

**International Experts Meeting on  
Strengthening Research and Development Effectiveness  
in the Light of  
the Accident at the Fukushima Daiichi Nuclear Power Plant**

**16–20 February 2015  
Vienna, Austria**

**Post Fukushima R&D in the Framework  
of the European Union**

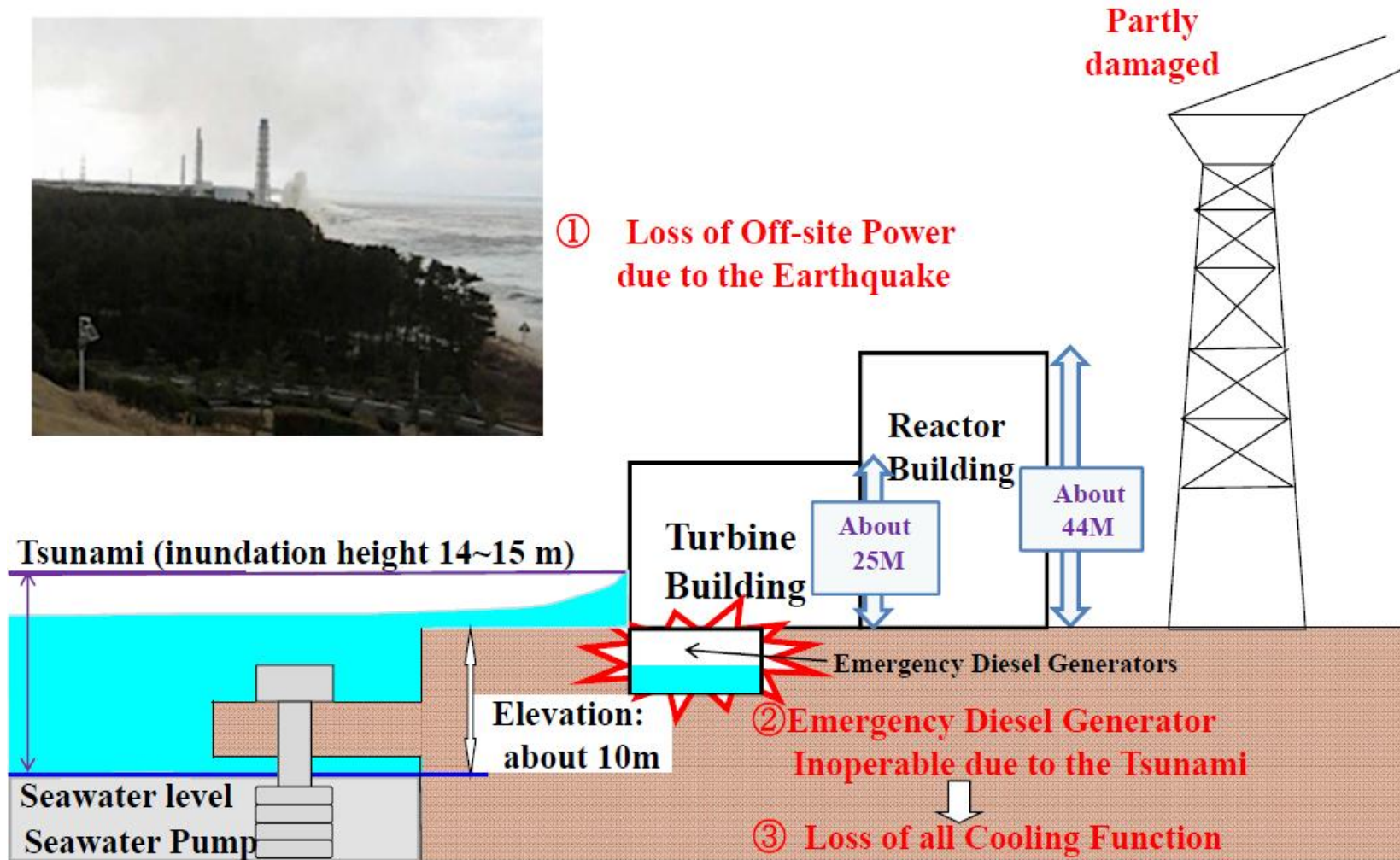


**G.B. BRUNA**

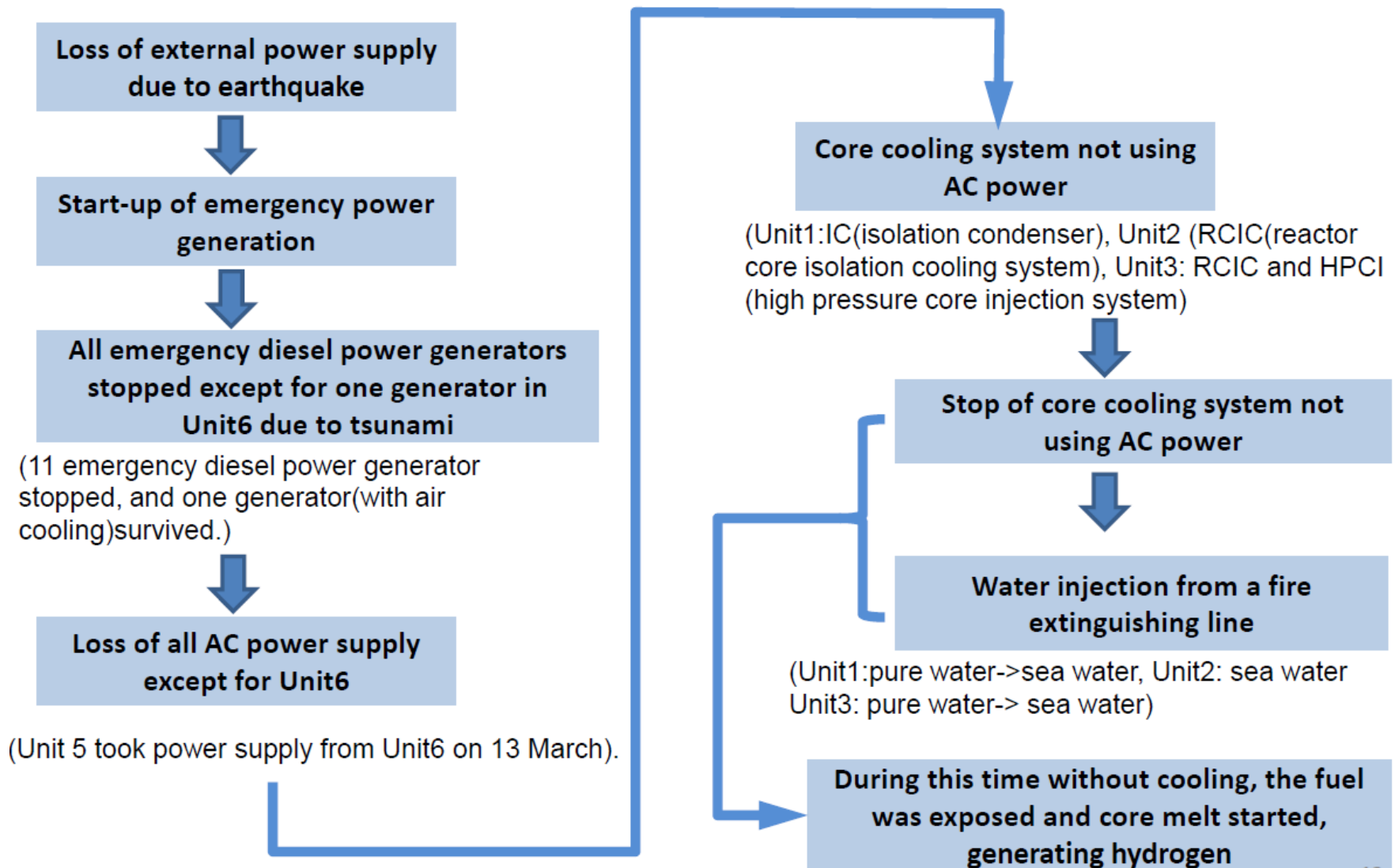
# Outline

- **Post Fukushima R&D in the Framework of the European Union**
- The Fukushima accident scenario and recovery actions
- Historical Background
- The SNETP **Task Group** on R&D
- Findings of the SNETP Fukushima *Task Group*
- Cross-cutting the *Task Group* Findings with NUGENIA's Topic Areas for R&D
- The NUGENIA Association and the SARNET network
- Concluding remarks

