EU - ABACC Cooperation: Strengthening Safeguards Capabilities

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Abstract

Following initial discussions in 2006 within the framework of the EURATOM – ABACC R&D Cooperation Agreement, in 2012 the European Union engaged into a cooperation project to strengthen Safeguards Capabilities at ABACC (the Brazilian-Argentinean Agency for Accountancy and Control). ABACC expressed interest in having access to two new Safeguards capabilities based on two JRC technologies approved for Safeguards use by both EURATOM and IAEA. This four-year cooperation project is funded by the European Commission Directorate General for Development and Cooperation – EuropeAid (DEVCO), under the Instrument for Nuclear Safety Cooperation (INSC). The new capabilities to be created at ABACC are: (i) Verification of complex plant design and lay-out ("as-is") and (ii) Containment of Spent Fuel in a complex Storage Environment. This is to be achieved by transferring to ABACC two JRC-owned technologies: (a) 3D Laser Verification System and (b) Ultrasonic Seals. The development of the two technologies to be transferred were funded by JRC's internal work-programme and targeted to Safeguards under the framework of the European Commission Support Programme to the IAEA (tasks EC-E-1425 and EC-E-1559). The transfer of technologies includes a set of comprehensive training actions and field support activities. Close coordination with the International Atomic Energy Agency (IAEA) takes place during the whole project's lifetime. The European Commission Directorate General for Energy (EURATOM Safeguards) is also informed on the project progress and achievements. Given the technologies to be transferred have been approved and are used by the IAEA, it could be possible at the end of the project to have the Safeguards equipment being jointly used by ABACC and the IAEA. This paper details all aspects of this cooperation project.

Keywords: Nuclear Safeguards, International Cooperation, ABACC, 3D Laser Verification System, Ultrasonic Seals

1. Introduction

The Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) is a regional Safeguards organisation created by the Bilateral Agreement signed in December 1991 between Argentina and Brazil[1]. ABACC is mandated to apply a full scope Nuclear Safeguards system in Brazil and Argentina.

In March 1994, the Quadripartite Agreement between the International Atomic Energy Agency (IAEA), ABACC, Argentina and Brazil entered into force [1]. For more than 20 years, the IAEA and ABACC jointly coordinate Safeguards activities avoiding unnecessary duplication of efforts, while maintaining the principle that both organisations shall be able to reach independent conclusions.

[1] Agreement between the Republic of Argentina and the Federative Republic of Brazil for the Exclusively Peaceful Use of Nuclear Energy.

The selection of Safeguards tools to be used by ABACC is guided by the goal of implementing effective and efficient safeguards while reducing intrusiveness and protecting sensitive information, when so required.

ABACC and EURATOM – the European Atomic Energy Community, signed in February 1999 a long standing cooperation agreement focussing on Safeguards related Research and Development and Training. Within the framework of this agreement, and as precursors of the current project, (a) a training course to ABACC staff on "3D Laser based Verification" was held at the JRC in Nov. 2007 (together with IAEA inspectors); (b) technology demonstrations took place at ABACC premises of 3D Laser based Verification (Nov. 2008) and Ultrasonic Sealing Bolt (Containment and Surveillance Workshop, Oct. 2010).

The European Commission approved in 2012 the project "*Strengthening the Safeguards Capabilities of ABACC*". The project is implemented by the European Commission's Joint Research Centre (JRC) and aims at creating at ABACC new technical, human and know-how capabilities addressing two major safeguards challenges:

A. Verification of Complex Plant Design and Layout

B. Containment of Spent Fuel in Complex Storage Environments

JRC will provide two specific Containment and Surveillance technologies: (a) 3D Laser Verification and (b) Ultrasonic Sealing. Both technologies were developed at the JRC's Institute for Transuranium Elements, Ispra, Italy, and are approved for Safeguards use by the IAEA and EURATOM Safeguards.

The following sections detail this cooperation project with ABACC, the technologies and the proposed implementation, including training and transfer of know-how.

2. Instrument for Nuclear Safety Cooperation

The EURATOM Community's *Instrument for Nuclear Safety Cooperation* (INSC) [2] promotes the application of efficient and effective safeguards of nuclear material in third countries. While pursuing a close cooperation with the IAEA, the Community finances measures supporting the application of effective safeguards of nuclear material in third countries, building on its own safeguard activities within the European Union.

