Current Status of NUGENIA-TA2: Severe Accidents

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OUTLINE

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


- This presentation is aimed at giving an update of TA2.
Background
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
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
- Publication of ≈ 200 papers in peer-review journals and nearly 400 presentations 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
Current Framework
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
SARNET in NUGENIA

- Overall objectives remain:
  - Integration of efforts of European R&D organisations in definition of research priorities and 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, young researchers and new nuclear countries.

- 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)
Present NUGENIA-TA2
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. H₂ 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: 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, FASTNET, IVMR, CORE-SOAR, QUESA

Yearly review meetings since 2014

CORDEB-2 experiments (©NITI, 2015)
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, ...)

- **Next meeting TA 2.1 and TA 2.2**: to be planned end of 2019 or 2020
TA2.1 & TA2.2: Corium/debris coolability

- **Ended FP7 projects:**
    Final meeting December 2018 CEA-Cadarache (France).
    16 tests performed.
    Road Map for corium experimental research (TA 2.1 & and TA2.2)
    Final meeting March 2018 (Spain).
    13 tests performed (7 European & 6 Chinese)
TA2.1 & TA2.2: Corium/debris coolability

- Ended in-kind NUGENIA projects:
  - QUESA (QUEench experiment with Steam and Air), led by EDF (2016-2018): complements of SAFEST by pre- and post-calculations of experiments done in the latter. Foreseen to be extended one more year.
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):

- 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)
International Workshop on Hydrogen Safety for Nuclear Power Plants

9-11 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 & EMgmt

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

Memorandum of Understanding to 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:
  - 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
TA 2.6: SA Scenarios

Activities recently carried out or ongoing

- SA Database within FASTNET (about 120 scenarios, so far)

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- ASCOM Nugenia Project

- R2CA project – EC.
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-Daiiichi NPP 2011 accidents.
Education and training (SAP)
Education and training (SAP)

A new one-week Course entitled "Severe Accident Phenomenology" is proposed in the frame of SARNET Severe Accident (SA) research network of excellence.

This course will focus on disseminating the knowledge gained on SA in the last two decades to Masters-PhD students, young engineers and researchers recently involved in Severe Accident. It will be hosted by CEA-Cadarache, near Aix-en-Provence. This short course is a sequel to the previous Ljubljana 2017 and Stockholm 2015 SARNET Courses.

The program will cover SA phenomenology, progression and mitigation in current water-cooled (Light Water Reactor and Heavy Water Reactor) Gen.II and III Nuclear Power Plants (NPP), but also the different design solutions in Gen.III NPPs. A special focus will be done on the Fukushima-Daiichi Severe Accident.

Lectures will be given by international experts from major Nuclear Institutes, Industries and Universities working on the topic. Lecturers will be able to describe how the different plants would react during a SA, keeping in mind that time constraints of the course would not allow students to actually perform simulations. The Course will also include background lectures on NPP safety, SA scenarios and the events leading, respectively, to the early and late failure of containment.

The course will be open to University students with a discount fee. The course can contribute for 3 ECTS (with a written work) as an advanced course for Master students (through the European Nuclear Education Network ENEN).

Registration fee:

- Professionals: € 1,700
- Students: € 600

The fee covers attendance of course lectures, a copy of the course material, coffee breaks and lunches. Travel and accommodation expenses are not included.

Contacts:

Registration, logistics: instn.sap2019@cea.fr

Organizer: Christophe TIFFREAU (INSTN)
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NUGENIA is mandated by SNETP to coordinate nuclear Generation II & III R&D
Final Remarks
# TA2 Projects Summary

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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:
  - 9th ERMSAR-2017, March 2019 (UJV, Prague Czech Rep.)
  - Next SAP education/training course, 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, and other financial opportunities.
Perspectives on Coordination

- **Coordination meetings (4/year).** Next on April 30th.

- **New sub-leaders of TA2.1 & TA2.4.**
  Procedure to be discussed in next TA2 Coordination meeting.

- **Pursuit collaboration (OECD; CSNI/WGAMA; IAEA)**
  - Complementarity of SA courses (IAEA vs SARNET).
  - Similarly-targeted projects (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)**
Thank you for your attention!

Thank you for making TA2 a reality!