"NUCLEAR FISSION "
Safety of Existing Nuclear Installations

Contract FI6O-CT-2004-509065

SARNET

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1. Introduction

This document describes the work to be performed during the second 18-month period of the SARNET contract with the EC, from April 2005 to September 2006.

The Chapter 2 reminds the list of participants.
The Chapter 3 is a "refreshed" description of the JPA as defined in the EC-SARNET contract.
The Chapter 4 reminds the performance indicators to be monitored during the project.

The Chapters 5, and 6 describe the work to be performed during the JPA2 (April 2005-September 2006), the required efforts and the incurred eligible costs.

2. Contractor list

List of Participants

Particip. Role*	Particip. Number	Participant name	Participant short name	Country	Date enter project**	Date exit project**
CO	1	Institut de Radioprotection et de Sûreté Nucléaire	IRSN	France	Month 1	Month 48
CR	2	AEA Technology	AEAT	United Kingdom	Month 1	Month 48
CR	3	KFKI Atomic Energy Research Institute	AEKI	Hungary	Month 1	Month 48
CR	4	ARC Seibersdorf research GmbH	ARCS	Austria	Month 1	Month 48
CR	5	Association Vincotte Nucleaire	AVN	Belgium	Month 1	Month 48
CR	6	Budapest University of Technology and Economics Institute of Nuclear Techniques	BUTE	Hungary	Month 1	Month 48
CR	7	Commissariat à l'Energie Atomique	CEA	France	Month 1	Month 48
CR	8	Centro Elettrotecnico Sperimentale Italanio Giacinto Motta SpA	CESI	Italy	Month 1	Month 48
CR	9	Chalmers tekniska högskola	CHALMERS	Sweden	Month 1	Month 48
CR	10	Centro de Investigaciones Energeticas Medio Ambientales y Tecnologicas	CIEMAT	Spain	Month 1	Month 48
CR	11	The Consejo de Seguridad Nuclear	CSN	Spain	Month 1	Month 48
CR	12	National Centre for Scientific Research "DEMOKRITOS"	DEMOKRITOS	Greece	Month 1	Month 48
CR	13	Universita' di Pisa	UPI	Italy	Month 1	Month 48
CR	14	Empresarios Agrupados International, S.A.	EA	Spain	Month 1	Month 48
CR	15	Electricité de France	EDF	France	Month 1	Month 48
CR	16	Ente per le Nuove Tecnologie, l'Energia e l'Ambiente	ENEA	Italy	Month 1	Month 48
CR	17	Fortum Nuclear Services Ltd.	FORTUM	Finland	Month 1	Month 48

Particip. Role	Particip. Number	Participant name	Participant short name	Country	Date enter project**	Date exit project**
CR	18	Framatome ANP SAS	FRA ANP SAS	France	Month 1	Month 48
CR	19	Framatome ANP-Gmbh	FRA ANP-Gmbh	Germany	Month 1	Month 48
CR	20	Forschungszentrum Juelich GmbH	FZJ	Germany	Month 1	Month 48
CR	21	Forschungszentrum Karlsruhe GmbH	FZK	Germany	Month 1	Month 48
CR	22	Forschungszentrum Rossendorf e.V.	FZR	Germany	Month 1	Month 48
CR	23	Gesellschaft für Anlagen- und Reaktorsicherheit mbH	GRS	Germany	Month 1	Month 48
CR	24	University of Stuttgart	IUSTT-IKE	Germany	Month 1	Month 48
CR	25	National Autonomous Company for Nuclear Activities Nuclear Research Subsidiary Pitesti	INR	Romania	Month 1	Month 48
CR	26	Institute for Nuclear Research and Nuclear Energy	INRNE	Bulgaria	Month 1	Month 48
CR	27	Inzinierska Vypoctova Spolocnost Trnava Ltd	IVS	Slovakia	Month 1	Month 48
CR	28	EURATOM Joint Research Center of ISPRA	JRC ISPRA	EEC	Month 1	Month 48
CR	29	EURATOM Joint Research Center Trans Uranian Institute	JRC ITU	EEC	Month 1	Month 48
CR	30	EURATOM Joint Research Center of Petten	JRC PETTEN	EEC	Month 1	Month 48
CR	31	Jozef Stephan Institute	JSI	Slovenia	Month 1	Month 48
CR	32	Kungl Tekniska Högskolan	KTH	Sweden	Month 1	Month 48
CR	33	Lithuanian Energy Institute	LEI	Lithuania	Month 1	Month 48
CR	34	National Nuclear Corporation Ltd	NNC	United Kingdom	Month 1	Month 48
CR	35	Nuclear Research & Consultancy Group v.o.f.	NRG	The Netherlands	Month 1	Month 48
CR	36	Paul Scherrer Institut	PSI	Switzerland	Month 1	Month 48
CR	37	Ruhr-Universität Bochum	RUB	Germany	Month 1	Month 48
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CR	39	Swedpower AB	SWP	Sweden	Month 1	Month 48

