The European Commission’s science and knowledge service
Joint Research Centre

JRC Nuclear Security Safeguards and non-proliferation Activities

Tokyo, 5 June 2017

Said Abousahl
Head of Euratom Coordination Unit
EC/JRC-HQ
**JRC at a glance**

Established 1957  
5 locations  
around 3000 staff

**The Vision:**  
To play a central role in creating, managing and making sense of collective scientific knowledge for better EU policies.

**The Mission:**  
As the scientific and knowledge service of the Commission our mission is to support EU policies with independent evidence throughout the whole policy cycle.
High-level objectives for JRC EURATOM Research and Training Programme (2014-2018)

1. – Improve nuclear safety including, fuel and reactor safety, waste management and decommissioning, and emergency preparedness.

2. – Improve nuclear security including: nuclear safeguards, non-proliferation, combating illicit trafficking and nuclear forensics.

3. – Raising excellence in the science base for standardisation.

4. – Foster knowledge management, education and training.

5. – Support the policy of the Union on nuclear safety and security and the related evolving Union legislation.
JRC's Euratom Activities

Safety of Generation II and III nuclear reactors

Safety of Generation IV nuclear reactors

Nuclear Emergency Preparedness and Response

Partnership and support to Member States, Stakeholders; international cooperation

Radioactive waste management

Nuclear safeguards and non-proliferation

Nuclear Security CBRNE

Nuclear decommissioning

Nuclear Science Application

Knowledge management, education & training, R&D infrastructure

Repository

1mm

EURDEP
**Nuclear Security and Safeguards at JRC**

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<th>Effective and Efficient Safeguards</th>
<th>Verification Absence of Undeclared Activities</th>
<th>Nuclear Non Proliferation</th>
<th>Combating Illicit Trafficking</th>
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<td>- Nuclear material measurements</td>
<td>- Trace &amp; particle analysis</td>
<td>- Export control</td>
<td>- Equipment development</td>
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<td>- Reference materials</td>
<td>- In-field tools for investigative inspector</td>
<td>- Trade analysis</td>
<td>- Testing &amp; validation</td>
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<tr>
<td>- Containment &amp; Surveillance</td>
<td>- Reference materials</td>
<td>- Non-proliferation studies</td>
<td>- Nuclear forensics</td>
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<tr>
<td>- Process monitoring</td>
<td></td>
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<td>- Nuclear preparedness</td>
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<td>- On-site laboratories</td>
<td></td>
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<td>- National response plan</td>
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<td></td>
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<td></td>
<td>- CBRN, IfS, ...</td>
</tr>
</tbody>
</table>

**TRAINING & EDUCATION**  European Nuclear Security Training Centre  Promotion /Dissemination of EU’s highest Safety/Security standards
Nuclear Security and Safeguards at JRC

Destructive and Non-Destructive Analysis for Safeguards

(10 years under ISO 17025)

- High precision U and Pu isotopic composition (TIMS)
- High precision U and Pu concentration (IDMS, Titration, Hybrid K-edge/XRF-densitometry)
- Impurity measurements (ICP-MS, C, N)
- Particle analysis using Large Geometry SIMS
- Pu and Am mass by Calorimetry
- Neutron Measurements
- Gamma measurements

Certified nuclear reference materials
Development and provision of uranium and plutonium reference materials for method validation, calibration and quality control in the analysis of nuclear material and environmental samples.
Nuclear Security and Safeguards at JRC

3D Laser Verification System (3DLVS)
Design Information Verification (DIV) and change monitoring

Laser Surface Mapping for Containment Verification (LMCV)
Identification/integrity verification of dry storage casks (DSC)

Laser Item Identification System (L2IS)
Identification/authentication of UF₆ cylinders for enrichment
Nuclear Security and Safeguards at JRC

- Ultrasonic bolt seals for underwater storage (JRC Candu Sealing System)
  - Pakistan, Canada, France, Romania

- Ultrasonic Optical Sealing Bolts (UOSB) for dry storage
  - Lithuania, others (brand new)

- Low cost electronic seal

- Automated image acquisition system for the verifying copper brass seal images
Nuclear safeguards and non-proliferation

On-site Labs at reprocessing plants
- Scientific support to Euratom safeguards implementation
- Equipment developments
- Sample analysis

Undeclared Nuclear Activities
Analysis of small aerosol particles in dust from environmental/swipe samples can provide information on the nuclear materials handled in the facility
- LG-SIMS lab under ISO17025
- Continuous R&D effort to improve analytical capabilities

