NUCLEAR REGULATORY AUTHORITY

The Nuclear Regulatory Authority (in Spanish, ARN) was created as an autarchic entity under Act 24,804, known as the National Act relating to Nuclear Activity, and as a successor to the National Nuclear Regulatory Board. The ARN reports directly to the Argentine Presidency.

The purpose of the Nuclear Regulatory Authority is to establish, develop and enforce a regulatory framework regarding all nuclear activities within Argentina, as well as to advise the Executive on issues associated with its scope of action. The goals set by this regulatory system are as follows:

- ✓ To provide people with an adequate level of protection against the damaging effects of ionizing radiation.
- ✓ To ensure a reasonable level of radiological and nuclear safety in all nuclear activities performed in Argentina.
- ✓ To ensure that nuclear activities are not diverted for unauthorized purposes and that nuclear activities are performed in conformity with the international agreements assumed by Argentina.
- ✓ To establish criteria and standards to prevent the deliberate occurrence of events that may lead to severe radiological consequences or the unauthorized removal of nuclear or other materials and equipment of nuclear interest.

Articles 1, 7, 14, 15, 16, 18, 25 and 26 of the above mentioned Act provide a detailed description of powers and duties conferred on the Nuclear Regulatory Authority.

The Nuclear Regulatory Authority is managed and administered by a Board of Directors composed of six members appointed by the Executive. The members of the Board are in office for six years -one third is renewed every two years- and must be technically and professionally qualified in the field.

The ARN's organic structure was approved by a Board resolution, as laid down in Act 24,804. Its organization chart is presented in Chapter 1 of the main report.

THE ARGENTINE REGULATORY FRAMEWORK

The ARN, in its capacity of national authority on radiological and nuclear safety, non-proliferation and physical protection issues, grants authorizations, licenses or permissions, as appropriate, for practices associated with radiation sources. In addition, it performs surveillance tasks to ensure that authorized persons responsible for each practice meet the requirements laid down in standards and other regulatory documents. Since the beginning of regulatory activities in the country, the prevailing approach has been that in order to efficiently perform this kind of role, appropriate scientific and technological knowledge is mandatory in order to assess -with an independent criteria- the design, construction, operation and decommissioning of installations under control.

The global strategy adopted by the Argentine regulatory system has focused on the following basic tasks:

- ✓ to issue specific standards on radiological and nuclear safety, safeguards and physical protection,
- ✓ to foster scientific and technological development on radiological and nuclear safety, safeguards and physical protection,
- ✓ to carry out independent studies and safety assessments on radiological and nuclear safety, safeguards and physical protection for licensing purposes,
- ✓ to perform regulatory inspections and audits to verify compliance with licenses and authorizations already granted, and
- ✓ to provide training in radiological and nuclear safety, safeguards and physical protection.

REGULATORY STANDARDS

The Nuclear Regulatory Authority is empowered to issue regulatory standards associated with radiological and nuclear safety, safeguards, physical protection and transport of nuclear materials, in accordance with Act 28,804. Chapter 2 of the main report presents the fifty-one regulatory standards currently in effect, which are applied to major and minor installations and practices existing in Argentina.

From the perspective of the Argentine regulatory framework, all the responsibility for the radiological and nuclear safety of any installation or practice lies within the organization concerned with the design, construction, commissioning, operation and decommissioning of the nuclear installation. No event involving safety relieves the organization and its head from their responsibility in each stage of the project. Compliance with standards and regulatory requirements is to be interpreted as nothing but minimum conditions, and does not relieve the organization from its responsibility to take any other necessary action to guarantee radiological and nuclear safety within the installation.

From the point of view of the licensing process, installations are classified in major and minor ones, on the basis of the associated radiological risk involved. The ARN grants licenses to major installations and authorizations to operate the minor ones. Applications for licenses or authorizations must be submitted together with appropriate assessments, the depth of which will depend on the radiological risk associated with the installation involved.

In order to efficiently perform its regulatory control tasks, the ARN issues three kinds of enforcement documents: requirements, recommendations and requests for further information.

LICENSING PROCEDURES

MAJOR INSTALLATIONS

Major installations require three kinds of licenses: construction, operating and decommissioning licenses. Licenses are granted to the responsible organization, i.e. the authorized legal organization being responsible for the safety of these installations.

Construction licenses are granted provided that the standards and requirements applicable to its site, basic design and expected safety level in future operations, have been met.

To obtain an operating license, the responsible organization must prove that applicable specific conditions, standards and requirements are met. In turn, the ARN independently evaluates the technical documentation and detailed studies submitted, the results of the inspections carried out during construction, the pre-operational results, etc.

The ARN demands that the staff should be properly trained and qualified for the tasks to be undertaken in a major installation. It also requires that individual licenses be granted to those staff members whose functions have a significant impact on safety. Training and qualification requirements comprise four broad areas: basic training, specialized training, in-job training and psycho-physical aptitude. Each task significant to safety within the organization must be undertaken by individual whose qualifications meet the corresponding requirements. Such qualifications include, if appropriate, university education compatible with the kind of responsibility to be assumed. Both the specialized and in-job training must be duly certified and applicants are examined by ad hoc examination boards.

Two types of regulatory documents are issued for staff licensing purposes. One consists in an individual license certifying that the applicant has the basic and specialized training to perform a specific function in a given type of installation. This document is issued at the request of the applicant and has no maturity term. However, this license is not the only requisite to enable the applicant to perform that task in an installation.

Apart from the individual license, the applicant must obtain a specific authorization to be requested by the responsible organization if important safety-related tasks are to be undertaken. The applicant must prove that he has specific knowledge about the installation involved, an adequate in-job training and a suitable psycho-physical aptitude. This specific authorization is valid for a period not longer than two years.

