

# LESSONS FROM FUKUSHIMA

*ENELA Conference Cycle*

*Munich 27 April 2012*

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**IAEA**

International Atomic Energy Agency

# TOWARDS A SUSTAINABLE AND RESPONSIBLE USE OF NUCLEAR ENERGY

- *The IAEA and the Global Nuclear Safety and Security Framework*
- *The IAEA Response to Fukushima Daiichi Accident*
- *Lessons Learned / Action Plan*

# Context

- Natural disaster
- Tragic loss of life
- Impairment of infrastructure
- Unprecedented scenario



# IAEA Mission and Activities: Three Pillars

## ➤ Safety & Security

The IAEA works to protect people and the environment from harmful radiation exposure

## ➤ Safeguards & Verification

The IAEA works to prevent the further spread of nuclear weapons

## ➤ Science & Technology

The IAEA works to mobilize peaceful applications of nuclear science and technology to developing countries.



# Safety History: from Chernobyl to Fukushima

- Acceleration in development of safety standards, guidelines and services to assist countries affected
- Adoption of the Notification and Assistance Conventions (1986), and of the Convention on Nuclear Safety in 1994
- Department of Nuclear Safety was created a decade later
- 25 years later: Fukushima



*“...Radioactivity does not respect national boundaries, or national sovereignties. Rules ensuring the safe use of large-scale nuclear activities should therefore be worked out internationally and accepted to apply everywhere....”*