OSL Sellafield (UK)  OSL La Hague (F)

Large Geometry SIMS

European Commission
# Training for Nuclear Safeguards Inspectors

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>Link</th>
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</thead>
<tbody>
<tr>
<td>Active neutron interrogation (JRC)</td>
<td>course</td>
<td>Link</td>
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<tr>
<td>Nucleonica - Nuclear data training (JRC)</td>
<td>course</td>
<td>Link</td>
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<tr>
<td>Uranium Enrichment Determination by gamma-ray spectrometry (JRC)</td>
<td>course</td>
<td>Link</td>
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<tr>
<td>Advanced hands-on RADAR/CRISP/XSEAT (JRC)</td>
<td>course</td>
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<tr>
<td>Mass/Volume Methodology and Tank calibration course (JRC)</td>
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<tr>
<td>Data Analysis and Interpretation (JRC)</td>
<td>course</td>
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<tr>
<td>3D Laser-based Design Information Verification (JRC)</td>
<td>course</td>
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<tr>
<td>Training course on JRC CANDU Sealing System (JCSS) (JRC)</td>
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<td>Link</td>
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<tr>
<td>Training on the JRC ultrasonic optical sealing bolt (UOSB) system (JRC)</td>
<td>course</td>
<td>Link</td>
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<tr>
<td>New Tools for image reviews (Luxembourg/Vienna) (JRC)</td>
<td>course</td>
<td>Link</td>
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<tr>
<td>IRTC SSAC Follow-up Course on Non-Destructive Analysis (NDA) of Nuclear Materials (JRC)</td>
<td>course</td>
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<tr>
<td>Passive neutron assay (JRC)</td>
<td>course</td>
<td>Link</td>
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<tr>
<td>Plutonium isotopic composition by gamma spectrometry (JRC)</td>
<td>course</td>
<td>Link</td>
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</table>
Training for Nuclear Safeguards Inspectors

U Enrichment Determination by Gamma-ray Spectrometry

Prerequisites
• Non Destructive Analysis Physics basic course

Scope
• The course is focused on non-destructive gamma spectrometric techniques for the measurement of the U235 enrichment.
• The physics and the measurement are outlined and oriented towards the operational requirements.
• The complete enrichment measurement procedure including spectrum evaluation and error estimation is discussed.
• An in-depth review of the algorithms routinely used including conceptual explanations is introduced. Insights into the behaviour and capabilities of these algorithms are developed.
• Two thirds of the time is foreseen for practical exercises to make the course participant familiar with the electronic chain, enrichment measurement technique and troubleshooting.
CBRN security Activities

CBRN - Chemical, Biological, Radiological, Nuclear

- Performance assessment of RN detection equipment. Commercial equipment testing

- Development of methods for detection of Special Nuclear Materials with a high potential for practical applications

- Identification of high confidence nuclear forensics signatures

- Urban Dispersion International Evaluation Exercise

- RN support to the EU CBRN Centres of Excellence Initiative
**ITRAP+10**

*Illicit Trafficking Radiation Detection Assessment Programme*

Performance tests of equipment used against illicit trafficking of nuclear material and radioactive sources
ITRAP+10 – Phase I

- Large-scale test of ±170 instruments
- Initiated by EU DG HOME (EU CBRN Action Plan 2009)
- Parallel programme by US DHS-DNDO & DOE
- Test against IEC & ANSI standards
- Vast amount of data: manufacturers; standards; policy makers/implementers

ITRAP+10 – Phase II

- Test vehicle mounted mobile detectors
- Prepare MS labs for EU certification: round robin (PRD, RID, SRPM)
- ITRAP+10 impartial test data used to revise and develop standards:
  - 11/2016-03/2020 IEC 62327 Ed.2 (RID) and IEC 62401 Ed.2 (PRD)
  - 06/2014-09/2017 IEC 62244 Ed.2 (RPM)
  - 03/2017-08/2020 IEC 63121 Ed.1 (vehicle-mounted mobile detectors)
Detection of SNM in Shielded Containers by Pulsed Neutron Interrogation

Scale-up of experimental results to industrial size (preliminary results)

- Assay of Unit Load Devices (ULDs) for air cargo
- Accommodate largest standard ULD: LD1 for Boeing 747-400: 234 x 153 x 163 cm, 4.90 m³

