Evolution of the Nuclear Safeguards Performance Laboratory
PERLA of the Ispra Site of the Institute for Transuranium Elements


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Abstract:

Based upon the experience of many years of operation, the safeguards Performance Laboratory PERLA will be re-shaped in the near future (and relocated on the Ispra site such as not to interfere with decommissioning activities). During almost 30 years of successfully operating nuclear facilities in Ispra for supporting nuclear safeguards inspectorates with R&D, equipment development and training for in the meantime more than 1250 trainees, this laboratory is the main work-horse in this field and has functioned very frequently in the last years as easily accessible nuclear laboratory for external users, even if a constant evolution took place in the last years, and additional facilities like the active neutron laboratory PUNITA or the ITRAP test laboratory for nuclear security R&D, testing and training have been taken in service, this step-change will allow refiguring the laboratory to face also new user expectations. NDA for safeguards continues to be a cornerstone of the measurement capacities complemented by experimental and advanced approaches, such as using active neutron interrogation, automation of measurements, complemented by Monte-Carlo simulations for neutron and gamma radiation. The tendency is also to integrate multiple plant signals (not only NDA measurements) in an overall assessment scheme and we envisage offering training and exercising capabilities for the inspectors also in this direction in the future. This paper will thus provide some insight in the concepts for the future use of the nuclear facilities on the Ispra site, which is complementary to two other contributions to this symposium, i.e. one describing the activities of our sister unit in Karlsruhe on NDA Safeguards Training and another on the new Advanced Safeguards Measurement, Monitoring and Modelling Laboratory (AS3ML) being built currently in Ispra.

1. Introduction

A substantial part of the Safeguards activities performed at ITU is executed in the PERformance Laboratory (PERLA) at the Ispra site of JRC since many years. PERLA deals in particular with Non-Destructive Analysis (NDA) methods for the determination of the isotopic composition of Uranium and Plutonium by gamma spectrometry and their masses by passive and active neutron measurements or calorimetry, used either individually or in integrated systems. The main activities performed in PERLA are linked to:

- Development, testing and implementation of reliable NDA instruments, associated data acquisition systems, interpretation models and software for user friendly applications of various techniques,
- Calibration of NDA instruments using well characterised PERLA standards,
- Training of inspectors.

In the course of the ongoing decommissioning project of other nuclear facilities at the Ispra site, a new strategy for R&D, support to stakeholder and training in the field of NDA has evolved. A central element is the planning to construct a dedicated new laboratory building

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outside the decommissioning area which will host the nuclear material, offer laboratory space for several activities, and will be the home base of the JRC for experimental work in the field of non-destructive assay.

This paper will thus provide some insight in the concepts for the future use of the nuclear facilities on the Ispra site.

2. PERLA laboratory

2.1. Infrastructure and capabilities

The today infrastructure for the NDA work consists in the large PERLA laboratory itself, which is mainly used for R&D and training for nuclear safeguards. Here, there are all typical gamma and neutron inspection instruments available and it is the place for developing and testing such devices as well as for inspector training. Beyond that there are new instrument types which are of interest for R&D and may become useful for safeguards and security at a later stage.

The active neutron interrogation with pulsed neutrons performed in the PUNITA laboratory (PUlsed Neutron Interrogation Test Assembly PUNITA) represents another development started from PERLA as complement to the mainly passive safeguards inspection methods.

When nuclear security became a politically important issue, several additional laboratories for dedicated tasks have been built up during the last years for systematic testing of nuclear security equipment from hand held devices to portal monitors, it is the laboratory dedicated to ITRAP (Illicit Trafficking Radiation Assessment Program) [1]. In parallel, the nuclear security training centre SeTraC (Security Training Centre) [2] was established for training of law enforcement staff but also for national trainers for this field. It has space for detection exercises with hand-held instruments and comprises an outdoor area with portal monitors next to "inspector rooms". It was inaugurated in 2009 and started operation with two courses in September and October 2009. Based on the Ispra experience, a similar laboratory was established at Karlsruhe (Germany), both sites are now offering training under the common name EUSECTRA.

