IAEA 60 Years Atoms for Peace and Development

2nd International Symposium on Technology Development for Nuclear Security
Tokyo – 27 Oct 2016

Nuclear Security Detection Technologies for Material Out Of Regulatory Control: Current Status and Future Needs

Thierry PELLETIER
Nuclear Security Division
Safety and Security department
International Atomic Energy Agency

Scope

- IAEA and Nuclear Security
- Detection Instrument for Nuclear Security application
- Challenges
- Next step

International Atomic Energy Agency

- **Specialised agency within UN system**
  - **Created in 1957 by international treaty**
  - **169 Member States (Feb 2016)**

- **IAEA Policy Making Bodies**
  - **General Conference**
    - Representatives of 169 Member States
  - **Board of Governors**
    - Representatives of 35 Member States

IAEA Establishments and Staff

- Headquarters in Vienna
- 4 Regional Offices
  - Tokyo, Toronto, Geneva, New York
- 5 Research Laboratories

- Director General & ~2300 Staff Members

- 6 Departments
  - Technical Cooperation
  - Nuclear Energy
  - Nuclear Science and Applications
  - Safeguards
  - Nuclear Safety and Security
  - Management

IAEA 60 Years Atoms for Peace and Development

What is Nuclear Security?

The prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities.

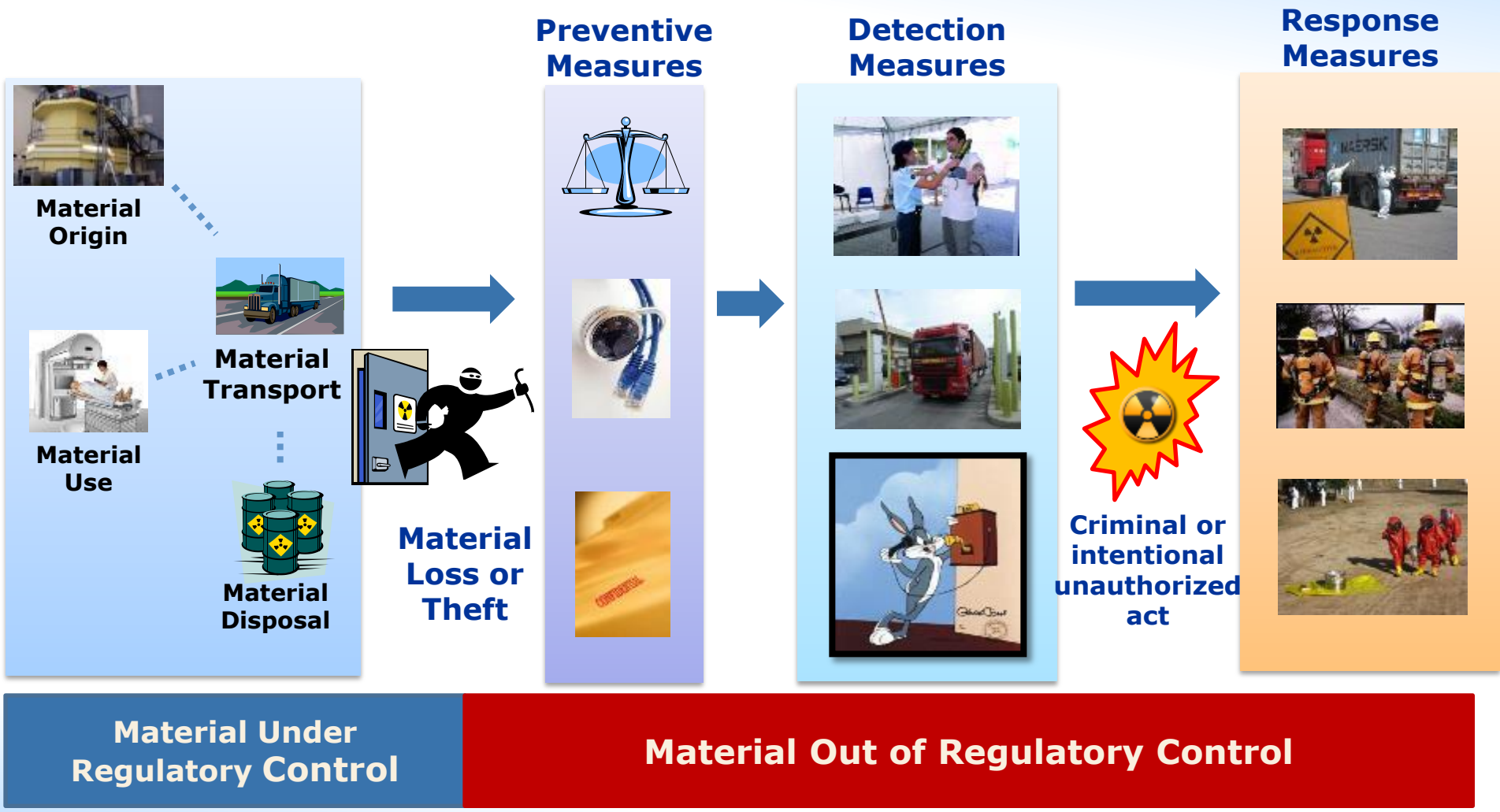
What is Nuclear Security Event?

