ABACC / DOE TECHNICAL COOPERATION 1997-1999

C. Feu Alvim, L. Palhares, L. Rovere, O. Mafra, R. Nicolas
Brazilian Argentine Agency for Accounting and Control of Nuclear Materials-ABACC
J. Busse, S. Hayes - U.S. Department of Energy, M. Whitaker - Oak Ridge National Laboratory,
M. I. Spaletto – New Brunswick National Laboratory, D. Glidewell – Sandia National Laboratory,
G. Bosler – Los Alamos National Laboratory, R. Holdren - Pacific Northwest National Laboratory

ABSTRACT

The Cooperation Agreement between the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the U.S. Department of Energy (DOE) entered into force on April 18, 1994, for a period of five years. The Agreement includes the cooperation on exchange of information, equipment, funding or personnel; exchange or loan of materials, equipment and components for evaluation and testing; joint projects for research, development, testing and evaluation of nuclear material control, accountancy, verification, and advanced containment and surveillance technologies, techniques or procedures. A Memorandum of Understanding was agreed to in 1995, for purposes of transferring U.S. Non-proliferation and Disarmament Fund (NDF) monies to ABACC, to assist in the procurement of NDA equipment, advanced containment and surveillance systems and training. Since then, three allotments were transferred to ABACC in March 1996, October 1997 and September 1999. In May 1999 the parties signed an amendment to the Agreement which extends it for an additional five-year period and foresees automatic extensions of five-year periods thereafter. This paper describes the activities carried out in the period 1997-1999 under individual projects concerning destructive and non-destructive analysis, environmental sampling, containment and surveillance, information management and training. Four new projects are under discussion, concerning databases, network and data transmission security, laboratory quality assurance, remote monitoring systems and the remote-monitoring project of the Embalse Nuclear Power Station. The technical cooperation between ABACC and DOE substantially contributed to improvements in ABACC's measurement methods, equipment and inspection procedures. This is reflected in the increasing effectiveness of the safeguards applied under the Common System of Accounting for and Control of Nuclear Material established by the Bilateral Agreement between Argentina and Brazil, and in the enhanced coordination with the International Atomic Energy Agency (IAEA) in the application of the Quadripartite Safeguards Agreement – INFCIRC/435.

INTRODUCTION

The Cooperation Agreement between the US DOE and ABACC entered into force on April 18, 1994 for a period of five years and was extended on May 21, 1999 for additional five years period, automatically renewable for further five year periods thereafter. The Agreement covers the cooperation in the areas of exchange of information, equipment, funding or personnel, exchange or loan of materials, equipment and components for evaluation and testing, joint projects for research, development,

testing and evaluation of nuclear material control, accountancy, verification, and advanced containment and surveillance technologies, techniques or procedures.
Since 1995, when a Memorandum of Understanding was agreed between the parties, three allotments of the U. S. Non-proliferation and Disarmament Fund (NDF) have been transferred to ABACC, to assist in procurement of NDA equipment, advanced C&S systems, and travel and per diem of ABACC inspectors attending training courses and workshops pursuant to the Agreement DOE/ABACC.

In defining the cooperation, a list of necessities was worked out by ABACC in the areas of safeguards measurements and developments, quality assurance of analytical laboratories, training and new techniques. On the basis of this list, specific projects have been defined in Action Sheets, which were approved and subsequently supervised by a Permanent Coordinating Group, which meets once a year to evaluate current projects, define and approve new ones.

One of the first projects aimed at improving the measurement capability of the laboratories that provide destructive analysis of ABACC safeguards samples. In this respect, intercomparison exercises were promoted, including the participation of the laboratories in NBL intercomparisons, reciprocal visits were carried out, improvements were achieved in the analytical laboratories and a quality assurance program is currently under way.

To meet the requirements defined by ABACC concerning training, several DOE experts participated in training courses organized by ABACC in Brazil and Argentina and a number of brazilian and argentinean experts took part in workshops and seminars organized at DOE facilities. As a result, ABACC has presently the necessary technical skills for the definition, procurement, installation and maintenance of containment and surveillance and non-destructive measurement systems, as well as a highly qualified staff to perform inspection and in field NDA measurements.

The cooperation has also made possible the acquisition and installation of containment and surveillance systems in a number of facilities. Examples are, the use of Cobra seals in an irradiated fuel storage and in a Candu reactor, and the installation of surveillance systems in LWR reactors and enrichment facility.