# Causes of the accident and plant damages



# Main accident sequence



# Historical Background 1/4

Immediately after the Fukushima's events, several organisations issued reports on "Lessons Learned"

Among others, we mention:

- Japanese Government Reports
- TEPCO's and other Japanese Organisations' Documents
- NRC Task Force Report
- OECD NEA Documents
- SARNET ranking of priorities
- ...

Key areas for further investigation identified in those and other documents included:

- **Nuclear system organization, safety infrastructure and safety culture**
- **Assessment of risk from external events and prevention measures**
- **Phenomenology, management and mitigation of severe accidents**
- **Emergency preparedness and management**

## Historical Background 2/4

- Additional inputs were expected from the stress tests, related to three areas
  - Accidents initiated by natural events
  - Loss of electrical power and ultimate heat sink
  - Severe Accidents
- None of these documents explicitly addressed R&D topics and priorities (nevertheless, elements were provided by SARNET and TSO).

## Historical Background 3/4

■ To address R&D topics and priorities, the Governing Board of the SNETP - Sustainable Nuclear energy Technology Platform - gathering in Rome on March 31 2011, settled a **Task Group**, the main duty of which was:

- Assessing the lessons learned from the accident,
- Assessing the results of the 'stress tests',
- Assessing their implications on R&D needs and priorities, established by the **SNETP SRA 2009**, for GEN II / GEN III, as well as on other components of the Platform,
- Making proposals to SNETP (and possibly in turn, by the Board to the European Commission).

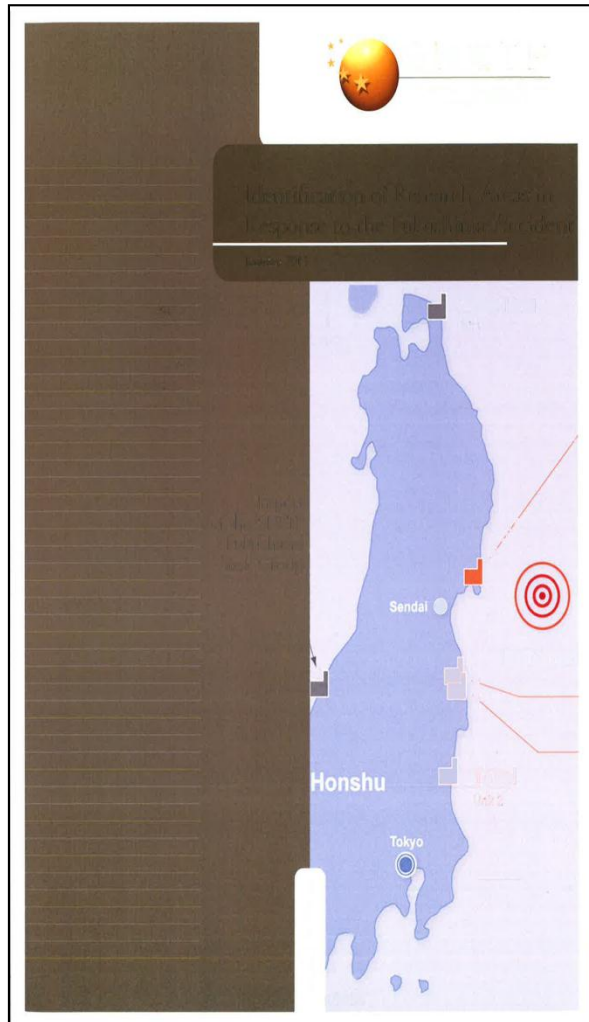
It was clearly stated that the **Task Group's** activity should focus on R&D

## Historical Background 4/4

- The following Organizations participated in the **Task Group** which was coordinated by **Jozef Misak from UJV Rez** :
  - AMEC, ENEL, EON, IRSN, JRC Petten, NRI Rez, SCK/CEN
- The Group started working in April 2011 with a survey of all the available information.
- Preliminary conclusions were issued in spring 2012
- They have been revised and complemented to include the outcome from the European Stress-Tests
- The Report - this presentation widely relies upon - was eventually issued January 2013, after SNETP EXCOM's approval.