In 1997, the ARN granted 28 individual licenses, 193 specific individual authorizations for staff working at major installations and 16 certificates authorizing the transport of radioactive materials.

MINOR INSTALLATIONS

Minor installations require an authorization to operate granted by the ARN to the organization responsible for a practice involving radioactive materials or ionizing radiation (excluding x-rays). This authorization is issued after the submitted documentation and pre-operational inspections have been evaluated, provided that applicable standards and requirements are met and that qualified staff is engaged.

Another condition to operate a minor installation is that, the individual responsible for the radiological safety have an individual authorization for the given practice. To that end, the applicant must meet several requisites, namely to have adequate basic and specialized training as well as sufficient in-job experience, in conformity with the corresponding specific standard.

Chapter 2 of the main report specifies the minimum requirements necessary to obtain authorizations and individual authorizations in the different minor installations in Argentina.

In 1997, the ARN granted 284 new individual permissions, 133 operation authorizations and 240 renewals or modifications of operation authorizations concerning medical, industrial, research and educational installations.

INSTITUTIONAL RELATIONS

The Nuclear Regulatory Authority, in compliance with its regulatory role, maintains close relations with domestic and foreign, governmental and non-governmental institutions, as well as with international agencies. This interaction has the following purposes:

- ✓ To exchange experience and information as well as to participate in the development of international recommendations on issues associated with radiological and nuclear safety, nuclear non-proliferation assurances and physical protection.
- ✓ To establish and develop technical cooperation agreements.
- ✓ To further cooperation in order to improve the effectiveness and efficiency of the international safeguards system, through the participation of experts and the implementation of technical developments in the country.

Furthermore, the Nuclear Regulatory Authority actively participates in the negotiation of international instruments related to nuclear regulatory activities and in their implementation. It additionally participates in the definition of Argentine policies on nuclear regulatory matters in different international fora.

One of the most significant tasks in the field of institutional relations is the negotiation of national and international agreements. At the local level, agreements have been reached with: Prefectura Naval Argentina (Argentine Coast Guards), Hospital de Clínicas (University Clinical Hospital), Gendarmería Nacional Argentina (Border Guards) and INVAP S.E. At the international level, cooperation agreements have been reached with the McMaster University of Canada, the Armenian Nuclear Regulatory Authority, the Swiss Regulatory Authority, the United States Nuclear Regulatory Commission, the South African Council for Nuclear Safety and the United Kingdom National Radiological Protection Board. In July 1997, the Ibero-American Forum of Nuclear Regulators was created in Veracruz (México), composed of the regulatory agencies operating in Ibero-American countries having nuclear power plants in operation or under construction.

Its relationship with the International Atomic Energy Agency (IAEA) is highly significant and works at three basic levels:

- ✓ Attendance to the regular meetings held by the IAEA's "policy-making" organs.
- ✓ Participation in highly level committees advising the IAEA Director General on nuclear safety issues and safeguards, as well as on activities related to the negotiation and implementation of international conventions relevant to nuclear safety.
- ✓ Participation of experts in technical assistance missions abroad, in the drafting of safety-related publications and in the training of foreign trainees.

The Nuclear Regulatory Authority participated in the preparatory meeting of the Contracting Parties of the Nuclear Safety Convention, which entered into force on October 24th, 1996, and was ratified by Argentina under Act 24,776.

The ARN participates in the National Commission for the Control of Sensitive and War Materials Exports (CONCESYMB) in cases involving nuclear exports. During 1997, the ARN prepared and issued its judgment regarding the applications submitted, signing the correspondingly authorized export licenses.

NON-PROLIFERATION RELATED ACTIVITIES

International safeguards are applied by the IAEA, an agency within the United Nations system, with the purpose of providing the international community with adequate assurances on the peaceful use of atomic energy. States are thus committed to nuclear non-proliferation policies and to reaching agreements regarding safeguards, which are later supervised by international agencies, who have the responsibility for applying controls of this kind.

The agreement between Argentina and Brazil for the peaceful use of atomic energy (Bilateral agreement) signed in the city of Guadalajara in 1991, led to the creation of an international agency known as the "Argentine-Brazilian Agency for Nuclear Material Accounting and Control " (in Spanish, ABACC). Its goal is to implement the "Common System of Accounting and Control of Nuclear Materials" (SCCC), in order to verify that all nuclear materials used in any nuclear activity are not diverted for unauthorized uses. Under this agreement, Argentina assumes the responsibility for providing cooperation and facilitating the implementation of SCCC, as well as for supporting ABACC's mission. The Nuclear Regulatory Authority is the competent agency for that purpose on behalf of the Argentine government.

The "Agreement between Argentina, Brazil, ABACC and the International Atomic Energy Agency for the Application of Safeguards" (Quadripartite Safeguards Agreement) was also subscribed in 1991. Under this agreement, the IAEA is responsible for applying safeguards to nuclear materials used in all nuclear activities in Argentina and Brazil, based on the SCCC.

The interchange of experts with other countries and the institutional meetings held by ARN officials during 1997 are detailed at the end of Chapter 3 of the main report.

SAFETY ASSESSMENTS AND INSPECTIONS AT NUCLEAR REACTORS

NUCLEAR POWER PLANTS

There are two nuclear power plants (NPP) operating in Argentina: Atucha I nuclear power plant (CNA I) with a net electrical output of 335 MW and commercially operating since 1974, and Embalse nuclear power plant (CNE) with a net electrical output of 600 MW, which was commissioned in 1984.

A third nuclear power plant, known as Atucha II (CNA II), with a net electrical output of 693 MW, is in the last construction stages.

Atucha I Nuclear Power Plant

This NPP is located near Lima, in the province of Buenos Aires, approximately one hundred kilometers to the northwest of the city of Buenos Aires. Its pressure vessel reactor is fuelled with natural uranium and uses heavy water as moderator and coolant.

