

# Current Status of NUGENIA-TA2: Severe Accidents

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NUGENIA is mandated by SNETP to coordinate  
nuclear Generation II & III R&D

## OUTLINE

- Context.
- Background
- Framework
- Present NUGENIA-TA2.
- Final Remarks.

# Context

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## Context

- The SARNET network (Severe Accident NETWORK of excellence) was co-funded by EC from 2004 to 2013 in FP6-FP7 and then integrated in NUGENIA.
- The main network activities are continuing in the NUGENIA Technical Area N°2.
- As of Dec. 2018, TA2 coordination by CIEMAT was approved by NUGENIA Excom.
- This presentation is aimed at giving an update of TA2, with particular emphasis on recent actions and plans.

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# Background

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## SARNET in Euratom (1/2)

- Coordinated by IRSN, gathered ≈50 partners (> 20 countries, EU and non-EU).
  - 250 researchers and 30 PhD students = work equivalent to 40 full-time persons per year.
- FP7 project divided into the following WPs:
  - ASTEC IRSN-GRS code development and assessment
  - Corium and debris coolability
  - Molten corium concrete interaction
  - Containment
  - Source term
- Main end-products:
  - Huge database and improved knowledge on phenomena
  - Knowledge capitalization in the ASTEC code and in an experimental database based on JRC STRESA tool

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## SARNET in Euratom (2/2)

### ■ Dissemination of knowledge

- 6 **ERMSAR** periodic conferences (100 to 150 participants)
- 6 **Education & Training one-week courses** (40 to 100 participants)
- Publication in 2011 of a 750-pages **textbook on severe accident phenomenology**
- During the FP6-7 projects, publication of  $\approx 200$  papers in peer-review journals and presentation of  $\approx 400$  lectures in international conferences
- Mobility programme for young researchers and students (52 delegations with average duration of 3 months)

### ■ Ranking of research priorities

- Periodic update to account for the results of recent research and, after 2011, for the impact of Fukushima Dai-ichi accidents
- This process led to define 20 issues of medium to high priority

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## Framework

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# NUGENIA Association



- **International non-profit association for collaborative R&D on Gen. II-III nuclear systems (2011)**

- More than 100 members from many countries (including out of Europe Korea, Japan, USA and Canada) from industry, research, TSOs and academia.
- 8 technical areas (TA): plant safety and risk assessment, integrity of structures, fuel development.... and "Severe accidents" TA2

- **New NUGENIA R&D roadmap to be published in 2019**

- Update of SARNET ranking (2013) - ERMSAR 2019 paper based
- Main priority of R&D efforts to focus on improvement of prevention of SA and **on mitigation of their consequences**, as underlined by the Fukushima Dai-ichi accidents

- **Towards a single nuclear platform (SNETP)**

- NUGENIA keeps its "technical identity" and project management



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# SARNET in NUGENIA



- **Overall objectives remain:**

- Integration of efforts of European R&D organisations in definition of research priorities and of common research programmes,
- Capitalizing the knowledge (SOAR, simulation codes, databases),
- Bringing together top scientists in SA research to constitute a world leadership position,
- Disseminating knowledge through E&T programmes and papers, to students and young researchers, and to new nuclear countries.

- **But extension to emergency preparedness and response and SA impact on environment**

- **The main network activities are continuing:**

- Technical workshops, ERMSAR, Education & Training courses
- Elaboration of new R&D projects (H2020 & in-kind types)



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# TA2 Current Status

## Context

- TA2 coordinator (JPvD, IRSN) retired Fall.
- An election set in Summer 2018.
  - Three candidates (CIEMAT, IRSN, TRACTEBEL)
  - 45 organizations voted
  - CIEMAT option was the most voted on.
  - Deputy coordination set on IRSN.
  - NUGENIA ExCom approval on Dec. 10<sup>th</sup>.
- First coordination meeting held on Jan. 17<sup>th</sup>.

# Introduction

- **Coordination:** CIEMAT (IRSN, Deputy)
- **Sub-TA and leaders:**
  - 2.1 In-vessel corium/debris coolability (KIT)
  - 2.2 Ex-vessel corium interactions-coolability (CEA)
  - 2.3 Containment behaviour, incl. H<sub>2</sub> risk (JSI)
  - 2.4 Source term to the environment (CIEMAT)
  - 2.5 Environmental Impact & emergency management (IRSN)
  - 2.6 Severe accident scenarios (ENEA)
- **Coordination of dissemination of knowledge:** UNIPI

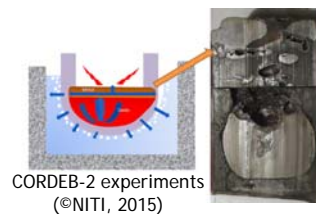
## TA2.1 & TA2.2: Corium/debris coolability

