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2011 International Forum
on the Peaceful Use of Nuclear Energy and Nuclear Security

Nuclear Safety and Security in the European Union

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Joint Research Centre

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Content

- General situation in Europe
- Status of the NPP stress tests (safety and security)
- Nuclear security strategy approach and research programme
- The STAR European programme (State Response to Terrorist Attack)
- International cooperation
- Conclusion

General situation in Europe

Power Reactors in Europe 2011

EU Member States	Number of Units	Units under construction	Net nuclear Generating Capacity (MWe)	National Generation (TWh)*	Nuclear Generation (TWh)*	Nuclear Share
Belgium	7	0	5,835	89.3	45.7	51%
Bulgaria	2	2	1,906	46.0	15.2	33%
Czech Republic	6	0	3,368	79.5	26.4	33%
Finland	4	1	4,276	76.9	21.8	28%
France	58	1	64,040	550.3	407.9	74%
Germany	9	0	12,068	588.1	133.0	23%
Hungary	4	0	1,755	35.1	14.8	42%
Lithuania	0	0	0	5.3	0.0	0%
Netherlands	1	0	449	111.0	3.7	3%
Romania	2	2	1,300	54.9	10.7	19%
Slovak Republic	4	2	1,688	26.1	13.5	52%
Slovenia	1	0	688	14.4	5.4	38%
Spain	8	0	7,442	294.9	59.2	20%
Sweden	10	0	8,851	144.5	55.1	38%
UK	18	0	9,920	360.3	56.4	16%
Total EU**	134	8	123,586	2,476.6	868.8	-
Switzerland	5	0	3,220	66.3	25.2	38%
Overall Total	139	8	126,806	2,542.9	894.0	

* Annual electrical pow er production for 2010 ** Totals may vary slightly due to rounding up/dow n to one decimal place.

Source: International Atomic Energy Agency

EU: 35%

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General situation in Europe

- 35% of nuclear electricity generation in Europe
- Power uprates to be noted in many cases, compensating for shutdowns
- Main decision after Fukushima: shut-down of 8 reactors in Germany
- 8 reactors under construction in France, Finland, Slovakia, Bulgaria, Romania
- 24+ reactors planned in Bulgaria, Tcheq Rep., Finland, France, Hungary, Lithuania, Netherlands, UK, Slovakia, Slovenia
- Projection for 2025 is difficult to assess but stability of nuclear electricity generation at 30-35% is feasible

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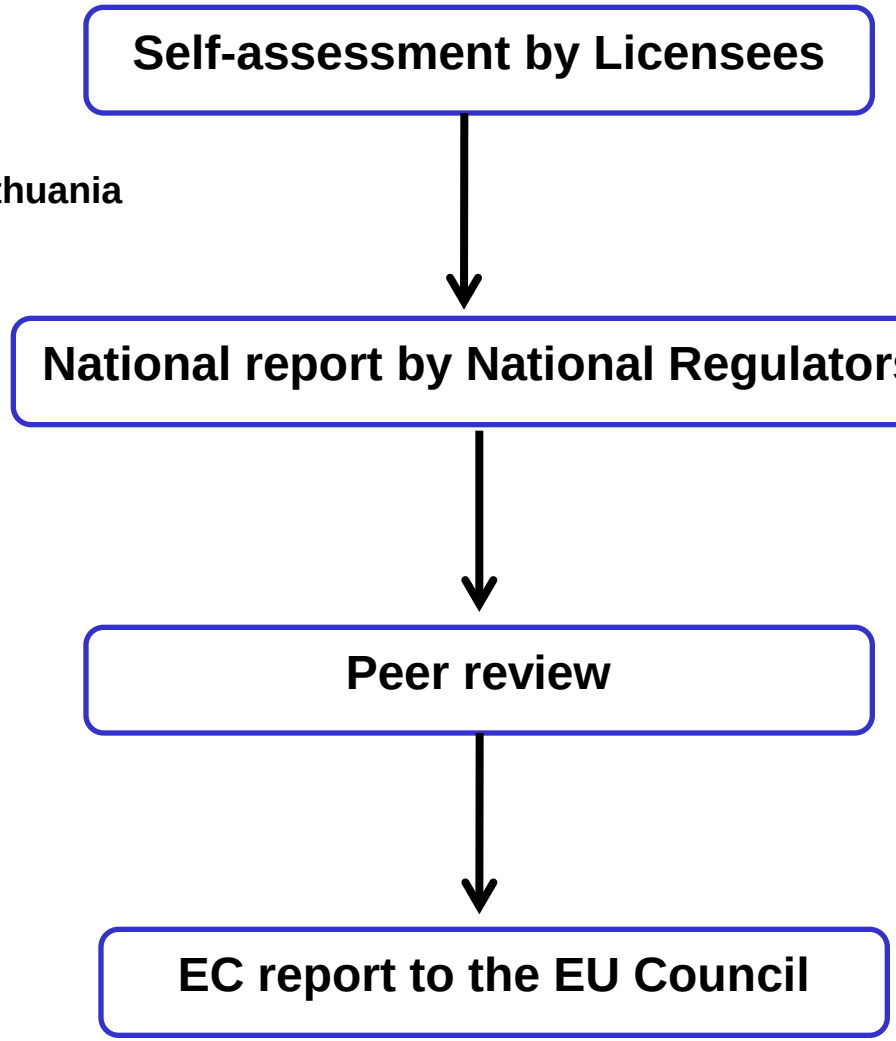
Stress test safety track implementation - Key Milestones