Nuclear material samples are available at Ispra for all these laboratory spaces. The inventory comprises typical nuclear material as found in the civil fuel cycle as well as some examples of weapon material.

2.2. Activities

2.2.1. Training

2.2.1.1. Nuclear Safeguards training

The Nuclear Security Unit (NUSEC) of the ITU delivers a very substantial contribution to the training of Nuclear Safeguards Inspectors of DG-ENER (Nuclear Safeguards inspectors Directorate, Luxembourg) and IAEA Nuclear Safeguards Department.

A wide variety of topics covering many key activities of nuclear safeguards are delivered by the four NUSEC laboratories namely PERLA, SILAB, AS3ML and 3D laboratory. In total, 1270 participation certificates were attributed during these three last decades.
The laboratory PERLA contributes to this activity with two third of the total trainee days. Right now, the following courses are held in routine up to two times per year:

- Gamma spectrometric measurement of the uranium enrichment,
- Gamma spectrometric measurement of the isotopic composition of Pu,
- Passive neutron interrogation (High Level Neutron Coincidence Counter- HLNCC),
- Advanced hands-on RADAR / iRAP / iRAP evaluation

A complete description of these courses is given at:

Moreover, there are often specialised courses dedicated to specific instruments or new methods which are applied only in a single facility. Recent examples are training on the use of the upgraded JRC Waste Drum Monitor (determination of small masses of fissile material in 220l waste drums) or on a new gamma spectrometric method for the $^{235}\text{U}$ mass determination in MTR fuel plates.

Although these courses are designed mainly for inspectors from DG-ENER and IAEA, nuclear inspectors from national authorities (e.g. Japanese Nuclear Material Control Centre, Spanish Nuclear Safety Council) occasionally participated to our sessions.

In complement, PERLA staff organises training sessions in operational facilities or modular courses at Inspectorate headquarter on request the EURATOM Nuclear Safeguards Directorate. The example of the in-field training course on uranium enrichment determination by gamma spectrometry given since several years and hosted by the AREVA site Tricastin (France) demonstrated the importance to link the training sessions given in PERLA laboratory with in-field training to better grasp the inspector measurement concerns and to orientate the laboratory sessions in a way that their contents will be most profitable.

2.2.1.2. Nuclear security training

The nuclear security training centre EUSECTRA hosts regularly relatively large groups of trainees from IAEA member states which work directly in the law enforcement structures of their states. The aim is to familiarize the participants with the threat from illicit trafficking with nuclear material and detection and counter measures. Every year there are about ten such courses. They are organised in close collaboration with IAEA and US-DoE. A joint syllabus for border guard training and Train-the-Trainer has been developed through this collaboration under the BMWG (Border Monitoring Working Group) [3].

2.2.1.3. Nuclear Safeguards and Non-proliferation education

Based on three decades experience in safeguards, the PERLA staff also contributes to the ESARDA course on Nuclear Safeguards and Non-proliferation delivered in Ispra since 10 years and which is now also “exported” outside Europe with funding from the European Commission, DG DEVCO, like to Malaysia in 2013 and Thailand in 2014. [4].

A complete description of the ESARDA course is given at:

https://esarda.jrc.ec.europa.eu/
2.2.2. Research and Development

Changes in the fuel cycle or new facilities require continuously new solutions for safeguards. For the time being the PERLA laboratory is carrying works on the following topics, most part of them are requested by DG-ENER or IAEA:

- Study of the digital MCA-527 (follower instrument of the analogue MCA-166) both for gamma spectrometry and neutron (replacement of old neutron counting electronics) [5, 6],
- Design and implementation of a NDA instrument to determine the $^{235}$U mass in MTR plates [7],
- Contribution to the Prototype Tomographic Spent-Fuel Detector System [8, 9],
- Development of a passive neutron system to determine the $^{235}$U enrichment in 30 B and 48 Y containers support to DG-ENER [10],

In parallel to the experimental work being performed in PERLA for instrument testing, the performance of the various NDA instrumentation devices can be assessed by theoretical simulations, mainly based on the MCNP code.