### Four subtopics

- Reflooding and coolability of a degraded core (REFCOOL)
- Remelting of debris, melt pool formation and coolability (MPF)
- Bringing research results into reactor application (COOL-RA)
- Spent fuel pool analysis (SFP)

### TA2.1 linked R&D projects

- SAFEST, ALISA, IVMR, FASTNET, CORE-SOAR, QUESA



CORDEB-2 experiments  
(©NITI, 2015)

### Yearly review meetings since 2014

## TA 2.1-TA2.2 Group Meetings:



- Yearly meetings : 2\*2 days, about 70 participants



- Preservation of Network of excellence
  - Technical and scientific presentations with in-depth discussion
  - Common preparation of future R&D SA projects (H2020, CoreSoar, ...)
- Strong manifestation of interest
  - Next meeting TA 2.1 and TA 2.2: to be planned end of 2019 or 2020

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## TA2.1 & TA2.2: Corium/debris coolability



- **Ended FP7 projects:**

- **SAFEST** (*Severe Accident Facilities for European Safety Targets*), led by KIT (2014-2018): pan-European platform on corium experimental facilities

Final meeting December 2018 CEA-Cadarache (France).  
16 tests performed.

Road Map for corium experimental research (TA 2.1 & and TA2.2)

- **ALISA** (*Access to Large Infrastructures for Severe Accidents*), led by KIT (2014-2018): Europa-China platform for SA experiments.

Final meeting March 2018 (Spain).

13 tests performed (7 European & 6 Chinese)

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## TA2.1 & TA2.2: Corium/debris coolability

- **Ended in-kind NUGENIA projects:**

- CORE-SOAR (*Core degradation State-of-the Art Report*), led by IRSN (2016-2018): update of SOAR 1995.
- QUESA (*QUench experiment with Steam and Air*), led by EDF (2016-2018): complements of SAFEST by pre- and post-calculations of experiments done in the latter.

## TA2.1 & TA2.2: Corium/debris coolability

- **Euratom current projects (FP7 or H2020):**

- **SAFEST-Gen 4** (Maintain the European network of excellence for experimental laboratories-Expertise/Gen4): **rejected**
- **EVEREST** (Ex Vessel Retention European Simulation Tools): **rejected**
- **SARICOB** (Maintain the European-Chinese network of excellence for experimental laboratories Expertise): **rejected**

- **OECD future projects**

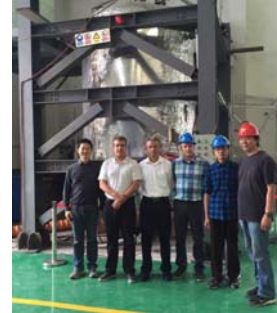
- OECD/ROSAU

## TA2.3: Containment behavior

### ■ FP7 projects:

- Link to ALISA project (*Access to Large Infrastructures for Severe Accidents - Coordinated by KIT*):

Experiments on H<sub>2</sub> combustion in Shanghai (2016) and H<sub>2</sub> mixing in Chengdu (2018).



### ■ NUGENIA projects:

- SAMHYCO-NET (Towards an improvement of Safety Management procedures for severe accident late phase including Hydrogen and Carbon monoxide mitigation and explosion risk assessment models), led by IRSN (2017-2020)



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## International workshop on Hydrogen Safety for Nuclear Power Plants

**MITHYGENE**

**SAMHYCO-NET**



**11 April 2019 - Fontenay-aux-Roses, France**

Hosted by Institut de Radioprotection et de Sûreté Nucléaire (IRSN)



## TA2.4: Source Term

### ■ H2020 projects:

- FASTNET (*FAST Nuclear Emergency Tools*), led by IRSN (2015-2019): fast-running tools for evaluation of source term in emergency situations,
- MUSA (*Management and Uncertainties in Severe Accidents*), led by CIEMAT. (2019-2023).

### ■ NUGENIA projects:

- IPRESCA (*Integration of Pool scrubbing Research to Enhance Source-term Calculations*), led by Becker Techn. (2017-2020).

## TA 2.5: Impact of severe accident on environment and EMgmt

- Signature of a MoU between NUGENIA and Radiation Protection platforms (MELODI, EURADOS, NERIS, ALLIANCE = MENA) in October 2017



Memorandum of Understanding  
initiate stakeholder dialogue and interactions between  
the  
European Radiation Protection Research Platforms  
MELODI, EURADOS, NERIS, ALLIANCE  
and  
NUGENIA

## TA 2.5: Impact of severe accident on environment and EMgmt

- Preparation of a 1st transverse workshop on projects of interest (end 2019)
- Preliminary list of transverse scientific issues (IRSN and SCK-CEN):
  - Liquid releases and the  $K_D$  issue (uncertainties !)
  - PSA level 2-3 and assessment of the radiological consequences of accidents, including inverse methods
  - On- and out-site interface to NERIS; a possible workshop on uncertainties of the assessment and mgmt of a severe accident (TERROTORIES and CONFIDENCE ongoing projects under MENA).
  - Instrumentation for severe accidents (OECD) - Environment

