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The ESARDA Working Group on Containment and Surveillance: Activities and achievements

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Abstract

The working group on containment and surveillance (C/S) is one of the discipline-oriented working groups of ESARDA – the European Safeguards Research and Development Association. Its mission is (a) to provide the safeguards community with expert advice on C/S instruments and methods and on their performance and (b) to act as a forum for the exchange of information on such instruments and methods, including unattended and remote monitoring systems. Currently, sixteen institutions contribute to the working group as members or observers. The institutions represent safeguards authorities including the European Commission's Directorate General for Energy (in charge of the implementation of the EURATOM treaty) and the International Atomic Energy Agency (IAEA), instrument developers, plant operators, national authorities and research laboratories. The working group meets twice per year, in order to address and discuss topics of interest. To this end, individual working group members volunteer to prepare discussion and working papers. The goal is to publish the results of the working group's discussions, preferably in the ESARDA Bulletin. The working group's current topics include: (i) Guidelines for developing sealing systems; (ii) XCam: IAEA's Next Generation Surveillance System; (iii) Interface between Safeguards and Security; (iv) 3D Laser based applications in Safeguards; (v) New generation of sealing developments; (vi) Enhanced Data Authentication System; (vii) Designing and simulating tools for surveillance and remote monitoring, and (viii) Performance & assurance of C/S instrumentation. For the ESARDA web site, the working group maintains a compendium of C/S instruments and methods and contributes to drafting technical sheets on safeguards-specific topics. When appropriate, the working group holds joint meetings with other ESARDA working groups to discuss topics of common interest. Regarding the annual ESARDA course on Nuclear Safeguards and Non-Proliferation, the working group provides a lecturer and material on C/S instrumentation and methods. The paper describes the working group's current terms of reference, membership, working method, topics of interest, achievements, and gives an outlook on the topics to be addressed in the near future.

1. Introduction

ESARDA, the European Safeguards Research and Development Association, is comprised of European organisations actively involved in the Research and Development of nuclear safeguards technologies, equipment and methodologies, including training. ESARDA's main objective is to assist the European safeguards community with the advancement of safeguards, enhancing the efficiency of systems and measures, as well as investigating how new techniques can be developed and implemented.

As a 40 year old R&D association [1], ESARDA aims to bring together all those involved in safeguards, so that progress and continuous improvement in international safeguards can be achieved efficiently and to a professional standard. The principal issues are co-ordination of research, exchange of information and joint execution of R&D programmes. To this end the following activities take place:

i) *Annual Meetings and Symposia*: aiming at stimulating collaboration and exchanging scientific and technical information.

ii) *Working Groups*: promoting and undertaking collaborative R&D and information exchange activities in specific fields. R&D activities are performed by more than 100 experts (members or observers of ESARDA) collaborating within the nine working groups.

iii) *Bulletin and web site* [2].

The purpose of this paper is to describe the Working Group on Containment and Surveillance (C/S WG) and detail its activities in the last four years. The C/S WG is a discipline oriented working group and was created in 1979.

2. The C/S Working Group

The C/S WG aims at providing the Safeguards Community with expert advice on Containment and Surveillance instruments and methods and on their performance; and act as a forum for the exchange of information on such instruments and methods, which are considered to include unattended and remote monitoring systems.

2.1 Terms of Reference

The C/S Working Group operates under the following terms of reference.