Much has been also enabled by the cooperation in respect to new technologies, especially in the area of swipe sampling. In this respect ABACC objective was to reach expertize in the development of sampling plans, sample collection and transportation, data interpretation and reaching safeguards conclusions, as well as the assessment of analitycal capabilities in Brazil and Argentina, discuss analitycal techniques to be implemented and upgrade laboratories capabilities as necessary. Although this is a relatively new project, much of the objectives defined by ABACC have been achieved through measuring exercises of swipe sample standards, discussion with DOE experts of dificulties experienced and participation of ABACC personnel in workshops at U.S organized by the DOE.

TRAINING

Until 1998, projects concerning this subject included the action sheets Annual Safeguards Training Course signed on July 1994 and ABACC Inspector Training Workshops of July 1994 with an addendum of 1995 on Advanced Measurement Workshops. The first one aimed at providing DOE instructors for specified sessions of ABACC's annual training courses and ABACC instructors to participate in DOE-sponsored training courses such as SSAC training course. The latter included the training on measurement instrumentation at simulatted PIVs at Argentinean and Brazilian facilities and the provision of advanced training for selected ABACC inspectors at U.S. facilities, using measurement instrumentation and systems not currently possessed by ABACC.

These projects terminated on November 1998 and a new action sheet was signed in October 1998. This new project, Safeguards Training and Instrumentation aimed at providing cooperation in the training of ABACC inspectors and specialists to assist in increasing ABACC's efficiency and effectiveness. The training might consist of comprehensive training courses, specific subject seminars, hands-on training with instrumentation used during inspections or advanced courses utilizing instrumentation that is being developed by DOE for future international applications.

Under this action sheet, ABACC officers have participated in INMM/ESARDA Workshop on Science and Modern Technology for Safeguards (Albuquerque, 20-24 September 1998), in the Workshop Rollback in Argentina and Brazil (Washington, 24-31 October 1998) and in the 21st ESARDA Symposium (Sevilla, 3-7 May 1999) with the presentation of the papers "Experience in Developing Safeguards Performance Requirements for a Remote Monitoring System" and "Implementation of the Guidelines for routine and ad-hoc inspection activities between the agency and ABACC".

Two ABACC training courses were held during this period under these projects, the Third Safeguards Training Course for ABACC inspectors and the Third Workshop for ABACC Inspectors Training on Physical Inventory Verification.

The Third Safeguards Training Course for ABACC inspectors was held in Buenos Aires from 30 October to 7 November 1997 with the participation of 24 inspectors from Brazil and Argentina. The course program included implementation of the SCCC, coordination activities between ABACC and IAEA, safeguards in conversion and fabrication facilities, reactors and enrichment plants, NDA techniques, containment and surveillance, environmental sampling, remote monitoring, and the measures for strengthening safeguards - part one. The course was presented by lecturers from ABACC, DOE, ARN, CNEN, IAEA, CEA, Los Alamos, JRC/Ispra, Sandia, PNNL and NMCC/Japan.

The Third Workshop for ABACC Inspectors Training on Physical Inventory Verification was held in "Fabrica de Elementos Combustibles Nucleares" in Buenos Aires, Argentina from 7 to 11 June 1999, with the participation of six inspectors from Brazil, six from Argentina and two observers from ARN and the facility. DOE, ABACC and ARN provided instructors and equipment. The inventory used in the workshop consisted of 45 drums of powder, 23 boxes of pellets, 1217 Candu fuel rods and 208 Candu fuel elements in a total of 15 ton of natural UO2.

These projects included also ABACC participation in the IAEA Regional Training Course carried out in São Paulo from 19 to 23 October 1998 and in Rio from 25 to 30 October 1998. ABACC presented several lectures and demonstrations on NDA and C&S equipment. DOE presented a lecture on the Additional Protocol.

ABACC Inspectors during the Third Workshop on
on Physical Inventory Verification

ABACC demonstration on C&S duting the
IAEA's Regional Training Course held in Brazil in October 1998

DESTRUCTIVE ANALYSIS

After the successful accomplishment in November 1997 of the first project in this area, which included the 1st round robin of the Laboratory Intercomparison Program and

reciprocal technical visits, a new Action Sheet was signed in October 1997. "Laboratory Quality Assurance" provided for the continual monitoring of the performance of ABACC's analytical laboratory network through sample exchange programs for chemical and isotopic analysis, the procurement, acquisition and repair of equipment and materials for the intercomparison activities and reciprocal visits between NBL and ABACC personnel to exchange information that will assist ABACC in maintaining a quality control and quality assurance program related to preparation of secondary standards.