Particip. Role	Particip. Number	Participant name	Participant short name	Country	Date enter project**	Date exit project**
CR	40	Technicatome	TA	France	Month 1	Month 48
CR	41	Thermodata	THERMODATA	France	Month 1	Month 48
CR	42	Suez-Tractebel SA	TE	Belgium	Month 1	Month 48
CR	43	Technical University of Sofia	TUS	Bulgaria	Month 1	Month 48
CR	44	Université Libre de Bruxelles	ULB	Belgium	Month 1	Month 48
CR	45	Université Catholique de Louvain	UCL	Belgium	Month 1	Month 48
CR	46	Urad Jadroveho Dozoru SR	UJD	Slovakia	Month 1	Month 48
CR	47	Ustav Jaderneho Vyzkumu Rez a.s.	UJV	Czech Republic	Month 1	Month 48
CR	48	Universidad Politecnica de Madrid	UPM	Spain	Month 1	Month 48
CR	49	VEIKI Institute for Electric Power Research Co.	VEIKI	Hungary	Month 1	Month 48
CR	50	VTT Technical Research Centre of Finland	VTT	Finland	Month 1	Month 48
CR	51	VUJE Trnava, a.s. – Inzinierska, Projektova a Vyskumna Organizacia	VUJE	Slovakia	Month 1	Month 48
CR	52	Becker Technologies GmbH	BTech	Germany	Month 1	Month 48

*CO = Coordinator
CR = Contractor

** Normally insert “month 1 (start of project)” and “month n (end of project)”
These columns are needed for possible later contract revisions caused by joining/leaving participants

WARNING:

- ***Participants 28, 29 and 30 are a unique contractor legal entity: EEC-JRC***
- ***There is no contractor N°38.***

3. The SARNET activities

The SARNET activities consist of:
- the R&D activities carried out by SARNET members in the frame of national or international programmes, contributing to the resolution of remaining issues identified in the EURSAFE project (or in its updates);
- and of a complementary programme jointly carried out, called Joint Programme of Activities (JPA) and aiming at:
    - progressively integrating the above national/international research programmes,
    - initiating and launching new programmes jointly carried out by sustainable research groups,
    - capitalizing the acquired knowledge in the integral code ASTEC and in data bases,
    - diffusing knowledge.

The JPA constitutes the kernel of SARNET. Such activities give the orientations to be followed, in terms of research and work distribution between SARNET members. They 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 most of available competences and means.

The JPA can be broken down in 4 main activities (see table NoE list of Activities, §9.2):

- Integrating Activities (IA) to strengthen links between organisations;
- Joint Research Activities (JRA) to pilot the research activities addressing remaining outstanding issues, to elaborate synthesis, and programme proposals;
- Spreading Excellence Activities (SEA);
- Management Activities (MA).

