Presentation of SARNET2

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Summary

Most of the actors involved in severe accident research in Europe, Canada, Korea and the United States (41 partners), will network their research capacities in SARNET2 (Severe Accident Research NETwork of Excellence - Phase 2) to resolve important pending issues concerning postulated severe accidents in existing and future Nuclear Power Plants (NPPs). The project has been defined in order to optimize the use of the available means and to constitute a sustainable consortium in which common research programmes and a common computer tool to predict NPP behaviour during a postulated severe accident (ASTEC integral code) are developed.

With this aim, the SARNET2 partners will contribute to a Joint Programme of Activities, consisting of:

- Maintaining and improving an advanced communication tool (developed during SARNET Phase 1) for accessing all project information, fostering exchange of information, and managing documents;
- Harmonizing and re-orienting the research programmes, and defining new ones;
- Performing experimental programmes on high priority issues, defined during SARNET Phase 1;
- Analyzing experimental results in order to elaborate a common understanding of relevant phenomena;
- Developing the European ASTEC code (including its applicability to all types of European NPPs), which capitalizes in terms of physical models the knowledge produced within SARNET2;
- Developing Scientific Databases, in which all the results of research programmes are stored in a common format (DATANET);
- Developing and organizing education courses on severe accidents for students and researchers, and training courses for specialists;
- Promoting personnel mobility amongst various organizations;
- Organizing yearly a large international conference on Severe Accident research (ERMSAR).

After the first phase (SARNET: 2004-2008), and the four-year second phase (SARNET2), both co-funded by the EC, the network will evolve toward self-sustainability: a legal entity will be created.

A. BACKGROUND

The current Nuclear Power Plants (NPPs) existing in Europe are designed with the principles of defence in depth. In particular, they incorporate a strong containment and engineering systems to protect the public against radioactivity release for a series of postulated accidents. Nevertheless, in some very low probability circumstances, severe accident sequences may result in core melting and plant damage leading to dispersal of radioactive material into the environment and thus constituting a health hazard to the public well beyond the borders of the State where the damaged plant is located.

It is therefore crucial that the best state of knowledge on severe accident phenomenology, qualified computer tools and appropriate methodology should be used uniformly throughout Europe, in order to evaluate the corresponding risks and update former evaluations, taking into account notably the inevitable evolutions in reactor operations (e.g. new type of fuel, higher burn-up, extension of plant life, new generations of reactors). Additional appropriate engineering devices and/or accident management measures may have then to be developed and implemented in order to reduce even more the risks.

In 2004, facing and anticipating budget reductions and seizing an opportunity offered by the European Commission (EC) in the 6th Framework Programme (FP), 49 European organizations[1] involved in research on nuclear safety, have decided to join their efforts in a durable way to resolve outstanding severe accident safety issues for enhancing the safety of existing and future NPPs. Integrating their respective and complementary know-how and spreading out the gained knowledge was the main objective of the Severe Accident Research Network of Excellence (SARNET) from April 2004 to September 2008 [1]. Three more organizations, including one from Canada, joined the network in 2006.

On the one hand, in spite of many major achievements [2], a limited number of specific issues remain where research activities are still necessary to reduce further uncertainties that are considered of importance for nuclear reactor safety and to consolidate severe accident management plans. Starting from previous work performed in the 5th European FP [3], one of the achievements of SARNET consisted in obtaining an European consensus on six high priority issues on which research was still considered as necessary [4]. These issues are:

- core coolability during re-flooding and debris cooling;
- ex-vessel melt pool configuration during Molten Corium Concrete Interaction (MCCI), ex-vessel corium coolability by top flooding;
- melt relocation into water, ex-vessel Fuel Coolant Interaction (FCI);
- hydrogen mixing and combustion in containment;
- oxidising impact on source term (Ruthenium oxidising conditions/air ingress for High Burn-up and Mixed Oxide (MOX) fuel elements);
- iodine chemistry in Reactor Coolant System (RCS) and in containment.

On the other hand, one aim of this network was to become self-sustainable, that is to say to be operational without EC funding. After four years and a half of operation, significant progress toward this self-sustainability has been achieved (courses, conferences, etc…). However, considering that industries have no strong willingness in supporting this type of research which does not produce direct benefits, some more time is necessary before actually reaching this self-sustainability.