The most recent studies were carried out on the matter are:

- Characterization of a cubic EJ-309 liquid scintillator detector [12],
- Calibration and Monte Carlo Modelling of a fast-UNCL for the IAEA, 2011 [13],
- Monte Carlo Modelling of a n-type coaxial high purity germanium detector [14].

2.2.3. Support to costumers

The support to customers represents the core activity of the PERLA laboratory. Two of the ongoing support activities to costumers are aimed to:

- replace the EURATOM measurement stations in the plutonium storages of the units UP2 and UP3 of La Hague (France) [15],
- create an unattended monitoring system for plutonium storage in Magnox plant (United Kingdom).

2.2.4. Hosting measurement campaigns and workshop

PERLA also offers to external users (fig.1) the possibility to access to nuclear material and expertise for their development work, and welcome several workshops per year, the most recent of which are:

- Common test campaigns of the MCA-527 with IAEA and EURATOM (Spring 2014), Scintilla [16] Bench mark campaigns (January and November 2014),
- Testing of alternatives to He-3 for neutron detection (October 2014).
3. INS3L laboratory

The INS3L laboratory (Ispra Nuclear Safeguards, Security and Standardization Laboratory), which is under planning, will group the different existing nuclear facilities of the nuclear Security Unit, i.e.:

- PERLA
- ITRAP (including a 30 m rail track for dynamic testing)
- EUSECTRA (with an open air space for radiation portal monitors)
- PUNITA instrument room (with its sealed (D,T) neutron generator)
- PUNITA control room
- Physics laboratory (including climatic chamber)
- Storage area

3.1. Infrastructure and capabilities

Fig.2 shows the conceptual project of the INS3L laboratory which comprises a total experimental hall of 800 m².

The concept of the new building involves three main areas:

a) Experimental Hall in a controlled zone with access control and license for work with, and storage of, nuclear and other radioactive sealed sources (about 800 m²)
b) Support areas: printer room, server room, radioprotection/dosimetry, conventional storage, electronics workshop (about 250 m²)
c) Offices, meeting and lecture rooms, entrance/reception, bathrooms (about 250 m³).
3.2. Activities

The laboratory INS3L is foreseen to continue the activities presently carried out in the different nuclear areas the NUSEC unit, both for safeguards and security i.e.:

1. R&D in NDA techniques applied to nuclear safeguards and nuclear security
2. Scientific/Technical support to ENER/IAEA and member states
3. Instruments testing, validation and standardization
4. Monte Carlo simulation and modeling combined with measurements
5. Training of inspectors in nuclear safeguards
6. Training of Front Line officers (FLO) and Train the Trainer of FLO in nuclear security and detection

3.3. Concept for the future use

The laboratory INS3L will not only continue the work as performed up to now in the above mentioned traditional laboratories, but will also evolve stepwise towards a “user laboratory” with easy access to nuclear material for guests and trainees. This is planned due to the foreseen use of only sealed sources with a low level of radiation emission and the low inventory of nuclear material. The situation, w.r.t. access, is thus expected to be quite different from the one in nuclear facilities with host also open radioactive and nuclear materials.
It is also the concept to integrate new tasks and working directions, e.g. contributions to standardization with security instruments. The Integration of nuclear and non-nuclear laboratories will go ahead, the RADAR/iRAP evaluation course for DG ENER in PERLA and AS3ML will be a forerunner in this direction. The experience of staff shall be used beyond the laboratories; the contribution to the outreach initiative for training is a new way of contributing to political needs. Integration of methods is also an aim in the technical work; the labs may deliver integrated solutions for the supervision of the first final repository in the world at Onkalo in Finland.

4. Conclusion

A positive development of the PERLA laboratory as an important place for fostering NDA techniques can be expected, based on the connection with the most important stakeholders IAEA, EURATOM and the DGs of the European Commission, with new laboratory infrastructure of interconnected nuclear and non-nuclear laboratories, and with the experience of the staff of the Nuclear Security Unit at the JRC in Ispra.

5. References