- polyethylene
- graphite
- scintillation detectors

Instrument fits in such a container

Standard ULD as applied for air cargo fits in instrument
Nuclear Forensics

**Background:**

JRC expertise in Safeguards (EURATOM Treaty) → Nuclear Forensics

- Origin of the nuclear material that has been diverted, stolen or lost

**Areas of Application**

- Illicit Traficking of Nuclear Materials (e.g. Uranium in scrap metal)
- Non-Proliferation (e.g. HEU particles)
- Nuclear Safeguards (e.g. consistency of chemical impurities with declared processes)
- Environmental Issues (e.g. analysis of radioactive particles found on the beaches near Doureay)
Example: IAEA Coordinated Research Project: Propagation of Nuclear Forensics Signatures at the Front-End Fuel Cycle:

1. Investigation of earlier identified signatures propagation throughout various stages of uranium processing (e.g. UOC, UO$_3$, UO$_2$, UF$_4$)
2. Identification of new signatures in those materials

1. Stable isotope ratios:
   - $^{204,206,207,208}\text{Pb}$
   - $^{87}\text{Sr}/^{86}\text{Sr}$
   - $^{143}\text{Nd}/^{144}\text{Nd}$
   - $^{34}\text{S}/^{32}\text{S}$

2. Morphology
Urban Dispersion International Evaluation Exercise (UDINEE)

Project included in the EU CBRN Action Plan 2013-2017

- verify and evaluate the capacities of dispersion models to simulate realistic RDD in urban environments;
- assess the real capacity of these systems to respond to emergency
- under many aspects such as: timeliness of the prediction, accuracy of the prediction, limitations;
- support the use of local models for decision making and policy development;
Activities 2014-2017

2nd Workshop 27-28 March 2017 @ the JRC, Ispra, Italy

Participants:
Italy, Belgium, UK, Greece, Slovakia, Poland, USA

Follow up actions of the workshop:
• Source term reconstruction
• Model uncertainties
• Explosion simulation capabilities

Horizontal dispersion – Horizontal agreement between models;
five minutes after the first release – 2m

Vertical dispersion – average of models
five minutes after the first release

Percentag of models agreeer

SF6 concentration
Strengthening Nuclear Security through continuous professional development and training
European nuclear security training centre (EUSECTRA)

**Audience** - front line officers, their management, trainers and other experts in the field of illicit trafficking

**Scope**
- To improve EU MS and partner countries capabilities to address the threats associated with illicit incidents involving nuclear or other radioactive materials by providing hands-on training using real nuclear material
- Training areas include: border detection, mobile detection, covert search, train-the-trainers, mobile response (i.e., MEST), reach-back, creation of national response plans, nuclear forensics, radiological crime scene management, nuclear security awareness and sustainability of a national nuclear security posture

More than **200 participants** in 2016
Hosted high level and specific events including NF methodology course, CNS, APEX, and recently NUFORSE
The NUclear FORensics Simulation Exercise (NUFORSE) 2-5 May 2017, JRC Karlsruhe

• **Table top exercise**, intended to provide an opportunity for those responding to material found outside of regulatory control to test their ability to respond to simulated incidents, to identify the response and coordination issues that could arise during a variety of scenarios and to make decisions in response to those issues

• The exercise focuses on nuclear security and forensics in the **GUAM region**

• Sponsored by the Nuclear Smuggling Detection and Deterrence (NSDD) program of the United States and the European Commission Joint Research Centre (JRC)

Some statistics:
• 2.5 days active simulation
• 300+ emails sent by the 4 teams
• (About 80% substantial)
• 160+ fictional documents created
• About 50% of the 4 prepared cases played
• 15 Participants
The important issue of security of radioactive sources was very recently addressed by the EU:
The APEX-Europa High Level EU Scenario-Based Exercise on Nuclear Security, 23/11/2016, JRC Karlsruhe

The first exercise of this nature involving almost all EU member states (all MS responded positively, 26 MS present due to last minute constraints)
**Apex Europa High level scenario-based radiological and nuclear security exercise**

Involving fictional states but in the context of the EU specific characteristics

Scenario included elements of radioactive source security:

- Physical protection
- Transport
- Detection
- Emergency preparedness
- Forensics

Scenario consists of two moments:

- radioactive source is stolen in one MS and taken to a second MS
- small quantity of nuclear materials originating from outside the EU is seized at Schengen border after being detected at the airport in a passenger's carry-on luggage.
Apex Europa High level scenario-based radiological and nuclear security exercise

• 26 out of 28 EU MS took part to the exercise
• MS delegations included policy and technical level, dealing with various aspects of nuclear security (prevention, detection, response)