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[1] including research organizations, technical safety organizations (TSOs), industry, utilities and universities

The remaining research work to be performed and the time still necessary to reach actual self-sustainability of the network conducted the EC to support a SARNET follow-up for a four year duration in the 7th FP: SARNET2.

B. OBJECTIVES OF SARNET2

The SARNET2 general objectives, in the streamline of the SARNET objectives, but with special emphasis on some specific points, are defined as follows:

- Tackle the fragmentation existing in defining/carrying out research programmes between different countries;
- Diffuse the knowledge to the stakeholders, especially in the new European Union (EU) member states, more efficiently, and associate them to the definition and the conduct of the research programmes more closely;
- Bring together top scientists in severe accident research so as to be the world leader in advanced computer tools for severe accident risk assessment;
- Perform significant progress towards the closure of the remaining high priority issues in the domain of severe accidents;
- Establish a self-sustaining organization in the field of severe accident research through activities in networking, integration, knowledge management, exchange of information, dissemination of results and training in order to keep the competence in severe accident management alive in Europe and worldwide.

The ultimate objective of the integration of the research is to form a “virtual centre of excellence” based on national resources, know-how and expertise, and having a strong coordinating structure. This centre of excellence will have the mission to carry out the commonly agreed research programmes in an optimised way in order to resolve remaining safety issues and produce highly validated and qualified tools for Level 2 PSA studies for any kind of NPP in Europe.

In a first step, already achieved in the frame of SARNET, the execution of the Joint Programme of Activities allows a progressive re-orientation of the existing national programmes and contributes to launch new ones in a more coordinated way and in accordance with the research priorities identified by the Network, eliminating duplications and developing complementarities. Thanks to the acknowledged weight of SARNET, this re-orientation of programmes already applies and will still apply within SARNET2 to programmes outside the EU (Russian projects of the International Science and Technology Centre (ISTC), OECD/NEA projects, etc…).

Complete integration of the experimental research capacities is necessarily more gradual. The main obstacle to the integration is the need to raise funding at national and extra-national levels in order to support the cost of the experimental programmes, notably in case of large ones. A clear policy in terms of access rights to experimental data produced within the network is proposed to preserve the interests of the different organizations. Progress reports on restricted experimental programmes were widely disseminated in the frame of SARNET in order to promote extension of existing collaborations within other members of the Network. This will be done again in the frame of SARNET2.

C. CONCEPTS AND ORGANIZATION OF SARNET2

The SARNET2 consortium will be constituted by most of the research capacities and expertise in severe accident from 41 organizations, coming from 17 EU Member States (Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, Lithuania, the Netherlands, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom), from Switzerland, the United States, Canada, Korea, plus two Joint Research Centres of the European Commission (IE/Petten and ITU/Karlsruhe). The active participation of the research community and users (industry and regulators) in the project will allow to better meet its objectives.

The list of participants is provided in Table 1. The organization, hereunder described, is shown schematically in Figure 1.

SARNET2 will be organized in 8 work-packages (WPs) (Cf. Table 2) to fulfill its general objectives: Management, Spreading of Excellence, Information Systems, ASTEC, Corium and Debris Coolability, Molten Corium Concrete Interaction, Containment, Source Term.

The Management Team, headed by the Coordinator, will be entrusted on behalf of the Core Group, with the operational tasks for the day-to-day management of the Network. Besides its role of direct link with the EC, for technical, administrative and financial matters, the SARNET2 Management Team will coordinate the knowledge generation through joint projects of research activities, monitoring integration in ASTEC, making sure that access rights are correctly implemented, disseminating appropriate information, preserving the knowledge in scientific databases, and identifying the missing knowledge.

A Core Group of 10 SARNET2 representatives (6 representatives of the "major partners", 2 representatives of smaller partners, 1 representative of utilities and 1 representative of vendors).will be in charge of strategic decisions. It will review the progress made by the Network, in particular in terms of general management, of integration, of spreading of excellence and of ranking of research priorities. It will make recommendations on future orientations to be taken regarding missing knowledge, from the work of the research priority team, taking into account the advice of end-user representatives (Advisory Committee).

The Advisory Committee will provide the Core Group with advice on strategic orientations of the research activities of SARNET2, with the ultimate goal of a better prevention and mitigation of severe accidents in European NPPs.