The second round robin of the Intercomparison Program was defined in 1997 and the samples and standards were distributed to five laboratories in Brazil, seven in Argentina and to NBL/DOE. NBL provided a reference value for the uranium content in the sample - rather than using a *grand mean* from all participants as in the 1st round robin - making thus possible to evaluate under a higher reliability, the bias achieved by all participants. Furthermore, NBL carried out a full characterization of ABACC standards to compare them with their own standards, improving hence the overall confidence levels. NBL also participated in the data treatment and statistical evaluation of the results. It has been concluded that all the laboratories improved its performance with respect to the first exercise. From a total of 13 laboratories, the results of nine of them are now between $\pm$0.1%. The other four are between $\pm$0.23%. One of the reasons for this improvement was due to the provision of standard reference material by ABACC to the laboratories.

Activities under this area of cooperation included a visit to NBL of two ABACC officers from 14th to 18th September 1998. The program of the visit consisted of a general introduction of the Laboratory activities in the certification of reference materials, sample characterization and exchange programs, the SME program and some hands-on experience with analytical methods such as thermo ionic mass spectrometry. The program also included an overview of the quality assurance and control used in NBL, with a view to implement a similar system in ABACC analytical net, where applicable and feasible.

Six laboratories in Brazil and seven in Argentina participated in the Safeguards Measurement Evaluation Program - SME organized by NBL/DOE. Samples were distributed by the end of 1997. An ABACC's representative have participated in the NBL meeting on Safeguards Measurement Evaluation Program held in Chicago from 25 to 27 May 1999 and discussed the results obtained by ABACC network laboratories. The representatives of participating laboratories have also met with DOE experts in ABACC headquarters on 27-28 July 1999. It has been noted that in general the performance of ABACC network laboratories was good. The general mean of the results of the laboratories had no significant deviation with respect to the reference value, but some laboratories do have.

It is foreseen that the current project will be closed and substituted by a new one embracing the 3rd round robin of ABACC Intercomparison Program, the next NBL Safeguards Measurement Evaluation Program and the preparation of standard reference material to be used in future exercises. Laboratories of Brazil and Argentina will prepare 1000 UO2 pellets of 1 g standard reference material and about 12-20 pellets would be sent to NBL for certification. The 3rd round robin would start when this standard material is ready for use and shall maintain the same analytical scheme Next NBL

intercomparison program, which includes elemental and isotopic analysis, started late in 1999.

INFORMATION MANAGEMENT

The project on information management, signed in November 1996, was intended to provide ABACC with an overview on the methodology for analyzing the consistency of safeguards information and to provide consulting to ABACC on databases tools and network and data transmission security.

A Workshop on Information Analysis was held in Washington from 21 to 23 of October 1997, with the participation of five ABACC officers. The workshop was presented by PNNL and Global Associates and focused mainly on open sources of information. ABACC officers also participated in the IAEA 1998 Seminar on Safeguards Information and had presentations from the Agency on its information evaluation process (physical model, state file) and on softwares for information retrieval (Topic, Search 97, Pathfinder).

Following the initial asessment of ABACC information infrastructure in December 1996, ABACC has implemented DOE recommendations on network security and started the standardization of its databases for future integration and unification. A Seminar on Secure Data Transmission was held in Buenos Aires in July 1998 with the participation of 16 inspectors, specialists and professionals from ARN, CNEA, and CNEN. The program included cryptography systems, authentication methods, commercial softwares and point to point communication security.

Seminar on Secure Data Transmission held in Buenos Aires.

Negotiations started in mid 1998 with Brazil and Argentina to implement the reports data transmission via Internet. ABACC selected the software Pretty Good Privacy (PGP) for authentication and encryption of electronic mail. A methodology was proposed to the National Authorities of Argentina and Brazil, with the objective of progressively replace the conventional procedure to forward the correspondence by using e-mail in order to

reduce practicaly to zero the time spent in transporting the information, while improving its security level. An e-mail account was established by each part for this purpose and a responsible was designated to manage this account. For transmission of documentation, the message is encrypted and signed, while for transmission of accounting reports, the message is double encripted. In June 1999 the transmission of information between ABACC and Argentina/Brazil through encrypted e-mail started to be tested and was fully implemented in September of the same year. The same procedure started to be tested by ABACC to transmit reports to the IAEA in November 1999 and it is expected to have it routinelly in use as from the beginning of the year 2000.