The ASTEC code is the main integrating component and is one of the gathering places of the knowledge. It contributes to the diffusion of this knowledge efficiently. Activities linked to ASTEC will thus appear as "*Integrating Activities*", whereas some of them contribute also to the range of "*Spreading Excellence Activities*". Concerning "*Joint Research Activities*", most of them have links with ASTEC, as it is one of their ultimate goals to provide physical models to be integrated in 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 in the different detailed codes (example of ICARE/CATHARE and ATHLET-CD). Besides, adequate models are derived from these detailed models and will be included in the common reference ASTEC code.

The R&D needs are periodically updated and the objectives of future experiments are defined taking into account the outcome of the collaborative work on risk studies. A consensus could be reached on closure of some issues and would allow redistributing competence and manpower on open ones in concert with other international projects (e.g. ISTC, OECD projects…).

Most of the JPA elements are interlinked: for instance, experimental database activity and ASTEC physical assessment; or model recommendation formulated in the JRA and model implementation in ASTEC. This contributes to tighten the links between the different participants to these activities (horizontal integration).

The R&D activities surrounding the JPA and connected to it are mainly:
- the GRS-IRSN programme aiming at developing the integral code ASTEC and making it open and available for all SARNET partners,
- the diverse national research activities (experimental programmes, related interpretation and modelling activities) that aim at resolving open issues identified as important and of common interest in EURSAFE conclusions (and their updating),
- the development of Level 2 PSA methodologies, the results of which will provide inputs for the definition of research priorities elaborated by SARNET partners.

These key programmes are called associated programmes in the rest of the document.

The JPA clearly constitutes the active link connecting all these associated programmes and making, in a sustainable way, the whole system more and more efficient.

Beyond programmes carried out by SARNET contractors, some external programmes are taken into account:
- ISTC,
- OECD projects,

- and more generally, programmes of interest carried out by non-SARNET members or non-European organizations (i.e. specific VVER joint research programmes, …).

It is a priority task of the Consortium to define the way to associate or integrate these programmes and the involved teams, when there are in a position to complement in a sustainable way the competence and expertise of SARNET in domains of importance. During the first SARNET year the interactions between SARNET and the CEG-SAM (Contact Expert Group on Severe Accident Management) of ISTC have been defined in order to integrate in SARNET activities results of ISTC projects devoted to Severe Accident.

3.1. Associated programmes

As said previously, the main elements of these associated programmes are:

- ASTEC development by GRS and IRSN,
- Research programmes carried out in organizations which are members of the network, (experimentation, interpretation and modelling),
- Current Level 2 PSA methodology developments.

They are described below in order to give the boundary conditions of the JPA, main component of the present contract.

3.1.1. ASTEC

This code, which is jointly developed by IRSN and GRS, describes the complete behaviour of a NPP under severe accident conditions. It is extensively used by IRSN for Level 2 PSA regarding 900 MWe Pressurized Reactors. It will behave as the main integrator of knowledge in SARNET and contribute to diffuse it to all members.

For the second 18-months period of SARNET (April 2005 to September 2006), one ASTEC V1 release is foreseen: ASTEC V1.2 consolidated version for which a large and detailed campaign of assessment is organized.

Then, the future versions V2 will be developed, taking into account inputs provided by different tasks and Work-Packages of the JPA. The other main characteristics of the V2 versions will be:

- The merging of ASTEC with ICARE (IRSN) for core degradation and with other specialized codes. This merging, performed by IRSN, will make more efficient and less time-consuming the development and the maintenance of the different computer tools;
- The capability to adequately treat other reactors than PWR and VVER.

3.1.2. Research programmes

Such activities concern experimental programmes, interpretation work and/or modelling activities. EURSAFE highlighted some remaining important safety issues, which can be broken down into:

- corium issues
- containment issues
- source term issues.

Current and future activities to be carried out by partners with the objective to solve the above-mentioned issues have been selected for SARNET. More precisely, they consist of:

- performing new experimental work (separate-effect or integral tests) and preparing/interpreting it with models or codes;
- interpreting already performed experiments with models or codes;
- performing scenario sensitivity studies in reactor conditions with models or codes in order to target actual conditions in the experiments or to investigate the influence of various models or model options;
- modelling activities.