The General Assembly will be constituted by one representative of each Consortium Contractor, plus the EC representative. It will be called yearly in order to inform and consult all the Consortium Contractors. In addition to the General Assembly, all the consortium members will be periodically informed of major progress and events by the Coordinator.

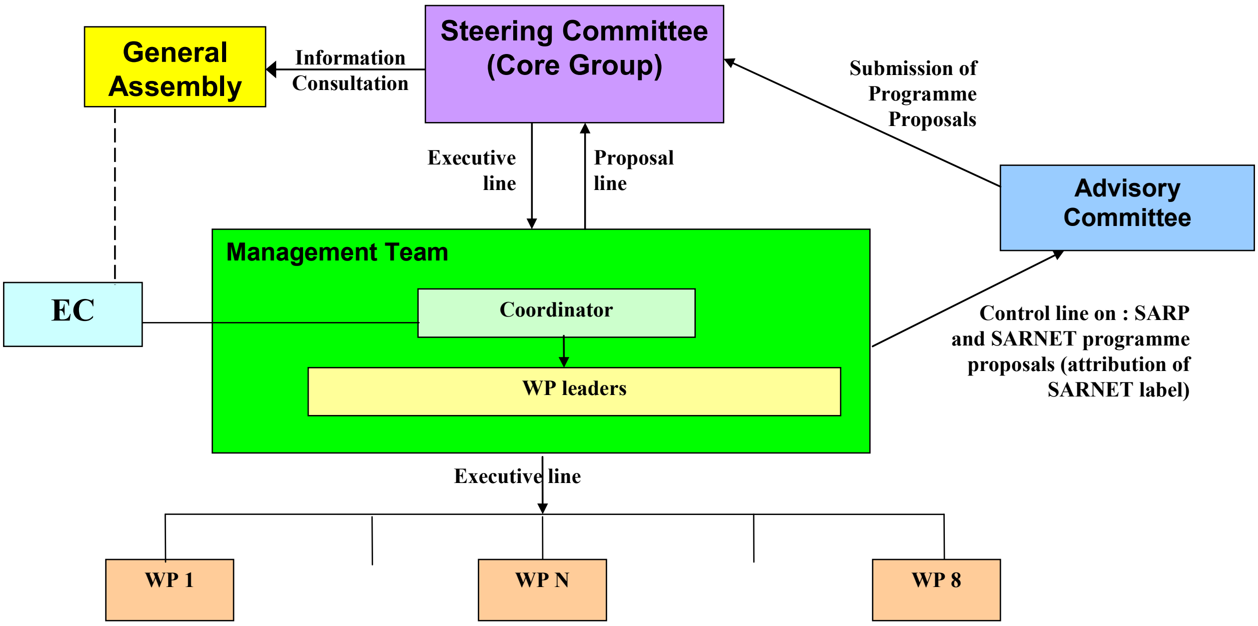

Figure 1: SARNET2 Organization Scheme

D. THE JOINT PROGRAMME OF ACTIVITIES

In the streamline of SARNET, the SARNET2 activities will consist of:

- the R&D activities carried out by SARNET2 members in the frame of national or international programmes, contributing to the resolution of remaining issues identified in the SARNET Network of Excellence (NoE);
- a programme jointly carried out, called Joint Programme of Activities (JPA) aiming at:
  - pursuing the integration of the above national/international research programmes (already well improved by SARNET);
  - initiating and launching new programmes jointly carried out by sustainable research groups, including experimental work co-funded through SARNET2;
  - going on to jointly analyze and interpret the available experimental results and capitalize the acquired knowledge into the experimental DATANET database and into the integral simulation tool ASTEC;
  - diffusing the knowledge.

The JPA will constitute the kernel of SARNET2. Such activities will give the orientations to be followed, in terms of research and work distribution among SARNET2 members. They will build the necessary links between national programmes, facilitate the necessary transfers of information (inside and outside the network), and organize the work partition in order to make the best use of available competences and means.

The JPA is broken down into 8 WPs and 26 sub-WPs as shown on Table 2.

The **Management** (WP1) sub-work-packages are: Coordination Administration and Budget; Integration Assessment; Severe Accident Research Priorities.