The NPP had a 92.91% load factor and has suffered three unscheduled outages. During 1997, there were no scheduled outages and several design modifications were introduced on the basis of the preliminary results obtained through Probabilistic Safety Analysis (PSA). Phase II of the program to incorporate slightly enriched uranium fuel elements was completed, a design modification was introduced in the boron-injection shutdown system and a leakage of heavy water was detected in a coolant channel seal. Failures were detected in the refueling machine and bivalve mollusks were observed in the service water system.

In April, the NPP received the visit of WANO experts (World Association of Nuclear Operators).

Embalse Nuclear Power Plant

This NPP is located near the city of Embalse, 110 km from the city of Córdoba. This pressure tube reactor is fuelled with natural uranium and uses heavy water as moderator and coolant.

The NPP had a 89.14% load factor and suffered three outages, two of which were unscheduled. The planned outage took place from April 26th until June 1st.

A mission from the OSART Program (Operational Safety Review Team) visited the plant within the framework of an International Atomic Energy Agency program.

The Probabilistic Safety Analysis (PSA) required by the ARN in 1996, has been initiated.

Atucha II Nuclear Power Plant

The CNA II, being constructed next to the CNA I, has the same type of nuclear reactor as the latter. During 1997, maintenance tasks were performed on equipment and assemblies, and the secondary emergency diesel unit was started.

REGULATORY INSPECTIONS

The regulatory activities carried out by the ARN to control nuclear power plants involve the analysis of documents related to design and operational aspects, the permanent evaluation of safety conditions during operation, the evaluation of the tasks to be performed during scheduled outages and, finally, the verification, through regulatory inspections and audits, of the compliance with licenses.

Analysis and evaluation tasks are performed by radiological and nuclear safety specialists, who use modern information technology for data management and are acquainted with the use of calculation codes to validate, with their own criteria, the documents supplied by the licensee.

Regulatory actions for control purposes are reinforced through a routine and a special inspections program, intended to perform a safety-related follow-up and to verify the compliance with the license granted.

Routine inspections are applied to ordinary plant operations, process monitoring and verification of the compliance with mandatory documents. They are carried out basically by resident inspectors, who are technically supported by assessment and analysis teams belonging to -or contracted by- the ARN for this purpose.

Special inspections are applied in specific circumstances or when it becomes advisable to increase inspection efforts, as in the case of scheduled or unscheduled outages. These inspections are carried out by specialists in several fields who belong either to the ARN or to other institutions related to it.

In 1997, a total number of 1170 man-hours were invested in routine and special inspections and audits in the three nuclear power plants.

Special inspections made during 1997 at the operating nuclear power plants consisted in: a) the surveillance of tasks performed during the scheduled outage of the CNE and of the commissioning and repetitive tests for Diesel generators in CNA II, b) the follow-up of tasks carried out during the unscheduled outages of both plants and c) the supervision of the annual exercises involving the implementation of emergency plans at the CNE and CNA I plants.

The main radiological and nuclear safety assessments carried out during 1997 are detailed in Chapter 4 of the main report.

RESEARCH REACTORS AND CRITICAL ASSEMBLIES

Research reactors and critical assemblies are facilities that produce neutrons and other ionizing radiation for a variety of uses, such as research, training, production of radioisotopes, testing of materials or irradiation of patients for therapeutic purposes.

RA 1 Research Reactor

The RA 1 reactor has been in operation since 1958 at the Constituyentes Atomic Center of the National Atomic Energy Commission (in Spanish, CNEA), in the province of Buenos Aires. Its authorized output is 40 kW. This reactor is fuelled with 20% enriched uranium in its isotope 235. The reactor is used for research, training and material testing.

During 1997, the scheduled inspections were conducted as planned, and the conclusion was that the installation had been operating in accordance with the conditions established in the operating license.

RA 3 Research Reactor

This reactor has been operating at the Ezeiza Atomic Center of the CNEA since 1967. Its authorized output is 5 MW. This reactor is fuelled with 20% enriched uranium in its isotope 235. The reactor is used for the production of radioisotopes, research, training and testing of materials.

The operation of the installation was in accordance with the conditions established in the operating license. Inspections scheduled for the current year have been made. In July, there was an incident involving a water leakage from the primary system to the vessel ground floor area and the controlled area access gate.

RA 6 Research Reactor

The RA 6 reactor has been in operation since 1982 at the Bariloche Atomic Center of the CNEA. Its authorized output is 500 kW. This reactor is fuelled with 90% enriched uranium in its isotope 235. The reactor is used for research, training and irradiation of materials.

The installation has been operated as established in the operating license. Four routine inspections have been performed.

RA 0 Critical Assembly

The RA 0 critical assembly is located within the School of Mathematics, Physics and Natural Sciences of the University of Córdoba. It has an authorized output of 1W. It is fuelled with 20% enriched uranium in its isotope 235, and is used for research and training.

The facility present status is that safe shutdown and the fuel assemblies are stored in a safe box within the premises.

RA 4 Critical Assembly

This assembly, in operation since 1971, is located within the School of Mathematics, Physics and Natural Sciences of the University of Rosario, in the province of Santa Fe. Its authorized output is 1 kW. This reactor is fuelled with 20% enriched uranium in its isotope 235. It is used for research and training.

This installation has been operated in accordance with the conditions established in the operating license. The three inspections scheduled for this year have already been carried out. The ARN participated in the assessment of the retraining of the operational staff as well as in the development of emergency planning exercises.

RA 8 Critical Assembly

The RA 8 critical assembly is located in Pilcaniyeu, province of Río Negro, and owned by the CNEA. Its authorized output is 10 W. This reactor is fuelled with 1.8% and 3.4% enriched uranium in its isotope 235. It shall be used to carry out the tests for assessing the neutronic design of the CAREM reactor (an advanced power reactor project which will generate 25 MW of electricity).

