de científicos de 21 Estados Miembros. Estos Estados miembros son en la actualidad: Argentina, Australia, Bélgica, Brasil, Canadá, China, Egipto, Francia, Alemania, India, Indonesia, Japón, México, Perú, Polonia, Rusia, Eslovaquia, Sudán, Suecia, Reino Unido, y los Estados Unidos de América del Norte. La Secretaría del UNSCEAR, brinda al Comité la ayuda necesaria para la realización de su trabajo y está localizada en Viena. Esta Secretaría consulta con científicos de todo el mundo para establecer bases de datos sobre exposiciones e información de los efectos de la radiación ionizante. El Comité produce los Informes de UNSCEAR, que son remitidos a la Asamblea General de la Naciones Unidas. Estos Informes también están a disposición como publicaciones de Naciones Unidas para el mundo científico. Estos informes son considerados por la comunidad científica como referencias fundadas, equilibradas y autoritativas. Los informes examinan exposiciones debido a fuentes de radiación natural, a la producción de energía nuclear, al historial de los ensayos nucleares, exposiciones por diagnóstico médico y tratamiento y la exposición ocupacional a la radiación. Incluyen también, estudios detallados del cáncer inducido por radiación, los mecanismos del desarrollo de cáncer y los sistemas de reparación del cuerpo, además de los riesgos de enfermedades hereditarias inducidas por la exposición a la radiación, y los efectos combinados de la radiación y otros agentes. Se le brinda una alta consideración también a la evaluación de las consecuencias radiológicas de accidentes, como el ocurrido en Chernobyl. Aunque el trabajo del Comité Científico sea realizado por sus 21 Estados Miembros, este recibe la colaboración de todos los Estados Miembros de las Naciones Unidas y la comunidad científica internacional. Las evaluaciones por el Comité Científico de fuentes de exposición son representativas de todas las regiones del mundo, ya que la información es compilada desde los cuestionarios sobre fuentes naturales, fuentes ocupacionales y fuentes médicas de la exposición, que son enviadas a todos los Estados Miembros. Muchos de estos estados han establecido sistemas gubernamentales que coleccionan datos para proporcionar la información necesaria al UNSCEAR. El trabajo del Comité Científico recibe también la contribución proporcionada por 58 Organizaciones Nacionales que comprenden las 21 delegaciones nacionales al Comité Científico y por 4 Organizaciones Internacionales que participan en sus deliberaciones.

Asociación Internacional de Protección Radiológica (IRPA): Es una organización internacional no-gubernamental de profesionales de protección de radiológica que son también miembros de Sociedades nacionales o regionales Asociadas. El objetivo primario de la Asociación es proporcionar un medio por el cual se promueve la vinculación internacional y la cooperación entre aquellos dedicados al trabajo de protección radiológica. Esto incluye aspectos relevantes de ramas del conocimiento tales como: las ciencias exactas, la medicina, la ingeniería, la tecnología y la ley, en el esfuerzo por asegurar la protección de hombre y su ambiente de los riesgos causados por la radiación ionizante y no-ionizante y así facilitar el uso de la radiación y energía nuclear con fines pacíficos en beneficio de la humanidad. Las actividades de la Asociación son aquellas características del desarrollo de su objetivo primario, a saber: (i) Propiciar el establecimiento de sociedades de protección radiológica en todo el mundo como un medio para incrementar la cooperación internacional entre aquellos comprometidos en la protección radiológica. (ii)Asegurar y apoyar reuniones internacionales para la discusión de todos los aspectos de la protección radiológica; (iii) Favorecer las publicaciones internacionales dedicadas a la protección radiológica; (iv) Alentar la investigación y oportunidades educativas en aquellas disciplinas científicas que apoyan la protección radiológica y (v) Apoyar el establecimiento y la revisión continua de estándares de protección radiológica universalmente

aceptables o recomendaciones por los cuerpos internacionales relevantes. El gobierno de las actividades del IRPA está establecido por medio de una Asamblea General, un cuerpo parlamentario que consiste en un número comparativamente grande de individuos formada por los miembros del Consejo Ejecutivo y delegados elegidos por las Sociedades Asociadas. La Asamblea General se reúne cada tres años en el Congreso IRPA que se desarrolla en distintos países con Sociedades miembro.

Comisión Internacional de Protección Radiológica (ICRP): Fue establecida en 1928 por el Congreso Internacional de la Radiología como una Comisión ligada a dicho Congreso llamada "Comité Internacional de la Protección de Rayos X y Radium". En 1950, cambió su organización y le fue dado actual nombre. La ICRP, sin embargo, ha retenido su relación especial con la Sociedad Internacional de Radiología y la profesión radiológica. No obstante, con el paso de los años, ha ampliado el alcance de sus actividades a todos aspectos de la protección radiológica. La ICRP está registrada como una entidad sin fines de lucro independiente en el Reino Unido de Gran Bretaña e Irlanda del Norte y es financiada principalmente por contribuciones voluntarias de organismos internacionales y nacionales gubernamentales con interés en la protección radiológica. La Comisión colabora con la Comisión Internacional en Unidades y Magnitudes de Radiación (ICRU) y tiene relaciones con muchos otros cuerpos internacionales con interés en la protección radiológica, tal como la IAEA, la Organización Internacional de Trabajo, el Programa de Ambiente de Naciones Unidas, el UNSCEAR, la WHO, la Comisión Electrotécnica Internacional, la IRPA, la Organización de Estándares Internacional, la Comisión Europea y la Agencia de Energía Nuclear de la Organización para Cooperación Económica y Desarrollo. Las recomendaciones de la Comisión forman la base para los estándares básicos de la protección radiológica, así como de los códigos y regulaciones más detallados publicados por otras organizaciones internacionales y por autoridades nacionales. Las primeras recomendaciones de la ICRP se publicaron en 1928, y la primera de la serie actual, la Publicación 1 (ICRP, 1959), contuvo las recomendaciones adoptadas en 1958. Las recomendaciones generales subsiguientes han aparecido como Publicaciones 6 (ICRP, 1964), la Publicación 9 (ICRP, 1966), la Publicación 26 (ICRP, 1977), y la Publicación 60 (ICRP, 1991). Los informes en temas más especializados han aparecido en publicaciones intermedias y subsiguientes a la publicación de cada recomendación principal.

Didier Louvat (IAEA)

Es el responsable de la Sección de Seguridad de los Desechos, en la División de Seguridad Radiológica, Transporte y Desechos del Departamento de Seguridad Nuclear y Seguridad Física del Organismo Internacional de Energía Atómica (IAEA). Se graduó en Geología con especialización avanzada en Aplicaciones Ambientales en 1984 en la Universidad de Paris, Francia. Se recibió de Doctor en Ciencias Geoquímicas Isotópicas en la misma Universidad en 1987. En ese año comenzó su carrera profesional en el Organismo Internacional de Energía Atómica (IAEA) trabajando como Oficial Técnico para la aplicación de técnicas nucleares en la resolución de problemas ambientales. En 1992, se incorporó al Departamento del Ciclo de Combustible Nuclear de la Comisión de Energía Atómica Francesa (CEA) donde desarrolló programas relacionados con la disposición geológica de desechos radioactivos. En particular, a partir de 1995 hasta 1999, coordinó el programa "Oklo-Natural Analogue" internacional. Desde el año 2000 fue responsable del Laboratorio de Radiactividad Ambiental para la Radioprotección Francés, en el Instituto de Radioprotección y Seguridad Nuclear (IRSN). En el 2004, volvió a incorporarse al IAEA. Actualmente además de ser responsable de Sección mencionada, conduce el Programa de Gestión de Desechos Radiactivos del IAEA. El Sr Louvat ha sido un conferenciante en el Curso Avanzado de Geociencias Ambientales de la Universidad de Marsella y ha sido Miembro del Consejo Consultivo Científico del Centro de Investigación Francés de la Geología del Uranio.

Zhanat Carr (WHO):

Es integrante del equipo Radiaciones Ionizantes, Unidad de Salud Radiológica y Ambiental de la Organización Mundial de la Salud (WHO), desde julio del 2002. Es Doctora en Medicina. Recibió su título de grado en 1989 de la Facultad de Medicina en Kazajstán, con una especialización en Radiación Oncológica. Defendió su Tesis Doctoral relacionada con la modificación biológica de la radiosensibilidad en el año 1993 en el Centro de Investigación Médica de Radiaciones en Obninsk, Rusia. Más tarde, completó una Licenciatura en ciencias Biologicas de Radiación en el Hospital de St Bartholomew y el Colegio Queen Mary Westfield de la Universidad de Londres, Reino Unido GBelN. En 1999 recibió el Premio Posdoctoral NIH y, durante los años 2000 y 2002, trabajó en el sector de Epidemiología de las Radiaciones en el Instituto Nacional de Cáncer de Maryland, U.S.A, donde estuvo aplicada a estudios epidemiológicos en sujetos expuestos a consecuencias nucleares y pacientes tratados con radioterapia. En la WHO, la Sra. Carr, actualmente participa en la definición, planificación y coordinación el rol de la WHO, su política, programas y actividades en áreas claves de las Radiaciones Ionizantes del Programa de RAD. Además, prepara, organiza y participa en reuniones internacionales y nacionales. Desarrolla el material de información para el público, especialistas y autoridades nacionales. Otras tareas incluyen la gestión de acuerdos de asesoramiento y colaboración de la PAHO con Estados Miembros y sus centros de colaboración nacionales, con Naciones Unidas y otros organismos internacionales.