IAEA 60 Years Atoms for Peace and Development

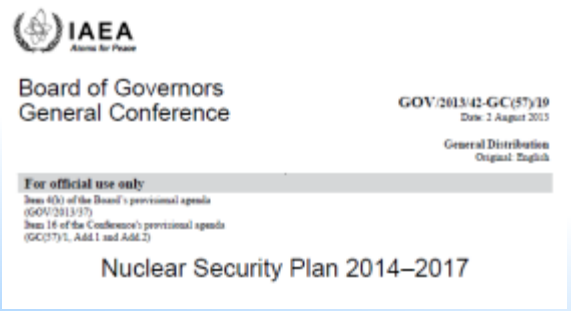
Criminal act(s) or unauthorized act(s) with nuclear security implications or measurement(s) indicating the unauthorized presence of nuclear material, or other radioactive material at a strategic location.

Nuclear Security
Prevention, Detection and Response Measures

IAEA 60 Years Atoms for Peace and Development



The Nuclear security plan


IAEA

Board of Governors
General Conference

GOV/2013/42-GC(57)/19
Date: 2 August 2013

General Distribution
Original: English

For official use only

Item 4(b) of the Board's provisional agenda
(GOV/2013/37)
Item 16 of the Conference's provisional agenda
(GC(57)/1, Add.1 and Add.2)

Nuclear Security Plan 2014–2017

In March 2002, the Agency embarked on its first **comprehensive programme** to combat the risk of criminal act involving Nuclear or Radioactive material by assisting States in strengthening their nuclear security.

Approved by the IAEA Board of Governors, the first three-year plan described a programme of work encompassing Activities in Nuclear Security.

- Actually 4th Nuclear Security Plan

Objective of Nuclear Security Plan

to contribute to global efforts to achieve effective security wherever nuclear and other radioactive material is in use, storage and/or transport, and of associated facilities by supporting States, upon request, in their efforts to meet their national responsibilities and international obligations, to reduce risks and to respond appropriately to threats

Statement during the last Nuclear Security Summit in Washington

- 1 April 2016, the 50 world leaders that attended the Nuclear Security Summit……stating that they

  "Advocate for the IAEA to strengthen national nuclear detection capabilities and architectures by developing guidance, training, workshops and exercises, facilitating the exchange of good practices and providing a forum for discussion and cooperation.“

- IAEA Director General Yukiya Amano welcomed the strong support expressed by more than 50 Heads of State and Government and stated:

  “Working closely with national experts and key international partners, the IAEA will continue to deliver tangible improvements in nuclear security.”