- 1 June: national regulators initiate the tests process
- 15 August: operators carry out reassessments and submit progress reports to national regulators
- 15 September: regulators consolidate the data into national progress reports → first input to EC
- 31 October: operators' final reports
- 9 Dec: EC report to the European Council
- End of 2011: final national reports – opening the door for the peer reviews
- 30 April 2012: completion of peer reviews
- June 2012: consolidated EC report to the European Council

Nuclear safety stress tests – process

Participants:
- **14 MS operating NPPs + Lithuania**
- **Switzerland**
- **Ukraine**



August 2011

June 2012

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Stress tests Safety Track: technical scope

- Definition based on - *but not limited to* – Fukushima
- Initiating events:
  - **Earthquake, flooding**
  - **Bad weather, forest fire, other external events, …**
- Consequence of loss of safety functions from any initiating event conceivable at the site:
  - **Loss of electrical power, incl. station blackout**
  - **Loss of ultimate heat sink**
  - **Combination of both (dependent failures)**
- Severe accident management issues:
  - **Licensee's provisions related to:**
    - **Means to protect from and to manage loss of core cooling function**
    - **Means to protect from and to manage loss of cooling function in the fuel storage pool**
    - **Means to protect from and to manage loss of containment integrity**
  - **Off-site support for maintaining the plant's safety functions**

Stress tests security track: status

- **Objective: to analyse security threats and the prevention of, and response to, incidents due to malevolent or terrorist acts**
- **Member States, assisted by the Commission are in charge of its implementation**
- **The progress report shows that Member States are committed to nuclear security and ready to make full use of and to strengthen relevant international regimes**
- **It emphasises the close link between nuclear safety and security dimensions.**
- **Sharing best practices at both European and international levels in the field of preparadness, nuclear security culture, emergency planning are also recommended**
- **Final report in June 2012**

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Nuclear security strategy approach

1. Identification, analysis and prevention of the risk

- legal framework, share of responsibilites
- scenario studies, threat assessment
- integrated approach safety/safeguard-security from the design stage
- analyses of vulnerabilities, effectiveness of protection systems
- security culture, training

2. Detection (e.g. potential theft of nuclear material)

- detection and monitoring strategies
- border control and response plan
- regional cooperation in combating illicit trafficking, exchange of information, data bases (IAEA)

3. Reaction and remediation

- ECURIE: European Union Urgent Radiological Information Exchange; reporting obligation
- assessment of nuclear/radioactive dispersion events and their consequences
- increase international exchanges
- safeguarding aspects in NPP after accident

EU Nuclear Security policy & instruments

EU EURATOM Framework: Euratom Safeguards

EU Nuclear security policy decisions

- EC communication on non proliferation- 2009
- Council Regulation 428/2009 on export control / dual use
- New Lines for Action in combating the proliferation of WMD - 2008
- Home Affairs Council Conclusions addressing CBRN risks, 2007
- EU strategy against proliferation of WMD – 2003
- European Security Strategy -2003
- Council Regulation 1334/2000 on export control / dual use
- Common Foreign Security Policy