Hans Blix,  
former IAEA Director General



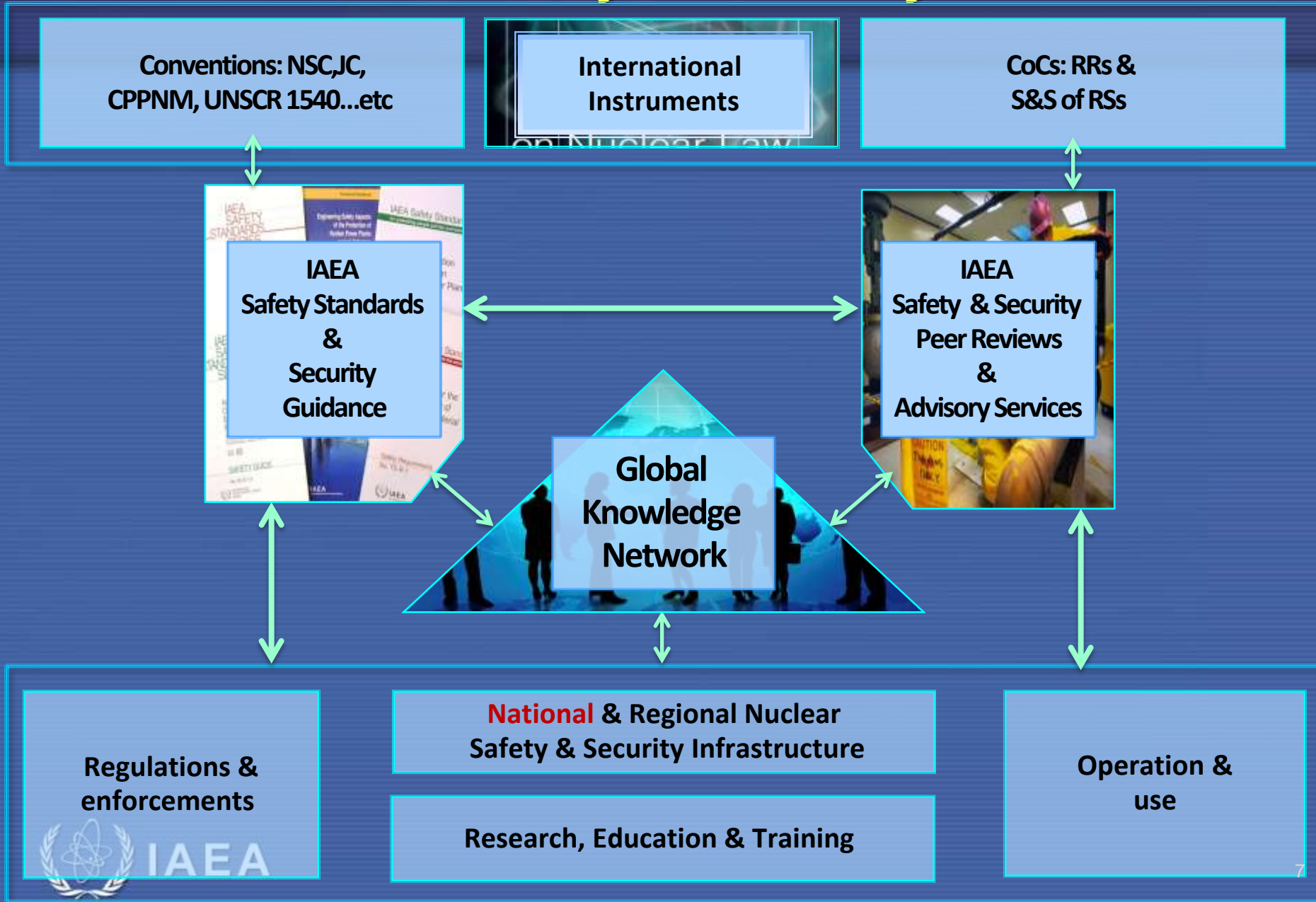
# Security History: 9/11

## September 11, 2001 aftermath of terrorist attack:

- Security risks from outside groups or insider threats became of paramount concern surrounding nuclear power plant critical infrastructure
- Questionable whether reactors would withstand such attacks
- 2003 Office of Security
- Amendment of the CPPNM launched in 1998, adopted in 2005, in Force: 20??
- Lessons from Fukushima?



# Global Nuclear Safety and Security Framework



# The IAEA Safety Standards

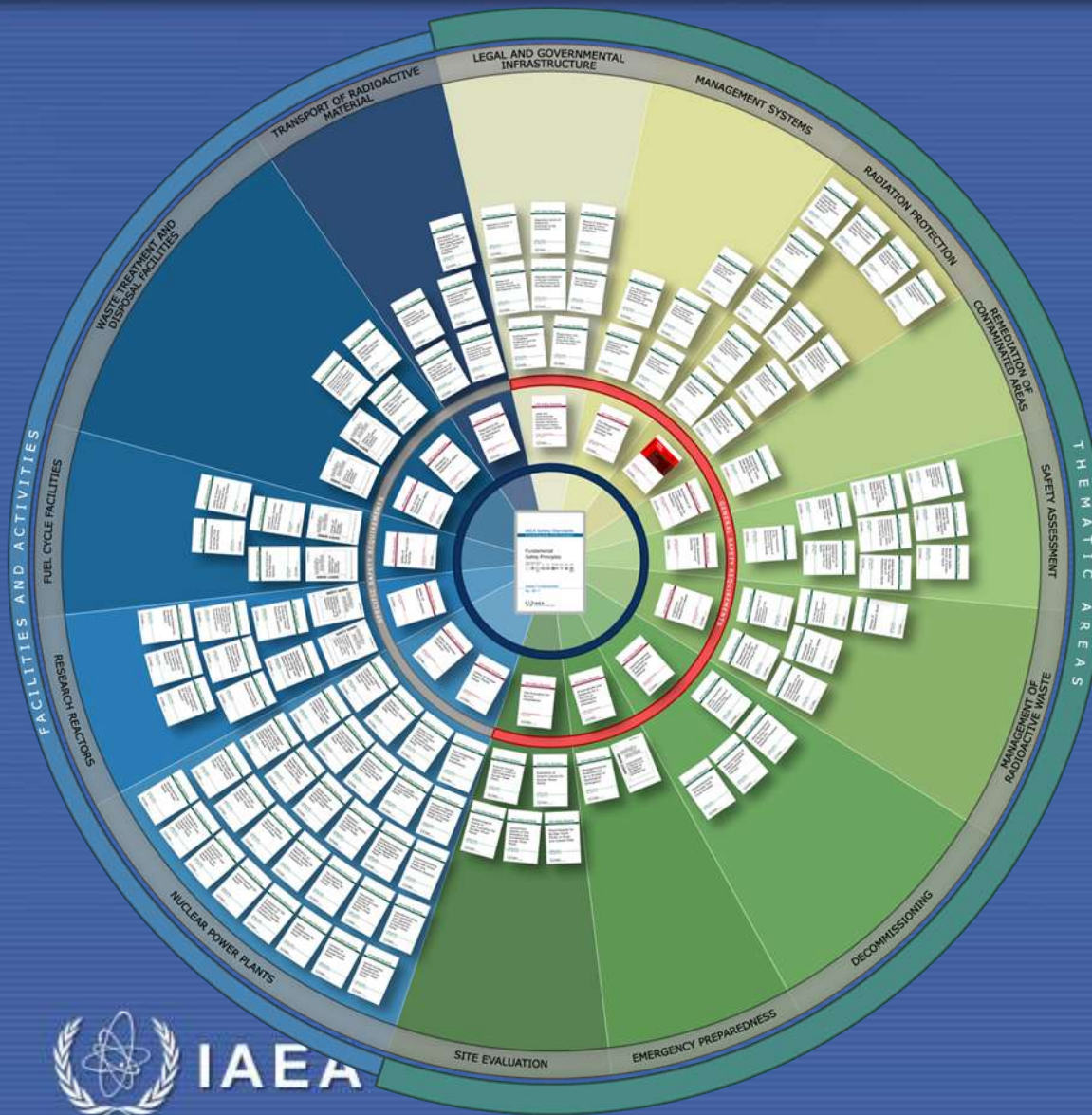


Safety Standards are:

- **Non binding** on Member States but may be adopted by them
- **Binding** for IAEA's own activities
- Binding on States in relation to operations assisted by the IAEA or States wishing to enter into project agreements with IAEA
- **Voluntarily binding** for States that have imbedded IAEA Safety Standards in their National Regulations



# Safety Standards and Security Guidelines



IAEA Nuclear Security Series No. 2  
**Technical Guidance**  
 Nuclear Forensic Support

IAEA Nuclear Security Series No. 3  
**Technical Guidance**  
 Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators

IAEA Nuclear Security Series No. 4  
**Technical Guidance**  
 Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage

IAEA Nuclear Security Series No. 9  
**Implementing Guide**  
 Security in the Transport of Radioactive Material

IAEA Nuclear Security Series No. 13  
**Recommendations**  
 Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 3)

IAEA Nuclear Security Series No. 1  
**Technical Guidance**  
 Identification of Radioactive Sources and Devices

IAEA Nuclear Security Series No. 5  
**Technical Guidance**  
 Combating Illicit Trafficking in Nuclear and other Radioactive Material

IAEA Nuclear Security Series No. 7  
**Implementing Guide**  
 Nuclear Security Culture

IAEA Nuclear Security Series No. 10  
**Implementing Guide**  
 Development, Use and Maintenance of the Design Basis Threat

IAEA Nuclear Security Series No. 14  
**Recommendations**  
 Nuclear Security Recommendations on Radioactive Material and Associated Facilities

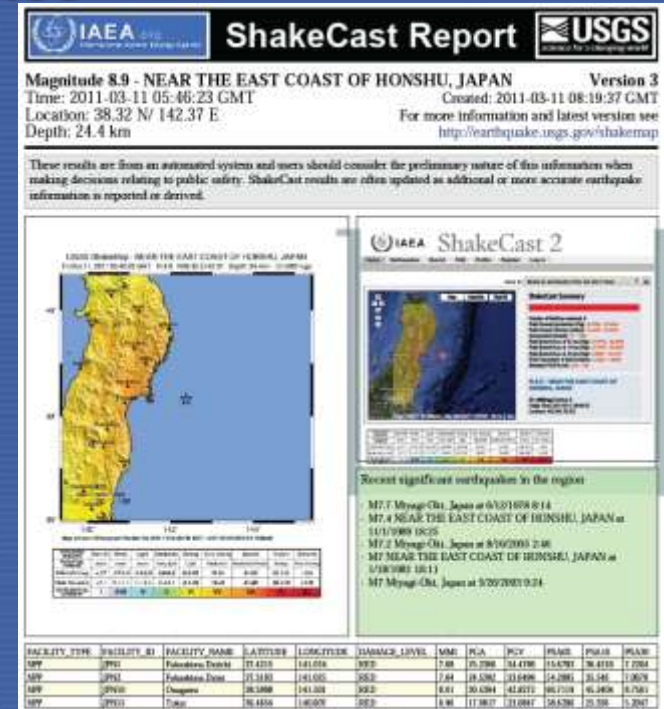
# Peer Reviews and Advisory Services



	Nuclear Safety	Radiation Protection & Safety	Radioactive Waste Management	Transport	Incident & Emergency	Nuclear Security
<b>Regulators</b>	IRRS, SCEA, INSARR, SSRS, Advisory mission for source safety, RP Fact Finding Mission	IRRS, EduTA, SSRS, RP Fact Finding Mission, Advisory mission for source safety	IRRS, NSRW waste management missions	IRRS, TranSAS	EPREV, SSRS, IRRS	IRRS, SCEA, IPPAS, INSServ, SSRS
<b>Operating organizations</b>	OSART, SCEA, INSARR, SEDO, SSRS	ORPAS, OSART, SEDO, SSRS, INSARR	SEDO, NSRW waste management missions, INSARR	TranSAS	EPREV, SEDO, OSART, SSRS, INSARR	IPPAS, SSRS
<b>Vendors</b>	SCEA					SCEA
<b>Educators</b>	SCEA, SEDO, OSART	ORPAS, EduTA			EPREV (EPR)	IPPAS, INSServ
<b>Law Enforcement</b>		ORPAS		IPPAS, INSServ	EPREV	INSServ
<b>State officials / Governments</b>						
<b>Health sector</b>		ORPAS, RPoPAS			EPREV	
<b>TSOs</b>						

# IAEA Response to Fukushima (1)

- International Seismic Safety Centre (ISSC)
  - potential for heavy damage at 4 sites
    - Fukushima Daiichi
    - Fukushima Daini
    - Onagawa
    - Tokai
  - potential for a tsunami
- Incident and Emergency Centre notified and manned as a result to the ISSC report.
- IEC has been continuously (24/7) staffed since event occurred during 54 days.