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## TA 2.6: SA Scenarios

- Activities recently carried out or ongoing
  - SA Database within FASTNET (about 120 scenarios, so far)

GENERIC DESIGNS	ATW	LFWSG	LB_LOCA	IB_LOCA	SB_LOCA	SBO	SGTR	SFP
BWR-MARK I				*		*		
BWR-ABB	*		*			*		
CANDU			*		*	*	*	
French PWR 1300		*	*	*	*	*		
French PWR 900			*	*	*	*		
PWR 1000			*	*	*	*		*
VVER 440			*			*	*	
VVER 1000					*	*	*	

- ASCOM Nugenia Project

- Activities within OECD/NEA WGAMA.



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## TA 2.6: SA Scenarios

- **UASA (BEPU methods) major focus in future**

- IAEA CRP on "Advancing the State-of-Practice in Uncertainty and Sensitivity Methodologies for Severe Accident Analysis in Water Cooled Reactors"
- EC MUSA Project

## Education and training (SAP)

- **8 editions of SAP Course (2005)**

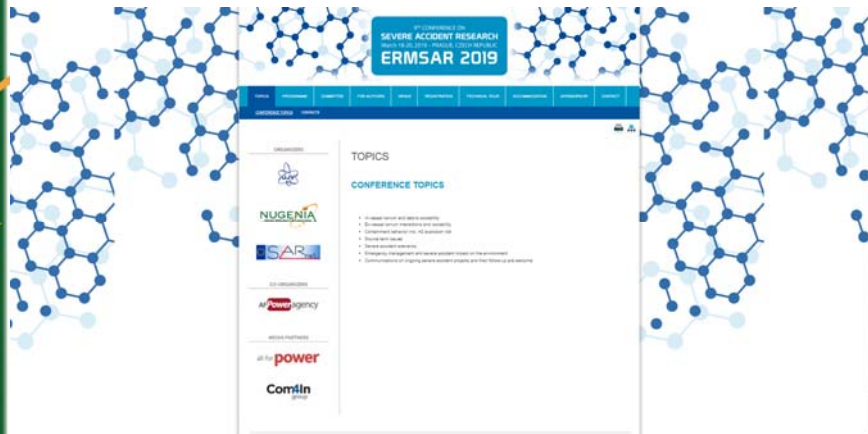
(France, Hungary, Italy, Germany, UK, Sweden and Slovenia)

- Open to university students with discount fees and contributed for 3 Credits (ECTS). Strong link with ENEN Association.
- Last one hosted by JSI in Oct. 2017 at Ljubljana: 65 trainees from 22 countries (and 18 lecturers)
- SAP-course in China- October 2018 in collaboration with Chinese organizations (link with the FP7 Euro-Chinese ALISA project)-
- **Next SAP : planned in France CEA/ INSTN-Cadarache : 9-14 September 2019**

- **Scope:**

- SA phenomenology, progression and mitigation in current Light Water-cooled Gen.II and III Nuclear Power Plants (NPP), but also different design solutions in Gen.III NPPs. **This edition will include HWRs.**
- Special session on Fukushima-Daiichi NPP 2011 accidents.

## ERMSAR-2019



## Perspectives

15 years after its start, SARNET networking continues efficiently in NUGENIA frame

- **Technical workshops** : essential “brick” for share of R&D progress and brain-storming for new R&D projects...
- **Next events:**
  - 9<sup>th</sup> ERMSAR-2017 hosted by UJV in Prague (Czech Rep.) in March 2019 (<https://www.ermisar2019.com/>)
  - Next education/training course to be held in Sept. 2019
- **SARP (SA Research Priorities):** ERMSAR Conf. Update
- **Main challenges to face:**
  - Keeping active the Community (workshops, new projects, publications), despite possible ↘ of R&D funding
  - Identify opportunities in new NPP types, such as SMR

# Perspectives on Coordination

- **Coordination meetings (4/year).** Next on April 30<sup>th</sup>.
- **New sub-leaders of TA2.1 & TA2.4.**  
Procedure to be discussed in next TA2 Coordination meeting.
- **Strengthen links with OECD, CSNI/WGAMA & IAEA.**
  - Severe accident courses (IAEA).
  - Similarly-targeted project (IAEA; MUSA vs CRP).
  - OECD projects (TCOFF; ROSAU; THAI ...).
  - WGAMA activities (ST workshop; ST instrumentation; ...)
- **“Renew” TA2 portfolio & TA2 EC projects initiatives (NOIP, a useful tool)**