The exercise allowed identification of some priority areas for enhanced cooperation:

• training and exercises
• border technologies and reachback capabilities
• different levels of capabilities among EU MS, the existing and emerging challenges, and the possible added value of the EC in liaising between interested MS, can be further explored
• the network for sharing nuclear forensic competences
• analysis and benchmarking of environmental dispersion models
• further discussion on security of radioactive sources at EU and global level would be welcomed
EU "External" Security Strategy

Instrument contributing to Stability and Peace (IcSP): € 2.3 billion
IcSP - art. 5 (€ 478 million)
Global and trans-regional and emerging threats

- Fighting Organised Crime (Human Beings, SALW, Drugs, Money Laundering, Cyber crime);
- Protecting Critical Infrastructures (Maritime, Aviation, Cyber Security);
- Countering Terrorism (Horn of Africa, Pakistan, Sahel...);
- Security threats emanating from Climate Change;
- CBRN Risk Mitigation (regional Centres of Excellence, Export Control, Bio safety, Dual Use containment...)

European Commission
EU CBRN Centres of Excellence Initiative
Partner Countries

56 Partner Countries in 8 regions, from African Atlantic Facade to South East Asia

28 of the GICNT nations are Partner Countries in the CoE Network

1. Afghanistan
2. Bosnia
3. Cambodia
4. Cote d'Ivoire
5. Albania
6. Georgia
7. Algeria
8. Iraq
9. Jordan
10. Kyrgyz Republic
11. Libya
12. Republic of Macedonia
13. Malaysia
14. Armenia
15. Montenegro
16. Morocco
17. Philippines
18. Saudi Arabia
19. Serbia
20. Seychelles
21. Singapore
22. Tajikistan
23. Thailand
24. Ukraine
25. United Arab Emirates
26. Uzbekistan
27. Vietnam
28. Zambia
Needs Assessment (NAQ)

- 8 sections in the scope of CBRN risk mitigation
- Approx. 300 closed questions with possibility to include additional information
- Available in English, French, Arabic, Russian
1. Assessment of CBRN threats and risks in the PC
2. Current capacities to mitigate risks
3. List of obligations linked to international instruments
4. Current national institutional structure
5. Proposed steps to reinforce national CBRN capacity
6. Elaboration of concrete actions to fill in gaps
Status of NAQs

- In 2016 - 5 NAQ Workshops
- In total 25 PC completed
- In 2017 - Plans for NAQs in 4 partner countries

Status of NAPs

- In 2016 - 13 NAP Workshops
- In 15 PC NAP completed
- In 13 PC NAP under development
**CoE Projects**

- **35 completed projects; 60 total**
- **Recent RN Projects**

| PROJECT 060 | Support to the Centre of Excellence of Eastern and Central Africa in Nuclear Security | Eastern and Central Africa |
| PROJECT 058 | CBRN SEEE Equipment for forensics | South East and Eastern Europe |
| PROJECT 057 | Strengthening crime scene forensics capabilities in investigating CBRN incidents in the South East and Eastern Europe region | South East and Eastern Europe |
| PROJECT 055 | Strengthening cross-border capacity for control and detection of CBRN substances | African Atlantic Façade, North Africa and Sahel |
| PROJECT 052 | Provision of specialised CBRN equipment for the training of first responders | South East and Eastern Europe |
| PROJECT 050 | Provision of specialised equipment to enhance CBRN preparedness and response capabilities | African Atlantic Façade, Eastern and Central Africa |
New activities

- **Regional training centres**
  - SEEE, SEA: identification of existing training infrastructure – to create regional network of training institutions and centres
  - AAF: under discussion – creation of physical regional training centre

- **Development of CoE CBRN training programme**
  - Objective: to develop a shareware and harmonised CoE training programme

**Technical Areas of the CoE training programmes**

- First response: 16%
- Illicit trafficking and border control: 8%
- Laboratory risk management: 8%
- Waste management: 8%
- Crisis management: 16%
- Other: 44%
International Cooperation and Coordination

- IAEA, NEA/OECD
- GICNT, UNSC 1540 Committee, GP
- Border Monitoring Working Group, Nuclear Smuggling International Technical WG
- Japan JAEA, China, Canada, India (ongoing)...
- CBRN CoE partners
**EU supports IAEA in the field of nuclear security and Technical cooperation**