# IAEA Response to Fukushima (2)

05:46 UTC

- Earthquake of magnitude 9.0 occurred near East coast of Honshu, Japan

06:42 UTC

- On-call external event specialist informed/alerted on-call ERM: occurrence of earthquake, possible damage at 4 NPPs and potential for tsunami anticipated

07:21 UTC

- IEC made first phone contact with Ministry of Economy, Trade and Industry (METI) –Nuclear and Industry Safety Agency (NISA)

07:48 UTC

- Offer of Agency's assistance sent to METI-NISA Japan

08:06 UTC

- First EMERCON message for MSs and IGOs published on ENAC web site

08:20 UTC

- IEC declares Full Response Mode operations

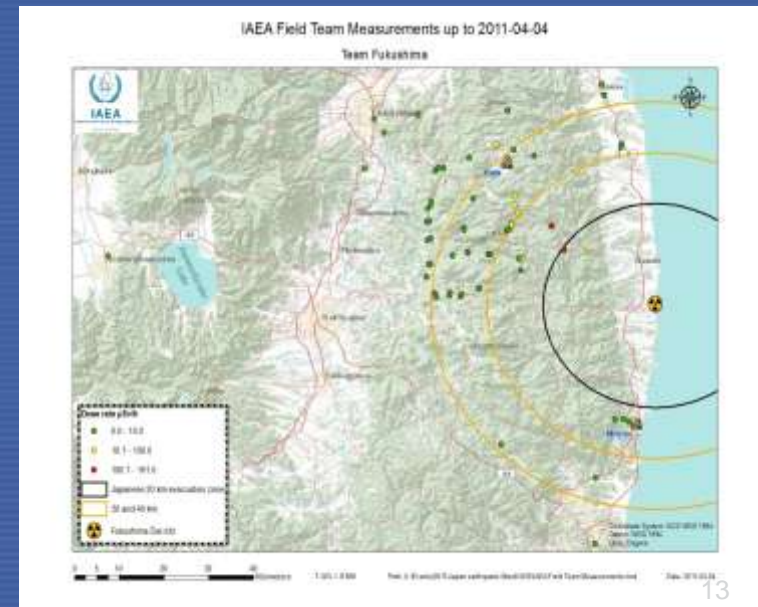
The screenshot shows the ENAC (Emergency Notification and Assistance Center) Standard Report Form. The form is titled "Standard Report Form" and includes a header with the ENAC logo and navigation links. The form is divided into several sections:

- 1. REPORTING STATE:** Reporting state: Japan
- 2. COMPETENT AUTHORITY:** Competent authority: Ministry of Economy, Trade and Industry (METI)
- 3. FACILITY / EVENT LOCATION:** Facility name: Fukushima Daiichi Nuclear Power Plant
- 4. NATURE OF EVENT:** Event type: Earthquake
- 5. DATE AND TIME OF OCCURRENCE:** Event date: 2011-03-11, Event time: 05:46 UTC
- 6. EVENT DESCRIPTION:** Event description: Earthquake of magnitude 9.0 occurred near East coast of Honshu, Japan
- 7. MEDIA INFORMATION:** Media information: None

The form also includes a "HEADER" section with fields for "To: IAEA/EMERCON", "From: IAEA/EMERCON ADVISORY", and "Status: Verified by IAEA".

# IAEA Response to Fukushima (3)

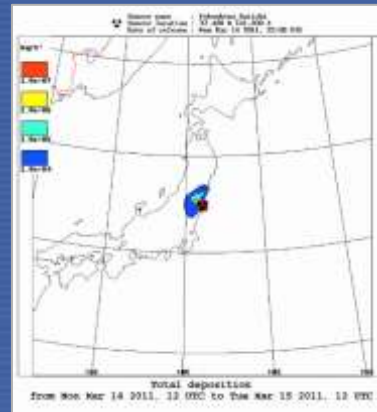
- Director General formed Fukushima Accident Coordination Team (FACT) and visited Japan
- Deputy Director General & Head of Nuclear Safety and Security Department
  - Fukushima Nuclear Safety Team (FNST)
  - Fukushima Radiological Consequences Team (FRCT)
  - Fukushima Monitoring Teams (FMT)



# MS/Press Briefings

- Daily/Weekly MS Briefings
  - Status of Fukushima Daiichi NPP
  - Radiological Status on site and off site
  - Marine monitoring
  - Food monitoring

Unit	1	2	3	4
Power (MW, %DWR)	60(138)	79(236)	79(235)	79(236)
Type of Reactor	BWR-3	BWR-4	BWR-4	BWR-4
Status at time of EQ	In service - auto shutdowns	In service - auto shutdowns	In service - auto shutdowns	Outage
Core and fuel integrity	Damage	Intact/stable	Damage	No fuel in the Reactor
RPV & RCS integrity	RPV temperature high but slowly decreasing	RPV temperature stable	RPV temperature stable	Not applicable due to damage prior status
Containment integrity	No information	Damage suspected	Damage suspected	
AC Power	AC power available - power to instrumentation - Lighting in Central Control Room	AC power available - power to instrumentation - Lighting in Central Control Room	AC power available - power to instrumentation - Lighting in Central Control Room	AC power available - power to instrumentation - Lighting in Central Control Room
Ducting	Severe damage	Slight damage	Severe damage	Severe damage
Water level of RPV	Assumed high or high in abnormal	Assumed high or high in abnormal	Assumed high or high in abnormal	
Pressure of RPV	Slowly increasing	Stable	Stable	
CV Pressure Decay	Stable	Stable	Stable	Not applicable due to damage prior status
Water injection to RPV	Injection of freshwater via mobile electric pump with off-site power	Injection of freshwater via mobile electric pump with off-site power	Injection of freshwater via mobile electric pump with off-site power	
Water injection to CV	No information	No information	No information	
Spent Fuel Pool Status	Fresh water injection by concrete pump truck	Freshwater injection to the Fuel Pool Cooling Line	Freshwater injection via Fuel Pool Cooling Line and Periodic spraying	Fresh water injection by concrete pump truck



