Contribution of European TSOs to research in nuclear safety, radiation protection, waste management and decommissioning

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Abstract. Following the European study on the benefits and limitations of Nuclear fission for a low-carbon economy (February 2013), the priorities on research are clearly oriented towards nuclear safety, radiation protection and active engagement of the public. The European Commission supports all these domains of research through its Euratom Framework Programmes. All European stakeholders endorsed these priorities, in particular ETSON, the European network of Technical Safety Organisations (TSO).

1. Support of the European Commission to the nuclear fission research

1.1 Euratom FP call

The European Commission manages the nuclear fission research through Euratom Framework Programmes (FP7 and now H2020…).

Programmes after programmes, the support of the European Commission allowed the research community to pool research resources and to favor the emergence of networks of excellence (NULIFE on nuclear plant life prediction, SARNET on severe accidents...).

The latest research call (FP7) supported the work to be done through research agendas of dedicated platforms (see Table 1) and associations with the aim to promote public/private and public/public funding when possible. In the future, the European Commission will favor the change of the governance by the creation of European Joint Projects (public/private) and JTI (Joint Technology Initiative).

TABLE 1: EXAMPLE OF EUROPEAN RESEARCH PLATFORMS OR ASSOCIATIONS

NUCLEAR RESEARCH	SNE-TP (Sustainable Nuclear Energy Technology Platform) - Strategic Research Agenda [1] and Fukushima Task group [2] o NUGENIA for GEN II & GEN III reactors o ESNII for GEN IV o NC2I for cogeneration
RADIATION PROTECTION	MELODI
RADIOECOLOGY	ALLIANCE
WASTE DISPOSAL	IGD-TP

1.2 Participation of European TSOs in FP7 projects

European TSOs have been involved in Euratom FP projects for years.

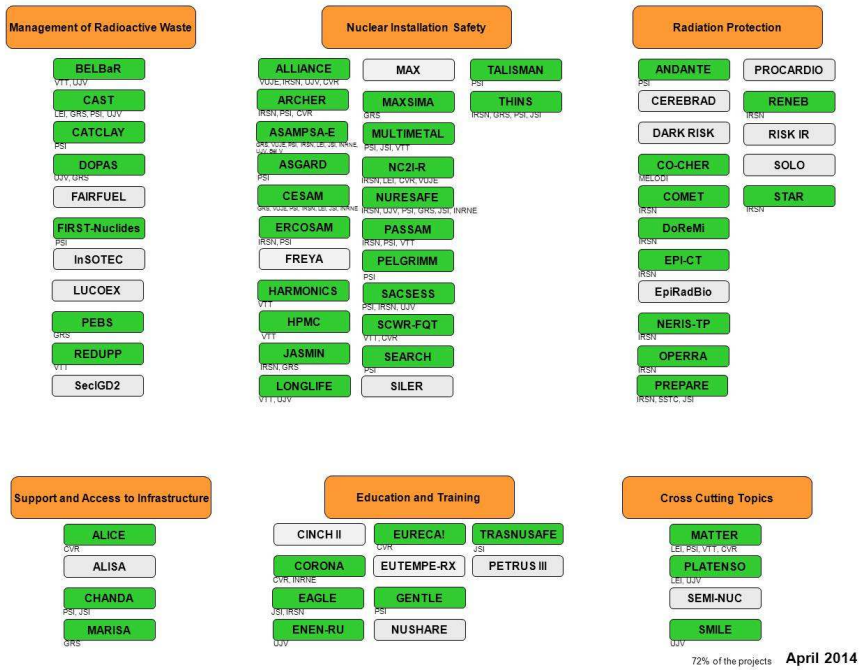

FIG.1 FP7 running projects involving TSOs in green (for April 2014)