This critical assembly was commissioned between March and July 1997, and the corresponding regulatory work was performed.

Multi-Purpose Reactor (MPR)

This is an experimental thermal power reactor of the pool-type, with 22 MW output, designed in Argentina for the production of radioisotopes, testing, research and development of fuels and materials for nuclear power plants.

The reactor, installed in El Cairo, Egypt, first reached criticality on November 27, 1997.

The role of the ARN, according to the agreement duly signed with INVAP S.E., consisted in advising the latter regarding regulatory items and giving its opinion about the reactor licensing.

INSPECTIONS AND SAFETY ASSESSMENTS AT RADIOACTIVE INSTALLATIONS

In Argentina, the ARN takes under control approximately 1500 installations using radioactive materials or sources and radiation-generating systems. These installations are used for different purposes, such as, the production of radioisotopes, basic and applied research or the use of ionizing radiation in medicine and industry.

The ARN inspection duties comprise radiological safety assessments and on-site checking of regulatory compliance, operating licenses and authorizations.

In 1997, the routine inspections carried out at medical, industrial, and research and training centers represented 1484 man-days. The 11 incidents recorded at these installations presented no hazard to the health of the workers or the population in general.

Below, there is a short description of these installations on a group basis, highlighting their major points of interest.

Particle Accelerators

These devices, having the capability of producing beams of charged particles (protons, deuterons, etc.) accelerated to a state of high energy, have been put to various uses, both in basic research on atomic structures and particles as well as in development and production applications. The National Atomic Energy Commission (in Spanish, CNEA) has several accelerators devoted to such uses, particularly the Tandar electrostatic accelerator and a cyclotron-type accelerator for production of radioisotopes which are mainly used in nuclear medicine. The Nuclear Medicine School located in Mendoza has a cyclotron for clinical research and diagnosis.

Radioisotope Production

Radioisotopes are used in several areas of the medical and industrial fields. The CNEA has a radioisotope production plant which operates with RA 3 reactor, mainly producing iodine 131 and molybdenum 99, the latter obtained from technetium 99m, a fission product of uranium 235.

Two private companies (Bacon and Tecnonuclear) perform the fractionation and distribution of radioisotopes and produce molybdenum 99 generators.

Radioactive Sources Production

Sealed radioactive sources are also in great demand due to their different applications, such as cobalt therapy, gamma radiography, industrial irradiation, etc. The CNEA has facilities for this purpose, where cobalt 60 encapsulated industrial sources are produced. A private enterprise (Polytec) is also involved in these activities, specially in the production of iridium192 sealed sources for gammagraphs.

Industrial Irradiation

The use of radioactive sources, having the capability of emitting high doses, is an extremely useful tool for sterilizing pharmaceutical and bio-medical products and for food storage. In Argentina there are two installations, one owned by the CNEA and the other by a private company (IONICS S.A.).

Another use of the industrial irradiation is related with insect sterilization. This is a technique applied, at present, in the provinces of Mendoza and San Juan, to eliminate the Mediterranean fly that damages fruit crops. The IMCO 20 and IMO 1 mobile facilities are used for irradiation with high doses of gamma rays from cobalt 60 sources.

Nuclear Fuel Fabrication

The fuel fabrication for nuclear power plants and for reactors used in production and research takes place at CNEA facilities and in plants with major private investment.

The natural uranium fuel used at the Atucha and Embalse nuclear power plants are manufactured by CONUAR S.A. The raw material for the fuel used in nuclear power plants (natural uranium oxide) is produced by Dioxitek S.A.

Fuels with up to 20% enrichment of uranium 235 are produced at the laboratories of the CNEA and at the installations of CONUAR S.A.

The enriched uranium fuel used in the research reactors is imported. The CNEA owns a gaseous diffusion-based enrichment plant in Pilcaniyeu, province of Río Negro, operated by INVAP S.E. In 1997, there were no operations at this plant.

The CNEA has a number of other multipurpose facilities, some of them devoted to nuclear fuels, such as the plant for the conversion of 20% uranium hexafluoride and the Alpha facility, to manufacture and determine the physical and chemical characteristics of nuclear fuels based on mixed uranium and plutonium oxides.

Mine and mill processing radioactive ores

After the exploitation of uranium mines and the operation of milling plants, the ARN monitors any activities taking place during the shutdown program and, later, during the decommissioning.

After decommissioning and environmental restoration of uranium mining and milling sites, environmental conditions are checked for suitability, including the condition of the ore tailings and the determination of whether or not materials have been dispersed due to water and wind erosion. These facilities include, among others, Pichiñán (Chubut), Tonco (Salta), Los Gigantes (Córdoba), Malargüe (Mendoza), Los Colorados (La Rioja) and La Estela (San Luis).

In 1997, nine inspections of those installations were carried out.

Radioactive Waste Management

The radioactive waste treatment area of the CNEA at the Ezeiza Atomic Center carries out the treatment and interim storage of radioactive wastes from diverse sources, and the final disposal of those with low activity levels and with short radioactive half-lives. This area includes the following facilities:

- ✓ Treatment Plant for Low Activity Solid Radioactive Wastes.
- ✓ Containment System for Low Activity Solid Radioactive Wastes.
- ✓ Final Disposal Facility for Solid and Structural Radioactive Wastes and Encapsulated Sources.
- ✓ Central Storage for Irradiated Fissionable Material.
- ✓ Containment System for Liquid Radioactive Wastes.

This area, important as regards the safety of sources which are no longer used and the confinement of discarded radioactive substances, was routinely inspected four times during 1997. At these facilities, there were no incidents that may have presented a hazard to the health of the workers or the population in general.