In addition to all the usual coordination, administration and budget activities one major activity at the management level and in direct link with the Core Group will consist in creating a legal entity to better ensure the long term self-sustainability of the network. A decision will be taken during the first year of SARNET2 to define the type of legal entity to be created. This entity will be operational before the end of SARNET2 in order to avoid any gap when the EC SARNET2 contract is finished.

The assessment of progress and results will be also followed at the Management level.

The R&D needs will be periodically updated and the objectives of future experiments will be defined taking into account the outcome of the R&D, of the risk studies (links with the PSA2 specialists) and the advices of the industry and utilities. In a continuity of what was done in SARNET, a consensus could be reached on closure of some more issues and would allow redistributing again competence and manpower on the few open ones. These activities will be conducted in close relation with the work performed in existing international organizations, as the OECD/NEA/CSNI and the ISTC projects.

The **Spreading of Excellence** work-package (WP2) aims at diffusing the knowledge. Three courses on Severe Accidents, as well for students and young researcher (education purpose) as for people already involved in the Severe Accident Field (training purpose) will be organized through the Education and Training programme. Links with the European Nuclear Education Network (ENEN) will be maintained and enhanced. Besides an "Information Day" will be targeted to NPP Managers to raise their consciousness on Severe Accident Management. The organization of periodic ERMSAR conferences will allow the general spreading of the knowledge gained by SARNET2, and by other entities working in the SA field. These periodic conferences should become the major worldwide conference on severe accident research. The Mobility programme will allow students and researchers to move to different laboratories for education and training in the severe accident area. The long term goal is to build teams which would engage together in certain activities in the SA field.

The **Information Systems** work-package (WP3) includes the external SARNET2 WEB site, the Advanced Communication Tool (ACT) and the Experimental Database. These are essential elements for giving information to the general public, for making easier the communication between the Coordinator and all the participants and reducing the number of meetings, and for having a standard common experimental database system. So, it largely contributes both to the spreading of excellence, and to the integration of the research work.

The European integral severe accident analysis code **ASTEC** (WP4) will provide the backbone of the integration, like in SARNET. Indeed, the past efforts by IRSN and GRS on this code, and the enhancement of these efforts thanks to its use by most of the SARNET participants have brought this code to an international acknowledgment level. In SARNET2, actions are proposed to continue to integrate in ASTEC the current and future knowledge, leading to release of new improved versions. The code assessment will focus on parametric and sensitivity studies on plant applications, for various NPP types and scenarios, in order to show the ASTEC reliability. Partners may benchmark ASTEC with other integral or mechanistic codes. Validation tasks will cover the phenomena not covered by the WP5 to 8 and the integral experiments like Phebus.FP. In complement to SARNET, investigations on ASTEC coupling with the PSA2 dynamic methods will continue. In addition, the code adaptation, including specific model validation, so as to be used for all types of existing water-cooled reactors in Europe will be pursued: the ASTEC V1 preliminary applications to BWR and CANDU reactors in SARNET have shown that most models are already applicable and that the main efforts must focus on core degradation [5]. IRSN and GRS will go on to provide the necessary capacity for maintenance, users' training and developments for satisfying the Network users (30 SARNET2 partners, i.e. roughly the same number as in SARNET, including some new users like AREVA GmbH and KAERI).

The **scientific research** will be organized in four WPs: Corium and Debris Coolability (WP5); Molten Corium Concrete Interaction (WP6); Containment (WP7); Source Term (WP8). These four WPs cover the six high level priorities issues as defined by SARNET [4].

In addition to the networking activities (similar to those conducted in SARNET), experimental programmes to be developed and implemented in the frame of SARNET2, are proposed. Two major experimental programmes will tackle two key priority issues identified in SARNET: in-vessel degraded core coolability and/or ex-vessel corium coolability; corium interaction with concrete. More than half of the SARNET2 efforts will be devoted to these research programmes. On the four WPs, full advantage will be taken of cooperation with international programmes such as Phebus FP, the International Source Term Programme (ISTP), the International Science and Technology Centre (ISTC) concerning collaboration with Russia, and the programmes of the OECD/CSNI Group on Analysis and Management of Accidents (GAMA), to avoid duplication of experiments, to help coherency of the programmes and to identify remaining needs.