## *SNETP Report on R&D Priorities*



*Identification of  
Research Areas in  
Response to the  
Fukushima  
Accident*

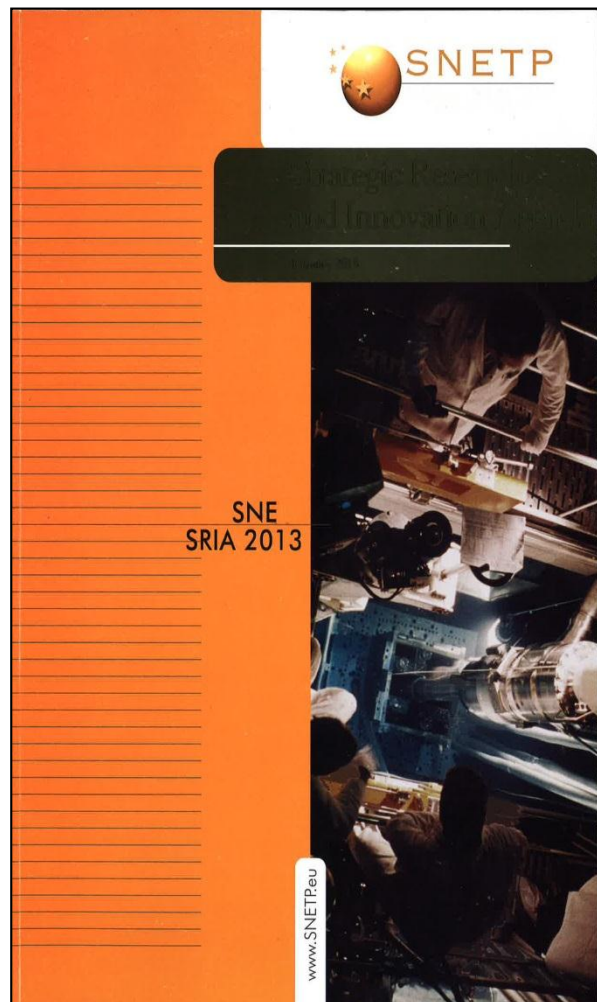
**SNETP January  
2013**

**Report  
Of the SNETP  
Fukushima  
Task Group**

## Findings of the SNETP Fukushima *Task Group* 1/4

- 13 Research Topics were established, gathering relevant issues into homogenous fields of endeavour
- None of these Research Topics identified a fully new area for research, but several topics in the **SRA 2009** appeared to be worthy for higher R&D priority **⇒ SRIA 2013** (**Strategic Research and Innovation Agenda**) **issued February 2013**
- Strong harmonization needs were identified - from basic research to applied and pre-normative research -

# *SNETP SRIA 2013*



*The SNETP SRIA 2013*

*Strategic Research  
&  
Innovation  
Agenda*

**SNETP, May 2013**

# Findings of the SNETP Fukushima *Task Group* 2/4

**Nuclear system organization, safety infrastructure and safety culture**

1. **Systematic assessment of vulnerabilities to defence-in-depth and safety margins for beyond design basis loads**
2. **Human/organizational factors under high stress and harmful conditions**

**Assessment of risk from external events and prevention measures**

3. **Improved methods for external event hazard evaluation**
4. **Use of the probabilistic methods to assess plant safety in relation to extreme events**
5. **Advanced deterministic methods to assess plant safety in relation to extreme events**
6. **Advanced safety systems for nuclear power plants**

## Findings of the SNETP Fukushima *Task Group* 3/4

### Phenomenology, management and mitigation of severe accidents

7. Advanced materials for nuclear power
8. Advanced methods for the analysis of severe accidents
9. Improved procedures for management of severe accidents
10. Assessment of the radiological effects of the severe accidents
11. Improved modelling of fuel degradation in the spent fuel pool