Resolution of Corium issues

In vessel phenomena

The issues identified in 5th FWP EURSAFE project concerning in-vessel phenomena are:

- Water injection (hydrogen generation, core coolability, ex-vessel corium coolability);
- Late-phase in-vessel degradation and loss of Reactor Pressure Vessel (RPV) integrity (molten pool/debris behaviour in the lower plenum);
- Lower head failure and corium release to cavity;
- Specific remaining issues on early-phase degradation (including B_4C effects from control rods and oxidation by air or steam/air mixtures),
- Reactor Cooling System (RCS) integrity including risk of induced breaks in steam generators.

Additional items have been added in the continuation of COLOSS European project according to their importance for fuel behaviour and fission product release: the B_4C effects and the oxidation by air or steam/air mixtures

For each one, experimental and interpretation activities have been initiated in the frame of national programmes. These programmes may be classified into six topics:

- T1: Hydrogen generation during core reflooding;
- T2: Core and debris coolability during reflooding, including ex-vessel debris bed coolability;
- T3: Late phase core degradation and corium behaviour in lower head, including in-vessel melt retention strategies;
- T4: Vessel failure and release into cavity;
- T5: Early phase degradation and boron carbide effects.
- T6: Zircaloy oxidation by air or steam/air mixture

The concerned experimental programmes underway (or planned) by the SARNET organisations and to be considered as associated to the network are given in the table below:

NAME	Topic	Leading organisation
Vessel external cooling facility	T3	CEA
DEBRIS	T2	IUSTT-IKE
FOREVER, SIMECO	T4, T3	KTH
LIVE	T3	FZK
MAESTRO plat-form	T1, T5,T6	IRSN
PHEBUS FP	T3, T5	IRSN
QUENCH and SETs	T1, T5,T6	FZK
STYX	T2	VTT

The interpretation of experiments is carried out with different models or codes (ICARE/CATHARE, SCDAP/RELAP5, SCDAPSIM, ATHLET-CD, KESS, MELCOR, ASTEC).

Among all needs of R&D identified in EURSAFE, only two in-vessel phenomena are not currently covered by experimental proposals: "Effect of Lower-head penetrations in case of external cooling" (very dependent on NPP design) and "Steam generator plenum and tube failure". They refer to thermal hydraulics studies and will be examined later on. A proposal to tackle these problems shall be elaborated in the frame of the JPA.

Ex-vessel phenomena

Likewise, the issues identified in the 5th FWP EURSAFE and EUROCORE projects concerning ex-vessel phenomena are:

- T7: MCCI: molten pool configuration and concrete ablation;
- T8: Ex-vessel corium coolability, top flooding;
- T9: Ex-vessel corium catcher: corium ceramics interaction and properties;

- T10: Ex-vessel corium catcher: coolability and water bottom injection.

These items have been selected with the following rationales:

- Improve predictability of axial versus radial ablation up to late phase MCCI to determine basemat failure time and loss of containment integrity;
- Increase the knowledge of cooling mechanisms by top flooding the corium pool to demonstrate termination of accident progression and keeping containment integrity;
- Demonstrate the efficiency of specific corium catcher designs by improving the predictability of the corium interaction with corium catcher materials;
- Demonstrate the efficiency of water bottom injection to cool corium pool and its impact on containment pressurisation.

They are addressed in the following experimental programmes to be considered as associated to the network:

NAME	Topic	Leading organisation
ARTEMIS	T7-T9	CEA
COLIMA	T7-T9	CEA
COMECO, POMECO	T8-T10	KTH
COMET	T10	FZK
DECOBI	T10	KTH
VULCANO	T7-T9-T10	CEA

The interpretation of experiments is carried out with different models or codes (WEX, WECHSL, MEDICIS, TOLBIAC, TOLBIAC-ICB, CROCO-2D, MELCOR, KESS, MEWA).