<table>
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<th>Sources of Funds</th>
<th>Budget (Euro)</th>
<th>Beneficiary Regions</th>
<th>Implementation period</th>
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<tr>
<td>EU - JA II</td>
<td>3,914,000</td>
<td>South-Eastern Europe, Central Asia, Caucasus, North Africa, Middle East</td>
<td>02/2006-09/2008</td>
</tr>
<tr>
<td>EU - JA III</td>
<td>6,995,000</td>
<td>South-Eastern Europe, Central Asia, Caucasus, Middle East, Africa</td>
<td>02/2007-12/2008</td>
</tr>
<tr>
<td>EU - JA IV</td>
<td>7,703,000</td>
<td>South-Eastern Europe, Central Asia, Caucasus, Middle East, Africa, South-East Asia</td>
<td>10/2009-06/2012</td>
</tr>
<tr>
<td>EU- CD V</td>
<td>9,966,000</td>
<td>South-Eastern Europe, Central Asia, Caucasus, Middle East, Africa, South-East Asia, Gulf, South America, Caribbean &amp; Central America</td>
<td>01/2011-12/2014</td>
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<tr>
<td>EU -CD VI</td>
<td>8,050,000</td>
<td>all IAEA Member States</td>
<td>01/2014-12/2016</td>
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<tr>
<td>EU - CD VII</td>
<td>8,645,374</td>
<td>all IAEA Member States</td>
<td>12/2016-12/2019</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>48,602,374</strong></td>
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</table>
Improving reporting culture to the IAEA's Incident and Trafficking (ITDB) through training and capacity building of the Point-of-Contacts in the European Union

- New project
- Duration 18 months (start was in Dec 2016)

Kick-off meeting at the IAEA in January 2017. Decided activities:

- JRC participation in the POC training in July 2017 at the IAEA (invited talk on the best practice document on reporting).
- Organising two workshops/trainings for the EU POCs in Karlsruhe (tentatively in Feb and Mar 2018) with the IAEA participation. Curriculum to be drafted.
- Sub-contract for the development/improvement of the ITDB web-based tools and data security (start in second half of 2017)
GICNT – Magic Maggiore
Ispra, 28-30 March 2017

- 75 participants
- 40+ countries
- 5 continents

Europe, Russia, USA, Canada, Africa, Latino America and Asia (India, Pakistan, Thailand, Tajikistan, Cambodia, Japan … ) and the IAEA

Focus:
- Role of Scientific and Technical Expert Support
- Opportunities and Challenges of Technical Reachback
- Building on Core Components of Technical Reachback
- Advanced Technologies
GICNT – Magic Maggiore Ispra, 28-30 March 2017

- 75 participants
- 40+ countries
- 5 continents

GICNT/Future joint activities

**FALCON 2 exercise** (scheduled for spring 2019 in UAE):
- Capacity building
  (lead by JRC in framework of COE)
- Exercise preparation
  (lead by GICNT)

**to be hosted at JRC**
Karlsruhe (26 June 2017)
Cooperation with JAEA

LEGAL BASIS: Agreement between Japan Atomic Energy Agency and the European Atomic Energy Community represented by the European Commission in the field of Nuclear Material Safeguards Research and Development.

- JAERI, former JAEA, and EC/JRC signed original agreement in 1990
- Cooperation, information exchange, researcher exchange

COOPERATION ON:

- AS-1 Neutron Resonance Densitometry Method
- AS-2 Information Exchange on Nuclear Forensics
- AS-3 Nuclear Forensics Uranium Age determination
- AS-4 Information Exchange on work relevant for CLEAR lab
- AS-5 Nuclear Safeguards Training
- AS-6 Nuclear Security Training
- AS-7 Active neutron NDA

Uranium age dating samples
Cooperation with JAEA

AS – 1 Feasibility study and development of Neutron Resonance Densitometry (NRD) for characterization of particle-like debris of melted fuel (2012 – 2015)


Combine complementary active techniques
• Neutron Resonance Transmission Analysis (NRTA)
• Neutron Resonance Capture & Prompt Gamma Ray Analysis (NRCA &PGA)
• Delayed Gamma Spectroscopy (DGS)
• Differential Die Away (DDA)

Objectives
• Study and improve methodologies
• Application studies
• Production of calibration and transfer standards
• Experimental validation at existing facilities
• Design parameters of a compact facility

Use of nuclear facilities at JRC & JAEA
• JRC Geel : GELINA, MONNET & TARGET
• JRC Ispra : PUNITA
• JAEA Tokai : TRP – PCDF
• JAEA Tokai : NUCEF