Instruments

- CBRN Action Plan (Dec 2009)
- Council Joint Actions (with IAEA)
- Instrument for Pre-Accession (2007-2013)
- Instrument for Stability (2007-2013)
- Instrument for Nuclear Safety Cooperation (2007-2013)
- FP7 Security Research 2007-2013

The Euratom nuclear safeguards and security programme

Science and technology support role of the JRC:

- Traditional Safeguards and Verification
  - **Nuclear material accountancy**
  - **Independent verification (Euratom, IAEA)**
- Strengthened Safeguards (Additional Protocol to be applied)
  - **Non proliferation**
  - **Absence of undeclared activities**
- Illicit trafficking and nuclear forensics
  - **Detection**
  - **Source attribution**
  - **Reference data**
- Training: prevention, detection and response

Traditional safeguards technology developments

NDA (Non Destructive Assay)

PERLA (Performance Laboratory) was established In 1989 in the JRC in Ispra (Italy)

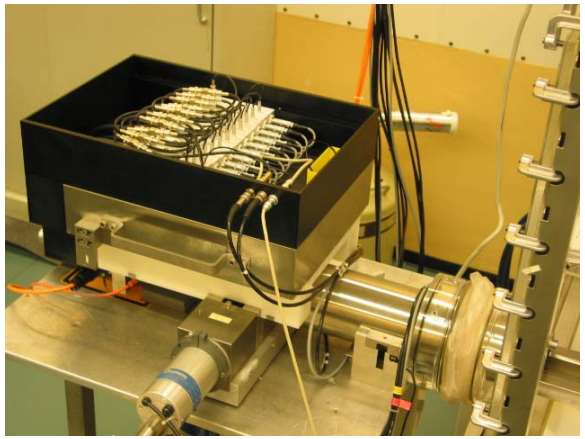
- using well characterised U and Pu samples
- calibration of NDA instruments
- development of new technologies
- training

Testing of organic scintillators for neutron detection in security applications

Combination of NDA / DA Techniques

NCC/ HKED for Pu control in solid waste

HKED= Hybrid K-edge technique
NCC= Neutron Coincidence Counting



Input solution:

- NCC ⟶ Cm-244 mainly
- HKED ⟶ Pu

  Yields Cm/Pu ratio

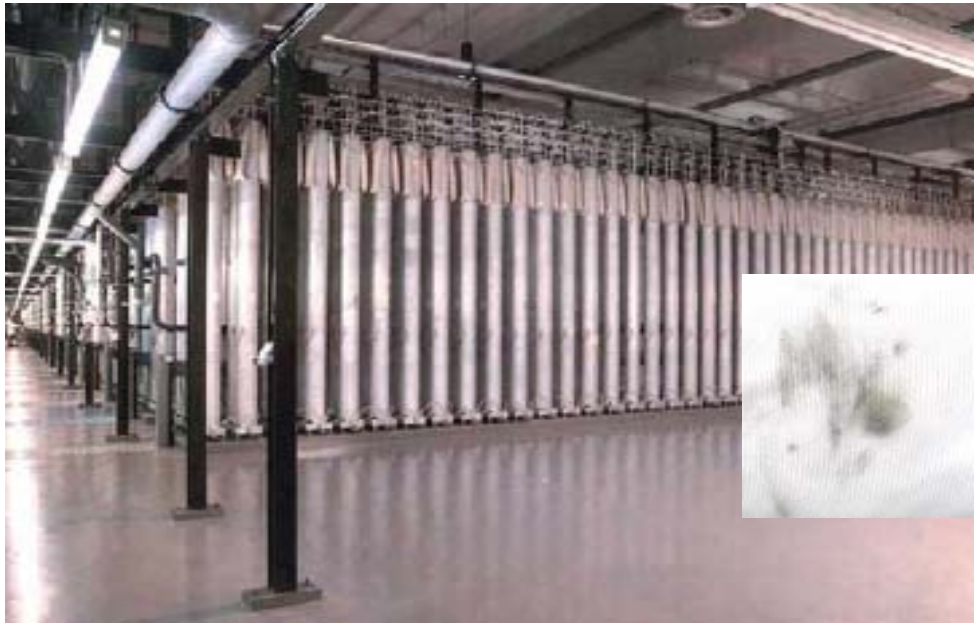
Undissolved material:

- NCC ⟶ Cm
- With above Cm/Pu ratio

  Pu in solids

Environmental Sampling

Detection of undeclared nuclear activities through environmental sampling



Safeguarding uranium enrichment facilities
Proliferation-sensitive

Particle diameter typically < 1 µm
& among millions of other dust particles

$^{235}U/^{238}U$ characteristic for process at facility
Minor isotopes ($^{234}U/^{238}U$, $^{236}U/^{238}U$) indicate different feed materials
NUCLEAR FINGERPRINT

Uranium enrichment

↓

Increase of relative concentration of ^{235}U using UF_6 gas

↓

Reaction with atmospheric moisture

↓

UO_2F_2 particles

↓

Particles settle onto various surfaces inside and around the facility

↓

Collection of particles in swipes

High Resolution SIMS

New infrastructure at JRC (ITU): High Resolution SIMS (Mass Spectrometer) installed in 2012

- Improved screening. (> 5 times faster than SG-SIMS)
- Distribution of enrichments in rich samples
- High sensitivity. (10 times higher than SG-SIMS)
- High quality minor isotope data U-234/236; source of the material + trace isotopes

Nuclear forensics : Finds 32-34

Find 32 – Dordrecht, found in the end of 2008, analysis March – May 2009

Find 33 – Rotterdam, found in the mid 2009, analysis December 2009 – March 2010

Find 34 – Tornio, found in the early 2010, analysis March – June 2010

Nuclear forensics (Finds 32-34): results

Sample	^{235}U bulk	U content	Production date	^{235}U particles
F32/1	4.1244 ± 0.0023	76.32 ± 0.24	June 2005	3.7 and 4.4 %
F32/2	4.1177 ± 0.0023	84.14 ± 0.27	May 2005	3.7 and 4.4 %
F32/3	16.7622 ± 0.0092	0.1541 ± 0.0005	-	17 % (7-21 %)
F33/1	9.0333 ± 0.0052	0.3362 ± 0.0011	April 1962	3.6 and 21 % (+90 %)
F33/2	45.847 ± 0.017	1.4769 ± 0.0047	June 1959	0.7; 21 and 90 %
F33/3	43.800 ± 0.016	3.409 ± 0.011	June 1972	35-45 % (+90 %)
F33/4	89.730 ± 0.036	16.930 ± 0.053	October 1983	90%
F34-A	0.71112 ± 0.00043	1.2046 ± 0.0038	July 2005	0.7 %
F34-B	-	-	-	0.7-21 %







Nuclear forensics (Finds 32-34): conclusion

The U-235 enrichments found in the particles could origin from the following reactor fuels:

- **VVER-type fuel – 3.6 and 4.4 %**
- **Fast breeder reactor BN-600 and BN-350 – 17, 21 and 26 % (and natural U in the breeding zone)**
- **3rd generation submarine fuel in Russia – 21/45 % (1st and 2nd – 21 %)**
- **Research reactor fuel – up to 90 %**

The Find-32 and -34 are from the same period of time

the Find-33 not.

The only manufacturer, which produces all these types of fuels is Elektrostal (MSZ) in Russia.

Nuclear forensics data bases

International Directory
(Data base of data bases)

Guiding Information (Material)
- Material Type
- Enrichment
- Chemical Form

Guiding Information (Country)
- Contact Point
- Query Conditions
- Query Format
- Handling of Results

National
Data base

Essential Data
- Chemical Composition
- Isotopic Composition
- Physical Parameters
- Production Place
- Storage Place

Supplementary Data
- Impurities
- Produced/stored amounts
- Non-numeric information
  - Photographs
  - Micrographs
  - Drawings
- Archive Sample