David H. Byron (FAO/IAEA):

Es el responsable de la Sección de Protección de Alimentos y Medio Ambiente de la División Conjunta Organización de las Naciones Unidas para Agricultura y Alimentación / Organismo Internacional de Energía Atómica (FAO/IAEA), Programa Conjunto para Técnicas Nucleares en la Alimentación y Agricultura. Esta Sección y su Unidad Agroquímica Asociada, el Laboratorio de Agricultura y Biotecnología Conjunto FAO/IAEA, proporcionan la ayuda técnica y el apoyo a los países en sus esfuerzos para asegurar la seguridad y la calidad de los alimentos y productos agrícolas, facilitando al mismo tiempo el comercio internacional. El Sr. Byron trabajó durante dieciséis años en la Secretaría Conjunta FAO/WHO de la Comisión del *Códex Alimentarius*, en la Oficina central de la FAO en Roma, Italia. Fue responsable del desarrollo de estándares de alimentación, guías y códigos de

práctica relacionados con la protección del consumidor y la facilitación del comercio internacional. En ese ámbito fue responsable de los Comités de Aditivos de Comida y Contaminantes de Alimentos; Importación de Alimentos y Sistemas de Certificación e Inspección de Exportación; Residuos de Medicinas Veterinarias en Alimentos; Higiene de Carnes y Aves; Frutas y Verduras; Fruta Fresca y Verduras y Leche y Derivados de la Leche y del Comité de Coordinación para Norteamérica y el Océano Pacífico Sur. Antes de su vinculación con la FAO el Sr. Byron trabajó en Washington, D.C. en la División de Estándares y Etiquetaje; Seguridad de Alimentos y Servicio de Inspección del Ministerio de Agricultura de los Estados Unidos de NA. También trabajó en la Ciudad de Sioux, Iowa como un calificador de materias primas con la División de Calidad de Carnes, Seguridad de Alimentos y Servicio de Inspección del Ministerio de Agricultura Norteamericano. Previamente el Sr. Byron sirvió como voluntario en un proyecto relacionado con la cultivación y producción de arroz junto con el cuerpo de Paz Norteamericano en la República de Benín, África de Occidental. En la FAO/IAEA el Sr Byron actualmente dirige las actividades de aplicación de regulaciones nacionales armonizadas para aplicaciones sanitarias y fitosanitarias de la irradiación sobre la base de estándares internacionales; la revisión y aplicación de regulaciones armonizadas relacionadas con niveles de radionucleidos en alimentos; la aplicación de regulaciones nacionales armonizadas relacionadas con buenas-prácticas de laboratorio y procedimientos analíticos para contaminantes de alimentos y residuos, incluso pesticidas y medicinas veterinarias, y la aplicación de directivas internacionales armonizadas relacionadas con estado de preparación y respuesta a eventos nucleares o radiológicos, incluso la aplicación de medidas preventivas agrícolas apropiadas.

Pablo Jiménez Cencerrado (PAHO)

Es el Asesor Regional del Programa de Salud Radiológica de la Organización Panamericana de la Salud (PAHO) / Organización Mundial de la Salud (OMS), en Washington DC- EEUU. Nació en Cuevas del Valle (España). Es Licenciado en Ciencias Físicas por la Universidad Complutense de Madrid, y especialista en Radiofísica Hospitalaria otorgado por la Subdirección de Especialidades en Ciencias de la Salud, Ministerio de Educación y Cultura de ese país. Es experto en Protección Radiológica de Instalaciones Médicas y Nucleares y posee Licencia de Jefe de Protección Radiológica otorgada por el Consejo de Seguridad Nuclear de España. Fue Profesor tutor de Técnico Especialista en Informática FP II en el Centro de Informática y Marketing S.A en Madrid España. Se desempeñó como Físico Investigador en la División de Proyectos y Sistemas, Subdirección de Investigación y Desarrollo de Tecnología y Materiales, Departamento de Ensayos No Destructivos en Construcciones Aeronáuticas S.A (C.A.S.A). Trabajó en PHILIPS Sistemas Médicos en Palma de Mallorca y en Madrid en el área de Radioterapia. En el Hospital Son Dureta, de Palma de Mallorca trabajó como Radiofísico Adjunto, y en el Instituto Galego de Medicina Técnica S.A. en Vigo como Jefe de Servicio de Protección Radiológica y Radiofísica antes de su incorporación a la OPS/OMS en el 2002.

Malcolm Crick (UNSCEAR):

Es el Secretario del Comité Científico de las Naciones Unidas para el Estudio de los Efectos de las Radiaciones Atómicas (UNSCEAR) que funciona bajo el patrocinio del Programa de Ambiente de Naciones Unidas. Luego de su egreso del Colegio Merton, Oxford, obtuvo su Licenciatura en Física y su Maestría en física nuclear y electrónica. Su maestría técnica cubre los campos de evaluación radiológica, modelado ambiental, protección radiológica, regulaciones internacionales y planificación de emergencia. Es autor de muchas publicaciones en estos temas. Antes de ser el secretario del UNSCEAR trabajó en el IAEA, donde en su última función fue Responsable del Centro para Incidentes y Emergencias. Previamente, había trabajado en la protección de la población que vive en territorios contaminados por el accidente Chernobyl y en el desarrollo de estándares para protección del público bajo situaciones rutinarias y en condiciones de accidente. Antes de ingresar al IAEA se desempeñó en varias posiciones dentro del National Radiological Protection Board, del Reino Unidos de Gran Bretaña e Irlanda del Norte. Su trabajo abarcó la evaluación radiológica del impacto de accidentes, modelado ambiental, protección radiológica ocupacional y planificación de respuesta frente a emergencias públicas radiológicas y nucleares. Durante aquel tiempo colaboró en comités internacionales de la Agencia de Energía

Nuclear y de la IAEA relacionados con emergencias nucleares y radiológicas. En el UNSCEAR, el Sr Crick, actualmente como Secretario, provee la ayuda científica, técnica y administrativa que el Comité necesita para llevar a cabo su trabajo, así como establecer y mantener los elevados estándares de excelencia científica en materiales a ser analizados por el Comité. Las actividades corrientes de UNSCEAR incluyen el análisis de exposiciones ocupacionales y del público a varias fuentes de la radiación; reevaluación de los riesgos de radón en hogares y lugares de trabajo; revisión del riesgo y efectos de radiación en biota no-humana; la consideración de nuevas pruebas para los mecanismos por los cuales la radiación de ionización puede inducir efectos de salud; evaluación de nuevos estudios epidemiológicos de radiación y cáncer; la revisión de pruebas para enfermedades además del cáncer que podría estar relacionado con la exposición de radiación; análisis de la amplia variabilidad global en exposiciones de radiación médicas; y el análisis del impacto en la salud debido a los efectos de la radiación desde el accidente de Chernobyl.

Philip Edward Metcalf (IRPA):