A new action sheet on this subject is being proposed by ABACC, embracing network, database and electronic data transmission.

REMOTE MONITORING AND CONTAINMENT AND SURVEILLANCE

The first project in this area of cooperation consisted of joint field test using technologies of the DOE remote monitoring project to monitor the spent fuel storage at Embalse Nuclear Power Plant. This Action sheet was extremely useful to introduce ABACC staff, inspectors and technicians in both countries to the remote monitoring area. Participation in the initial installation of the system, as well as in later upgrades, provided to ABACC an invaluable first hand experience in components, systems and technology used in remote monitoring.

ABACC participated in the coordinating meeting of the Embalse Remote Monitoring Project in Vienna in September 1998, in the installation of the remote monitoring system at Embalse and in the upgrade of the same system performed by DOE, ARN and IAEA in late April 99. IAEA and Aquila personnel (under DOE contract) installed a remote station at ABACC's headquarters in Rio de Janeiro. ABACC has installed a review station at headquarters for downloading images and sensor data.

A new draft action sheet on this subject is under discussion, having as main objective the reinforcement of the technical capabilities of R&D groups in the two countries aiming at developing a regional expertise to support ABACC's requirements in the area.

The objective of the action sheet on containment and surveillance, signed in July 1995, is the development, procurement, evaluation and testing of appropriate containment / surveillance equipment that would increase ABACC's safeguards effectiveness while reducing inspection effort.

At the beginning of 1998, as part of the studies and discussions of the safeguards approaches for enrichment facilities the use of a surveillance system having a response time for image capture process of less then 1 second and the frame rate in the order of 1 image every 2 seconds was defined for use at Isotope Enrichment Laboratory (LEI). The routine use of EMOSS system at this facility has been then defined and agreed along with the IAEA. Four cameras and two review stations have been procured by ABACC and two technicians of the ABACC containment and surveillance consultants group have been trained at Euratom and Hymaton in the installation, use and maintenance of this system. In August 1998, a final agreement for conducting unannounced inspections at LEI facility

was reached, which includes the use of two EMOSS systems as part of perimeter control of this facility.

A first seminar on Containment and Surveillance was held in ABACC Headquarters from 13 to 17 of July 1998. In total, 17 inspectors and members of ABACC Containment and Surveillance Group attended the seminar. The first part of the Seminar covered brief history of C&S, unattended systems, remote monitoring, web technologies for remote monitoring applications. The second part consisted of description, working principles and hands-on training on EMOSS and Gemini surveillance systems and on VACOSS and COBRA seals. The first of the two parts was delivered by Sandia National Laboratory and the second part was covered by the Training Section of the IAEA.

Seminar on C&S held at ABACC Headquarters

Another workshop on this subject was held in December 1999 in Rio de Janeiro from 6 to 10 and from 13 to 17 in Buenos Aires, with the participation of two DOE instructors, two ABACC instructors and two instructors from the IAEA Training Section. The workshop was attended by 20 inspectors and consisted of hands-on training on the use of VACOSS and Cobra seals, and operation of Cosmos cameras, Bundle Counter, MIVS, MUX and Alis surveillance systems and MORE and GARS review stations as well as presentation on remote monitoring.

Workshop on C&Ss held in December 1999 in Rio de Janeiro

In September 1998 a Gemini system was installed at the equipment hatch in Angra 1 Nuclear Power Station to cover the refueling campaign. The system was installed outdoors, with a protective enclosure and was paired with an uninterruptible power supply and lighting to provide continuous coverage day and night. This equipment is being shared with the IAEA. There were concerns on whether the Gemini system installed outdoors in Angra 1 NPP could function properly during the summer season. A field test followed a regular surveillance period during refueling, and it was observed that the system performed well without exceeding design temperature limits.

In 1999, three DCM-14 based digital surveillance units and a communication server were purchased. After a testing and training period at ABACC headquarters, the complete system was installed at Angra 2 Nuclear Power Station in Brazil. A new action sheet draft proposal on C&S is being prepared for DOE review and will include the purchase of additional units, as well as training and demonstration exercises.