IAEA - Nuclear Security Division
Support to States

Establishment of a National Nuclear Security Regime

- Development of recommendations and guidelines
- Evaluation and advisory services
- Human resource development
- Information services
- Technical improvements and upgrades

Nuclear Security Series

- Fundamentals (PRINCIPLES)
  - Objectives and principles
  - Basis for Nuclear Security Recommendations
  - Essentials from international instruments
- Recommendations (WHAT)
  - General approaches, actions, concepts and strategies
  - Applications of Fundamentals
- Implementing Guides (HOW)
  - Broad guides on how Recommendations to be applied
  - Ways and means for how Recommendations implemented at systems level
- Technical Guidance
  - Reference Manuals, Training Guides, Service Guides

Dedicated Advisory Services

- **Nuclear Security Advisory Services**
  - INSServ - International Nuclear Security Advisory Service for MORC
  - IPPAS Mission - International Nuclear Security Advisory Service for Physical Protection
- **Other Services**
  - NUSIMS - Nuclear Security Information Management System
  - Technical Visits

Human Resource Development

Education

- Educational Programme in Nuclear Security

Training

- General Training
- Specialized Training
- Training of Trainer
- On-the-Job Training
- Fellow-ships

INSEN: International Nuclear Security Education Network

- Enhance global nuclear security by developing, sharing and promoting excellence in nuclear security education.

Dedicated e-learning for FLO

Technical improvements and upgrades

- Forum of exchange on technical issues around radiation detection equipment.
- Coordinated Research Projects on alarm assessment.

- *Coordinated Research Projects on Advancing Radiation Detection Equipment for Detecting Nuclear and Other Radioactive out of MORC.*
- *Coordinated Research Projects on Advancing Detection Equipment Maintenance and Calibration*

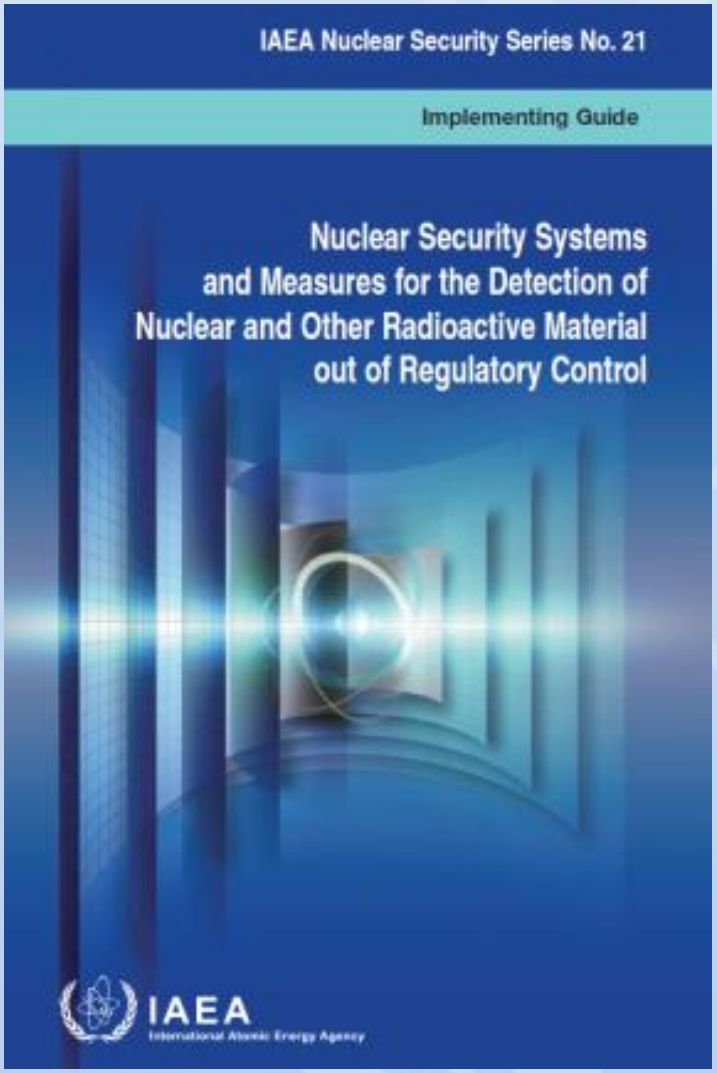
What is a Nuclear Security Detection Architecture (NSDA)?