Es el Presidente del la Asociación Internacional de Protección Radiológica (IRPA). Después de su graduación en Física y postgrado estudia una maestría en ciencias en protección radiológica de la salud y seguridad en la Universidad de Salford en el Reino Unido de Gran Bretaña e IN Dictó matemáticas y física en la universidad y a continuación se enrola en la Rama Regulatoria del Board de Energía Atómica Sudafricano. Durante su carrera tuvo una participación intensa con asuntos de sociedades de protección radiológica profesionales. Ha sido miembro de la Sociedad Sudafricana de Radioprotección desde 1973, como miembro de su consejo controlador durante quince años y Presidente durante tres años. Colaboró en el Consejo Ejecutivo del IRPA durante trece años siendo miembro de consejo, director de publicaciones y Vicepresidente. Antes de retirarse de las Autoridades Regulatorias nucleares Sudafricanas llegó al puesto de Gerente de General, con la responsabilidad de aspectos científicos, técnicos y legales del proceso licenciamiento. Durante ese período como regulador tuvo responsabilidades en el desarrollo de estándares de seguridad y legislación, evaluación de seguridad, establecimiento de condiciones de autorización y programas inspección. Las actividades y las instalaciones licenciadas durante su carrera abarcan desde la minería de uranio, procesamiento de minerales, enriquecimiento de uranio y fabricación de combustible, investigación, reactores de potencia, producción de radioisótopos y gestión de desechos radiactivos. Ha estado extensivamente implicado con el desarrollo de estándares de seguridad internacionales. Contribuyo al desarrollo de las Normas Básicas de Seguridad del IAEA, fue el coautor de varios estándares internacionales, incluidos los de Seguridad sobre Infraestructura Gubernamental y Legal en Protección Radiológica y Nuclear, Seguridad de Desechos y en el Transporte; Seguridad para el Manejo de Eliminación de Desechos Radiactivos y Desmantelamiento. Presidió el Comité de Normas de Seguridad de Desechos WASSC, desde su establecimiento en 1996, durante seis años. También representó a Sudáfrica en todas las reuniones del grupo de expertos, que desarrolló la Convención Conjunta sobre el Manejo Seguro de Combustible Gastado y de los Desechos Radiactivos. En el IAEA, estuvo implicado con el Proyecto Modelo de Protección de Radiológica en varios países en África, Europa, Asia y América Ha sido responsable de Planes de Acción para la seguridad de desechos radiactivos, el desarrollo de varios estándares de seguridad, incluso los Requerimientos de Seguridad en la Disposición Geológica, programas de investigación coordinados en metodología de evaluación de seguridad, misiones de valoración internacionales (incluida la Revisión de pares del "Proyecto Yuca Mountain" para gestión de desechos nucleares en EEUU) y varias misiones de asistencia técnica. También ha estado implicado en la organización de conferencias internacionales sobre la seguridad en el manejo de los desechos radiactivos.

Annie Sugier (ICRP):

Es miembro del Comité Principal de la Comisión Internacional de Protección Radiológica (ICRP). Se especializó en el Instituto Universitario de Radioprotección y de Seguridad Nuclear, de la Facultad de Orsay, en temas asociados al ciclo de combustible nuclear. En Francia inició su carrera en la Comisión de Energía Atómica (CEA). En 1989, es nombrada Directora delegada del Programa de Desmantelamiento de las Instalaciones Nucleares de la CEA. Llegó a ser Directora en el Instituto de Radioprotección y Seguridad Nuclear Francés en el cual dirige el

programa estratégico de radioprotección y articula los trabajos de investigación. Para llevar a cabo esta misión doble, ella se apoya en su experiencia como presidente del Grupo de Peritaje pluralista puesto funciones por los Ministros de Salud y del Medio Ambiente a consecuencia de la polémica científica ambiental alrededor de la instalación nuclear Nord-Cotentin. Se trata del GRNC (Group Radioécologique Nord-Cotentin) que funcionó originalmente del 1997 al 2002 y actualmente ha sido renovado. Este Grupo de Peritos involucra a expertos institucionales, industriales y civiles, así como expertos en las instancias internacionales sobre radioprotección y fue utilizado para analizar el verdadero riesgo para la población en esta región de Francia y emitir su juicio a la opinión pública. La Sra Sugier, en el ICRP, integra el Comité superior que emite recomendaciones sobre las reglas de radioprotección a partir del análisis de los estudios científicos sobre los efectos de las radiaciones. Es la sucesora en esta instancia del Profesor Jammet y al Dr. Nenot. Asimismo, preside uno de los Comités adjuntos. Es miembro del Consejo Científico de la Oficina Parlamentaria de Evaluación de la Opción Científica y Tecnológica y fue miembro del Consejo Científico de las Escuelas de las Minas, ambos de Francia Fue condecorada por el Gobierno Francés como Caballero de la Orden de la Legión de Honor y Oficial de la Orden del Mérito.

Paul Craig Martin (Laboratorio Internacional Seibersdorf)

Es el responsable del Laboratorio de Física, Química e Instrumentación del Laboratorio Internacional Seibersdorf del IAEA, en Austria. Nació en Adelaida, Australia. Inició su carrera profesional en el campo de servicios de química analítica para la industria minera con fines de exploración y aplicaciones ambientales. Desde 1983 hasta el 2004 vivió en el Norte de Australia, donde llevo a cabo la investigación de proyectos relacionados con el manejo ambiental de operaciones de minería y procesamiento del mineral de uranio. Estuvo activamente involucrado en la formación de la Asociación de Radiactividad Ambiental del Pacífico Sur (SPERA), una organización que encara y facilita la comunicación entre científicos que trabajan en la región del Pacífico Sur, y es un miembro del Cuerpo Editorial del Diario de la Radiactividad Ambiental. En el Laboratorio de Seibersdorf donde es responsable, el Sr. Martín, actualmente desarrolla tareas de investigación relacionada con el desarrollo de técnicas para la medición de radionucleidos en muestras ambientales por espectrometría alfa y gamma y estudios del comportamiento de radionucleidos en el ambiente tropical, tanto para su uso como trazadores de procesos ambientales como para objetivos de evaluación de impacto radiológicos.

Annex 3: List of Persons met by the IEA during the mission to Buenos Aires

Participants at the 5th December 2005 meeting, Argentine Ministry of Foreign Affairs

Name	Institution	Function
Abel GONZÁLEZ	ARN	Liaison Officer for the Argentine Government
Gabriel TERIGI	ARN	Institutional Relations and Non-Proliferation Division
Cristina DOMÍNGUEZ	ARN	Head, Legal Division
Juan Carlos FERRERI	ARN	Head, Scientific and Technical Support Department
Pablo ZUNINO	ARN	Institutional Relations and Non Proliferation Division
Rolando POCOVI	Ministry of Foreign Affairs	International Security, Nuclear and Space Affairs Directorate
Claudia CORTI	Ministry of Foreign Affairs	International Security, Nuclear and Space Affairs Directorate
G. ROSELLINI	Ministry of Foreign Affairs	International Negotiations on Environment

Participants in the 5th December 2005 meeting, ARN Headquarters

Name	Institution	Function
Abel GONZÁLEZ	ARN	Liaison Officer for the Argentine Government
Gabriel TERIGI	ARN	Institutional Relations and Non-Proliferation Division
Cristina DOMÍNGUEZ	ARN	Head, Legal Division
Juan Carlos FERRERI	ARN	Head, Scientific and Technical Support Department
Eduardo QUINTANA	ARN	Head, Environmental Control Division
Gustavo MASSERA	ARN	Head, Safeguards, Radiological and Physical Security Department
Daniel HERNANDEZ	ARN	Head, Emergency Response Group
Osvaldo JORDAN	ARN	Emergency Response Group
Susana MULVANY	Government of the Province of Buenos Aires	Environmental Policy Secretariat
Comandante Guillermo MEZA	National Gendarmerie	Environment Division of the Scientific Police Directorate
Cabo 1° Daniela VALLONE	National Gendarmerie	Environment Division of the Scientific Police Directorate
Subalferez Adrián ALVAREZ	National Gendarmerie	Environment Division of the Scientific Police Directorate

Persons at the meeting at the Ezeiza Atomic Center, 6th and 7th December 2005

Name	Institution	Function
Abel GONZÁLEZ	ARN	Liaison Officer for the Argentine Government
Gabriel TERIGI	ARN	Institutional Relations and Non Proliferation Division
Cristina DOMÍNGUEZ	ARN	Head, Legal Division
Juan Carlos FERRERI	ARN	Head, Scientific and Technical Support Department
Eduardo QUINTANA	ARN	Head, Environmental Control Division
Analia CANOBA	ARN	Environmental Control Division
Jorge DIODATI	ARN	Environmental Control Division
Daniel GIUSTINA	ARN	Environmental Control Division
María del Rosario PEREZ	ARN	Scientific and Technical Support Department
Pablo CESARIO	ARN	Institutional Relations and Non Proliferation Division
Eduardo GRASSI	ARN	Environmental Control Division
Nestor FRUTTERO	ARN	Environmental Control Division
Alexandro L. BLANCHARD	CONUAR S. A	Head department Safety and Environment
Susana MULVANY	Government of the Province of Buenos Aires	Environmental Policy Secretariat
Ana GIRARDELLI	Government of the Province of Buenos Aires	Ministry of Health, Director of the Toxicology Centre
José María REGUEIRA	Government of the Province of Buenos Aires	Secretariat of Public Work
Comandante Guillermo MEZA	National Gendarmerie	Environment Division of the Scientific Police Directorate
Cabo 1° Daniela VALLONE	National Gendarmerie	Environment Division of the Scientific Police Directorate
Subalferez Adrián ALVAREZ	National Gendarmerie	Environment Division of the Scientific Police Directorate
Martín LAZARTE.	District Attorney Office of the Province of Buenos Aires	District Attorney
Alberto GENTILI	Federal Attorney, Office of Lomas de Zamora	Federal Attorney
Ariel BERZE	Federal Attorney, Office of Lomas de Zamora	Secretary

Participants at the 9th December 2005 meeting, Ministry of Foreign Affairs of Argentina