In the case of a severe accident with vessel melt-through, the containment is the ultimate barrier between the **corium** and the environment. Two accident management strategies exist depending on countries and reactor designs: either the cavity is dry at the vessel melt-through and Molten Core Concrete Interaction (MCCI) will occur, or the cavity is flooded prior to the corium ejection and a debris bed will be formed. Both configurations have been studied for quite a long time, mainly in idealized one-dimensional (1D) configurations and it was commonly expected, when SARNET was proposed, that they were reasonably close to conclusion. However, recent results indicated that multidimensional configurations of MCCI and debris bed (and inhomogenity of the bed formation) have specific behaviours that totally affect the validity of 1D-models and require a new research programme.

As regards **Corium and Debris Coolability** (WP5), the major motivation is to reduce or possibly solve the remaining uncertainties on the possibility of cooling structures and materials during severe accidents, either in the core or the vessel bottom head or in the reactor cavity, so as to limit the progression of the accident. This could be achieved either by ensuring corium retention within the vessel or at least a slow corium progression and small flow rates of corium release into the cavity. These issues are to be covered within the scope of accident management for current reactors, and also within the scope of the design and safety evaluation of future reactors. Increased understanding was reached with the help of computer codes such as the ASTEC code, nevertheless, the required status of validation and partly modelling are not yet fully achieved and the analytical tools still show very large uncertainties in the results of the reflooding phase.

The different actions of the “Corium and Debris Coolability” work package have to improve our understanding of the phenomena associated with reflooding and allow the integration of validated models applicable to reactor conditions into the severe accident codes, in particular the ASTEC integral code, with the final aim of reducing the uncertainties on the evaluation of in- or ex-vessel coolability, during the different phases of the severe accident. Three key situations and processes are considered for coolability and retention, leading to the four tasks mentioned below (including a general one on application to reactor):

- Reflooding and Coolability of a degraded core (RefCool)
- Remelting of debris, Melt Pool Formation and coolability (MPF)
- EX-vessel debris formation and COOLability (EXCOOL)
- Bringing research results into Reactor Application (COOL-RA)

During the key situations of porous media formation and their coolability, two main aspects are important to investigate:

- the geometrical characteristics of the "porous media" like damaged rods with molten materials or debris bed in the core, debris bed in the lower head or in the cavity (ex-vessel),
- the thermal-hydraulic phenomena in these porous media.

Due to the similarity of the processes, the proposed experiments and related modelling tasks will be useful for any kind of porous media and will have a strong link to the activities covered by the work package 6, especially the investigations on the efficiency of late water cooling. All partners will be engaged in joint work to conclude from the experiments and calculations on improved, validated modelling and to propose models for ASTEC based on the elaborated major processes and evaluation results.

Further research on **Molten Core Concrete Interaction** (WP6) is aimed to provide new data and to understand corium-concrete interaction, by using innovative approaches to address more prototypical phenomena with the view of closing the issue in 2013 or, at least that significant progress toward this issue closure will be reached. It has been designed to ensure complementarity with the ongoing MCCI project of the OECD-NEA.

It is planned to study the effect of the concrete nature on 2D ablation profiles (limestone-rich concretes is ablated isotropically while silica-rich concretes interacting with oxidic corium are more ablated on the sides than downwards); the role of the metallic layer on the MCCI (for instance, MEDICIS calculations of the same reactor configuration lead to melt through times between 23 hours and 9 days depending on the calculation hypotheses); the efficiency of water cooling to terminate the ablation of concrete and, finally to transfer the R&D results to the reactor scale.

The proposed research will regroup experiments both with simulant and prototypic materials (mainly at CEA, FZK and VTT) to determine which phenomena are causing the observed effect of concrete composition on the ablation shape and to assess their influence at reactor scale. The use of simulant material enables precise measurements while prototypic materials allow taking better into account the various phenomena occurring in the reactor case. In particular, it is planned to use specially designed artificial concretes to assess which property of the siliceous and limestone concretes control the observed differences in ablation behaviours. Finally, data must be acquired (at ITU and UJV) on the phase diagrams between corium and concrete.