### Emergency preparedness and management

12. Methods for minimization of contamination in the NPP surroundings and for treatment of large volume of radioactive waste
13. Accident management in the framework of the integrated rescue system

## Findings of the SNETP Fukushima *Task Group* 4/4

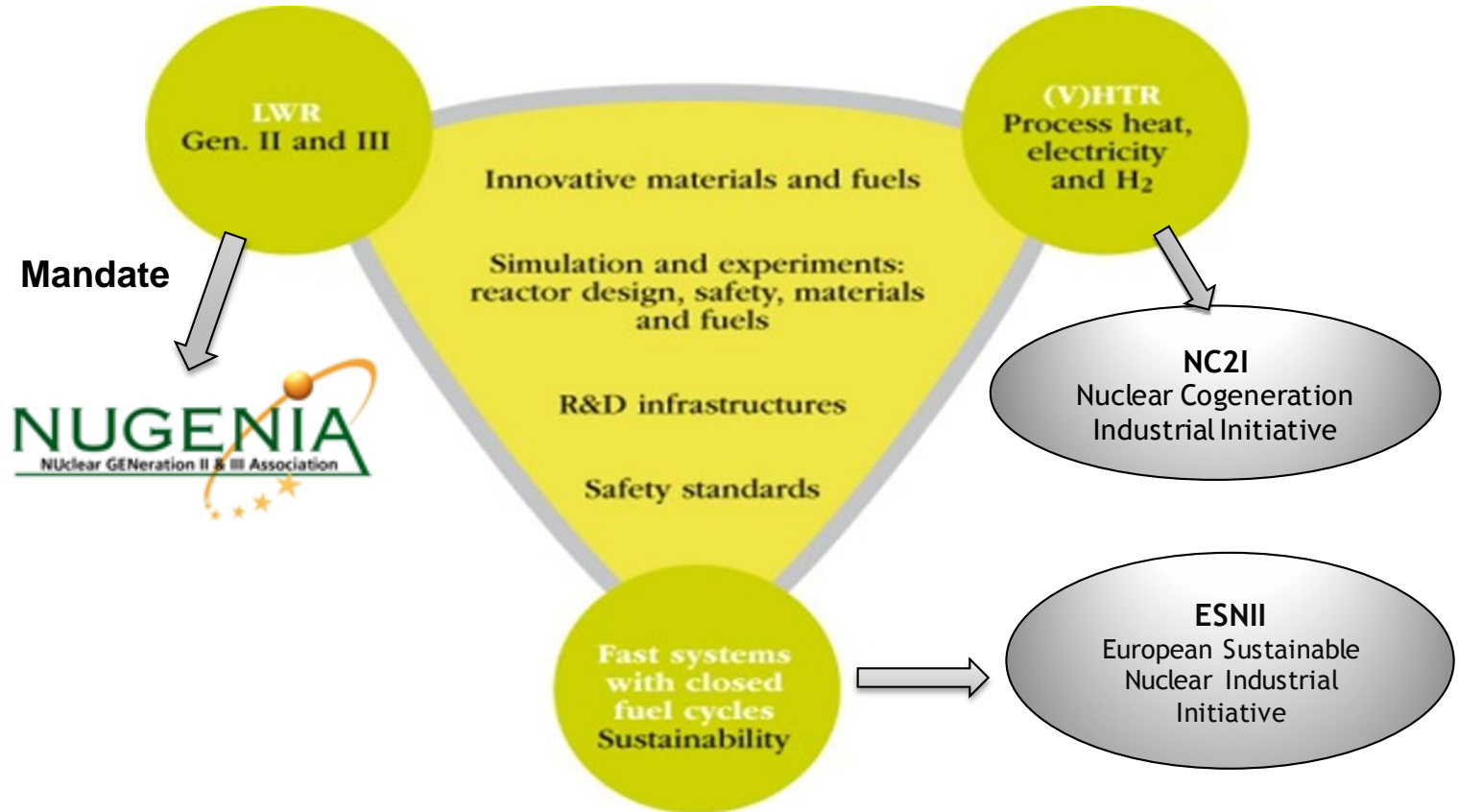
- Not only technical issues, but also organizational and societal ones were addressed
- Implementation was judged very important: it was claimed that attention should be devoted on how the research outcomes profits to the design and operation  
⇒ **transfer to industrial practice**
- For Gen II/III, implications on R&D topics were drafted through cross-cutting the **13** identified Research Topics with the **8** NUGENIA's Technical Areas