Thermodynamic and material property research

The objective is to develop reference thermodynamic and thermo-physical property databases for a consistent analysis of severe accidents.

In the case of thermodynamic properties, a database exists (NUCLEA), which is already used in computer codes and for severe accident analysis in general. The work in SARNET will mainly be a continuation of the effort of the ENTHALPY project (5^{th} FWP) to complement and improve this database.

In the case of thermo-physical properties, no such a database exists at European level for severe accident analysis. Existing databases cover essentially properties under normal conditions. Works have been already identified with the scope of filling this gap.

The work consists in analytical and experimental activities as follows:

- Thermodynamic properties database NUCLEA (continuation and extension of work performed in ENTHALPY)
  - Assessment, validation, merging, editing and maintenance
  - Develop approaches for coupling the data base with SA codes (ASTEC)
  - Identify the experimental needs for completing the data base
  - Select the most appropriate capability(ies) of the Network to provide the missing data.
- Thermo-physical properties database preparatory work
  - Collect information on systems used by partners in order to find the best solution to normalise corium thermo-physical properties used for severe accident analysis (continuation and extension of work performed in 5^{TH} FWP ECOSTAR project)
  - Make syntheses from existing experimental data
  - Select the most appropriate capability(ies) of the Network to measure properties of first importance still lacking data
  - Develop a reference database.
- Experimental work
  - Measurement of density of liquid Zr, Fe, U
  - Phase diagram of U-O-Zr-Fe systems.

Resolution of containment issues

The issues identified in 5th FWP EURSAFE project concerning containment phenomena are:

- Hydrogen combustion/detonation and containment atmosphere mixing;
- Fuel-coolant interaction;
- Direct containment heating.

The knowledge about the formation of combustible gas mixtures in containments, local gas composition and potential combustion modes is the basis for hydrogen risk assessment and the development of mitigation strategies for real plants. The experimental and theoretical ongoing research concentrates on the reduction of still existing uncertainties, especially concerning:

- Local multidimensional effects of combustion;
- Reaction kinetics inside catalytic recombiners (PAR);
- Hydrogen distribution in the different parts of the containment with the risk of high local concentrations, taking account of containment geometry (multi-compartment), mass and energy exchanges coming from phenomena as wall condensation, spray and sump evaporation, but also the effect of recombiners on the gas distribution.

During the first months of SARNET, a consolidation of knowledge in the last domain has been obtained, taking account of results of the associated experimental programmes TOSQAN (IRSN), MISTRA (CEA) and ThAI (BTech) experiments, especially in the framework of the ISP47. The interpretation of experiments was mainly carried out with ASTEC, COCOSYS, TONUS-0D Lumped-Parameter codes and with CFD codes (TONUS, GASFLOW, CFX, FLUENT). Several issues were also identified during that time, which need to be further investigated:

- the modelling of saturation conditions (in particular not well modelled in CFD codes)
- the interaction of spray mitigation systems with containment atmospheres
- the interaction of recombiners with the containment atmosphere: hot gases exiting recombiner chimneys create natural convection flows due to thermal buoyancy effects, which affect the distribution and mixing of the different gases within the containment, and therefore the amount of hydrogen that can enter into the recombiners.
- the need to futher validate CFD codes on genuinely 3D but well instrumented experiments.

For the estimation of potential consequences in real plants due to fuel-coolant interactions, a deep understanding and an increased knowledge is required about specific processes like premixing, melt fragmentation, particle heat transfer mode for code modelling and code validation. After the experimental programmes TREPAM (CEA) and ECO (FZK) have been finished and the feasibility of MICRONIS (CEA) is still under investigation, MISTEE (KTH) is the only remaining experiment at present. KROTOS (CEA) is expected to start in 2006 and to form the main focus of the future work. The interpretation of experimental programmes will be carried out with the codes MC3D, MATTINA, IKEJET/IKEMIX, IDEMO-2D and FRADEMO.