The **Containment** work package (WP7) will be dedicated to the investigation of two highly energetic phenomena – steam explosions and hydrogen combustion – that may threaten the containment integrity, as well as of other processes that preclude these phenomena and may either create more favourable conditions or prevent them, such as: melt fragmentation, containment atmosphere mixing and stratification (including influence of steam condensation), hydrogen recombination in passive autocatalytic recombiners (PAR), interaction of containment atmosphere with PARs and containment sprays. In addition, the applicability of the research results to actual plants will be addressed. The sub-work package Ex-vessel fuel-coolant interaction (FCI) will deal with phenomena that may lead to steam explosions. The corium ejected in the reactor cavity after reactor pressure vessel failure may lead to high-pressure loads on the containment or vital components in case of FCI. At present, the major uncertainties that make it difficult to quantify containment safety margins to ex-vessel steam explosion concern the level of void in the pre-mixing phase and the role of material properties on explosion energetics. In the Hydrogen mixing and combustion in containment (H2) sub-work package, phenomena that are linked to the hydrogen-in-containment issue will be addressed. Containment thermal-hydraulics, including hydrogen distribution, different hydrogen combustion regimes (including deflagration-to-detonation transition and combustion in the course of Direct Containment Heating), their impact on containment structures and measures to prevent (severe) combustion processes or at least to mitigate their consequences with accident management measures like PARs and containment sprays are covered by this issue. The main purpose of the sub-work package Bringing research results into reactor application (CONT-RA) will be to find a common understanding of the comprehensive available material, resulting from both ongoing and past experimental and theoretical research, and to make use of it in a harmonized manner for application to safety analyses of actual plants. One of the tasks will be the elaboration of a generic containment model, including all important components and allowing analyses to be performed with lumped-parameter codes as well as with Computational Fluid Dynamics (CFD) codes. This task will be part of the analytical scaling step from test facilities to real plant dimensions.

The **Source Term** research (WP8) aims to reduce uncertainties in calculating potential release of radiotoxic fission products (FPs) to the environment. It concentrates on iodine and ruthenium, given their high radiotoxicity, noting that Ru release is enhanced in oxidising atmospheres, as might follow air ingress into the reactor coolant system (RCS). Of particular importance in the containment is the prediction of volatile I and Ru species in the atmosphere, as these forms are hard to remove by containment sprays, or by filtered containment venting.

The oxidizing impact on source term sub-work package (OX) considers:

- *FP release:* from HBU and MOX fuels; role of cladding, i.e. competition amongst cladding oxidation, UO_2 oxidation and FP release; release under mixed steam-air conditions (more realistic than 100% air conditions in accident situations);
- *Ruthenium transport in RCS*: thermodynamic behaviour of Ru oxides; reactivity with surfaces and species such as Cs;
- *Ruthenium behaviour in containment:* behaviour of Ru oxides as aerosols and possible conversion to volatile forms; thermodynamic behaviour of Ru species in liquid phase and potential volatilization.

A similar approach is adopted in the iodine sub-work package (IOD):

- *Iodine transport in circuits:* kinetics of gas phase reactions; speciation of revaporised iodine and of other FPs; compilation of a plant iodine spiking databank, development of a correlation-type model for iodine retention on the secondary side in some SGTR events;
- *Iodine behaviour in containment:* iodine association with painted surfaces; subsequent volatile iodine formation from iodine-loaded paint; radiolytic destruction of gaseous iodine species to form nucleate particles and their subsequent behaviour; iodine binding on sump materials and in sump screen blockages; the effect of passive autocatalytic recombiners (PARs) on iodine on the source term.

The sub-work package (ST-RA), on bringing the results to reactor safety analysis, includes:

- *Integral plant scenario calculations* to assess the impact of including recent research results in the source term area;
- *Benchmarking of codes* against data such as from Phebus FPT2/3 and ThAI-Iod-11/-12, and also via a 'TMI-2 like' exercise considering circuit and containment matters;

- *Maintenance of data books* where existing, such as for iodine, and *development*, such as for ruthenium;
- *Critical assessment* of severe accident management guidelines.

The main Source term deliverables will cover periodic progress reports, benchmark exercises, and the new data book for ruthenium. Other detailed technical reports would be issued as needed.

Note 1) The last four research WPs have strong links with ASTEC, as one of their ultimate goals consists in providing physical models to be integrated into ASTEC. Furthermore, the exchange of information on the detailed models developed by the various experts through interpretation of experiments will lead at medium and long term to generic common models used first in the different detailed codes (e.g. ICARE/CATHARE and ATHLET-CD). Then, adequate models will be derived from these detailed models and will be included into the common reference ASTEC code.