The integrated set of nuclear security systems and measures.

- **Based on an appropriate legal and regulatory framework**
- **Needed to implement a national strategy for the detection of nuclear and other radioactive material out of regulatory control**

IAEA 60 Years
Atoms for Peace and Development

IAEA Reference - NSS 21



Detection by Instruments

Detection and identification instruments come in many types for use in different operational environments

- Handheld
- Backpack/wearable
- Fixed
- Vehicle-, Air-, and Sea-borne

IAEA 60 Years
Atoms for Peace and Development

Instrument used in Nuclear Security

Families of instruments used in Nuclear Security

IAEA 60 Years Atoms for Peace and Development

Detection

- Radiation Portals Monitors

- Personal Radiation Detectors (Pagers)

- Contamination Monitors

Localization

- Gamma Search Devices

- Neutron Search Devices

Categorization

- Radioisotope Identifiers (RI

Radiation Portal Monitors (Detection)

RPM: Radiation Portal Monitor installed at border checkpoints (road, rail, airport, seaport) to detect the presence of smuggled nuclear and other radioactive materials

Vehicles at land border crossings

Containerized Cargo at seaports

Rail crossing

Pedestrian crossing

Their main requirement is a high efficiency: detect the presence of radioactive material in the short transit time

Personal Radiation Detector

- **Small equipment to be worn**
- **by personnel with dosimeter**
- **and acoustic alarm**

They are much more sensitive than personal dosimeters, which are used for more precise dose-rate and dose measurement

- Simple to use for non-experts users
- Separate **gamma and neutron radiation alarms**
- Visual and acoustic alerts
- Some models have spectrometric capabilities

Radioisotope Identifier (Categorization/Identification

The handheld gamma spectrometer (radioactive isotope identification device – RIID) is sensitive, more advanced instrument designed for accurate categorization of radioactive materials.

- Gamma spectrometers employ NaI(Tl) scintillator, HPGe or CdZnTe technologies to provide nuclide identification
- Isotope identification can be challenging for low level radiation such as that typically encountered with Naturally Occurring Radioactive Materials (NORM)

Spectroscopic portal monitors

- new generation of portal monitors under development
- combination of detection and nuclide identification provides the possibility to immediately identify NORM, medical as well as legal radioisotopes and to dramatically reduce innocent alarms
- complex system of detection modules and sophisticated software requires extensive testing
- can be applied in principle for trains, trucks, cargo, pedestrians
- spectroscopic portals provide an interesting option for future installations, however, they have higher resource requirements

- **High resolution**
- **High sensitivity** (results in a short time)
- Require **cooling to low temperatures**
- **High price**
- **Complexity of data treatment**

IAEA 60 Years
Atoms for Peace and Development

Challenges

Detection instruments main challenges

The ideal detector should have/be:

- High efficiency
- Good resolution: discrimination of the radiation source
- Easy to use (for non-experts)
- Reliable and able to work in harsh environmental conditions

Main factors playing a role in radiation detection:

- Amount and quality (energy) of radiation
- Distance source/detector
- Exposure time
- Presence of radiation (background/natural/other sources)
- Presence of shields
- Properties of the sensor (efficiency/resolution)

No perfect solution !