Regarding direct containment heating, experiments performed with different materials (metal and oxide mixtures) are of importance for real plant applications. The dispersion of melt in the cavity, the reactor compartments and the containment in a scaled geometry of German and French reactors are being performed to determine the pressure increase by Direct Containment Heating. The underway main associated experimental programme is DISCO (FZK). The interpretation of this experimental programme will be carried out with the codes AFDM, MC3D, CONTAIN and ASTEC.

Resolution of source term issues

The issues identified in the 5th FWP EURSAFE project concerning the source term are:

- Effect of air ingress;
- Iodine volatility in the Primary Circuit;
- Containment by-pass in case of Steam Generator Tube rupture;
- Iodine behaviour in containment.

In addition, the evolution of current NPP operations, as the evolution of fuel management towards higher burn-up and the use of MOX fuel, make it necessary to assess the possible consequences on severe accidents.

Assessment of the source term takes on additional importance for future NPPs, as most European Safety authorities require that severe accidents be considered in the design of future power plants.

In the SARNET frame, the following research activities associated with these issues will be carried out.

Several effects of air ingress are being addressed. The impact of oxidising environment on the fuel and on fission products release is being studied through different experimental programmes, consisting of separate-effects experiments to examine the behaviour of fuel rods and especially the release of ruthenium (Ru) species under various oxidizing atmospheres (such as RUSET, VERDON and VTT speciation tests). On the theoretical side, reactor scenario studies are in progress for definition of test conditions in separate-effect experiments; interpretation of experimental programmes will be also conducted. The main objective of this research is a better evaluation of the consequences of air ingress on the reactor source term, in particular the source term associated with Ru under oxidising conditions and for various kinds of fuel. Models for ASTEC are being proposed.

The impact of high temperature behaviour of fission products, especially iodine, in the Reactor Coolant System (RCS), will be also investigated in the network. The objective is to improve the predictability of iodine species exiting the RCS to provide the best estimate of the source into the containment. It is well known that such behaviour is difficult to predict due to the importance of non-equilibrium chemistry. Associated programme activities include experimental and theoretical work: separate-effect experiments to examine the species formed in the gas phase above the core in the RCS (such as VERCORS and the future CHIP facility), analysis of fission products and aerosol transport and speciation in the integral test Phébus FPT2, and analysis of control rod material release and modelling proposals for ASTEC code.

Some specifics aspects of aerosol behaviour in the reactor have been also identified as an important unresolved issue. The main objective, as recommended by the EURSAFE experts, is to quantify the source term and especially in the case of steam generator tube ruptures which leads to a reactor containment building by-pass. As for other issues, activities consist of experiments (such as ARTIST, PSAERO, PECA/SGTR, HORIZON, RADSOL…) and theoretical work. Experimental work consists of separate-effect tests on aerosol trapping on the steam generator secondary side and of tests on fission product reaction with the substrate and revaporisation with simulants and/or samples from integral experiments. Corresponding interpretation work is being performed, along with modelling proposals for the ASTEC code. Additionally, a model for aerosol behaviour through containment cracks (not previously treated in ASTEC) is under development, and some experiments could be carried out within SARNET to help formulate and assess this treatment.

Containment chemistry impact on the source term is still an unclosed issue. The main objective of associated activities carried out in SARNET is to improve the predictability of the various chemical and physical processes which control the iodine behaviour both in the gas phase and in the water phase inside the containment. Various phenomena affecting the iodine chemistry in these phases (adsorption/RI formation/radiolytic destruction/ effect of steam condensation/effects of paints) have and are being experimentally investigated in separate-effect tests (EPICUR, SISYPHE…). Related interpretation will be carried out, as well as interpretation of iodine behaviour in the containment of Phébus FPT2. An Iodine Data Manual that will provide recommendations for experiments and for iodine codes in the context of their use for reactor safety estimates is being prepared. All this work is leading to modelling proposals for ASTEC code.