During 1997, 204 man-days were devoted to routine inspections at the 28 major installations previously mentioned. No incidents affecting the health of the public or workers occurred.

Minor Installations of the CNEA

There are 25 laboratories and installations of the CNEA devoted to applied research which, due to their characteristics or related radioactive inventory, generally, present low radioactive risk. No deviations from the provisions of radiological safety rules were detected during the 25 inspections of this group of minor installations of the CNEA.

Teletherapy

This kind of facility is used in cancer therapy. The treatment consists in using high intensity radiation on the malignant tumor from outside the patient's body and, if possible, from different directions, thus killing the tumoral cells and causing limited damage to healthy tissue.

In Argentina, there are 104 cobalt therapy equipments and 40 linear accelerators for medical purposes. During 1997, there were 127 inspections of these facilities. No incident that might have presented a hazard to the radiological safety of individuals took place.

Brachytherapy

Several types of cancer treatments may be grouped under a therapy generally referred to as brachytherapy, in which radioactive sources are placed inside body cavities, in places close to the tumor area, or are inserted into the tumor itself.

In Argentina, there are 83 brachytherapy facilities located in various medical centers. In 1997, there were 83 inspections of such installations.

Nuclear Medicine

The diagnosis and study of certain illnesses, not only from the anatomic but also from the functional standpoint, are performed at nuclear medicine facilities. The procedure consists in administering radioactively "marked" drugs (radiopharmaceuticals). The benefits deriving from such a procedure are that some radioisotopes may assist in performing "in vivo" diagnosis.

In Argentina, there are 331 centers performing these activities, in which 154 inspections took place during 1997. There were no incidents that may present a hazard to the radiological safety of individuals.

Diagnosis Laboratories

The facilities for "in vitro" diagnosis consist of a laboratory, generally supplementary to clinical tests laboratories, to determine peptidic and non-peptidic hormons, and non-hormonal substances present in a patient's sample of urine or plasma.

In Argentina, there are, approximately, 500 centers of this type which, due to the low risk they entail, are inspected only at the time their first operating licenses are issued.

Nuclear Gauges

The measurement of different process parameters or variables in an industrial plant (thickness, level, moisture, density, flow rate, weight, etc.) is based on the principle of detecting the radiation sent out by an sealed radioactive source which is attenuated in its passage through the medium to be measured. The industrial measuring equipments use different radioactive sources according to the physical characteristics of the material it is intended to measure.

In 1997, the ARN carried out 118 inspections and intervened in 4 incidents involving this type of equipment. During these incidents, no radiological effects were detected on the workers or the population in general.

Well-logging

Several techniques to assess the characteristics of oil fields and drilling activities use radioactive materials. These are, for example, the determination of mixture density; measurement of the concentration of hydrocarbons at different watertable levels; existence of communicating channels between wells, etc.

Companies using radioisotopes in oil activities have 82 operating units in Argentina. During 1997, 35 regulatory inspections were performed by the ARN.

Industrial radiography

Gamma radiography is a non-destructive inspection technique involving gamma rays emitted by radioactive sources to check weldings in structures, facilities and various parts. This technique allows, for instance, to detect defects or inclusions in the welded seams of piping and containers used to store and transport high pressure fluids.

In Argentina, there are 71 companies which own one or more industrial radiography devices. During 1997, the ARN conducted 61 inspections of this kind of installations.

Education and Research

The use of radionuclides in experimental laboratory techniques, for both research and training, is a tool that provides important information that would sometimes be impossible to gather with other methods. This technique can be applied in areas of research such as pest control, agriculture, cattle breeding, geochemistry, molecular biology and genetics, ecology and environment research.

In Argentina, there are approximately 200 installations engaging in this field, at national and provincial universities and research centers. In 1997, 47 installations were inspected.

INSPECTIONS AND ASSESSMENTS OF SAFEGUARDS AND PHYSICAL PROTECTION

The State System of Accounting and Control (SSAC) and the nuclear non-proliferation regime is intended to ensure that nuclear energy is employed only for peaceful purposes. Physical protection is related to preventing theft or unauthorized removal of protected material, and the sabotage of such installations that may result in severe radiological consequences.

The SSAC is based on a system that accounts for all nuclear materials (as well as other materials and equipment and installations) and on its independent control by the ARN. They are supplemented by containment and surveillance measures such as optical cameras, use of seals, radiation detectors, etc. The accounting must be understood in its strictest sense. That is to say, any statement as to existing stocks or inventory of nuclear materials must be based on a physical inventory taking.

The "Design Information Questionnaire" is the starting point to develop a safeguards approach and for the ARN to issue a License or Authorization. The safeguards approach consists in the examination for each facility of its features and the possible diversion paths, and of the safeguards measures and procedures, that allow the ARN to accomplish its safeguards goals at a reasonable cost and with the minimum possible interference with the normal operation of the facility.

In its capacity as control authority in this area, the ARN conducts inspections of all the installations under its jurisdiction. The ARN's inspections may be classified as follows:

- ✓ Design information verification.
- ✓ Physical protection routine inspections.
- ✓ Safeguards interim inspections.
- ✓ Physical inventory verifications.
- ✓ Safeguards control inspections.
- ✓ Special Inspections.

In 1997 physical protection and safeguards control inspections were conducted at 36 nuclear installations in the Republic of Argentina, according to the following breakdown:

- ✓ Safeguards inspection effort: 629 man-days in 152 inspections.
- ✓ Physical protection inspections effort: 176 man-days in 89 inspections.

Inspection activities carried out for ABACC

The ARN met its obligation to cooperate with the ABACC in the enforcement of the "Common System of Accounting and Control of Nuclear Materials" (SCCC). In 1997, 24 of the ARN's inspectors were put at ABACC's disposal. These inspectors performed 242 man-days of inspection at Brazilian installations.