ENVIRONMENTAL SAMPLING

The cooperation on environmental sampling is covered by a project signed in October 1996 providing for the conduction of seminars in Argentina and Brazil, the organization of technical discussions on sampling plan, sample collection, analytical techniques, data interpretation and conclusions, the organization of workshops in the U.S. to provide hands-on training on sample collection and analysis, and the upgrading of Argentinean and Brazilian laboratory capabilities as necessary.

In March 1997 an environmental sampling seminar was held in Rio de Janeiro in cooperation with CNEN. Instructors from ORNL and PNNL, 19 participants from Brazil and 4 from Argentina. attended the seminar. Following the Seminar, ORNL, PNNL and ABACC participants visited the Environmental Laboratory in Buenos Aires and had discussion with ARN personnel. A Workshop on Environmental Sampling was held in Buenos Aires from 10 to 12 November 1997 with the participation of four Argentinean inspectors, two Brazilian inspectors and two Brazilian experts. The program included fundaments of environmental sampling and its application to safeguards, sampling techniques, gamma spectrometry, thermo ionization mass spectrometry, fluorimetry and alpha spectrometry, particles measurement, demonstration of sampling and analysis of

results. Lecturers from PNNL, Oak Ridge, ARN, ABACC and CNEN participated in the Workshop.

An exercise for measuring standards of swipe samples was defined in June 1998. To start the exercise, a meeting was held in ABACC headquarters between ABACC project leaders, experts from DOE and the representatives of four laboratories in Brazil and two in Argentina, when standard swipe samples provided by the IAEA were distributed. A description of the general procedures for the exercise was also provided and discussed. Topics discussed included the procedures to be followed in the preparation of ultra low concentrate samples, the use of correct tracers and measurements with mass spectrometer. Durind the discussion it became clear the need of using U-233 spikes and Atombags to keep clean the working environmental. The material was provided by DOE later in 1998 and distributed to the participants by ABACC.

At the end of the exercise, in May 1999 a meeting was held at ABACC headquarters with the participation of the representatives of the laboratories, and experts from Oak Ridge National Laboratory, Pacific Northwest National Laboratory and DOE headquarters, when each laboratory presented its results, experiences and problems faced. Even taking into account the several problems involved in this type of sample preparation and measurement, two of the laboratories presented very reasonable results for the ratio 234/238, 235/238 and 236/238. After a very open and useful discussion, recommendations were made by DOE experts, taking into account the future activities of this Action Sheet. It was decided that the laboratories would measure all their blanks, first without the cotton tissue and then with a clean cotton tissue supplied by ABACC. After that measurement, taking into account all the recommendations that came up during the meeting, a new standard swipe sample will be supplied by DOE and distributed to the laboratories. After the meeting, DOE participants were invited to visit one of the Environmental Monitoring Laboratories located at the IRD (Instituto de Radioproteção e Dosimetria) in Rio de Janeiro.

NDA MEASUREMENT SYSTEMS

The action sheet on this subject was signed in April 1997 and foresees the analysis, development and testing of selected NDA systems and techniques, applicable to ABACC's safeguards approach at specific facilities or to be used during inspections and demonstration of selected NDA techniques at U.S. facilities, as required.

During this last two years three workshops have been held under this Action Sheet, all related to the training on measurements, techniques and procedures applicable to unannounced inspections at enrichment facilities.

The gamma and neutron NDA training course has been held at IPEN/SP from 31st August to 4th September 1998 with the participation of six Argentinean and eight Brazilian inspectors/operators, two ABACC and two DOE instructors. After introductory lectures the participants were divided into groups. The groups performed a series of experiments on the operation and basic physics of neutron detection assay, passive neutron measurements and active measurements by neutron transmission using an experimental arrangement simulating the conditions at the enrichment installation.

Images of the NDA training course held at IPEN in São Paulo.

The first Workshop for ABACC and IAEA inspectors on unannounced inspection has been held at IPEN/SP from 14 to 19 March 1999 with the participation of one DOE instructor, two ABACC instructors, three CNEN instructors and a representative of the Operator and of the IAEA. Five ABACC inspectors and five IAEA inspectors were trained. The workshop included lectures on the procedures agreed for unannounced inspection and the methodology for detection of cylinders. Working in groups, the inspectors then performed passive gamma and neutron measurements and active measurements by neutron transmission using an experimental arrangement. A visit to LEI enrichment laboratory was performed to acquaint the inspectors with the cascade hall, the perimeter activities and for training in the surveillance system.