TABLE 2: FP7 PROJECTS INVOLVING EUROPEAN TSOs IN NUCLEAR SAFETY

ADRIANA	ADvanced Reactor Initiative And Network Arrangement
ALLIANCE	Preparation of ALLegro - Implementing Advanced Nuclear Fuel Cycle in Central Europe
ARCADIA	Assessment of Regional CApabilities for new reactors Development through an Integrated Approach
ARCHER	Advanced High-Temperature Reactors for Cogeneration of Heat and Electricity R&D
ASAMPSA_E	Advanced Safety Assessment : Extended PSA
ASAMPSA2	Advanced safety assessment methodologies : level 2 PSA (European best practices L2 PSA guidelines)
CESAM	Code for European Severe Accident Management
CP-ESFR	Collaborative project on European sodium fast reactor
ERCOSAM	Containment thermal-hydraulics of current and future LWRs for severe accident management
EUROPAIRS	End User Requirement fOr Process heat Applications with Innovative Reactors for Sustainable energy supply
GOFASTR	European Gas Cooled Fast Reactor
JASMIN	Joint Advanced Severe accidents Modelling and Integration for Na-cooled fast neutron reactors
NC2I-R	Nuclear Cogeneration Industrial Initiative - Research and Development Coordination
NUGENIA-PLUS	Preparing NUGENIA for HORIZON2020
NURESAFE	Nuclear Reactor Safety Simulation Platform
NURISP	Nuclear reactor integrated simulation project
PASSAM	Passive and Active Systems on Severe Accident source term Mitigation
SARGEN_IV	Proposal for a harmonized European methodology for the safety assessment of innovative reactors with fast neutron spectrum planned to be built in Europe
SARNET2	Severe accident research network of excellence 2 (confer Fig.2)
THINS	Thermal-hydraulics of Innovative Nuclear Systems

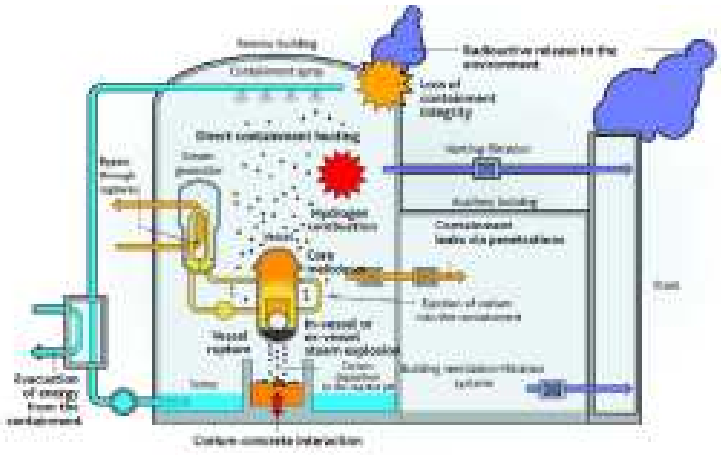

FIG.2 Phenomenology of severe accident in a reactor (SARNET 2)

TABLE 3: FP7 PROJECTS INVOLVING EUROPEAN TSOs IN RADIATION PROTECTION

CARDIORISK	The mechanisms of cardiovascular risks after low radiation doses
COMET	COordination and iMplementation of a pan-European instrumenT for radioecology
DOREMI	Low Dose Research towards Multidisciplinary Integration
EAGLE	Enhancing educAtion, traininG and communication processes for informed behaviours and decision-making reLatEd to ionizing radiation risks
EPI-CT	Epidemiological study to quantify risks for paediatric computerized tomography and to optimise doses.
OPERRA	Open Project for the European Radiation Research Area
ORAMED	Optimization of radiation protection of medical staff
PREPARE	Innovative integrative tools and platforms to be prepared for radiological emergencies and post-accident response in Europe
RENEB	Realizing the European Network in Biodosimetry
STAR	Strategy for Allied Radioecology
TENEB	Towards a European network of excellence in biological dosimetry

TABLE 4: FP7 PROJECTS INVOLVING EUROPEAN TSOs IN WASTE MANAGEMENT

FORGE	Fate of repository gases
SACSESS	Safety of ACtinide Separation proceSSes
SITEX	Sustainable network of Independent Technical EXpertise for radioactive waste disposal

2. Support of ETSON to nuclear safety research

2.1 TSO position paper

In October 2011, ETSON including the associated members SSTC NRS (Ukraine) and JNES (Japan) and with the contribution of safety authorities SSM (Sweden), CSN (Spain), KFD (Netherlands) had released the TSO position paper [1] on R&D to support nuclear safety with the highest priority needs which are also presented in the EUROSAFE Tribune 20 (see list in table 2).