1. Advise the European Commission and IAEA on new and improved instruments and methods and on areas where R&D effort is still needed
2. Maintain a list of C/S instruments and methods currently used or under development for safeguards purposes
3. Develop methods for determining the assurance and performance of C/S equipment and contribute to their evaluation
4. Contribute to determining, on request, the assurance and performance of C/S equipment
5. Promote cooperation with other working groups and the inspection authorities
6. Assist in the development of C/S instruments and methods in support of safeguards approaches including the definition of technical requirements
7. Assist in the development and assessment of data evaluation and decision tools
8. Collaborate with other working groups to develop comprehensive and integrated tools to support safeguards approaches
9. Promote the exchange of information and experience among facility operators, safeguards authorities, and developers
10. Study technical characteristics of instruments and devices from other domains (e.g., physical protection) and investigate into the possible transfer of technology from these domains to the safeguards area
11. Look at other verification regimes and assess to what extent their techniques and methods could be used for safeguards

2.2 Membership

The ESARDA Working Group on Containment and Surveillance has 18 members and observers from R&D establishments, safeguards equipment manufacturers, safeguards inspectorates, plant operators, regulatory agencies, and ministries. The following organisations are represented:

ESARDA Organisations

European Commission (DG ENERGY, DG JRC)	German nuclear operators (GNS, VGB)
STUK – Finnish nuclear regulatory authority	German Jülich Research Centre
SSM – Swedish nuclear regulatory authority	NNL – British nuclear laboratory
IRSN – French Institute for Radiation Protection, Safety and Security	British Sellafield Safeguards Department
AREVA – French nuclear industry	

Observers

IAEA – International Atomic Energy Agency	CNSC – Canadian Nuclear Safety Commission
ABACC – Argentine-Brazilian Safeguards Authority	US DoE - Sandia National Laboratories
ASNO – Australian Safeguards and Non-Proliferation Office	

2.3 Working Methods

The working group meets twice per year. One meeting is usually coordinated with the ESARDA Annual Meeting taking place in May or June. The second meeting is held in autumn with the Joint Research Centre Ispra being the usual venue. Contributions to the working group are voluntary in nature and depend on the delegating organisation's capabilities and resources. Other factors are expertise and availability of individual working group members.

In consultation with the ESARDA management and in compliance with its mission and terms of reference, the working group addresses and discusses topics of interest. To this end, individual working group members volunteer to prepare discussion and working papers. Certain topics may be of an interdisciplinary character raising the interest of more than one ESARDA working group. In such cases, two or more working groups enter into a temporary cooperation.

The results arising from the working group discussions are primarily published in the ESARDA Bulletin.

2.4 Support to Other ESARDA Activities and Working Groups

The results of the discussions of the C/S working group are made available to ESARDA members and Working Groups. Further, the working group contributes regularly to the ESARDA Technical Sheets – published at the ESARDA web site.

Since 2005, the working group has supported the ESARDA working group on Training and Knowledge Management by contributing with a lecturer and teaching material to the yearly ESARDA course on Nuclear Safeguards and Non-Proliferation [3].

3. Past and Present Activities

Each working group meeting normally addresses several topics, the discussion of which can take more than one meeting. The following topics were addressed in the last four years (alphabetical order):

- 3D Surveillance
- 3D laser scanning techniques for safeguarding fairly static storage facilities
- Audit Group guidelines and C/S development
- C/S Approaches for Spent Fuel Management
- Data Security: key management issues
- Design and simulation tools for surveillance and remote monitoring
- Design Information Verification (DIV) / Basic Technical Characteristics (BTC)
- Enhanced Data Authentication (EDAS)
- Euratom Safeguards Approaches and Needs
- Geological Repositories: C/S approaches
- Guidelines for Sealing, Identification, and Containment Verification Systems
- IAEA Integrated Safeguards
- IAEA's New Generation Surveillance System
- IAEA's Remote Monitoring Centre
- Implementation of the Additional Protocol
- Interface between safeguards and security
- Interface between the EOSS electronic seal and video surveillance
- Laser based 3D System for grid verification
- Laser Scanning for DIV at Underground Repositories
- Laser Techniques for Identification and Containment Verification of Pu Cans and UF6 Cylinders.
- Performance assessment of C/S instrumentation
- Proliferation resistance
- Remote Data Transmission system (jointly operated DG-ENERGY and IAEA)
- Remote-monitored sealing array
- Review of Surveillance Data – Safeguards Review Station Concept
- Ultrasonic Seals – new generation
- Wireless in-plant data transmission

4. Highlighted Issues Dealt with by the Working Group

The following subsections detail some of the work that was discussed by the ESARDA C/S Working Group since 2006.