OCCUPATIONAL AND PUBLIC RADIOLOGICAL SURVEILLANCE

The basic criteria underlying radiological safety determine that ionizing radiation practices should be justified, radiological protection should be optimized, dose limits and constraints should be observed as established and accident probability (potential exposure) should be minimized.

Occupational Exposures

The total number of workers under control in the major facilities amounted to 1596, 78% of whom were working at nuclear power plants. The annual collective dose resulting from the operation of such facilities was 6 man Sv.

At the CNA I, no worker exceeded 50 mSv in 1997, and 92% of them received individual doses of less than 20 mSv. The highest dose was 39 mSv, mostly due to work performed on the steam generators while the plant was in operation.

At the CNE, no worker exceeded 20 mSv in 1997 and 50% of them received doses lower than 1.5 mSv. There was a plant shutdown for inspection and maintenance in May, which implied an important contribution to occupational doses.

The research reactors and critical assemblies have a staff of 102 controlled workers. The annual collective doses received as a result of operating these facilities was 0.12 man Sv. No worker received doses in excess of 10 mSv during the year.

At the three radioisotopes production plants of the CNEA at the Ezeiza Atomic Center, no worker exceeded 20 mSv in 1997 and 95% of the 84 workers received doses less than 10 mSv.

No worker received more than 10 mSv at the fuel fabrication facilities, and 93% of the 44 workers received doses of less than 5 mSv.

In all other major facilities, no worker exceeded 6 mSv during the year.

Public Exposure

The release of radioactive effluents to the environment during the nuclear power plants operation represented 30% and 7% of the annual dose constraints for CNA I and CNE, respectively.

The critical group doses resulting from the operation of Atucha I and Embalse nuclear power plants were 0.011 and 0.005 mSv, respectively, representing less than 5% of the annual dose constraint for any particular installation, set by the ARN in 0.3 mSv.

The critical group doses resulting from the operation of research reactors were lower than 0.005 mSv, representing approximately 1% of the mentioned dose constraint.

The critical group doses resulting from the operation of the CNEA production plants were as follows: 0.028 mSv for the radioisotopes production plant, 0.002 mSv for the molybdenum 99 fission production plant, and less than 0.001 mSv for the sealed sources production plant. Such doses were one order of magnitude lower than the annual dose constraint.

The critical group doses resulting from the operation of the nuclear fuel fabrication plant and of all other major facilities authorized to release radioactive materials to the environment were lower than 0.001 mSv, which represents less than 1% of the annual dose restriction value.

Environmental Surveillance

The ARN performs the environmental monitoring in the surrounding of the nuclear facilities. Measurements enable the ARN to verify dose assessment models as well as the validity of the transfer factors used in such models. These environmental monitoring tasks are performed independently of those made at each facility.

In the surroundings of Atucha I and Embalse nuclear power plants, the ARN collected samples representing the different compartments of the radionuclide transfer environmental matrix. To assess the environmental impact of liquid discharges, river and lake waters, sediments and fishes were sampled and analyzed. To assess the environmental impact of airborne effluents releases to the atmosphere, samples of locally produced food, such as milk and vegetables, were collected and analyzed. Grass was analyzed as an indicator of radioactive deposition. Radioactive fission products (cesium 137, strontium 90, iodine 131) and neutron activation products (tritium and cobalt 60) were the main radionuclides subjected to analysis, due to their radiological significance.

No environmental contamination attributable to the operation of the nuclear power plants was found, except for very low activity levels in some sediment samples.

Environmental monitoring at the Ezeiza Atomic Center of CNEA was also performed. As with nuclear power plants, samples representing the different compartments of the environmental matrix were taken at points surrounding the Center. No radionuclides were detected that could be attributed to the Atomic Center operations, except for some sediment samples.

The ARN has been regularly carrying out environmental monitoring tasks around operating and discontinued uranium mining and milling sites. Monitoring was also performed at the Córdoba plant and at Los Gigantes, La Estela, Tonco and Los Colorados, mining and milling plants where the exploitation was concluded.

To evaluate the environmental radiological impact of different facilities, surface waters, sediments and ground waters were sampled. Natural uranium concentrations, radium 226 activities and the radon gas emission rates at uranium ore tailings were determined, since these radionuclides produce the most significant exposure from the radiological point of view. Results enable to conclude that no environmental contamination is attributable to the monitored facilities.

In addition, with the purpose of evaluating the exposure caused by radioactive fallout from atmospheric nuclear weapons tests conducted in the past, samplings were made outside the nuclear facilities boundary sites to determine some radionuclides of interest concentrations in air, milk and various food samples.

It is widely recognized that radon, and its decay products are the most important natural radiation source of the effective dose in human beings. Due to its radiological significance, in 1997, radon concentration was measured in households located in several cities, so as to estimate public exposure.

Taking into consideration the 1409 households monitored (from 1983 up to 1997 for the whole country), the mean value of radon concentration was estimated to be 35.5 Bq/m^3 and no house exceeded the prescribed limit of 400 Bq/m^3 (the maximum permissible value as specified in the Radiological Safety Basic Standard). From the analyses conducted, it can be concluded that, in Argentina, radon levels in households are well within acceptable values.

Radon concentration was also measured in facilities associated with the nuclear fuel cycle. The radon concentration levels obtained are acceptable for these kinds of facilities and for the geological characteristics of the areas involved, posing no radiological risk to the population.

SCIENTIFIC AND TECHNOLOGICAL TASKS

The ARN performs different kinds of scientific and technological tasks in order to assess, by its own means and independently, nuclear and radiological safety in facilities subject to control, to evaluate occupational and public radiological safety, as well as, to implement national and international safeguards. For these purposes, the ARN has appropriate facilities, equipment and specialized staff who develop and implement methodologies and their validations within the different areas.