Concept under discussion within

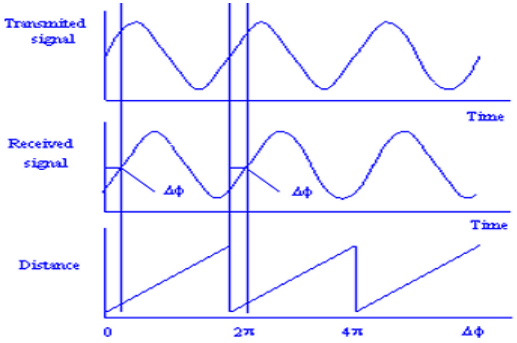
ITWG Nuclear Forensics

Global Initiative
for
Combating Nuclear Terrorism

IAEA International Atomic Energy Agency

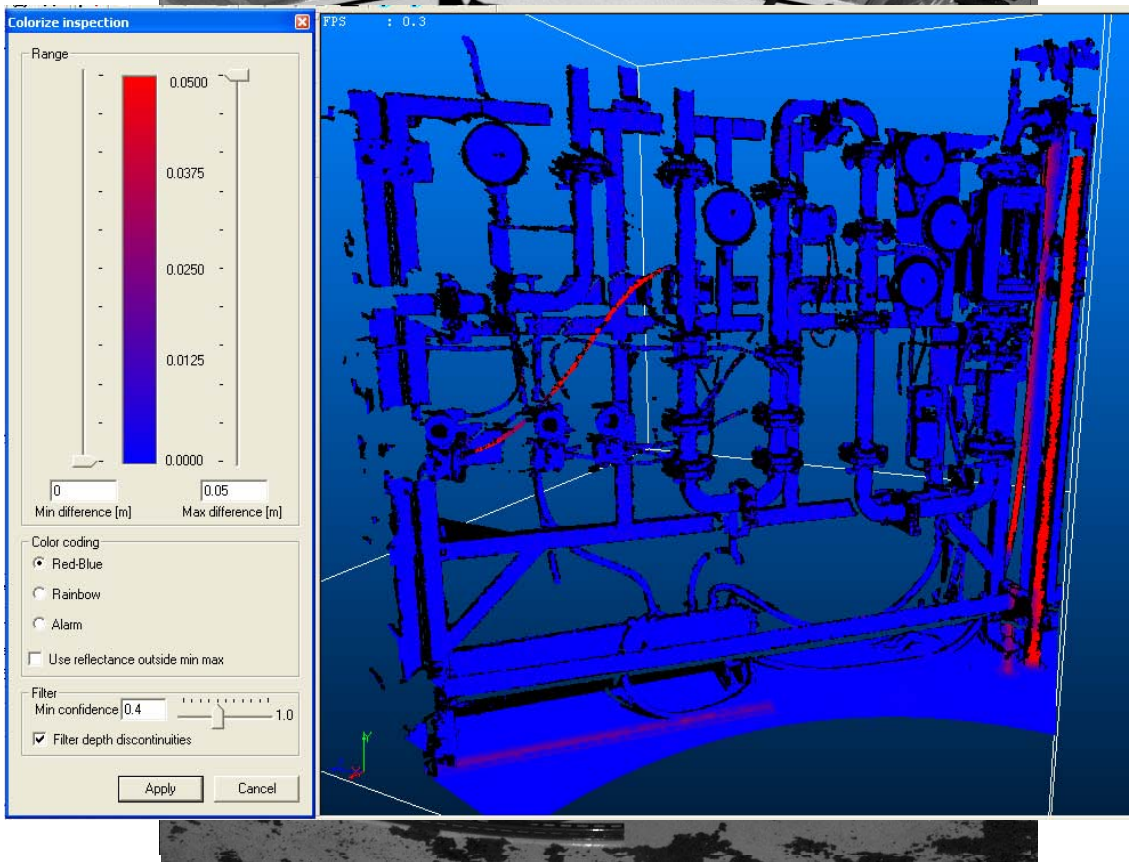
Tokyo, Japan, 8-9 December 2011

3D Laser based DIV (3DLR)



$$\Delta\phi = 2\pi f_a \Delta t = 4\pi f_a \frac{d}{c}$$

$$d(\Delta\phi) = \frac{c}{4\pi f_a}\Delta\phi = \frac{\lambda_a}{4\pi}\Delta\phi$$



- Range is determined by measuring the difference in phase of the emitted and received laser beams
- Range < 80 m (mm accuracy)
- Up to 500,000 points per second

3D Laser based DIV Inspection Steps:

Creation of 3D Reference Models of the facility (buildings, cells, equipment, piping) by scanning each environment from multiple view points.

Verification of the 3D reference model versus the engineering drawings (dimensions, pipe tracing,…).

Re-verification by automatic comparison of the 3D reference model with newly acquired scans.