# IAEA International Fact-finding Expert Mission

- Based upon the agreement between the IAEA and the Government of Japan.
- Visited Japan between 24 May and 02 June 2011
  - For a preliminary assessment of the safety issues linked with the Fukushima Daiichi
  - And to identify areas that need further exploration or assessment, based on the IAEA safety standards
- Reported to the IAEA Ministerial Conference on Nuclear Safety (20-24 June 2011)



# IAEA Ministerial Conference, 20-24 June Vienna

- **IAEA Ministerial Conference**
  - *Ministerial Declaration*
  - *Working Sessions*
    - ✓ Assessment of the accident
    - ✓ Emergency preparedness and response
    - ✓ Global nuclear safety framework
  - *Conclusions and recommendations for the future,*
  - *Way forward through an action plan*





# Major themes for strengthening nuclear safety

- The IAEA Safety Standards
- The Safety of NPPs
- Peer review mechanisms
- EPR Framework
- International cooperation
- Global nuclear safety framework

# IAEA ACTION PLAN ON NUCLEAR SAFETY

## 12 Point Plan

- Safety Vulnerabilities,
- Peer Reviews,
- Emergency Preparedness and Response
- Regulatory Bodies,
- Operating Organisations
- IAEA Safety Standards,
- Legal Framework
- Embarking countries,
- Capacity Building
- Protection of People + Environment
- Communication,
- Research + Development