In 1997, in the field of physical dosimetry, research was carried out to evaluate doses from external radiation in occupationally exposed workers as well as in the public, both under normal and accidental conditions. For these purposes, gamma and neutron dosimetric evaluations were carried out at part of personal dosimetry. Special measurements were also taken at a number of reactors, critical assemblies and accelerators used for medical and research purposes. Research was also carried out for the implementation and calibration of different types of neutron dosimeters.

With reference to internal dose assessment, doses from intakes through different pathways were evaluated, based on the analysis of data obtained through direct and indirect measurements and through the application of biokinetic and dosimetric models. These dosimetric evaluations were carried out for workers and members of the public.

With reference to the Biological Dosimetry, the aim of the activities and research projects undertaken has been the dose assessment by measuring radiation-induced changes in the human body for which purpose biological samples were processed by different cytogenetic methodologies. Developments in the accidental overexposure dosimetry and in the retrospective dosimetry were carried out, focusing on the implementation of new biological indicators and on the improvement of the application of those indicators of current use. The fluorescence in situ hibridization (FISH) method was applied to detect stable (translocations) chromosome aberrations, whose set up was completed by using commercially available probes. In order to extend the response capability of the laboratory, an automated detection software for unstable chromosome aberrations is under development. Studies on Relative Biological Efficiency through unstable and stable chromosome aberrations are ongoing work.

In the context of the medical assistance program in radiological protection, medical response to accidentally overexposed patients to external radiation was planned and organized. Procedure guidelines including evaluation, therapy and follow-up of overexposed patients were written. A system to provide assistance to overexposed patients was created by signing cooperation agreements with several hospitals, to ensure an adequate medical response in the event of radiological or nuclear accidents and to provide medical advice on issues related to the biological effects of ionizing radiation.

As to the development of diagnostic and prognostic indicators applicable to accidental overexposure, radiation-induced effects on lymphocytes subsets were measured by flow cytometry. Radiation-induced oxidative stress indicators were studied with the purpose of estimating the absorbed dose, and its relationship with criteria for therapeutic management. Experiments were carried out to implement the electro spin paramagnetic resonance technique to be applied to dosimetric reconstructions in accidents. Additionally, the frequency of genetic mutations (HPGRT gene) was assessed as an indicator of radiation-induced damage.

With reference to the studies on prenatal irradiation effects on the central nervous system, certain damage mechanisms were analyzed and their correlation with doses were studied. Enzymatic systems, the production of radiation-induced lipoperoxides and the behavior of organic radicals were studied by applying an animal model of intrauterine irradiation. The nervous cell culture technique (glial and neuronal cells) is expected to become a valuable instrument for the study of radiation-induced effects on the central nervous system.

With the purpose of improving the measurement operational capacity of the laboratories, much has been done to upgrade the equipment, incorporating new instruments and calibration standards, improving measuring and analyses techniques, and developing new methods, validated by participating in international renown laboratories intercalibration programs. At the whole-body counter, used to measure the internal contamination by gamma emitters, routine and special measurements were made on the thyroid, the lungs and the whole body. At the gamma spectrometry laboratory, measurements associated with environmental monitoring, inspections and audits were made. At the gross alpha and beta activity and alpha spectrometry different other kind of alpha activity measurements were performed on samples processed in the radiochemical analytical laboratories and samples referred by different ARN projects.

As part of the safeguards program implemented by the ARN in the framework of international agreements, attention was given to the development of a methodology to check the nuclear material inventory at the CNEA gaseous diffusion enrichment plant, applying non-destructive gamma spectrometric techniques. This methodology was applied to measurements in piping, scatterers, vessels and tanks from the enrichment plant, fuel elements with different degrees of enrichment used in research reactors and uranium oxide powder samples.

The radiochemical laboratories analyzed different kinds of samples to determine alpha and beta emitting radionuclides. The samples were obtained from the environmental monitoring programs, inspections, evaluations and audits; and include: waters, soils, sediments, vegetables, filters (air samples and sweep-tests) and biological samples (urines, feces and nasal wipes). Different tests were carried out to upgrade and optimize process methodologies and implement new techniques. Furthermore, the analytical techniques used in environmental and biological measurements were validated through the participation in intercalibration programs.

With the aim of detecting -for safeguard purposes- undeclared activities concerned with uranium enrichment or fuel reprocessing, techniques to detect different radionuclides of interest in environmental samples taken from the areas surrounding nuclear facilities, have been developed. To detect uranium particles in filters, an electronic autoradiographic system was used. Preliminary and supporting tasks were performed to start up a mass spectrometer with a particle accelerator. Progress was made in relation to the iodine 129 determination technique for environmental samples, as well as in relation to the alpha spectrometry technique to determine plutonium in soil. All stages involved in these techniques have been optimized.

Bio-concentration and transfer factors in aquatic organisms were studied to apply in models of public dose estimations, to be used in cases of radioactive material discharges during the operation of nuclear facilities. One laboratory was reconditioned for this purpose and radionuclides of interest were measured in the different compartments of the aquatic food chain.

Techniques for measuring radon in air were developed to continue with routine radon concentration measurements in households and uranium mining and milling sites. Solid state nuclear-track detectors and Electret devices were used. Besides, a passive method was developed based on activated carbon adsorption and liquid scintillation counting. A technique for measuring radon in water was implemented using Electret devices and another method based on pulse-shape discrimination liquid scintillation counting was developed.

The establishment of an international surveillance system for the detection of nuclear explosions is one of the goals set forth by the Complete Nuclear Test Ban Treaty (CTBT). One of the techniques to be employed consists in detecting radionuclides; for this reason, 80 monitoring stations will be installed worldwide, three of which will be located in Argentina. The setting up of the Buenos Aires monitoring station has already been completed. This station will be used to detect radioactive aerosols in air. In addition, a laboratory for gamma spectrometry has been built and is already in operation, serving as a primary laboratory within the international network of CTBT certified laboratories. The other two monitoring stations will be constructed in Salta and Bariloche, for this purpose, specific agreements with the Federal Police have been signed.