Note 2) The Probabilistic Safety Assessment of level 2 (PSA2) harmonization which was part of SARNET is not considered anymore in SARNET2. A specific project (ASAM-PSA2) has been put in place following the first call for proposals of the EC in the frame of the 7th FP [6]. Direct links with this project will be maintained, mainly for contributing to the definition of ASTEC code requirements and of research priorities as regards PSA2 needs.

Note 3) All the JPA elements are interlinked. For instance, experimental work and subsequent interpretation in WPs 5 and 6, experimental database activity in WP3, ASTEC development in WP4 and dissemination of results through the ERMSAR Conferences in WP2. This will contribute to tighten the links between the different participants to these activities (horizontal integration).

The total personnel to perform the four-year JPA is foreseen at 1710 person.months (not taking into account the experimenter person-months, as the cost of experiments has been determined as a global value (including researcher and technician manpower, consumables, etc...) by each partner providing experimental results).

Finally, the R&D activities surrounding the JPA (so-called associated programmes) and connected to it are mainly:

- the IRSN-GRS programme aiming at developing the integral code ASTEC and making it open and available for all SARNET2 partners,
- the diverse national research activities (experimental programmes, related interpretation and modelling activities on national basis or on specific international agreements, e.g. Phebus FP, ISTP, ISTC Projects, OECD Projects, etc…) that aim at resolving open issues identified as important and of common interest in SARNET/SARP conclusions.

The JPA will clearly constitute the active link connecting all these associated programmes and making, in a sustainable way, the whole system more and more efficient. It will be a priority task of the Consortium to define the way to associate or integrate these programmes and the involved teams, when they are in a position to complement the competence and expertise of SARNET2 in domains of importance.

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Part. N.	Participant organisation full name	Part. short	Country
1	Institut de Radioprotection et de Sûreté Nucléaire	IRSN	France
2	KFKI Atomic Energy Research Institute	AEKI	Hungary
3	AREVA NP GmbH	AREVA NP GmbH	Germany
4	AREVA NP SAS	AREVA NP SAS	France
5	Budapest University of Technology and Economics Institute of Nuclear Techniques	BUTE INT	Hungary
6	Commissariat à l'Energie Atomique	CEA	France
7	CESI RICERCA SpA	CESI R	Italy
8	Chalmers tekniska högskola AB	CHALMERS	Sweden
9	Centro de Investigaciones Energeticas Medio Ambientales y Tecnologicas	CIEMAT	Spain
10	National Centre for Scientific Research "DEMOKRITOS"	DEMOKRITOS	Greece
11	Electricité de France SA	EDF	France
12	Energy Institute JSC Sofia	EI	Bulgaria
13	Ente per le Nuove Tecnologie, l'Energia e l'Ambiente	ENEA	Italy
14	Forschungszentrum Juelich GmbH	JÜLICH	Germany
15	Forschungszentrum Karlsruhe GmbH	FZK	Germany
16	Gesellschaft für Anlagen- und Reaktorsicherheit mbH	GRS	Germany
17	National Autonomous Company for Nuclear Activities Nuclear Research Subsidiary Pitesti	INR	Romania
18	Institute for Nuclear Research and Nuclear Energy	INRNE	Bulgaria
19	Inzinierska Vypoctova Spolocnost Trnava s.r.o.	IVS	Slovakia
20	Jozef Stefan Institute	JSI	Slovenia
21	Kungl Tekniska Högskolan	KTH	Sweden
22	Lithuanian Energy Institute	LEI	Lithuania
23	Nexia solutions Ltd	NEXIA	United Kingdom
24	Nuclear Research & Consultancy Group v.o.f.	NRG	Netherlands
25	Paul Scherrer Institut	PSI	Switzerland
26	Ruhr-Universität Bochum	RUB-LEE	Germany
27	Suez-Tractebel SA	TE SUEZ	Belgium
28	Thermodata	THERMODATA	France
29	Technical University of Sofia	TUS	Bulgaria
30	Urad Jadroveho Dozoru SR	UJD	Slovakia
31	Ustav Jaderneho Vyzkumu Rez a.s.	UJV	Czech Republic
32	University of Newcastle upon Tyne	UNEW	United Kingdom
33	Dipartimento di Ingegneria Meccanica, Nucleare e della Produzione - Università di Pisa	UNIPI	Italy
34	Universität Stuttgart	USTUTT-IKE	Germany
35	VEIKI Institute for Electric Power Research Co.	VEIKI	Hungary
36	VTT Technical Research Centre of Finland	VTT	Finland
37	VUJE Trnava, a.s. – Inzinierska, Projektova a Vyskumna Organizacia	VUJE	Slovakia
38	EURATOM Joint Research Centres	JRCs	European Union
39	Atomic Energy Canada Limited	AECL	Canada
40	Korea Atomic Energy Research Institute	KAERI	Korea
41	United States Nuclear Regulatory Commission	USNRC	United States