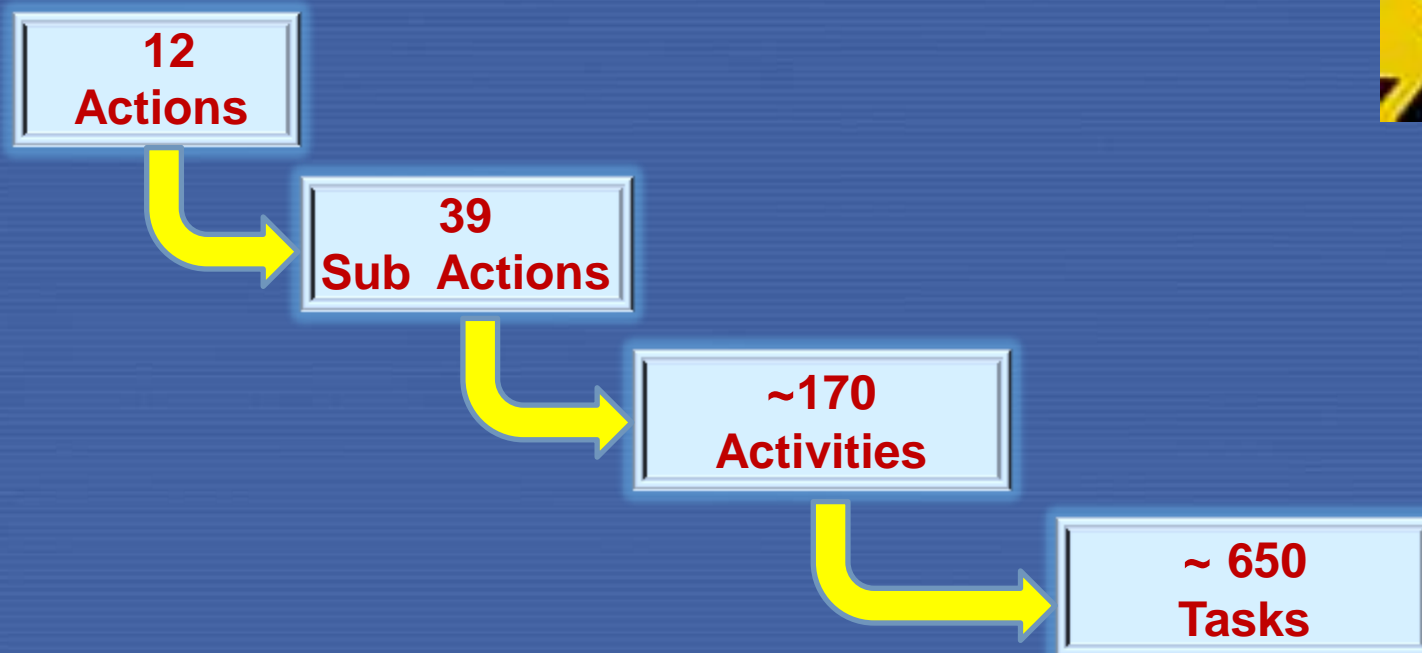


### Actions on

- IAEA Secretariat
- Member States
- Other Relevant Stakeholders



# IAEA Secretariat Implementation Plan



# ASSESSMENT OF SAFETY VULNERABILITIES

**We the Ministers [...] Encourage States with operating nuclear power plants to conduct, as a response to the accident at the Fukushima Daiichi Nuclear Power Station, comprehensive risk and safety assessments of their nuclear power plants in a transparent manner;**

# ASSESSMENT OF SAFETY VULNERABILITIES

## Action Plan

- **Member States** to promptly undertake a national assessment
- **IAEA** develop a methodology and make it available for MSs
- **IAEA** upon request, to provide assistance and support to MSs

## Key Achievements

- IAEA Methodology
- Support and Advice to Member States
- International Expert Mission to Japan (01/2012)



# STRENGTHEN IAEA PEER REVIEWS

**We the Ministers [...] Underline the benefits of strengthened and high quality independent international safety expert assessments, in particular within the established IAEA framework**

# STRENGTHEN IAEA PEER REVIEWS

## Action Plan

- **IAEA** to strengthen peer reviews
- Provide information on where and when IAEA peer reviews done
- **Member States** to provide experts for peer review missions

## Key Achievements

- **IRRS + EPREV**
  - Dedicated 'Fukushima' Modules
- **OSART + DRS**
  - Severe Accident Management / Assessment
- **Publish peer review results**

## Increase in Demand for IAEA Peer Reviews



# STRENGTHEN EMERGENCY PREPAREDNESS AND RESPONSE

## Action Plan

- **Member States** conduct prompt national review
- **IAEA/stakeholders** to
  - Strengthen the international EPR framework
  - Strengthen assistance mechanisms

## Key Achievements

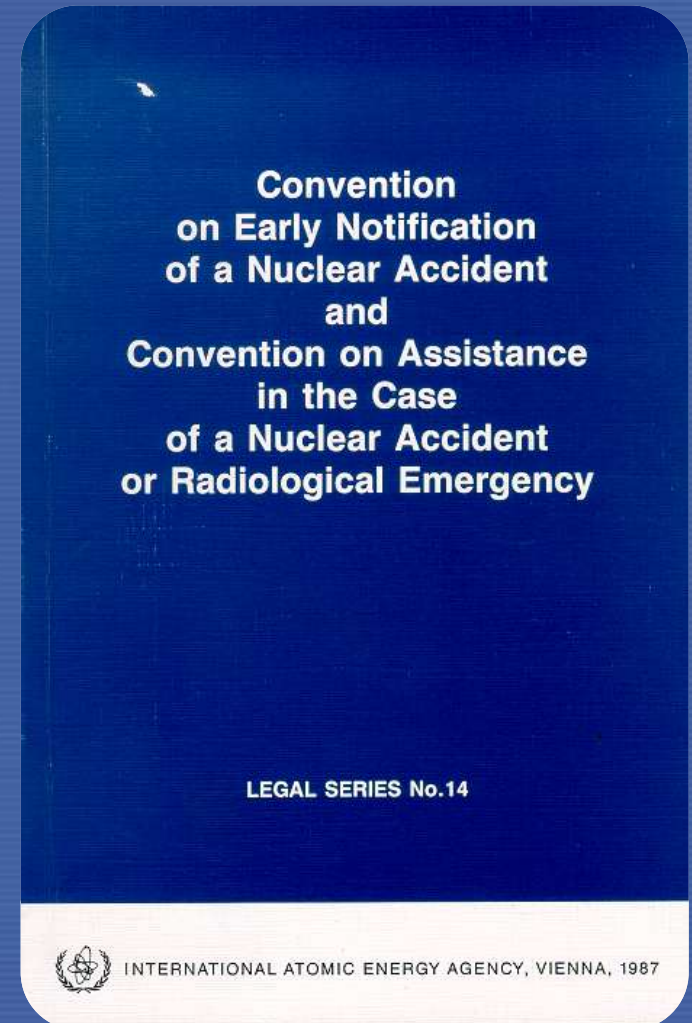
- Meeting of Inter-Agency Committee on Radiological and Nuclear Emergencies IARCNE - December 2011
- RANET meeting - Feb 2012
- C.A. meeting April 2012





# Emergency Preparedness & Response

- **Strengthen legal instruments**, adopted 25 years ago, for international EPR framework, to address today's concerns.
- Member States should consider making use of systematic and regular **Emergency Preparedness Review (EPREV)** and follow-up missions to appraise national EPR arrangements and capabilities to ensure their continuous improvement
- Amendment proposal of the “Notification Convention” from Russia