To identify and analyze environmental uranium micro-particles for safeguard purposes, a tandem accelerator from the McMaster University (Canada) will be installed at the Ezeiza Atomic Center. Within the framework of the agreement signed with this university, the accelerator together with its low and high power lines were dismantled during 1997. The foundations for the accelerator tank and for the two auxiliary insulating gas storage tanks have been completed. Construction of a high-production ion source with a spherical ionizer was initiated. The accelerator is expected to start operating in the second half of 1998.

In the electronic research area to support regulatory tasks, a remote monitoring and surveillance system, for the control of nuclear material was developed. A prototype was installed in the fissionable material storage tank at CNEA. Within the framework of the CTBT goals, the ARN has decided to construct an infrasonic sensing system. The sensors associated with the system that will allow measuring infrasonic signals from atmospheric nuclear tests have already been selected and obtained. Likewise, a system has been developed to keep track of CNE spent fuel elements from the decay pool to the storage tanks.

RADIOLOGICAL EMERGENCIES

The ARN evaluates the radiological and nuclear emergency procedures in case of accidents developed by the facilities under control. What to do, who will do it and how it will be done are the main components of the emergency plan on which intervention is based. It comprises the set of procedures to be followed in the event of an accident. The procedures should be flexible enough to be adjusted to real situations, which are usually different from the accidents taken as reference.

Emergency plans are license-requested for major installations and in the case of minor practices, emergency procedures are required to counteract the accident causing sequences and their consequences.

In the event of an emergency, the ARN assists both the primarily responsible persons from the facilities and the pertinent authorities.

As established in its duties, the ARN acts in the stage of consequence mitigations of incidents and radiological accidents through its Radiological Emergency Intervention System (in Spanish, SIER). This system is intended to:

- ✓ Advise both users and public authorities who intervene in the control of radiological emergencies.
- ✓ Take part in emergencies whenever minor practices and facilities cannot control accidents by themselves, when the population is involved or in the event of unexpected radiological emergencies in public areas.

The SIER is composed of two groups: the primary intervention and the support teams. The primary intervention team keeps watch working weekly shifts throughout and the year; the support team is made up of all the other ARN technical staff members, who do not work in shifts but can nevertheless be summoned when so required. The SIER has the specific equipment and the necessary logistic infrastructure to ensure a prompt and efficient intervention in accidents having potential radiological consequences. It works in close connection with other bodies, such as the provincial and federal Civil Defense Agencies, the Federal Police, the National Border Guards, the Coast Guards, the Armed Forces and the Secretariat of Internal Security, with which cooperation agreements have been reached.

During 1997, the SIER took part in 13 incidents involving radioactive material in medical centers and industrial facilities.

TRAINING

The ARN regularly undertakes the training of specialists in radiological and nuclear safety, safeguards and physical protection through training courses and participation in national and international congresses and meetings with experts.

These activities are managed by its training department, which is in charge of defining, organizing and coordinating courses, workshops and seminars for the ARN staff as well as for staff members working in other entities, either private or public, using ionizing radiation. Besides, trainees from the International Atomic Energy Agency attend the Postgraduate Course on Radiological Protection and Nuclear Safety.

Apart from specific training courses in the nuclear field, the training department implements and coordinates courses and workshops aimed at retraining the ARN staff.

The Postgraduate Course on Radiological Protection and Nuclear Safety organized within the framework of an agreement with the University of Buenos Aires and the Ministry of Health and Social Welfare, under the auspices of the IAEA, is given on an yearly basis since its inauguration in 1980. Since then, a total of 514 professionals have graduated, of which approximately half of them are foreigners. During 1997, 25 professionals specialized in different disciplines from Argentina and other Latin American countries attended the course.

The course is made up of two modules devoted to radiological protection and nuclear safety, lasting 20 and 10 weeks, respectively. Both courses are run on a daily seven-hour basis.

A course on radiological protection is offered to train technicians from public and private institutions, interested in improving their performance in facilities operating with radioactive material. The duration of this course is eight weeks, seven hours per day. The attendees last year amounted to 20, among them members of the ARN, Coast Guards, Air Force and Border Guards.

In 1997, courses oriented to the specific training of ARN staff were organized, in areas as varied as statistics, information technology, reliability and foreign languages.

During 1997, ARN staff members presented approximately 60 papers in national and international congresses and meetings.

Twenty four seminars were performed made covering different issues related to radiological and nuclear safety, safeguards and physical protection.

Chapter 9 of the main report presents, in detail, the training courses held locally or abroad in which ARN staff members participated, the scientific visits made, as well as the foreign professionals who were trained at the ARN, during 1997.

ECONOMIC AND HUMAN RESOURCES

The organizational structure of the ARN is made up of 221 regular members and 6 positions in the Board of Directors. At the end of 1997, the ARN had 11 research trainees.

As to the staff, 70% of its members have completed their university studies, 85% perform specialized technical and scientific tasks within the ARN scope of action, and the remaining 15% are engaged in administrative tasks.

The annual ARN budget in 1997 —the allocation of which was approved by an administrative decision dated 12/97— was $15,619,121, funded by National Treasury Contributions, Specific Resources and Specific Allocation Resources. This budget was later modified to include $ 424,570, thus totaling $16,043,691.

Staff expenses represented 65.7% of the total ordinary spending, including tax deductions to the personnel, contributions to be made by the employer and social security expenses. Consumption goods and non-personal services represented 15.8% of the total amount.

The expense allocation as well as the general balance sheet of the ARN till December 31, 1997, are presented in detail in Chapter 11 of the main report.