In 2012, and following a specific request from ABACC, the project "*Strengthening the Safeguards Capabilities of ABACC*" was approved by the European Commission Directorate General for Development and Cooperation (DEVCO). The project is funded by the European Commission *Instrument for Nuclear Safety Cooperation* (INSC). The four year project is implemented by the European Commission's Joint Research Centre (JRC) in cooperation with ABACC.

Following the appointment of the Commission of the ABACC[2], the ABACC Secretariat became the Beneficiary of the project.

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[2] The Commission of ABACC is ABACC's policy planning organ and is constituted by diplomatic and technical representatives of Argentina and Brazil. The Commission is responsible for the approval of the decisions, resolutions and regulations applied to the performance of the ABACC's Safeguards. Among other responsibilities, the Commission of ABACC approves the General Procedures and the Manuals for Application of nuclear safeguards in Brazil and Argentina.

3. Project Structure

The project aims at creating new Safeguards capabilities, ie, technical, human and know-how, at ABACC. To achieve this objective the project includes the following actions:

i) Transfer of two Safeguards technologies: (a) 3D Verification System and (b) Ultrasonic Seals;

ii) Prototype and field demonstrations of the two above technologies at selected facilities (to be agreed with national authorities and operators);

iii) Training courses for ABACC staff and inspectors, including:

(a) Train-the-Trainers: train a selected group of ABACC officers on how to teach the two new technological capabilities

(b) Inspectors' Training: train a first group of inspectors on the use of the above mentioned technologies for safeguards verification and inspection purposes.

iv) Cooperation and technical support on the practical use of the two above technologies

In terms of implementation, the project is divided in three tasks:

Task A. Verification of Plant Design and Layout

Task B. Containment of Spent Fuel in Complex Storage Environments

Task C: Project Management

4. Technologies

The technologies to be transferred to ABACC were selected and requested by ABACC as they fit ABACC's mandate to strengthen and implement nuclear safeguards in Brazil and Argentina. The project involves two technical tasks, each one addressing the use of a specific Containment and Surveillance technology as follows:

A) 3D Laser Verification for detecting spatial changes in a nuclear site (indoor application)

B) Ultrasonic Sealing to safeguard irradiated fuel in interim or permanent storage (Figure 1).

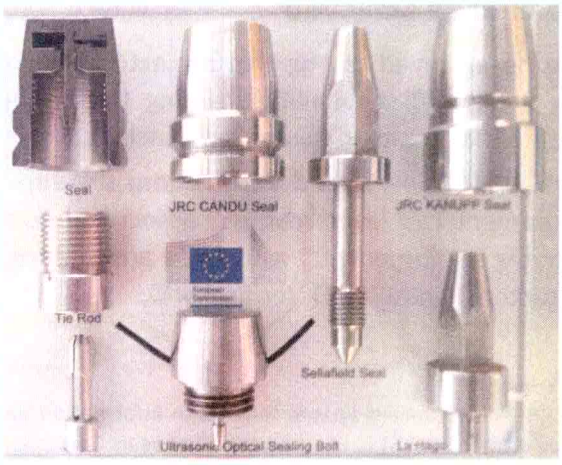

Figure 1: Examples of JRC Ultrasonic Seals.

Both technologies were initially developed at the JRC's Institute for Transuranium Elements, Ispra site, Italy, as an internal research activity and then applied to EURATOM and IAEA safeguards. In what concerns the IAEA, the application of both technologies was done under the framework of the European Commission Support Programme (EC-SP) [3] to the IAEA, namely:

i) EC-SP Task: EC-E-01425 – *"3D Laser Range Finder for Design Verification at the Rokkasho Reprocessing Plant (RRP)"* and EC-E-01993 – *"3DLR Support"*

ii) EC-SP Task: EC-E-01559 – *"Update of the Ultrasonic Sealing Bolt"*

Both technologies are approved for safeguards use by both the IAEA (responsible for the implementation of the Nuclear Non-Proliferation Treaty – NPT) and by the European Commission's DG-Energy (responsible for the implementation of the EURATOM Treaty).

4.1 Task A: Verification of Plant Design and Layout

The verification of minute details over large areas in complex environments represents a difficult task. Covering these scenarios, the application of safeguards has to verify if changes or new elements relevant to safeguards are introduced into the facility operating conditions and/or its layout.