4.1 Performance Assessment Methodology for Containment and Surveillance Equipment

Equipment performance aims at the creation of relevant data. The issue of how to assess the performance of C/S equipment, especially for unattended operation, is important not only for the development of appropriate safeguards systems but also for the review of existing systems. Performance assessment facilitates the selection process of appropriate equipment.

In contrast to nuclear material measuring methods, the application of C/S measures, i.e., optical surveillance and sealing, yields non-quantifiable results involving some degree of subjective judgement. Hence, a quantitative mathematical approach is not conceivable.

Therefore, the developed C/S performance assessment methodology is a non-quantitative, structured procedure that allows assessing the suitability of different C/S instrumentation to comply with the objectives of its application, i.e., with the safeguards approach.

The basic principle is to define, based on safeguards requirements, *a facility-specific task profile against which the equipment performance profile is to be checked*. The performance profile of C/S equipment is derived from the functional specifications and design basis tolerances provided by the equipment manufacturers.

The methodological approach [4,5,6] comprises the following steps: (1) Acquisition and analysis of design information and operational characteristics of the facility under consideration; (2) assumptions on diversion and misuse scenarios; (3) definition of safeguards requirements; (4) compilation of candidate C/S equipment; (5) performance assessment of C/S equipment.

The method is still not fully developed and has been applied on a trial basis to a long-term dry storage facility of spent fuel assemblies in Castor® casks. Among others, the application ‘seal on protective lid’ was examined, for which safeguards requirements were defined. The following candidate C/S equipment routinely used by the IAEA was taken into account: Type E cap-and-wire seal [7], COBRA fibre optic seal [8], and VACOSS electronic seal [9]. In comparing the performance levels achieved by the seals the following ratings were applied:

no compliance	not relevant	satisfactory	Good
-1	±0	+0.5	+1

The following table lists some safeguards requirements (task profile) and ratings (performance profile) for the assessment of a seal application.

Some requirements for seal on protective lid	Performance level of seal		
	Type E	**COBRA**	**VACOSS**
Seal wire diameter less than 7 mm	+1	+1	+1
In situ verifiable	-1	+1	+1
Operating temperature between 0°C and 80°C (max. temperature of cask body)	+1	+0.5	+0.5
Capable to function in high-level radiation field [replacement strategy required]	+1	-1	-1
Remote interrogation of seal possible; low frequency of access to seal for interrogation (i.e. low radiation exposure, low interference with plant operation)	-1	-1	+1
Embedded time stamp	-1	-1	+1
State-of-Health (SoH) information available	-1	-1	+1
Performance sum	**-1**	**-1.5**	**+4.5**

The results suggest that the VACOSS seal would be the most appropriate seal for this application. The advantages of this seal are mainly due to its remote interrogation capability and the consequences thereof, i.e., evasion of radiation risk for inspectors and plant operators. However, the complete trial application conducted by the working group revealed that there remain problems of defining the required level of fulfilment and of rating the level of fulfilment by an individual C/S system. Methodological problems still to be solved are, among others, the issue of comparing and unifying the different nature of factors; i.e., how effects of equipment costs, health impacts on persons due to radiation exposure and levels of reliability are correlated with each other.