3.1.3. Level 2 PSA

Several methodologies are under parallel development in organisations needing such a tool for safety analyse. It will be one of the objectives of the JPA to provide a comparison of these different approaches and to promote their harmonisation.

During the first months of SARNET, different elements of existing Level 2 PSA amongst partners have be reviewed and compared:

- Level 1 / Level 2 interface,
- Tools used for the study,
- Accident progression event tree,
- Release categories,
- Assessment of physical events,

- Assessment of systems and human actions,
- Assessment of radiological releases.

Besides, methods used by the different partners to assess uncertainties in their study have been reviewed and compared and other possible methods have also been identified.

A state of the art of existing and under development dynamic reliability methods has also been performed.

For the next 18 months period of SARNET more deep comparisons of the methods used to address some specific physical phenomena:

- hydrogen combustion,
- melt corium concrete interaction,
- iodine releases assessment.

and to assess the associated uncertainties will be achieved to draw up some recommendations on the best way to take these phenomena into account in a level 2 PSA.
The comparison of the probabilistic software will be continued.
The results of benefit of existing application of dynamic reliability methods to level 2 PSA will be reviewed.
Software development and new example(s) of application using the Monte Carlo Dynamic Event Tree and the Stimuli Driven Theory of Probabilistic Dynamic will be engaged.
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3.2. Joint Programme of Activities (JPA)

Joint Programme Activities can be broken down in 4 series:

- Integrating Activities consisting in:
  - the development of "physical" links between contractors in order to make easier and more fluid the exchange of information,
  - the development of common tools or methodology to enhance the capacity of contractors to enhance their capability to harmonize their research activities (ASTEC, Level 2 PSA);
  - the monitoring of end-users need and the joint elaboration of research priorities;
  - the monitoring of the integration and the elaboration of proposal to integrate further the activities carried out in the frame of SARNET.
- Joint Research Activities consisting in:
  - the elaboration of synthesis, based on the results of the different associated programmes; these synthesis shall lead to scientific consensus on proposal of models to be implemented in ASTEC;
  - the coordination of R&D tasks carried out in the frame of SARNET, with the objective to make the best of available competences and means;
  - the proposal of revision or initiation of programme with the objective to tackle the important pending issues.
- Spreading Excellence Activities mainly consisting of education and training, and mobility.
- Management Activities mainly consisting of the administrative tasks.

3.2.1. Integrating activities (JPA/IA)

The Integrating Activities comprise:

- Implementation of an Advanced Communication Tool for fostering exchange of information;
- Delivery of ASTEC code and support to code users, adaptation of ASTEC to users needs and qualification;
- Harmonization of Level 2 PSA methodology and development of advanced tools;
- Implementation of scientific databases;
- Research priority assessment;
- Monitoring of integration criteria.

Advanced communication Tool

Description

Advanced Communication Tool (ACT) is a key concept to achieve SARNET goals. Indeed, ACT is the unified support for efficient communication between SARNET partners to achieve the following needs:

- Access, search, publish documents and access codes (concept of knowledge repository),
- Contact and communicate with partners (interactive and collaborative services),
- Joint co-ordination of actions and programmes (co-operative management of the network),
- List links to satellites community projects (R&D projects, related sites).