The application of laser technology for the verification of plant layout and configuration relies on the capability of the system to measure accurate distances of objects, and between objects, in a given scene [4, 5]. It is thus possible to detect minor changes in three dimensions (as opposed to normal video surveillance projecting the 3D world onto an image plane) – 3D scene change detection. Furthermore, 3D visualization tools help an inspector to interpret the spatial changes, their origins, safeguards relevance and impact (see Figure 2). The system is able to remount a 3D model independent from the capture point of the system.

Characteristics of the 3DLR[3] system such as self-illumination, independence of ambient lighting, high spatial resolution, high accuracy, fast speed acquisition, well defined measurement parameters (such as: distance, size, speed, motion orientation and easy interfacing) make this type of system suitable for the detection of changes in complex environments.

4.2 Task A: Results to be achieved

The specific objective to be achieved during this project is "to create within the regional authority ABACC a new Safeguards capability enabling the verification of complex plant design and lay-out ('as-is')". The results to be achieved include:

i) **Provision of two 3DLR (Laser based Verification) systems.** Each system integrates commercial equipment (3D laser scanner, associated computers and accessories, e.g., tripod, carrying equipment, ...) with JRC's proprietary dedicated software, i.e., JRC 3D Reconstructor© and JRC 3D Verificator©;

[3] 3DLR is the code name for JRC's laser based system for Design Information Verification – DIV - used by the IAEA. A similar system (code name: 3DLVS) is used by the European Commission's DG-Energy for inventory verification purposes (in quasi-static storage areas). The 3DLR system (3DLVS also) includes two JRC's proprietary software packages: JRC 3D Reconstructor© and JRC 3D Verificator©.

(a)

(b)

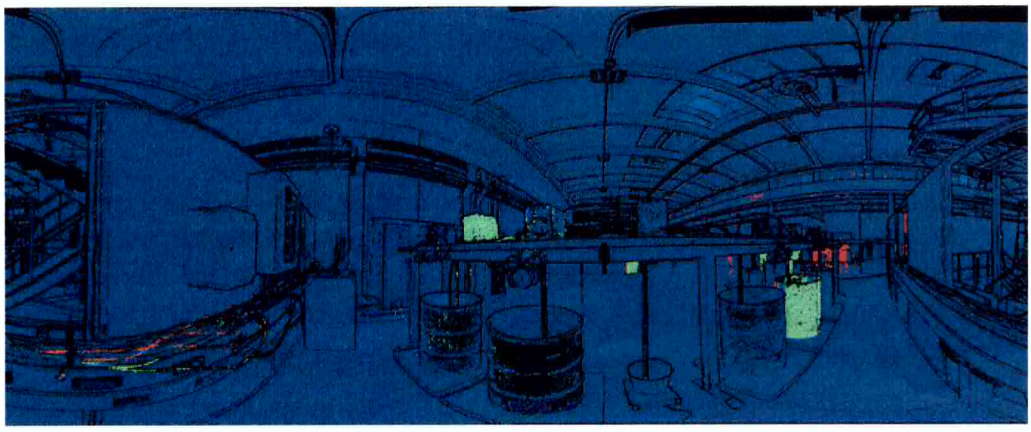

Figure 2. (a) 3D model of a facility as shown by JRC's 3DLVS software; (b) Map of changes derived from two 3D models acquired at different points of time. Changes are highlighted in red and green.

ii) **Field Test of a Laser based 3D Verification System**, for Design Information Verification purposes, at a nuclear facility in Brazil.

iii) **Train-the-Trainers**: train two ABACC officers on how to teach the new technological capability – 3D Laser Verification, to ABACC inspectors.

iv) **Inspectors' Training**: train a first group of 16-20 inspectors on the use of the 3D Laser Verification technology for safeguards verification and inspection purposes.

v) **Cooperation and technical support** on the practical use of the 3D Laser Verification System.

vi) **Maintenance activities**, including two further releases of the application specific software and yearly calibration of the laser range finders.

vii) **Delivery of support documentation** (operation guide and maintenance manuals)

4.3 Task B. Containment of Spent Fuel in a Complex Storage Environment

The second challenging goal is applying efficient and effective safeguards for on load reactors, based on the verification of the irradiated fuels that leave the core and keep the knowledge of such items during interim or permanent storage. For doing that, tools such Core Discharge Monitor and Fuel Bundle Counter are used together with containment and surveillance. Besides, the verification of the inventory of the spent fuel stored at the reactor's pools is periodically performed.