Name	Institution	Function
Raul RACANA	ARN	Chairman of the Board of Directors
Abel GONZÁLEZ	ARN	Liaison Officer for the Argentine Government
Gabriel TERIGI	ARN	Institutional Relations and Non Proliferation Division
Cristina DOMÍNGUEZ	ARN	Head, Legal Division
Pablo ZUNINO	ARN	Institutional Relations and Non Proliferation Division
Rolando POCOVI	Ministry of Foreign Affairs	International Security, Nuclear and Space Affairs Directorate
Claudia CORTI	Ministry of Foreign Affairs	International Security, Nuclear and Space Affairs Directorate
Susana MULVANY	Government of the Province of Buenos Aires	Environmental Policy Secretariat
Comandante Guillermo MEZA	National Gendarmerie	Environment Division of the Scientific Police Directorate
Subalferez Adrián ALVAREZ	National Gendarmerie	Environment Division of the Scientific Police Directorate

Annex 4: Official acts for the transfer and delivery of IEA samples to PCIL

National Gendarmerie
Argentine Republic

OFFICIAL RECORD

In the city of Buenos Aires, Federal Capital district, on the ninth day of the month of December 2005, at 14:00 hours, at the Hotel Design Suites & Towers, Marcelo T. de Alvear 1683, in the city of Buenos Aires, the undersigned public official, Commandant GUILLERMO ANTONIO MEZA, serving in the Division of the Environment, Chemical Department, Scientific Police Directorate of the Argentine National Gendarmerie, in the presence of the competent witnesses summoned for this purpose, Mr. GUILLERMO FERRERO, national identity card No. 28 711 693, aged 24 years, marital status SINGLE, domiciled at José Bonifacio 650 6A — city of Buenos Aires, and Mr. WALTER ESTIGARRIBIA, national identity card No. 30 678 010, aged 22 years, marital status SINGLE, domiciled at Rivadavia 371, 1A, city of Buenos Aires, together with Mr. PAUL MARTIN (IAEA Laboratory, Austria) Seibersdorf, proceed to draw up the following OFFICIAL RECORD for the purpose of placing on record activities ordered in the framework of case No. 5452 entitled: "Proceedings instituted to inquire into presumed infringement of articles 200 and 207 of the Penal Code", being brought before the Lomas de Zamora Federal Criminal and Correctional Court of First Instance No. 1, registry No. 1 headed by Dr. Gustavo F. González.

Activities carried out

1) First of all, the green cardboard box was opened for the purpose of dividing the samples from the countersamples, that is "archive-sample" — "IAEA-samples", in the presence of the witnesses, leaving six (6) environmental samples labelled "IAEA-SAMPLE" in the possession of Paul Martin and the rest in the possession of the Argentine National Gendarmerie ("archive-samples"). 2) The identical procedure was carried out with the blue plastic box, leaving eleven (11) samples of surface and well water labelled "IAEA SAMPLES" and eleven (11) labelled "archive sample"; adding to the samples being transferred to Austria one (1) in a signed and sealed envelope containing a filter with an environmental air sample. It should be added that the samples being sent to Austria are deposited in the blue plastic box with a seal in the form of one (1) label with the identification "INTERNATIONAL ATOMIC ENERGY AGENCY" No. 50349, to be transferred in Mr. PAUL MARTIN's baggage — UNITED NATIONS PASSPORT UN [United Nations] LP [laissez-passer] 127987. It should be added that the "archive samples" remain in the possession of the Argentine National Gendarmerie (GNA) at your disposal. There being nothing further, after reading of the entire contents, this official document is considered finalized, through signature by the participants below, for the record.

(signed) Guillermo Ferrero — Walter Estigarribia

Paul Martin, IAEA — Guillermo Meza, Commandant
GNA [Argentine National Gendarmerie]

National Gendarmerie
Argentine Republic

"2005 — Year of Homage to Antonio Berni"

OFFICIAL RECORD

In the town of SEIBERSDORF, on the tenth day of the month of December 2005, at 16:00 hours, in the Republic of Austria at the International Atomic Energy Agency (IAEA) Laboratories, in the framework of case 5452 being processed before Federal Judge No. 1 of Lomas de Zamora, Dr. ALBERTO P. SANTA MARINA, the undersigned public official, Commandant of the ARGENTINE NATIONAL GENDARMERIE, Guillermo Antonio MEZA (supervisor) of the international expert appraisal ordered in the case in question, accompanied by the Head of the Physics, Chemistry and Instrumentation Laboratory, PAUL MARTIN, whose other data and details are already recorded in the case documents, proceed to opening of the blue box, transferred from the Argentine Republic, opening the band with the signatures of the witnesses, which remains in the possession of the undersigned for the record, and it is also placed on record that the samples are those identified with the following numbers and letters **AA 0019; AA 0022; AA 0025; AA 0028; AA 0031; AA 0052; AA 0055; AA 0010; AA 0016; AA 0013; AA 0058; AA 0049; AA 0040; AA 0037; AA 0046; AA 0043; AA 0034 and the filter kept in envelope No. 014.** Likewise, after opening, it was recorded that the security seals of all the samples are in good order, and there was no evidence of any loss or change in the material (soil and/or water). It was recorded that the surface water samples (**AA 0010; AA 0016; AA 0013; AA 0058**), showed coloration (cloudiness) and in two of them precipitate was observed (AA 0010 and AA0058). When it was the Head of the International Laboratory's turn to speak, he spontaneously stated that all the aforementioned (samples) would undergo the following alpha spectrometry analyses for ***groundwaters and surface waters*** with the following characteristics: isotopic dilution by alpha spectrometry would be performed to determine the uranium isotopes using a version of the Swiss Radiation Protection Institute's method to determine uranium isotopes in water (reference 93-14, ISSN: 0282-4434, dated 18/08/1993, by Jorma Suomela), which takes 500 mL of each sample for analysis of ^{234}U and ^{238}U, the uranium will be coprecipitated with calcium phosphate after adding ^{232}U as a tracer and then separated by ion exchange resin; for ***soils*** the following technique will be applied to approximately 600 grams of sample, which will be dried at 105°C for 12 hours, or more as required, and then sieved and homogenized. This fraction will be measured directly by means of gamma spectrometry, and for the ***environmental air (filter No. 014)*** the same technique described above will be used but without drying, but it should be added that the envelope containing this sample is kept by the undersigned for the record. All the samples will be kept safe, using the International Agency's own security system at your disposal, until they have been processed which, as I am told, will take a total time of approximately 30 days, in SAMPLE STORAGE ROOM LE 19. There being nothing further, this official record is considered finalized, after reading through using an interpreter, for the record before me as the executing official. CERTIFIED FOR THE RECORD.

(signed)PAUL MARTIN
IAEA (LABORATORY)

(signed)GUILLERMO A. MEZA
COMMANDER GNA [Argentine National Gendarmerie]

Annex 5: References and results of the Intercomparison Exercise

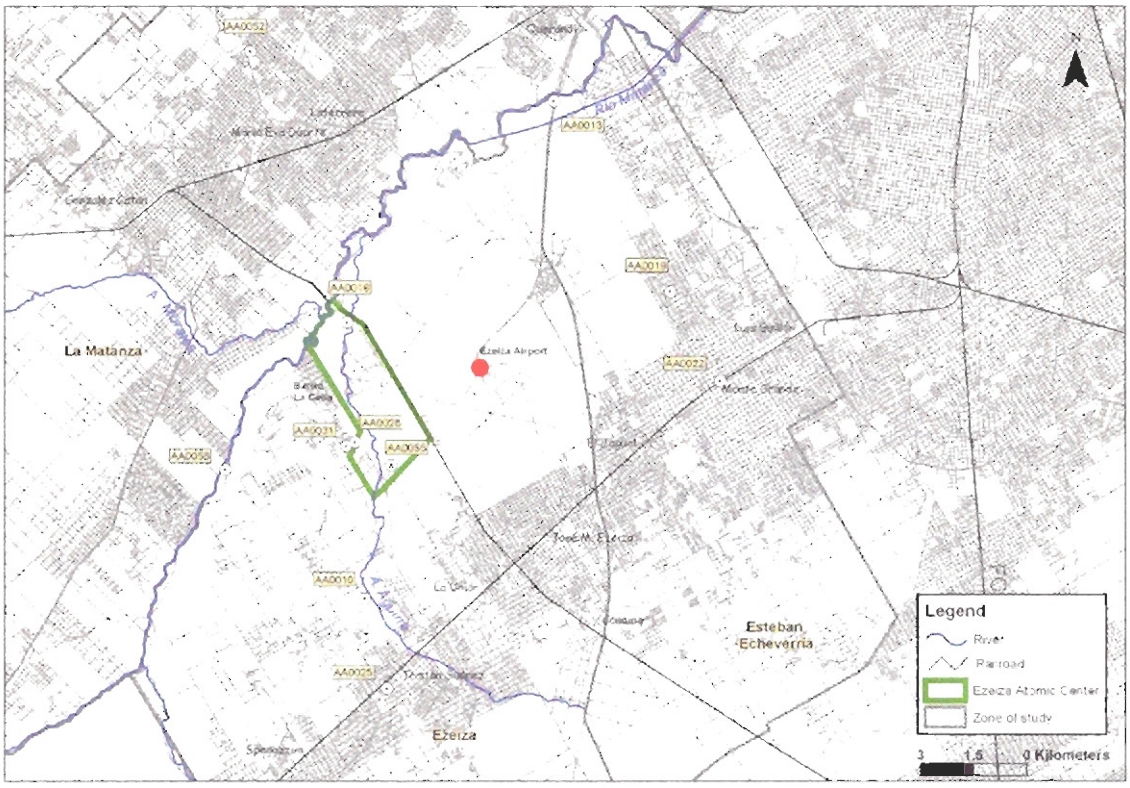
Table 1: List of water samples collected for intercomparison