# STRENGTHEN THE EFFECTIVENESS OF NATIONAL REGULATORY BODIES

## Action Plan

- **Member States** to promptly review regulatory bodies
- **IAEA** to enhance the IRRS
- Each **Member State** with nuclear power plants to voluntarily host an IRRS

## Key Achievements

- IRRS International workshop USA Oct 2011
- IRRS - more systematic assessment of national regulations and guidance + Fukushima module
- Effective Nuclear Regulatory Systems



# STRENGTHEN EFFECTIVENESS OF OPERATING ORGANIZATIONS

## Action Plan

- Strengthen **IAEA/WANO** links
- **Member States** to
  - Improve management systems, safety culture, human resources management, in operating organizations
  - Host OSART in next three years

## Key Achievements

- Cooperation WANO
  - DG Amano - WANO Conference 2011
  - Coordinate Peer Reviews, Safety Standards, Embarking Countries
  - New MoU



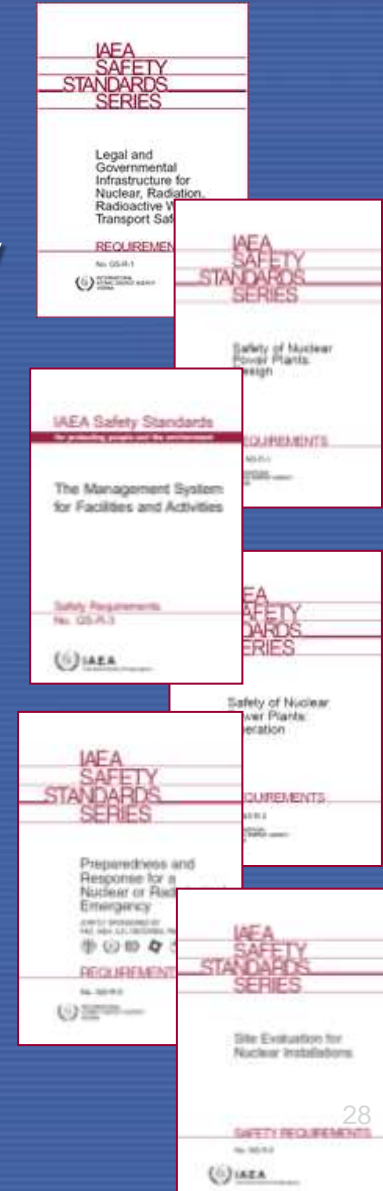
# REVIEW AND STRENGTHEN IAEA SAFETY STANDARDS

## Action Plan

- **IAEA** to review, and revise as necessary
- **Member States** to utilize as broadly and effectively as possible the IAEA Safety Standards

## Key Achievements

- Systematic Review Requirements for NPPs
  - No Gaps, some enhancements needed
- Streamline Review Process
- Report to IAEA Director General - June 2012



# IMPROVE EFFECTIVENESS OF INTERNATIONAL LEGAL FRAMEWORK

## Action Plan

- **States parties** to consider enhancing the effectiveness of CNS et al.
- **Member States** encouraged to join and effectively implement these Conventions

## Key Achievements

- International Expert Group on Nuclear Liability (INLEX)
- Nuclear Law Institute (NLI)
- CNS Extraordinary Meeting Aug 2012



# Decision of the 5<sup>th</sup> CNS Review Meeting

## Extraordinary Meeting on Fukushima Daiichi Accident in August 2012

- Aim of the Meeting:
  - To **enhance safety** through reviewing and sharing lessons learned and actions taken by CPs in response to Fukushima Accident;
  - To **review the effectiveness** and, if necessary, the continued **suitability** of the provisions of the CNS.
- Structure
  - developed by General Committee
  - no Country Groups

# Topics

## National Reports organized by topics that cross the boundaries of multiple CNS Articles

1. External Events
2. Design Issues
3. Severe Accident Management and Recovery (on-site)
4. National Organizations (Regulator, TSO, Operator, Government)
5. Emergency Preparedness & Response and Post-accident Management (off-site)
6. International Cooperation

# MEMBER STATES EMBARKING ON NUCLEAR POWER PROGRAMME

## Action Plan

- **Member States** - appropriate infrastructure
  - IAEA Safety Standards and
  - Other relevant guidance
- **IAEA** to provide assistance
- **Member States** to host INIRs



## Key Achievements

- Infrastructure Workshop Jan 12
- INIR Mission Bangladesh
- Safety Infrastructure Guide SSG-16





# STRENGTHEN AND MAINTAIN CAPACITY BUILDING

## Action Plan

- **Member States** with NPPs and those embarking to strengthen, develop, maintain and implement their capacity building programs
- **IAEA** to assist as requested

## Key Achievements

- IAEA Guidance on capacity building,
- Self-assessment, including
  - Human resources,
  - Education and training,
  - Knowledge management and networks