IAEA 60 Years Atoms for Peace and Development

Efficiency

Resolution

Liquid scintillators

Plastic scintillators (PVT)

Inorganic scintillators (NaI, $LaBr_3$,…)

Semiconductors (HPGe,…)

Many Different Conveyances May Be Used in Nuclear Smuggling

60 Years
IAEA Atoms for Peace and Development

IAEA 60 Years
Atoms for Peace and Development

Next step - IAEA Involvement

Detection Instrument Specifications

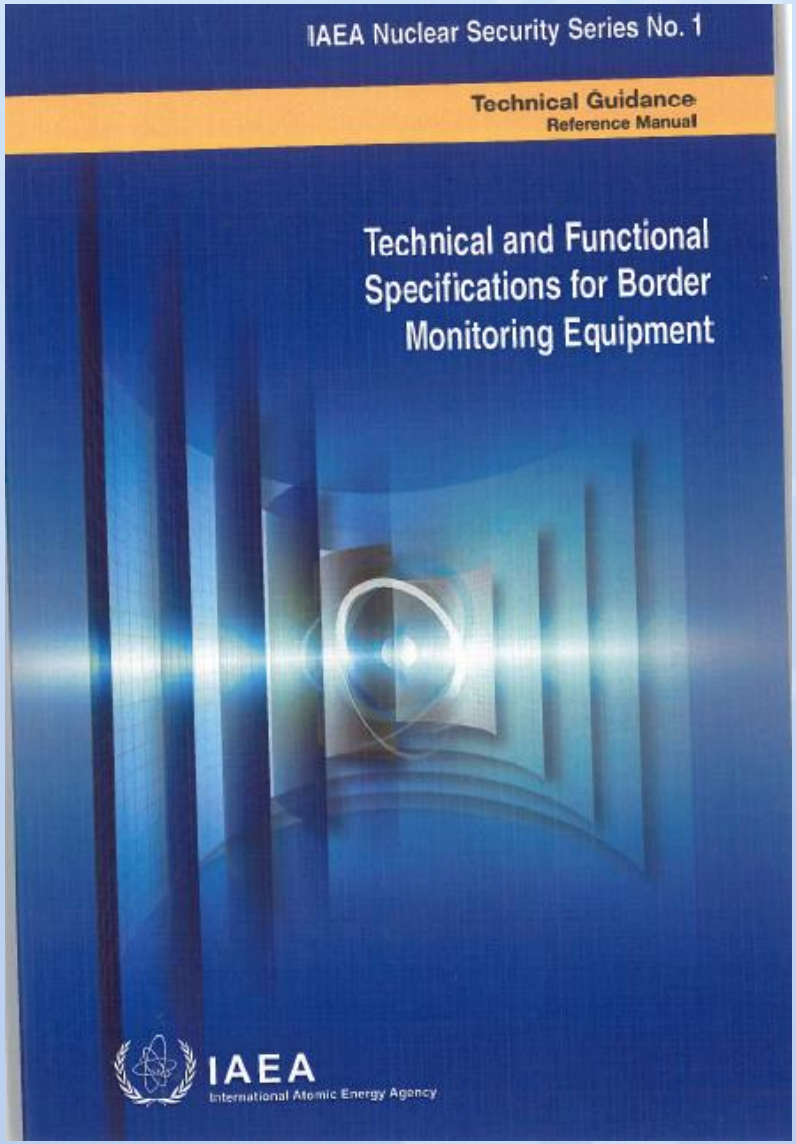
- Current instruments specifications can be improve to better meet needs of users and sustainment requirements.

- IAEA should undertake revision of NSS1 and focus on application-driven specifications.

- Specifications should also consider training and sustainability.