Illicit Trafficking Radiation Assessment Programme: ITRAP+10

- A large number of equipment is already in operation today and experience has been gathered with respect to innocent alarms, due to Naturally Occurring Radioactive Materials (NORM) and medical isotopes.

- Shielded and masked isotopes remain being a serious problem.

The EU through the JRC is organising the new "ITRAP + 10" project (2009-2012)

Partners: US DNDO, US DoE, IAEA

Tokyo, Japan, 8-9 December 2011

EU Nuclear Security Training Centre

- With support of DG Home Affairs
- Ensuring high standard in detection and response
- Complementary to national training activities
- Focus on advanced training using nuclear material
- In collaboration with the EU MS, the IAEA and international initiatives
- Benefiting from expertise of the JRC in Ispra and Karlsruhe
- Target audience: front line officers, trainers, experts, decision makers

- Implementation in 2011, fully operational by mid 2012

Tokyo, Japan, 8-9 December 2011

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

STAR: table top exercise
A European Programme

25-26 May 2011

STAte Response to terrorist attacks

Prevention of and Fight against Crime 2009
With financial support from the Prevention of and Fight against Crime Programme
European Commission - Directorate-General Justice, Freedom and Security

Tokyo, Japan, 8-9 December 2011

Experts coming from:

Belgium

Czech Rep.

Denmark

Finland

France

Germany

Hungary

Italy

Lithuania

Slovakia

Spain

Sweden

Switzerland

United Kingdom

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Security

- Detection and assessment of security events
- Contingency plan activated (regional / national level)
- National response forces required

REFLEX PHASE

S1

The attack

- Reactor automatic shutdown
- Detection and assessment of safety events
- Emergency plan activated
- National safety emergency organisation activated

Safety

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Security

- National forces lead negotiation with adversaries
- Last details of assault tactics are decided
- Adversaries overpowered
- Release of hostages

RESPONSE PHASE

S8

Assault

- Assessment of 5 hrs to recover core cooling

Safety

OBJECTIVES OF THE STAR SEMINAR

Open discussions about issues like:

- Time managing
- Coherence/complementary of emergency and contingency plans
- Management of interfaces between on-site and off-site forces
- The coordination, cooperation and complementarities between safety and security
- Issues related to the recovery phase

Euratom International collaborations on Nuclear Safeguards and Security

IAEA	**Euratom support programme**
USA	**US DOE: Safeguards and Security Cooperation Agreement** **US DOE NNSA: coordination of Second Line of Defence Activities (incl. IAEA)** **US DNDO: Collaboration on ITRAP+10 project**
IAEA+US DOE	**BMWG (Border Monitoring Working Group)**
ITWG	**International Technical Working Group on Nuclear Forensics**
JAPAN	**Cooperation JRC- JAEA on nuclear safeguards and security** **Main topics: Non-destructive assay on molten fuel; forensics; nuclear and environmental material analyses; training; spent fuel surveillance**
CHINA	**Cooperation Agreement with MOST/CAEA on nuclear safeguards and security**
CANADA	**R&D Cooperation agreement including CANDU safeguards**
RF and CIS	**Instrument for Stability projects in the area of Nuclear safeguards, non-proliferation and nuclear security (e.g. project on illicit trafficking)**

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CBRN Centres of Excellence

2010: launch of a global initiative to establish BCRN regional Centres of Excellence

- **Within the framework of the Instument for Stability, one of the EU's external cooperation instruments**
- **Aims at building international, regional and national capacity to address trans-regional and global threats (crisis response)**
- **Five regions concerned: South Caucasus / Ukraine/South East Europe, North Africa, West Africa, the Middle East, and South East Asia**
- **The Centres of Excellence will address legal, regulatory, technical, enforcement and control issues relating to CBRN risk mitigation**
- **In each region, range of networks of experts will be created or reinforced for sharing best practices, reviewing laws and regulation, developing technical capacities on the above subjects**
- **The projects cover a broad scope of CBRN issues. Implementation will start in early 2012**

Cooperation with regional actors necessary

Conclusion

- After March 2011, a stress test process has been started in Europe
- Interim report to be followed by peer reviews with external observers (Japan)
- From design phase on: safety and security to be integrated
- From both points of view, only the more advanced NPP technologies should be implemented in the future
- International cooperation needed
- Strong EU-Japan links in particular on safeguards and security science and technology