4.2 Wireless In-Plant Data Transmission

Given the advances in wireless communication technologies, the working group did a study on the potential of wireless in-plant data transmission for Safeguards purposes. This study led to a two-part report published in the ESARDA Bulletin [10,11]. The first part provided specific arguments for considering the use of wireless communications as a complement to fixed cable installations. From a safeguards authority's point of view, wireless in-plant data transmission is attractive for the ease of installation and the ability to respond to the changing requirements as the inspection approach evolves. However, for wireless technologies to be considered as a viable complement to cables, a number of concerns should be accounted for. There are specific requirements arising from the plant operators' boundary conditions which have to be addressed before wireless techniques are deployable in nuclear facilities. The study presents an overview of state-of-the-art wireless technologies and makes a projection on capabilities that are likely to be reached in the near future. The second part was dedicated to Radio-Frequency technologies in a safeguards concept, to information security considerations, and to the integration of wireless technologies into existing and new facilities.

4.3 IAEA's New Generation Surveillance System (NGSS)

IAEA's Next Generation Surveillance System is a joint development of the German and United States Support Programmes to the IAEA. Its design goals include:

- Integration of the surveillance camera and the security critical components into one tamper-indicating, electronically sealed assembly
- Advanced data security (authentication and encryption)
- Short Picture Taking Interval (PTI)
- Support for high resolution and colour images
- Support for modern TCP/IP networking over Ethernet and possible co-existence with current surveillance equipment (backward compatibility)
- Modular, fully scalable system to allow simpler installation, maintenance and spare parts logistics
- Low power consumption
- High reliability under harsh environmental conditions
- Commercial-Off-The-Shelf (COTS) and non-proprietary components where possible (extended life cycle management)
- Designed to be easily implemented as Joint-Use-Equipment (JUE)

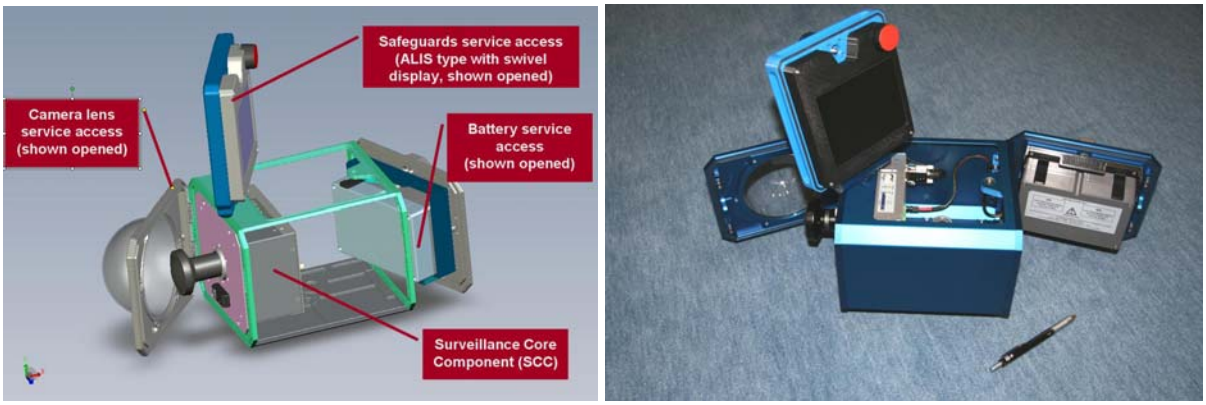

Figure 1: NGSS: exploded view and existing prototype (courtesy of IAEA)

The first prototypes became available late in 2009 and are now under test (see Figure 1). Also, the IAEA has started the required vulnerability assessment studies. The NGSS development is scheduled to be completed by mid 2010. Regular updates to the C/S Working Group on the progress of the NGSS development and its authorization for IAEA safeguards use are expected late in 2010 [12,13].

4.4. Trial of 3D laser scanning equipment in France

This presentation focused on the trial use of 3D laser scanning at an installation in France [14]. The trial involved the close collaboration between the European Commission DG Energy (EURATOM Safeguards), Comité Technique Euratom (France's coordination Authority), AREVA (operator) and the European Commission Joint Research Centre (technology provider). The discussion at the C/S working group focussed on the technical aspects of the verification system used.