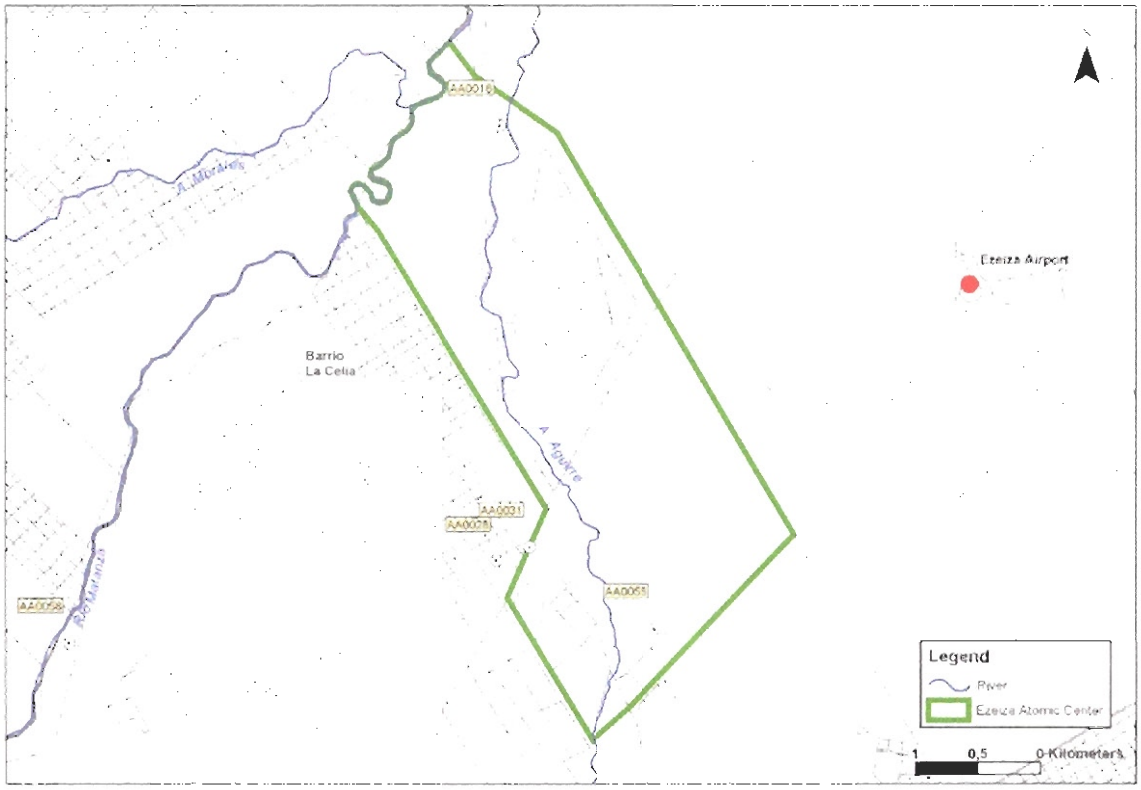
IAEA seal Code	ARN seal Code	Gendarmerie seal Code	Sampling location	Geographical coordinates
AA0010	AA0011	AA0012	Arroyo Aguirre, Punto N°1	S 34° 52' 8,2'' W 58° 34' 38,2''
AA0013	AA0014	AA0015	Río Matanza, Punto N°8	S 34° 44' 27,4'' W 58° 31' 15,2''
AA0016	AA0017	AA0018	Arroyo Aguirre, Punto N°6	S 34° 47' 54,1'' W 58° 35' 2,9''
AA0019	AA0020	AA0021	Agua Potable Pozo EEN007, Aguas Argentinas, M. Grande	S 34 ° 47' 21,5'' W 58 ° 29' 2,5''
AA0022	AA0023	AA0024	Agua Potable Ag. Argentinas Pozo EE001 Monte Grande	S 34 ° 48' 43,3'' W 58 ° 28' 5,5''
AA0025	AA0026	AA0027	Agua Potable hidrante Aguas Arg., T. Suárez	S 34° 53' 30,8'' W 58° 34'12,3''
AA0028	AA0029	AA0030	Agua Potable EGB N° 12 Ezeiza	S 34° 49' 48,1'' W 58° 35' 1,6''
AA0031	AA0032	AA0033	Club Empleados de Comercio, Ezeiza	S 34° 49' 44,3'' W 58° 34' 51,3''
AA0052	AA0053	AA0054	Agua Industrial, Fábrica de mosaicos, Laferrere	S 34° 43' 45,3'' W 58° 36' 54,2''
AA0055	AA0056	AA0057	Agua Potable, Pozo N°2, CONUAR	S 34° 50' 5,2'' W 58° 34'11,4''
AA0058	AA0059	AA0060	Río Matanza Punto N° 9	S 34° 50' 11,1'' W 34° 37'16,1''

Table 2: List of soil samples collected for intercomparison

IAEA seal Code	ARN seal Code	Gendarmerie seal Code	Sampling location	Geographical coordinates
AA0034	AA0035	AA0036	Campo de Girasoles, Ruta 52, Canning	S 34° 57' 12,9'' W 58° 27' 49,4''
AA0037	AA0038	AA0039	Camino real, huerta antes de Autopista	S 34° 52' 50,7'' W 58° 35' 55,1''
AA0040	AA0041	AA0042	Tosquera, 30-40 cm	S 34° 48' 51,2'' W 58° 34' 13,7''
AA0043	AA0044	AA0045	Tosquera, 20-30 cm	Idem
AA0046	AA0047	AA0048	Tosquera, 10-20 cm	Idem
AA0049	AA0050	AA0051	Tosquera, 0-10 cm	Idem

Locations of groundwater samples





Locations of soil samples

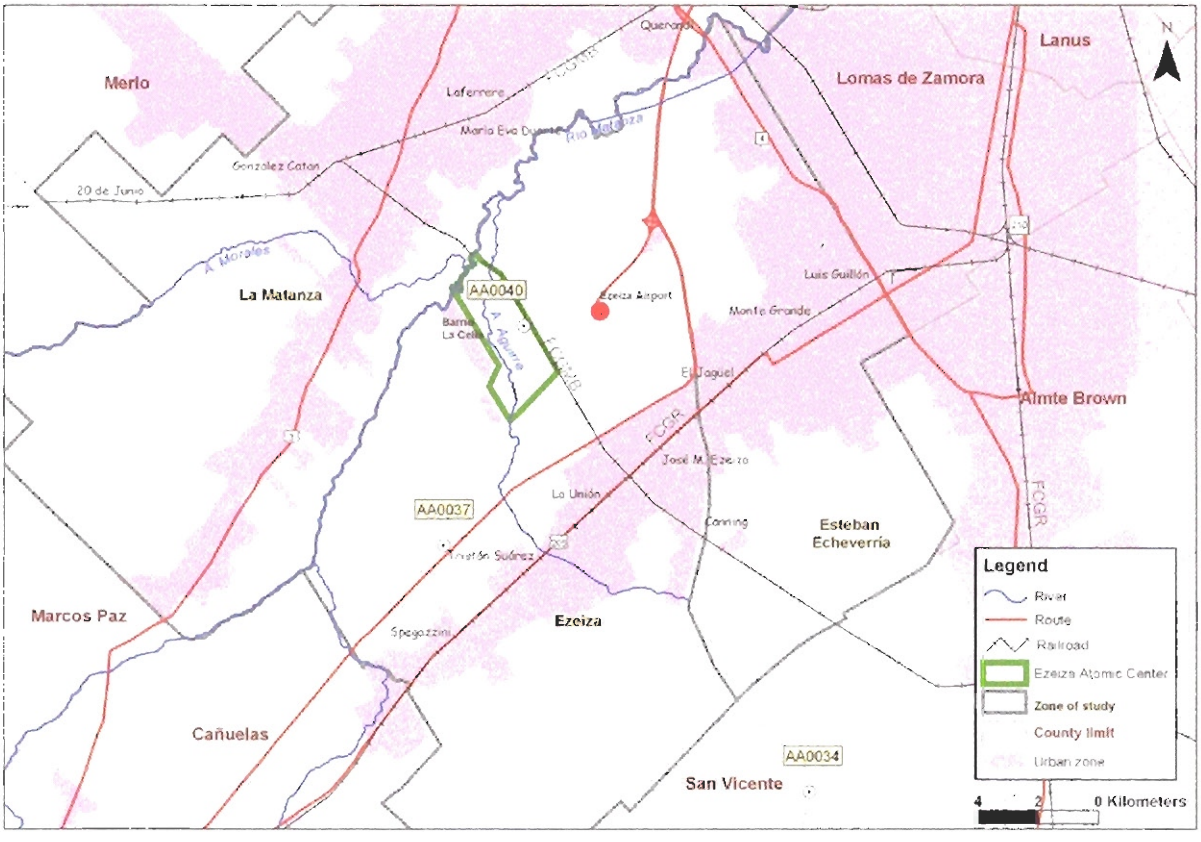


Table 3: pH and conductivity of water measured at the time of sampling.