## Training

Knowledge  
useful abilities  
backbone of co  
quired for a tr  
today

# PROTECTION OF PEOPLE + ENVIRONMENT FROM IONIZING RADIATION

## Action Plan

- **Member States, IAEA Secretariat + relevant stakeholders** to facilitate use of information/expertise for
  - Monitoring, decontamination and remediation
  - Removal of damaged nuclear fuel and the management and disposal of radioactive waste, and
  - Share information regarding the assessment of radiation doses and impacts on people and the environment
  - IAEA to assist as requested

## Key Achievements

- International Expert Mission Remediation
  - Japan Oct 2011
- **Models and Data for Radiological Impact Assessment (MODARIA)**



# COMMUNICATION AND DISSEMINATION OF INFORMATION

## Action Plan

- Strengthen the emergency notification system
- Enhance the transparency and effectiveness of communication among operators, regulators and various international organizations
- Review application of INES scale as a communication tool
- Organize international experts meetings IEMs

## Key Achievements

- International Experts' Meetings IEMs
  - Reactor and Spent Fuel Safety March 2012
  - Transparency and Communication June 2012
  - Remediation and Decommissioning March 2013
  - Workshop on Seismic and Tsunami Hazards ~ Sept 2012
- Ministerial Conference on Nuclear Safety December 2012
- Effective Regulatory Systems Conference Canada April 2013



**International Experts' Meeting on  
Reactor and Spent Fuel Safety  
in the Light of the Accident at the  
Fukushima Daiichi Nuclear Power Plant**

Organized in connection with the implementation of the IAEA Action Plan on Nuclear Safety



IAEA Headquarters  
Vienna, Austria  
19-22 March 2012



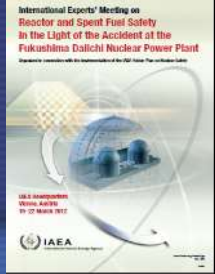
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# COMMUNICATION AND DISSEMINATION OF INFORMATION

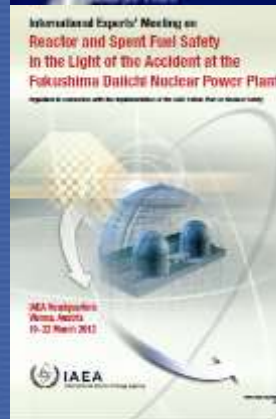
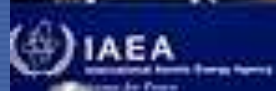


- INES as a communication tool did not play its role: it should be reviewed and improved to make it more effective
- Action Plan: “...review of INES as a communication tool...”:
  - hence no changes in number of levels and criteria
  - identified issues related to applying methodology for severe, complex and evolving event
- Secretariat with support of INES Advisory Committee is developing additional guidance on use of INES in severe accidents

# INTERNATIONAL EXPERTS' MEETING REACTOR AND SPENT FUEL SAFETY



- 230 experts - 44 Member States 4 international organizations
- Objectives
  - Analyse relevant technical aspects
  - understand more fully its root causes
  - Share lessons learned + facilitate information sharing
- Overview
  - More attention on Mitigation
  - Severe accident management
  - IAEA Report





# INTERNATIONAL EXPERTS' MEETING REACTOR AND SPENT FUEL SAFETY

- Combination of hazards and multiple-units
- Several proposals to explore new IAEA guidance and documents
- More attention on Mitigation
- Severe accident management
- Key systems for safe state
- I&C systems for monitoring
- On-site / off-site mobile equipment and facilities
- Embarking countries
- Defence in depth philosophy and strategies
- Probabilistic and deterministic aspects
- Safety spent fuel: Loss of cooling; Loss of water; Re-criticality; Hydrogen production; Zirconium fires; damage and release of radioactivity.
- Human and Organization Factors



# INTERNATIONAL EXPERTS' MEETING REACTOR AND SPENT FUEL SAFETY

- “The IAEA should make available the information from the experts’ meeting to the Safety Standards Committees and the Commission of Safety Standards (CSS).”
- “The lessons that were discussed at the meeting should be considered in the response to the Action Plan and evaluated for incorporation into IAEA SS.”

# RESEARCH AND DEVELOPMENT

## Action Plan

- **Relevant Stakeholders** with **IAEA** support to conduct necessary research and development
- Establish a Forum for organisations dealing with research and development
- Relevant Stakeholders with IAEA support to utilize the results of research and development and to share them, as appropriate, to the benefit of all Member States.

## Key Achievements

- Technical and Scientific Support Organization (TSO) Forum to strengthen scientific and technical coordination and collaboration among Member States

- Steering Committee January 2012





# The Global Nuclear Safety Framework

## The need for strengthening the Global Nuclear Safety Framework was confirmed

- Primary responsibility for safety is placed on the operator with oversight from the National Regulatory Body
- Supported by an international framework
  - Intergovernmental Organizations
  - Operator Networks
  - Regulator Networks

**IAEA plays a central role and is the appropriate international organization for strengthening the global nuclear safety framework.**

Thank you