One way to maintain the knowledge on the nuclear material at a spent fuel pond is to apply containment measures at flasks or racks where these fuels are stored. It is important to guarantee that ABACC and IAEA maintain the knowledge over multiple layers of the spent fuel storage through the application of seals on fuel elements, racks or hangers.

For this application, ultrasonic seals[4] [6] have the necessary characteristics since they are designed to be attached underwater, are very resistant to harsh environments like storage pools, are easy to apply and can be regularly verified. The verification of ultrasonic seals does not involve the replacement of cables or substitution of the seal, nor does it require the movement of spent fuel. This improves inspectors' productivity, takes due care of radiation safety considerations and decreases the disturbance to the plant operator.

4.4 Task B: Results to be achieved

The specific objective to be achieved during this project is "to create within the regional authority ABACC a new Safeguards capability based on JRC ultrasonic sealing technology, and have a demonstration prototype adapted to specific PHWR underwater storage deeper ponds and particular spent fuel storage configuration". The results to be achieved include:

i) **Design of a complete and specific sealing system** based on real conditions of an underwater spent fuel storage pond;

ii) **Field Test and demonstration of Ultrasonic Seals**, for maintaining the continuity of knowledge of verified irradiated fuel. For this test, It will be assumed that spent fuel is stored in a closed packed way, in two layers at the storage pool (see Figure 3). For verification of this particular configuration, the accessibility of nuclear instrumentation to the lower layer of spent fuel is very complex and time consuming. Ultrasonic seals should make verification much more easy and straightforward. This test will be also useful to consider the technology for other types of nuclear reactors with different spent fuel storage configurations.

iii) **Improvement of the control software**, including tele-operation assistance requested by the high water depth;

iv) **Equipment** to be supplied: 150 ultrasonic seals and three reading systems. Handling tool interfaces and specific sealing accessories will be also supplied.

v) **Associated computers, accessories and JRC's dedicated software** for identifying and reading the seals;

vi) **Train-the-Trainers**: train two ABACC officers on how to teach the new technological capability – Ultrasonic Sealing, to ABACC inspectors.

[4] Ultrasonic seals developed by the JRC are patented and currently used in Canada, France, Pakistan, Romania and UK by both EURATOM Safeguards and IAEA.

vii) **Inspectors' Training**: train a first group of 16-20 inspectors on the use of Ultrasonic Sealing for safeguards verification and inspection purposes.

viii) **Cooperation and technical support** on the practical use of Ultrasonic Sealing.

ix) **Delivery of support documentation** (operation guide and maintenance manuals);

x) **Preventive maintenance** (2 years).

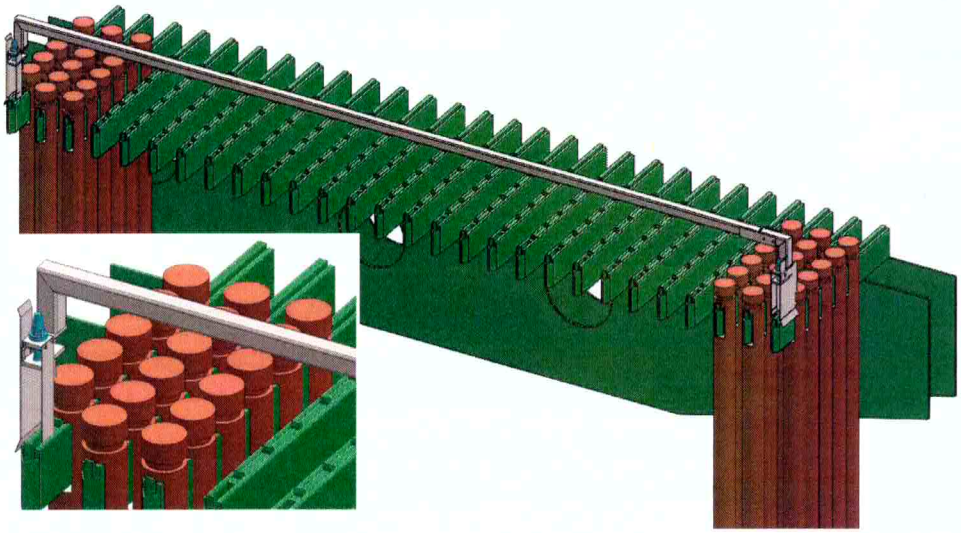

Figure 3. Proposed solution to seal a spent fuel pond

5. Safeguards and Coordination with the IAEA

The project foresees close interaction with the International Atomic Energy Agency (IAEA). Indeed, the IAEA has been, and will be, invited for major project events, including:

i) Kick-off meeting,

ii) Technical meetings,

iii) Demonstration of the technologies,

iv) Distribution of specific documentation issued during the project

v) Training sessions, both in Europe (Train-the-Trainers) and in South America (inspectors' training)