Date/Time	Sample N°	pH	Conductivity ($\mu S\ cm^{-1}$)
5.12.2005/1250	AA0010	7.83	1489
5.12.2005/1200	AA0013	8.23	13860
5.12.2005/1115	AA0016	8.01	1108
6.12.2005/1730	AA0058	Not measured	Not measured
5.12.2005/1550	AA0019	7.9	896
5.12.2005/1515	AA0022	7.7	1148
6.12.2005/1515	AA0025	8.2	1388
6.12.2005/1020	AA0028	8.0	1560
6.12.2005/1220	AA0031	8.0	1665
6.12.2005/1630	AA0052	7.1	1373
6.12.2005/1700	AA0055	7.8	960

Table 4: Results for uranium isotopes in groundwater, determined by alpha spectrometry

Sample code	^{234}U ($Bq\ L^{-1}$)	^{238}U ($Bq\ L^{-1}$)	$^{234}U/^{238}U$ activity ratio
AA0019	0.18±0.01	0.13±0.01	1.37±0.07
AA0022	0.28±0.01	0.20±0.01	1.37±0.07
AA0025	0.33±0.01	0.24±0.01	1.37±0.07
AA0028	0.50±0.02	0.41±0.01	1.21±0.06
AA0031	0.52±0.02	0.43±0.02	1.20±0.06
AA0052	0.148±0.005	0.110±0.004	1.34±0.07
AA0055	0.263±0.009	0.209±0.007	1.26±0.06
IAEA-381	0.046±0.002	0.040±0.002	1.14±0.08
IAEA-381 information value	0.050 (0.043–0.058)	0.041 (0.038–0.048)	

The results are reported with combined standard uncertainties.

Table 5. Results for surface water: particulate concentration, and uranium isotopes determined by alpha spectrometry

Sample code	Particulate concentration ($mg\ L^{-1}$)	Dissolved ^{234}U ($Bq\ L^{-1}$)	Dissolved ^{238}U ($Bq\ L^{-1}$)	Particulate ^{234}U ($Bq\ L^{-1}$)	Particulate ^{238}U ($Bq\ L^{-1}$)	Total ^{238}U ($Bq\ L^{-1}$)
AA0010	23.7	0.163±0.006	0.132±0.005	0.028±0.001	0.021±0.001	0.153±0.005
AA0013	9.6	0.126±0.005	0.091±0.003	0.022±0.001	0.017±0.001	0.108±0.003
AA0016	5.2	0.163±0.006	0.126±0.005	0.021±0.001	0.017±0.001	0.143±0.005
AA0058	31.0	0.037±0.002	0.026±0.001	0.154±0.004	0.111±0.004	0.137±0.004

* The concentration of particulate uranium isotopes is given as the activity of particulates present in 1 L water.
The results are reported with combined standard uncertainties.

Table 6. Activity ratios of uranium isotopes in surface water

Sample code	Dissolved	Particulate
	$^{234}U/^{238}U$	$^{234}U/^{238}U$
AA0010	1.24±0.06	1.33±0.07
AA0013	1.39±0.07	1.34±0.07
AA0016	1.30±0.07	1.21±0.07
AA0058	1.42±0.10	1.39±0.07

The results are reported with combined standard uncertainties.

Table 7. Activity ratios of uranium isotopes in ground and surface water, determined by ICP-MS. The results for the surface waters are for the filtered (dissolved) fraction.

Sample code	Atom ratio	Activity ratio	RSD%
	$^{235}U/^{238}U$	$^{235}U/^{238}U$	
AA0019	0.00722	0.0458	1.19
AA0022	0.00727	0.0462	1.09
AA0025	0.00724	0.0460	1.67
AA0028	0.00713	0.0453	0.91
AA0031	0.00714	0.0453	0.83
AA0052	0.00719	0.0456	1.06
AA0055	0.00721	0.0458	1.51
AA0010	0.00722	0.0458	0.98
AA0013	0.00716	0.0455	2.21
AA0016	0.00716	0.0455	0.45
AA0058	0.00715	0.0454	2.43

Uranium concentrations ($\mu g.L^{-1}$) for groundwater and surface water reported in Table A of the main text are calculated from the activity concentration results given in Tables 4 and 5 above, together with the $^{235}U/^{238}U$ ratio results in Table 7. The results for the surface waters are for the total water (i.e. dissolved plus particulate). The total mass of U is then given by: $m_U = m_{234} + m_{235} + m_{238}$

with $m = \frac{A}{a}$, A being the Activity measured in Bq and a being the specific activity in Bq g^{-1}.

	U-234	U-235	U-238
a [Bq g^{-1}]	2.302×10^8	7.996×10^4	1.244×10^4

Table 8. Soil samples: moisture content, and dry and coarse fraction masses

Sample code	Location and depth (cm)	Moisture content in original soil material	Dry mass fine fraction (g)	Dry mass coarse fraction (g)
AA0049	1. 0–10	14%	1267	126
AA0046	1. 10–20	14%	1128	315
AA0043	1. 20–30	14%	1133	330
AA0040	1. 30–40	12%	1357	233
AA0037	2. 0–10	12%	1681	8.04
AA0034	3. 0–0	15%	1513	218

Table 9. Activity concentrations obtained for soil samples: fine fraction (< 2mm), coarse fraction (> 2mm) and total (from coarse fraction and fine fraction results, and the relative mass proportions of coarse and fine fractions)

Sample code	Location & depth (cm)	^{235}U (Bq kg^{-1})	^{238}U * (Bq kg^{-1})	^{226}Ra (Bq kg^{-1})	^{228}Ra (Bq kg^{-1})	^{137}Cs (Bq kg^{-1})	^{40}K (Bq kg^{-1})
Soil: fine fraction							
AA0049	1. 0–10	1.15±0.12	24.9±2.6	21.6±1.1	36.8±0.7	1.71±0.08	612±15
AA0046	1. 10–20	0.98±0.16	21.2±3.4	25.9±1.4	36.1±0.7	1.51±0.09	535±14
AA0043	1. 20–30	1.24±0.11	26.8±2.3	23.4±1.0	37.0±0.7	4.51±0.12	559±14
AA0040	1. 30–40	0.92±0.17	19.9±3.7	29.5±1.5	38.2±0.8	3.24±0.13	541±14
AA0037	2. 0–10	1.81±0.19	39.3±4.0	28.4±1.4	38.8±0.8	1.00±0.08	546±14
AA0034	3. 0–10	1.80±0.18	39.0±4.0	30.1±1.5	38.8±0.8	2.59±0.12	538±14
Soil: coarse fraction							
AA0049	1. 0–10	1.35±0.29	29.3±6.3	24.4±3.8	35.7±1.6	1.35±0.45	504±18
AA0046	1. 10–20	1.06±0.19	22.9±4.1	29.3±2.0	37.6±0.9	1.23±0.2	515±14
AA0043	1. 20–30	0.79±0.19	17.1±4.2	29.8±1.9	41.2±0.9	3.99±0.25	585±15
AA0040	1. 30–40	1.26±0.28	27.4±6.1	30.5±2.7	37.2±1.2	2.52±0.28	539±16
AA0037	2. 0–10	–	–	–	–	–	–
AA0034	3. 0–10	1.79±0.19	38.9±4.2	29.6±1.8	39.6±0.9	2.46±0.14	513±13
Soil: total							
AA0049	1. 0–10	1.19±0.11	25.7±2.4	22.1±1.2	36.6±0.6	1.64±0.11	591±13
AA0046	1. 10–20	1.00±0.12	21.8±2.6	27.1±1.1	36.6±0.6	1.41±0.09	528±10
AA0043	1. 20–30	1.07±0.10	23.2±2.1	25.8±0.9	38.5±0.5	4.32±0.12	569±10
AA0040	1. 30–40	1.02±0.15	22.1±3.2	29.8±1.3	37.9±0.6	3.03±0.12	540±11
AA0037	2. 0–10	1.81±0.19	39.3±4.0	28.4±1.4	38.8±0.8	1.00±0.08	546±14
AA0034	3. 0–10	1.80±0.14	39.0±3.1	30.0±1.2	39.0±0.6	2.56±0.10	531±11

The results are reported with combined standard uncertainties.