# Cross-cutting the *Task Group Findings* with NUGENIA's Technical Areas for R&D

	Material behaviour during SA	Advanced methods for the analysis of SA	Improved procedures for management of SA	Assessment of the radiological effects of the SA	Improved modeling of fuel degradation in the spent fuel pool	Methods for minimization of contamination.	Accident management in the framework of the integrated rescue system
Plant safety & risk assessment	* *	*	*	*	*		*
Severe accidents	*	**	**	**	*		*
Core & reactor operation			*	*	*		*
Integrity assessment & ageing of SSCs	**						
Fuel development, waste & spent fuel management & decommissioning	**				**	*	
Innovative Gen III design	* *						
Harmonization							*
Inspection and Qualification	*		*				*



# NUGENIA within SNETP





# NUGENIA in short

- International non-profit Association of Belgian law founded in November 2011 and officially launched in Brussels, March 2012
- R&D on fission technology, mainly GEN II-III
  - Redaction of *Roadmaps*
  - Contribution to SNETP SRIA
  - Elaboration of R&D projects (Portfolio, Platform Innovation)
  - Annual GA and Forum
  - Strong support to harmonization of practices, codes and standards
  - Dissemination of knowledge



# NUGENIA : 8 Technical Areas for R&D

1 Safety and Risk of NPPs



2 Severe Accidents



3 Core and Reactor Operation



4 Integrity Assessment of Systems, Structure and Components



5 Fuel Development, Waste and Spent Fuel Management and Decommissioning



6 Innovative LWR Design and Technology

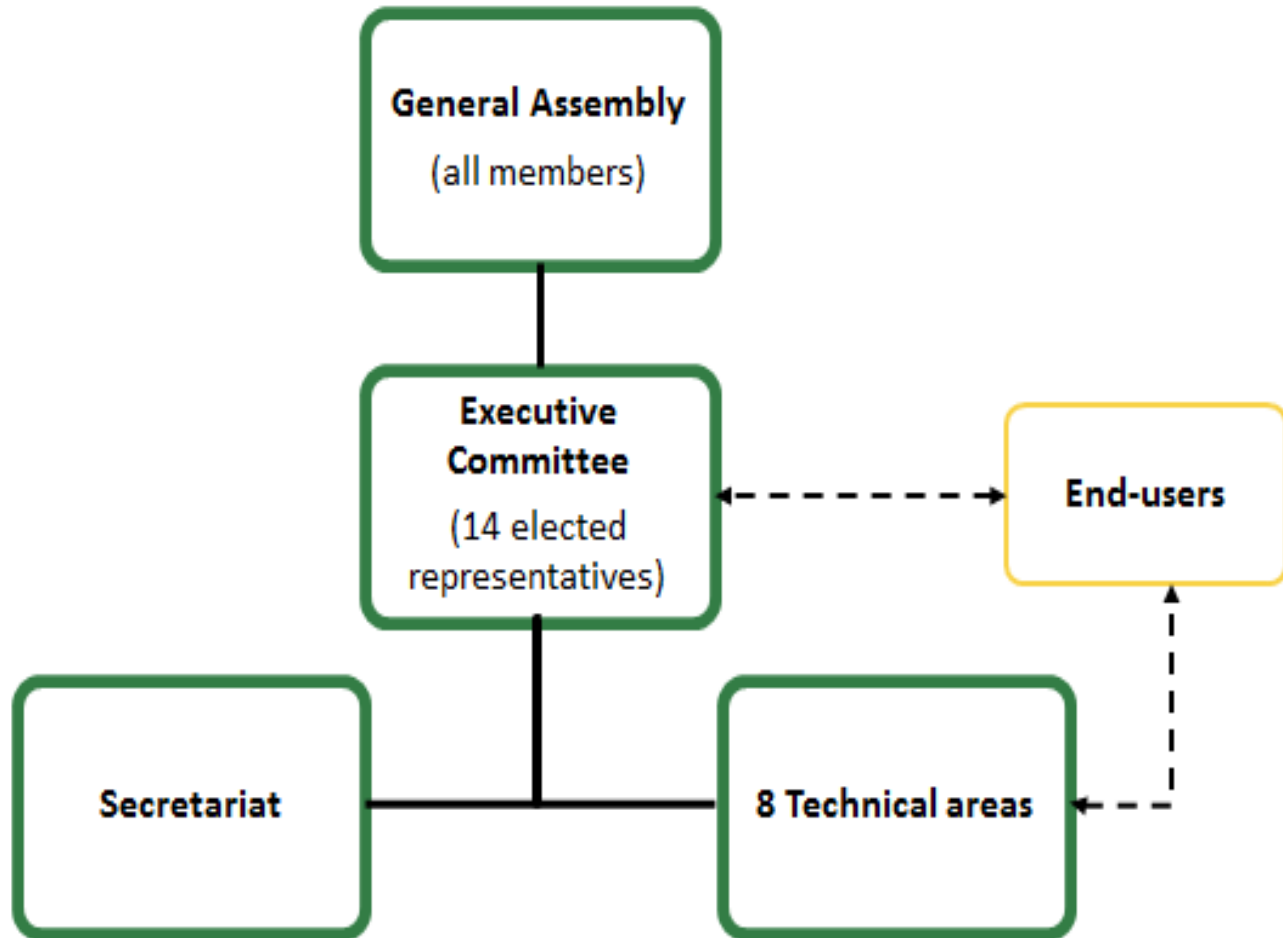


7 Harmonisation



8 In-service Inspection and NDE (ENIQ)

# NUGENIA's Governance



# NUGENIA's Management & Staff



**President:**  
Jean-Pierre West,  
EDF R&D (France)



**Vice-President:**  
Rauno Rintamaa,  
VTT (Finland)



**Chairman of  
the ExCom:**  
Steve Napier,  
NNL (UK)



**Vice-Chairman  
of the ExCom:**  
Sven Reese,  
E.ON (Germany)



***Brussels, 21 March 2012***

***Jean-Pierre West and Frantisek Pazdera, Chairs of NUGENIA and SNETP respectively, sign the mandate between both organisations***