It should be noted that by creating new safeguards capabilities at ABACC, it will be possible (and desirable) that the instrumentation provided can be jointly used with the IAEA. To this effect, the IAEA will be contacted for relevant technical decisions. This will ensure that IAEA expectations in terms of the equipment to be supplied will be met in view of future joint-use.

More specifically, the IAEA met ABACC and EC/JRC representatives in the following occasions:

- September 2013: the European Commission and ABACC organised a presentation of the project to the IAEA Deputy Director General for Safeguards (see Figure);
- February 2014: JRC and ABACC met the IAEA to discuss in detail how EC funded equipment and systems, namely 3D laser scanners, can be made available later for Joint

Safeguards Use by both ABACC and the IAEA. This led to the agreement on the technical specifications of the 3D laser scanners to be procured.

- September 2014: short presentation of the status of the project was made by ABACC and JRC to IAEA staff.

6. Status of the Project

The following activities have already taken place or are programmed shortly:

- Technical specifications for the laser based equipment to be procured, 2014;
- Technical specifications for the ultrasonic sealing equipment to be procured, 2014;
- Specification of the demonstration and field test of the 3DLR system at a nuclear facility in Brazil, November 2014;
- Train-the-Trainers course for the Ultrasonic Seals, May 2015;
- Train-the-Trainers course for the 3DLR verification system, June 2015;
- Technical proposals for sealing a multiple layer spent fuel storage pond, considering Atucha I spent fuel storage configuration, March 2015
- Specification of the demonstration and field test of the Ultrasonic Seals at a storage configuration type of Atucha I, Argentina, June 2015

7. Discussion and Conclusions

Looking for the best practices in the safeguards application, ABACC and EURATOM – the European Atomic Energy Community – signed in February 1999 a cooperation agreement based on mutually agreed Research and Development topics and the training of nuclear safeguards inspectors in the field of nuclear safeguards. Cooperation between the parties to this Agreement shall be on the basis of mutual benefit, equality and reciprocity.

ABACC and the European Commission engaged into a collaborative project on Strengthening the Safeguards Capabilities. This project involves two technologies – 3D Laser Verification and Ultrasonic Sealing, the benefits of which are to be evaluated for possible Safeguards application at facilities in Argentina and Brazil.

3D laser-based techniques continue to improve and cover a large range of activities including Design Information Verification (DIV), containment verification and UF6 cylinders tracking. The ABACC expectation is that the use of 3D laser-based instrumentation will increase over the coming years and a direct benefit to the effectiveness and efficiency of its safeguards implementation can be provided in a near future.

The main purpose of sealing using ultrasonic technique is to maintain the continuity of knowledge and avoid re-measurement of nuclear material inventories. This is particularly important when applied to spent fuel storages. The historical application of this technique has been analysed by ABACC since the development of the underwater seal based on ultrasound in conjunction with a randomly produced wire coil which create the seal signature. The new bolt for underwater sealing is derived from the design of the sealing bolts already used in the La Hague reprocessing plant. On-going developments of various

Ultrasonic Sealing Systems for both underwater and dry spent fuel storages applications, in particular for dry storages using cask with concrete biological shielding have been tested.

Within the framework of the Quadripartite Agreement [1], ABACC, together with national authorities and operators in Brazil and Argentina, is analysing the application of 3D laser and/or ultrasonic seals technologies. In particular, the analysis will focus on how the use of the new technologies improves safeguards without affecting operational tasks and turning activities less intrusive and more efficient.

The use of new technologies is key to enhancing Safeguards effectiveness and efficiency. In this particular case, any future application of these technologies should be developed and implemented such that it allows Joint Use between ABACC and IAEA when the application on safeguards is discussed and approved. Results from the containment provided by the ultrasonic seals and verification of design by 3D laser-based techniques shall permit that ABACC and IAEA draw independent conclusions.

8. References

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