* Note that the estimates of ^{238}U activity concentrations are based on the ^{235}U activity concentrations plus an assumption that the uranium is of natural origin. However, the estimates of ^{235}U activity concentrations are not made on the basis of this assumption of natural origin.

Table 10: Activities obtained for air filter samples.

Sample	^{235}U (Bq)	^{226}Ra (Bq)	^{228}Ra (Bq)	^{137}Cs (Bq)	^{40}K (Bq)
Air filter	nd (0.34)	1.14±0.24	nd (0.41)	nd (0.093)	2.66±0.64
Air filter blank	nd (0.38)	0.83±0.21	nd (0.21)	nd (0.096)	7.73±0.60

The results are reported with combined standard uncertainties. nd = not detected (MDA — minimum detectable activity — indicated in brackets).

Table 11: ARN determination for artificial radionuclides in water samples

Sample N°	Cs-137 (Bq/L)	Co-60 (Bq/L)	H-3 (Bq/L)
AA0011	< 0,2	< 0,1	< 5,0
AA0014	< 0,2	< 0,1	< 5,0
AA0017	< 0,3	< 0,2	< 5,0
AA0020	< 0,1	< 0,2	< 5,0
AA0023	< 0,1	< 0,1	< 5,0
AA0026	< 0,3	< 0,2	< 5,0
AA0029	< 0,2	< 0,2	< 5,0
AA0032	< 0,2	< 0,2	< 5,0
AA0053	< 0,2	< 0,1	< 5,0
AA0056	< 0,3	< 0,2	< 5,0
AA0059	< 0,3	< 0,2	< 5,0

Table 12: ARN Alpha and beta counting on groundwater samples

Sample N°	Gross alpha Bq/L	Gross Beta Bq/L
AA0020	0,24 ± 0,05	0,70 ± 0,10
AA0023	0,33 ± 0,05	0,93 ± 0,12
AA0026	0,43 ± 0,06	0,96 ± 0,11
AA0029	0,49 ± 0,07	1,27 ± 0,14
AA0032	0,49 ± 0,07	1,25 ± 0,13
AA0053	0,16 ± 0,04	0,89 ± 0,11
AA0056	0,28 ± 0,05	0,77 ± 0,11

Table 13: ARN results for soil samples

Sample	Cs-137 (Bq/kg)	Co-60 (Bq/kg)	U (µg/g)
AA0035	3,1 ± 0,6	< 0,5	1,4 ± 0,3
AA0038	1,2 ± 0,4	< 0,4	1,8 ± 0,4
AA0041	3,5 ± 0,4	< 0,4	1,2 ± 0,4
AA0044	4,8 ± 0,5	< 0,3	1,0 ± 0,2
AA0047	1,6 ± 0,4	< 0,3	0,72 ± 0,15
AA0050	1,4 ± 0,4	< 0,3	0,72 ± 0,15

Table 14: U in Argentinian soils by alpha-spectrometry

Original code	A U-238 Bq/kg	A U-234 Bq/kg
AA0049	**24.4**	**22.3**
AA0037	**34.1**	**36.4**
AA0034	**42.4**	**43.1**
IAEA-326	**27.0**	**27.2**
RB	**<0.24**	**<0.24**

IAEA-326: recommended value 29.4 (28.1-30.7); information value 29.3 (26.5-29.3)

Annex 6: List of the facilities visited by the Review Group

Alpha–Beta Measurement and Alpha Spectroscopy Laboratory

Personnel interviewed: Hugo Equillor

Techniques:

- α and β screening
- Evaporation in acid media
- Scintillator addition and α β measurement with pulse decay discrimination.

Equipment in the laboratory:

- Two ultra low level liquid scintillation counters PACKARD, 2550 TR/LL and 2550 TR/AB model. Both counters are arranged for pulse shape discriminated measurements allowing simultaneous alpha/beta activity determination.
- An alpha spectrometer system CANBERRA (Alpha Analyst model) with eight vacuum chambers and implanted ion detectors.
- An alpha spectrometer system CANBERRA (Quad Alpha model) with four vacuum chambers and implanted ion detectors.
- An arrange of ten alpha chambers with solid S Zn(Ag) scintillation detectors for alpha particles.
- An alpha beta automatic CANBERRA equipment model 2404.

^{90}Sr and ^{14}C Laboratory

Personnel interviewed: Cecilia Lewis

Techniques:

- ^{90}Sr: chemical separation and Cerenkov counting of ^{90}Y.
- C in vegetables: oxidation, distillation, CO_2 trapping and LSC counting.

Uranium and ^{226}Ra Laboratory

Personnel interviewed: Miguel Palacios, Ana Grinman

Techniques:

- ^{226}Ra: chemical separation
- In-growth of radon gas in toluene phase
- LSC counting with pulse shape discrimination
- Uranium by concentration prior to fluorimetry and direct fluorimetry.

Kinetic Phosphorescence Analysis Laboratory

Personnel interviewed: Jorge Diodati

Techniques: Special sample pretreatment with ultra pure reagent (Especially for air samples)

Ultra low level measurements:

Personnel interviewed: Jorge Diodati

Equipment in the laboratory:

- An ultra low level liquid scintillation counter PACKARD, Tri-Carb-2770 TR/SL.
- Two alpha spectrometer systems ORTEC (Octete model) with eight vacuum chambers and implanted ion detectors.

Gamma Spectrometry Laboratory

Personnel interviewed: Jorge Fernandez and Hugo Ciallela

Techniques:

- Direct measurements in Ge(hp) under norm ISO 10703.

- Two laboratories: one for ultra low level samples and the other for environmental samples.

Equipment in the laboratory:

- 2 gamma spectrometer systems, one of them is ORTEC (V) and the other one is CANBERRA (Q).
- 5 gamma spectrometer systems (CANBERRA): J (100% efficiency), P and W (60% efficiency) and C and D (25 % efficiency).
- 1 planar gamma spectrometer system for low energies (CANBERRA): detector G.2 gamma spectrometer systems ORTEC: L and T (60% efficiency).

Environmental ^{3}H Measurement Laboratory

Personnel interviewed: Ricardo Gavini, Jorge Diodati

Techniques:

- Water extraction in vegetables for ^{3}H analyses by Deam Starck method.
- Direct measurements (LSC).
- Distillation and electrolysis enrichment for low level LSC (for research).

Radon Gas Measurement Laboratory

Personnel interviewed: Analia Canoba

Techniques:

1. for radon in air:
   - Instantaneous method: Lucas method.
   - Screening method: activated charcoal adsorption and LSC measurement.
   - Integrated method: nuclear track detector: CR-39, Makrofol, electrets.
2. for radon progeny in air:
   - Continuous monitors and collection on filters and alpha counting.
   - Equilibrium factor: nuclear track detector.

Annex 7: List of the documents provided to the Review Group

1. Annual Reports of ARN since its formation in 1995.
2. Annual Reports synthesis.
3. CVs of personnel interviewed.
4. "Overall results of the participation by ARN in the programme of quality evaluation of EML-DOE (3 papers: 1995–2004; 1995–1999; 2002–2004)
5. Regulatory control of the releases in the environment of the Ezeiza Centre, ARN Report.
6. Studies on groundwater in Tucuman (2 Studies, 2001). Trace element quality problems in groundwater.
7. Hydrogeochemistry of arsenic and other inorganic constituents in the groundwater from la Pampa, Argentina, (2002).
8. Natural uranium and Ra-226 in potable water in Argentina (2001).
9. Informacion preliminar para Mision Internacional de Expertos Provista por la Autoridad Regulatoria Nuclear de la Republica Argentina.
10. Results of measurements of uranium in drinking-water for a private well, done by SRC Analytical, a laboratory group under the Saskatchewan Research Council, informed by ARN.
12. Evaluaciones realizadas por la comunidad cientifica nacional e internacional sobre las mediciones ambientales de agua de bebida en la zona de influencia del Centro Atomico de Ezeiza.

Annex 8: Considerations of the WHO provisional guideline value for uranium

The Guidelines are intended to support the development and implementation of risk management strategies to ensure the safety of drinking water. The Guidelines describe minimum requirements of safe practice to protect the health of consumers and to derive numerical values for indicators of water quality. Neither the minimum safe practices nor the numeric guideline values are mandatory limits. In order to define such limits, it is necessary to consider the guidelines in the context of local or national environmental, social, economic and cultural conditions.

Uranium in drinking water is considered under two separate aspects in the WHO Guidelines [2]: chemical and radiological. Therefore, two different reference levels of uranium in water are considered — for its chemical toxicity and its radioactivity.