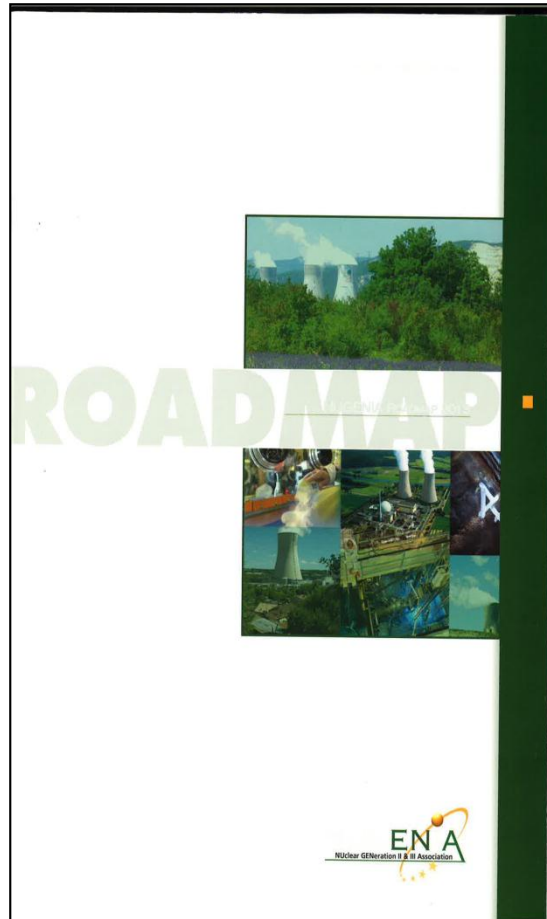
# NUGENIA's Roadmaps

## Two Roadmaps:

- ***NUGENIA Roadmap – Challenges and Priorities - 2013, a summary document*** (≈ 60 pages)
  - **April 2012:** Decision of launching
  - **July 2012:** Editing (Objectives, Challenges, R&D Topics) for consultation
  - **From September 2012:** Contribution to **SNETP SRIA**
    - **January 2013 :** Publication of the **SNETP report on Fukushima R&D Priorities**
    - **February 2013:** Publication of the **SNETP SRIA**
  - **October 2013:** Publication and presentation at **FISA Conference in Vilnius**
- ***NUGENIA Roadmap Working Document,***
  - A detailed working document (≈ 400 pages)
  - Launched first in 2012 then put on stand-by to implement the ***NUGENIA Roadmap – Challenges and Priorities – 2013***
  - Coordinated by G. Bruna, NUGENIA's current Technical Coordinator
  - Under publication : issuance scheduled by **March 2015**
  - **To be presented at 4<sup>th</sup> NUGENIA Forum in Bled (SL), April 2015**



# ***NUGENIA Roadmap 2013***



***The***

***NUGENIA  
Roadmap  
- Challenges &  
Priorities - 2013***

***October 2013***



# SARNET network 1/3

| The Severe Accident Research NETwork started in 2004 and was co-funded by EC in FP6-FP7 until 2013



- 24 countries (Europe, Canada, USA, Korea, India...)
  - 47 organizations (TSO, research, industry, vendors, universities)
  - 250 researchers and PhDs
- ⇒ *Now integrated in NUGENIA and still coordinated by IRSN*

| A key task is the periodic ranking of R&D priorities:

- Latest update in 2013, accounting for the whole recent international R&D outcomes (FP7, OECD...) and for 1<sup>st</sup> analyses of the Fukushima accidents: directly used for the NUGENIA SRIA 2013

# SARNET network 2/3

## Main conclusions of the 2013 update:

- A few changes / 2008 ranking: the main highest priority issues remain open despite large progress in understanding,
  - In-vessel: corium configurations in vessel lower head and coolability by water injection in the vessel and flooding of the cavity,
  - Premixing phase of steam explosion and gas combustion in containment (deflagration/detonation, PAR efficiency...),
  - MCCI and corium coolability in the cavity,
  - Source term: trapping or filtration of I and Ru (FCVS, pool scrubbing),
  - Improvement of SA scenario codes
- In relation with Fukushima, some SA topics get higher relevance and a few “new issues” need to be addressed.

**→ Most physical phenomena that occurred in Fukushima had already been considered in SARNET as high-priority for R&D.**



# SARNET network 3/3

## Main impact of Fukushima on priorities:

### Pay more attention to:

- Mitigation of consequences for inefficient SA prevention: H<sub>2</sub> explosion, melt debris coolability, containment venting/filtering...
- BWR modelling and experiments.

### Increase efforts on the following issues:

- Behaviour of spent fuel pool scenarios,
- Instrumentation ad-hoc for SA diagnosis,
- Effect of water impurities (on core degradation, chemistry, FCl...),
- Pool scrubbing under boiling conditions.

## Concluding remarks 1/2

- The Fukushima's accident revealed no fully and completely new phenomena.
- Accordingly, the basic directions of the research programs, as defined in the key SNETP documents, such as the **SRA 2009**, were considered still valid.
- Nevertheless, a rearrangement of ranking and priorities among the research areas was estimated appropriate.
- The prioritization and ranking toward major R&D objectives has been made in the **SRIA 2013**, with a significant contribution from the SARNET network.

## Concluding remarks 2/2

- As stated in the **SRIA 2013**, **the safety-oriented R&D** is to become the actual driving force and engine for any future program of the nuclear research agenda. That is illustrated by EURATOM FP7 ongoing projects, such as ASAMPSA\_E (PSA and external events), CESAM (on ASTEC code), PASSAM (on fission product mitigation).
- **NUGENIA** endorses this founding statement to elaborate and structure fission R&D GEN II / III Roadmaps and promote R&D programs.
- In this objective, **NUGENIA** allows gathering people and joining forces to address important topics and search for adequate, comprehensive and convenient solutions.

**Thank you for your attention**