Table 1: SARNET2 List of Participants

WPs	Sub WPs	Full titles	Short titles	Leader	Country
WP1		Management	MANAG	IRSN (T. Albiol)	France
	WP1-1	COORdination, Administration and Budget	COOR	IRSN (T. Albiol)	France
	WP1-2	Integration Assessment	IA	IRSN (T. Albiol)	France
	WP1-3	Severe Accident Research Priorities	SARP	GRS (B. Schwinges)	Germany
WP2		Spreading of Excellence	SE	KTH (B. R. Sehgal)	Sweden
	WP2-1	Education and Training	ET	UNIPI (S. Paci))	Italy
	WP2-2	ERMSAR conferences	ERMSAR	Hosting Partners	
	WP2-3	MOBility programme	MOB	KTH (B. R. Sehgal)	Sweden
WP3		Information Systems	IS	GRS (D. Beraha)	Germany
	WP3-1	WEB site	WEB	GRS (D. Beraha)	Germany
	WP3-2	Advanced Commuinication Tool	ACT	GRS (D. Beraha)	Germany
	WP3-3	Experimental Database	ED	JRC Petten (to be defined)	Netherlands
WP4		ASTEC	ASTEC	IRSN (J.-P. Van Dorsselaere)	France
	WP4-1	Users' Support, Training and Integration	USTI	IRSN (J.-P. Van Dorsselaere)	France
	WP4-2	ASTEC Code ASsessment	ACAS	IRSN (J.-P. Van Dorsselaere)	France
	WP4-3	ASTEC Model EXtension	AMEX	GRS (W. Luther)	Germany
WP5		Corium and debris COOLability	COOL	FZK (W. Tromm)	Germany
	WP5-1	Reflooding and Coolability of a degraded core	RefCool	PSI (J. Birchley)	Switzerland
	WP5-2	Remelting of debris, Melt Pool Formation and coolability	MPF	KTH (W. Ma)	Sweden
	WP5-3	EX-vessel debris formation and COOLability	EXCOOL	USTUTT-IKE (M. Bürger)	Germany
	WP5-4	bringing research results into Reactor Application	COOL-RA	IVS (P. Matejovic)	Slovakia
WP6		Molten Corium Concrete Interaction	MCCI	CEA (C. Journeau)	France
	WP6-1	effect of the concrete nature on 2D Ablation Profiles	AbProf	IRSN (M. Cranga)	France
	WP6-2	role of Metallic Layer on the MCCI	MetLay	FZK (J. Foit)	Germany
	WP6-3	efficiency of Late Water Cooling	LWC	KTH (W. Ma)	Sweden
	WP6-4	bringing research results into Reactor Application	MCCI-RA	INRNE (P. Groudev)	Bulgaria
WP7		CONTainment	CONT	JSI (I. Kljenak)	Slovenia
	WP7-1	ex-vessel Fuel Coolant Interaction	FCI	IRSN (R. Meignen)	France
	WP7-2	Hydrogen mixing and combustion in containment	H2	GRS (H.-J. Allelein)	Germany
	WP7-3	bringing research results into Reactor Application	CONT-RA	Jülich (E.-A. Reinecke)	Germany
WP8		Source Term	ST	PSI (T. Haste)	Switzerland
	WP8-1	OXidizing impact on source term	OX	VTT (A. Auvinen)	Finland
	WP8-2	IODine chemistry in RCS and in containment	IOD	IRSN (N. Girault)	France
	WP8-3	bringing research results into Reactor Application	ST-RA	CIEMAT (L. Herranz)	Spain

Table 2: SARNET2 Work package list (leaders as foreseen on September 1st, 2008)