Chemical toxicity

There are insufficient data regarding the carcinogenicity of uranium in humans and experimental animals. The guideline value for the chemical toxicity of uranium was therefore derived using a tolerable daily intake (TDI) approach. In the 91 day study in rats, the lowest observable adverse-effect level (LOAEL) for degenerative lesions in the kidney was considered to be 0.96 mg of uranyl nitrate hexahydrate per litre, which is equivalent to 0.06 mg (or 60 µg) of uranium per kg of body weight per day (Gilman et al., 1998a). A TDI of 0.6 µg/kg of body weight per day was derived using the LOAEL of 60 µg/kg of body weight per day and an uncertainty factor of 100 (for intra- and interspecies variation). There was no need to apply an additional uncertainty factor because of the minimal degree of severity of the reported lesions. Also, an additional uncertainty factor for the length of the study (91 days) was not required because the estimated half-life of uranium in the kidney is 15 days, and there is no indication that the severity of the renal lesions will be exacerbated following continued exposure.

This TDI yields a provisional guideline value of 15 µg/L (rounded figure), assuming a 60 kg adult consuming 2 L of drinking water per day and an 80% allocation of the TDI to drinking water.

Radiological aspects

The WHO provisional guidance values for drinking water are presented in Table X.

Table X. WHO Guidance values for uranium radionuclides in drinking water

Radio-nuclides	Drinking water (Bq/L)[a]
U-230	1
U-231	1000
U-232	1
U-233	1
U-234[a,b]	10
U-235[b]	1
U-236[b]	1
U-237	100
U-238[b,c]	10

[a] guidance values are rounded according to averaging the log scale values (to 10^n if the calculated value was below 3×10^n and above $3 \times 10^{n+1}$)

[b] natural radionuclides

[c] The guideline value for uranium in drinking water is 15 g/L based on its chemical toxicity.

The recommended reference level of committed effective dose of 0.1 mSv/a from a one year consumption of drinking water applies to any individual, independent of her/his age.

The provisional guidance values of radionuclides in drinking water were calculated — in accordance with WHO and IAEA guides [WHO, 1996; IAEA, 2002] — on the basis of an annual dose criterion of 0.1 mSv/a from drinking 2 L of water per day by an adult.

The recommended reference level of committed effective dose is 0.1 mSv from one year's consumption of drinking water. This reference level of dose represents less than 5% of the average effective dose attributable annually to natural background radiation and therefore an insignificant additional risk to human health over the whole lifetime.

Below this reference level of committed effective dose (0.1 mSv/a), the drinking water is acceptable for life long human consumption and action to further reduce the activity is not necessary.

For routine and practical monitoring purposes, to determine if individual radionuclide guidance values are exceeded, the use of screening values of 0.5 Bq/L for gross alpha and 1 Bq/L for gross beta activity are recommended. If the initial gross alpha and gross beta activity levels are below these screening values, no further action on radioactive content of drinking water will be needed. If the screening values are exceeded, this should prompt further action, notably a radionuclide specific analysis.

This dose criterion has also been adopted by the European Union [EC, 1998]. The guidance values for both artificial and natural radionuclides in drinking water were calculated from equation (1) for adults:

$$GL = (IDC / (h_{ing} \cdot q)) \qquad (1)$$

where

GL [Bq/L] guidance value of radionuclide in drinking water;

IDC [mSv/a] individual dose criterion equal to 0.1 mSv/a for this calculation;

h_{ing} [mSv/Bq] dose coefficient for ingestion by adults;

q [L/a] annual ingested volume of drinking water assumed to be 730 L/a.

Several methods are available for the removal of uranium from drinking water, although some of these methods have been tested at laboratory or pilot scale only. Coagulation using ferric sulphate or aluminium sulphate at optimal pH and coagulant dosages can achieve 80–95% removal of uranium, whereas at least 99% removal can be achieved using lime softening, anion exchange resin or reverse osmosis processes.

In rural areas with high natural uranium levels, uranium concentrations lower than the guideline value may be difficult to achieve with the treatment technology available [WRc, 1997]. The guideline value for uranium is therefore provisional because it may be difficult to achieve with the treatment technology available and because of limitations in the database on health effects and the need for more analytical epidemiological studies. It must be noted that the concentration of uranium in drinking water associated with the onset of measurable tubular dysfunction remains uncertain, as does the clinical significance of the observed changes at low exposure levels. Indeed, a guideline value of up to 30 µg/L may be protective of kidney toxicity because of uncertainty regarding the clinical significance of changes observed in epidemiological studies.

Annex 9: Socio-demographic profile of the area under investigation

The area under investigation includes three districts: Ezeiza, Esteban Echeverria, and La Matanza, which are within the limits of Sanitary Regions (RS) VI and VIIA of the Buenos Aires province (Figures 1 and 2).

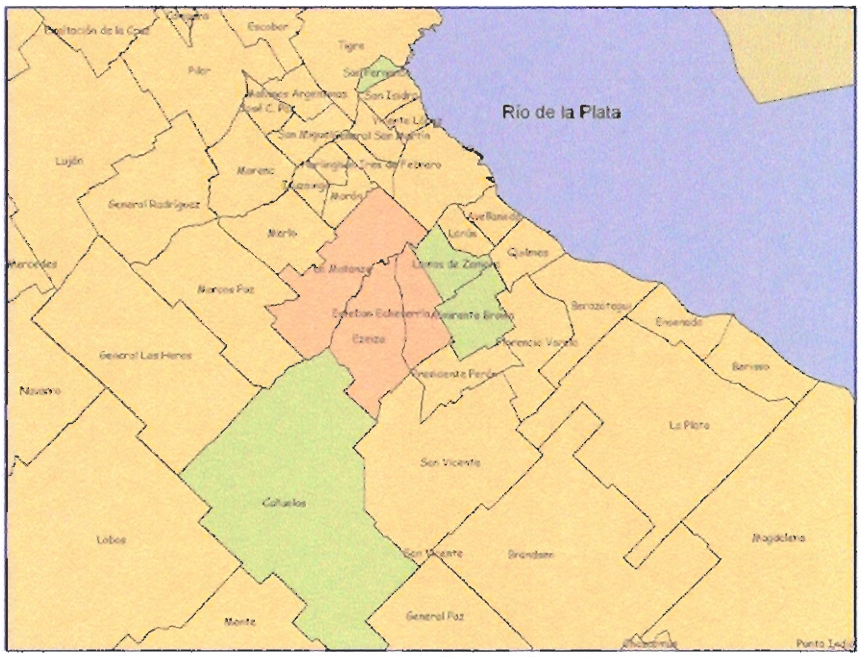


Figure 1: Map of Buenos Aires province and three areas under investigation, La Matanza, Ezeiza and Esteban Echeverria.

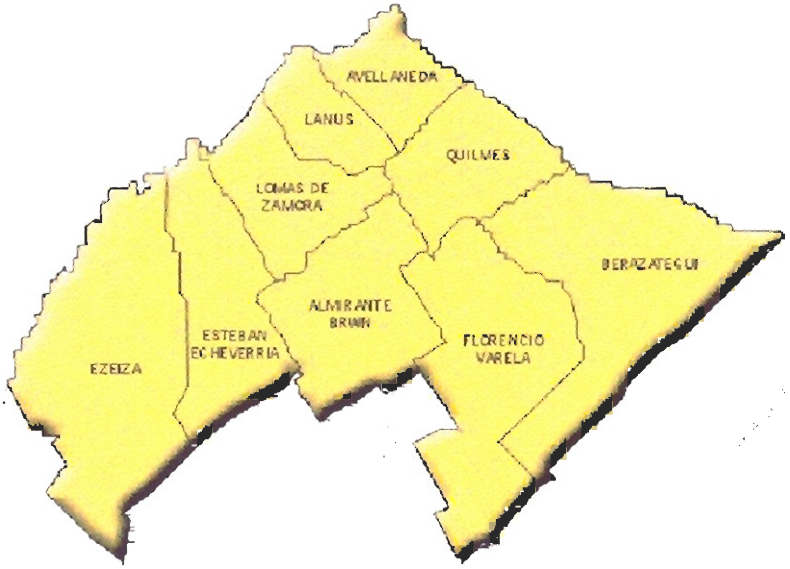


Figure 2: Sanitary Region (RS) VI of the Buenos Aires Province

The population size of the districts under consideration:

Ezeiza	118,807 people
Esteban Echeverría	243,974 people
La Matanza	1,255,288 people

Table 1: The distribution for the selected districts of Buenos Aires Province*:

Age group	Ezeiza Distribution, %	Esteban Echeverría Distribution, %	La Matanza Distribution, %
Under 15	35.7	34.0	30.5
15 to 64	58.9	60.4	62.8
65+	5.4	5.6	6.7

* http://www.gba.gov.ar/ms_infor/infor_sist/provincia1.htm