Workshop for ABACC and IAEA inspectors
on unannounced inspections held in Argentina

Mock–up simulator built for neutrons NDA measurements

Another Workshop for ABACC and IAEA Inspectors Training in Unannounced Inspections was held in Buenos Aires/Ezeiza from 20 to 24 September 1999, with the participation of DOE, ABACC, ARN, CNEN and IAEA. Gamma and neutron NDA and surveillance techniques were discussed and used. A mock –up simulator has been built in Argentina in order to permit the neutrons NDA measurements.

Detail of the mock up simultor

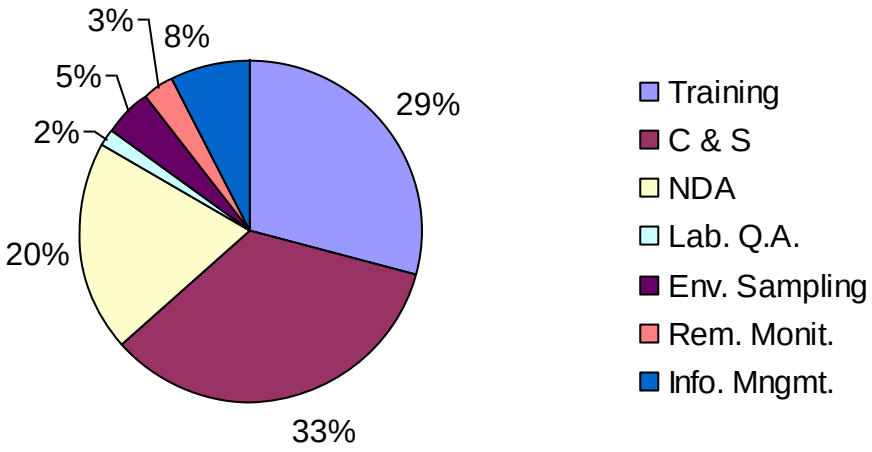
An ABACC officer participated in the demonstration and comparison of software tools used for the analysis of the hold-up measurement data from the Pilcaniyeu Enrichment Plant, held at Portsmouth from 26th to 30th October 1998.

Exercise held in Portsmouth.

A variable focus collimator was designed and constructed, to be used with a 3X3" NaI (Tl) detector. This system should be used to verify the amount of U-235 within the diffusers of the Pilcaniyeu Enrichment Plant.

CONCLUSION

This six years of cooperation helped ABACC in developing a solid measurement capability, a high level instrumentation and a high qualified personnel and provided the participation of several experts and laboratories of the U. S. DOE in a number of projects carried out in Brazil and Argentina. The allotments of the U. S. Non-proliferation and Disarmament Funds that had been transferred to ABACC since 1995 supported the development of activities in the different cooperation areas as shown in the chart below.



The cooperation between ABACC and the U.S. DOE has been highly positive for both parties and activities are foreseen to continue in the future under existing or new projects. Next cooperative activities, some of which have already started, include improvements of a NDA system to be used in enrichment facilities including consolidation of the cascade measurement equipment into compact assemblies, the investigation of a neutron generator for use in active measurements at an enrichment facility, the calculation using MCNP codes of the response of a UNCC to a poisoned fuel element and to geometry variations and the specification, design, construction and characterization of a UNCC fuel element standard. New intercomparison and swipe samples measuring exercises has also started and new training courses and workshops such as another training for IAEA and ABACC inspectors on unannounced inspections and a generalized NDA workshop at the U. S. to demonstrate multiple measurement methods and systems related mainly to techniques used in enrichment plants, neutron interrogation methods, special software and new developments are foreseen as well. Seminars on the Additional Protocol are also foreseen to be carried out in Brazil in the first semester of 2000, associated to the 4th Safeguards Course for ABACC inspectors and in Argentina in the second half of 2000.

In the future, it is expected that the cooperation with the U. S. DOE and the support of the U. S. Non-proliferation and Disarmament Funds will reinforce present ABACC safeguards activities and help in the development of new activities that will arise with the implementation of the Additional Protocol and the integration of these safeguards measures. This will permit the increasing effectiveness of the safeguards applied under the Common System of Accounting for and Control of Nuclear Material established by the Bilateral Agreement between Argentina and Brazil, and an enhanced coordination with the International Atomic Energy Agency (IAEA) in the application of the Quadripartite Safeguards Agreement – INFCIRC/435.