FIG.2 TSO position paper and EUROSAFE Tribune 20 cover pages

TABLE 5: TSO R&D PRIORITIES (from TSO position paper [3])

1. Safety assessment methods	Safety margins methodology, which comprehensively combines the advantages of deterministic and probabilistic approach
2. Multi-physics safety approach	●Multi-physics tools coupling several disciplines ●Multi-scale tools from the microscopic to the macroscopic level ●Methods to propagate uncertainties within (coupled) multi-physics and multi-scale tools using both probabilistic and deterministic methods
3. Ageing of materials	● Common understanding of relevant ageing mechanisms on material and component properties from a long-term operational perspective ● Relevant and reliable material properties for extended service
4. Fuel behaviour	● Inside the RPV ▪ LOCA, RIA ● Outside RPV ▪ Criticality
5. Human & organisational factors	Human and organizational factors in safety management, including ▪ Operation feedback ▪ Resilience engineering ▪ Safety culture
6. Instrumentation & control	● Development of test to predict ageing effects on instrumentation and components. ● Implementation of new technological solutions (programmable digital automation) in instrumentation and control systems including the Protection Systems of current plants.
7.1 Severe accidents : phenomenology and methodology	● Ex-vessel and in vessel corium cooling: ▪ Experimental activities ▪ Development of specific computation capabilities also accounting for BWR needs ● Iodine chemistry in the RCS and in the containment
7.2 Severe accidents: crisis preparedness & management	● Emergency preparedness ● Crisis management ● Short term consequences ● Site recovery

2.2 Regular work of ETSON Research Group (ERG)

ETSON has several technical groups (ETSON Research Group so called ERG, Knowledge Management Group, Waste Management Group from the Technical Board on Reactor Safety, etc…).

The ETSON R&D needs were taken into account when building the R&D roadmap [4] of the new NUGENIA association on Gen II – Gen III nuclear research and ETSON members are strongly involved in the governance and the technical areas of NUGENIA (www.nugenia.org).

On a regular basis, the research group of ETSON (ERG) updates the state-of-the-art and the list of priorities taking into account the latest results given by completed R&D projects. The ERG also proposes projects to be submitted to Euratom FP calls, or to be run only with contributions from ETSON members. Training sessions as well as sharing of PhD subjects are also organized in order to disseminate knowledge.

Moreover, during the development of the roadmap of NUGENIA (association dedicated to GEN II – GEN III reactors research), the ERG coordinated the review of the drafted NUGENIA roadmap by ETSON members.

The ERG is currently mapping the relevant research infrastructures of ETSON network which can support nuclear safety research in consistency with the NUGENIA survey on key research infrastructures.

ETSON members, aware of the forthcoming challenge in term of safety assessment, have decided in July 2013 to create an ETSON experts group on the safety of Waste Management, Decommissioning & remediation (WM&D group). A current objective of this group is to establish a common TSO position on the assets and drawbacks of various strategies and the conditions on their applications, in view of fostering the good integration of safety issues related to decommissioning in international guidance documents.

3. Conclusion and perspectives

With research priorities clearly oriented towards nuclear safety, radiation protection and active engagement of the public, the European Commission has allowed the emergence of networks of excellence and the funding of research projects. On their side, TSOs of ETSON have been working together on these projects and networks of excellence have been shared. The research results enhanced the state-of-the-art. The TSO position papers will emphasise the remaining R&D challenges as key inputs for research programming and roadmaps in Europe. ETSON members will go on their participation in research projects and in the update of the TSO position papers.

Appendix 1: References

[1] SNETP Strategic Research Innovation Agenda (SRIA) February 2013

[2] SNETP Fukushima Task group - Identification of Research Areas in Response to the Fukushima Accident January 2013

[3] Position paper of the Technical Safety Organisations: Research needs in nuclear safety for GEN 2 and GEN 3 NPPs, ETSON/2011-001 October 2011

[4] NUGENIA Roadmap 2013