The purpose of these trials was evaluating the capabilities of the 3D laser verification system (3DVS) in Safeguarding fairly static storage facilities. More specifically, the aim was evaluating the capability of the 3DVS in detecting whether containers had been moved inside a nuclear material storage. Ultimately, the scope is to ensure that containers had been handled in accordance with the declaration of the operator.

The conclusion is that it seems feasible to use the 3DVS for confirming the movement of containers (or its absence) in the storage area (see Figure 2).

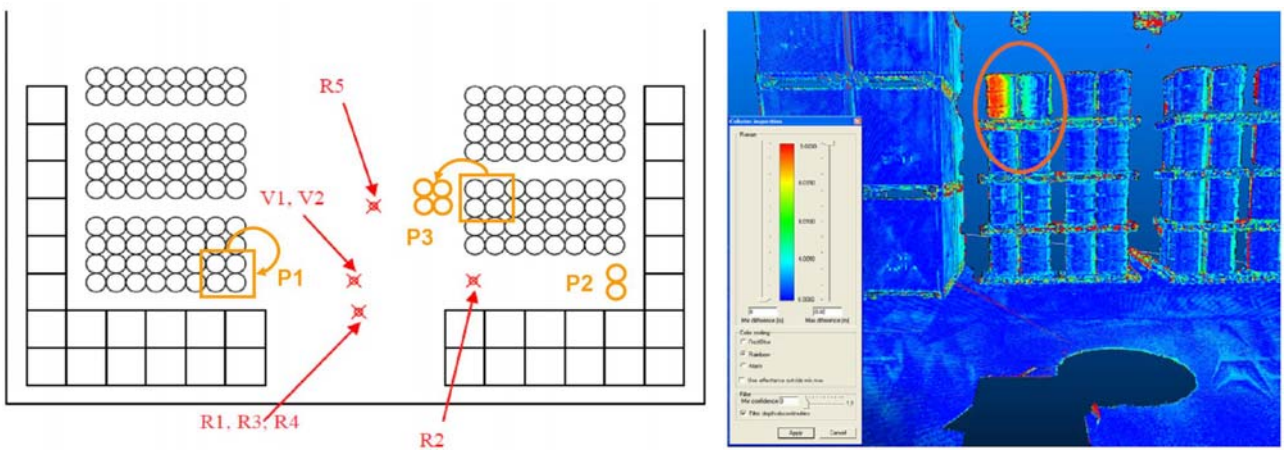

Figure 2: Description of the container changes made by the operator (unknown to the verification team) and detection of a group of containers put back in, allegedly, the 'same' place.

5. Future Topics

The following topics (alphabetical order) are scheduled to be discussed in the forthcoming meetings of the C/S Working Group:

- C/S at Final Disposal Facilities (including Geological Repositories)
- Guidelines on sealing, identification Techniques
- Joint Session with NDA WG: Surveillance and Security, including NDA Surveillance and Unattended and Remote Monitoring and Measurement Systems
- New developments in sealing technologies
- Remote system control
- Review of Surveillance Data Streams
- Safeguards, Safety and Security: C/S perspective
- Technical Updates on the following new instruments and technologies: Examples: NGSS-camera, EDAS

6. Conclusions

The paper provided an overview of ESARDA's Working Group on Containment and Surveillance, its working methods and a description of the current and future topics of discussion. The results of the discussions are normally summarised and published in a form of paper to the ESARDA Bulletin, ESARDA Symposia, INMM Annual Meeting or any other relevant Safeguards relevant forum. Some organisations

present their R&D results to the working group for discussion and application feedback, prior to publishing their work.

In the period 2007-2010, twenty publications resulting from the work of the C/S working group were published in the ESARDA Bulletin or as part of the Proceedings of the ESARDA Meeting. Many other publications authored by C/S working group members were published at other Safeguards fora.

The C/S Working Group also maintains a Compendium of all C/S instruments used by Safeguards inspectorates (typically, DG-ENERGY and IAEA) [15].

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