IAEA 60 Years
Atoms for Peace and Development

IAEA Guidance - NSS 1



IAEA Future projects on Detection Instrument

- IAEA should initiate a new CRP to focus on improving radiation detection equipment performances.
- IAEA should initiate a new CRP to focus on improving detection equipment maintenance and calibration.
- Projects proposed to improve engineering, operation, and “soft” applications
    a. E.g., improved human interface, improved software, communication linkage

CRP – Improving the Assessment of Initial Alarms

IAEA 60 Years Atoms for Peace and Development

Objectives:

- Develop technical documents and tools that can be used by FLOs and expert organizations to enhance MS ability to make high confidence assessments on whether or not nuclear and other radioactive material out of regulatory control is present when an initial alarm occurs.

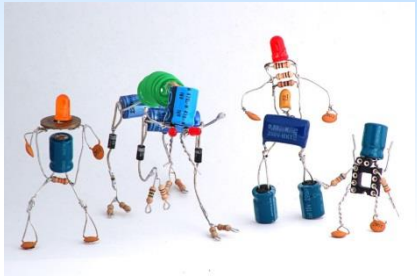
- Significantly reduce the time and effort spent by FLOs on NORM alarms and with confidence only require action on suspicious alarms. Also reduce training needs and sustainability costs.

Current Participants : Albania, Cambodia, Djibouti, Georgia, Jordan, Malaysia, Pakistan, Philippines, Russia, South Korea, Sri Lanka, Thailand, UK, US

Expected Soon: Bangladesh, China, Namibia, Romania

2016 – Will produce on-line alarm catalogue, collecting ~4,000 alarm files, initial algorithm development. RCM in October in Sri Lanka.

CRP – Advancing Radiation Detection Equipment for Detecting Nuclear and Other Radioactive Material out of Regulatory Control



Radiation detector elements:

- The detecting medium (gas, liquid, solid)
- The electronics/hardware converting energy from the medium into an electrical signal
- The electronics/algorithms/firmware used to convert the digitalized signal into usable information on the detection
- The physical components of the instrument (internal components, “outer casing,” power source, form factor, display screen, etc.)

This CRP will examine areas where these elements can be advanced to improve detection.

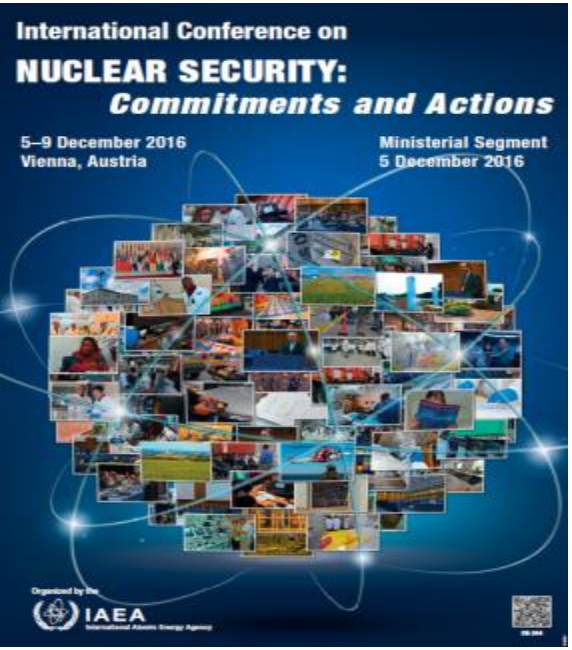
Proposed CRP

IAEA 60 Years
Atoms for Peace and Development

Advancing Detection Equipment Maintenance and Calibration

IAEA
International Atomic Energy Agency

Conclusion



- The IAEA has developed a comprehensive Nuclear Security Plan, including an extensive assistance program, to support Member States in their efforts to establish and maintain Sustainable Nuclear Security Regimes.

- IAEA is playing a central role in strengthening Nuclear Security as well as leading role in facilitating and coordinating nuclear security activities among international organizations and initiatives and supporting the efforts of States to full fit their nuclear security responsibilities.

IAEA 60 Years
Atoms for Peace and Development

Thank you!

Thierry PELLETIER
Nuclear Security Division
Safety and Security department
International Atomic Energy Agency
T.Pelletier@iaea.org