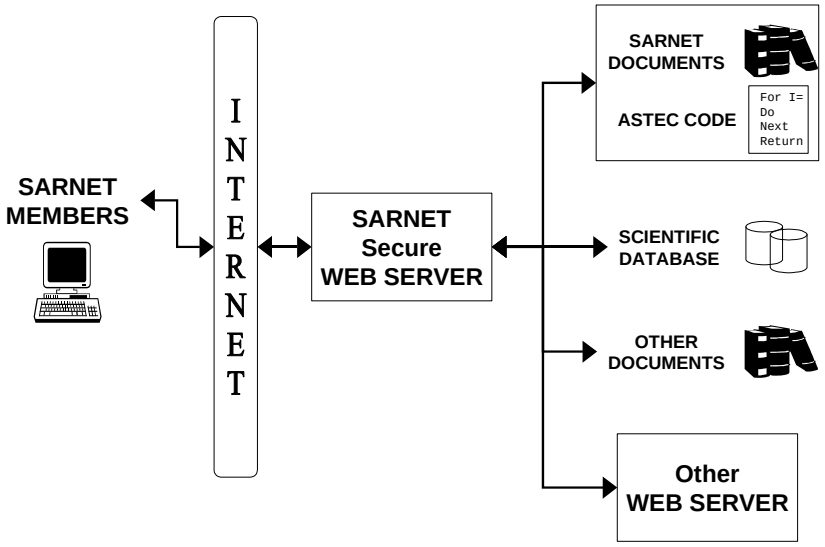
Since members are working in a heterogeneous environment, a web portal has been designed to provide a central access point to all relevant information of a particular domain and collaboration platform, including:

- A framework for documents (all common document types),
- Cooperative solutions (forums, subscriptions…),
- Links to community sites (organisation, projects…).

The web portal also provides access to existing documentation and code that members are willing to share. This implies that the structure should provide the means to describe data (notion of metadata) in order to ensure the long-term archiving and the homogeneity of the documents served on the portal.

The solution for the ACT consists of the following modules fulfilling requirements (non exhaustive nor compulsory list):

- Web portal framework,
- Product Data Management solution to provide knowledge repository for documents produced in SARNET context,
- Easy access to scientific,
- Links to community's tools (portals and databases).



The Web portal framework is the backbone of the community; it provides an integration framework for services, document repository and SARNET codes (mainly ASTEC). This model is in charge of authentication and first discrimination for user access.

The Product Lifecycle Management (PLM) solution consists in a strategic business approach that applies a consistent set of business solutions in support to the collaborative creation, management, dissemination, and use of product definition information across the extended organisation from concept to end of life, integrating people, processes, and information.

It provides the following functionalities:

- Document management;
- Support tools for collaboration;
- Support for system administration;
- Code management and versioning support.

The scientific code integration module consists in providing for SARNET partners a simple and easy access to ASTEC code. It first implies for code users access to the reference versions (and tools for delivery and installation), as well as communication between users and the maintenance team (user requests, maintenance answers…). Training support (user's guide, samples…) will be also available to ASTEC code neophytes. For partners involved in code development, it will give access to the software management tool.

SARNET Advanced Communication Tool is providing a welcoming access point linked to the existing and future partners portals as well as technical databases. Each partner could ask for integration of links pointing to its own systems and information services whether he considers that it is useful to the community.

Only a small number of partners are involved in the development/maintenance of this tool; nevertheless most of the SARNET partners are be involved in providing feedback and suggestions for improvement.

The development strategy has been based on 3 phases (see below

Phase 1 : Analysis

Functional Analysis
Technical Analysis
Analysis of existing tools
Definition of the solution

Phase 2 : Development

Prototype development
Portal module development
PLM module development
Integration of links

Phase 3 : Deployment

Deployment on a validation platform
Deployment

The basic development and deployment of an Advanced Communication Tool (ACT) for the management of information and documents as well as the communication and collaboration of partners in the project is performed in the first 12 months of the project. As a result, a workable platform is now established and in use. The further work will concentrate on five topics:

- Maintenance of the ACT
- Support of the Users
- Evaluation of the feedback from users which may lead to new functionality
- Structuring and mapping the information content of the ACT
- Extension of the public Internet Web Site.

The maintenance of the ACT is an ongoing work, which concerns the hardware employed, the server and ACT software, and the administration of users and of users rights, particularly as new users join and old users leave the project. Regular backups will guarantee the function of the portal in case of hardware breakdowns or inadvertent loss of information.
The support of users is an ongoing task, giving help and advice notably to document management issues, setting up new shared spaces, or designing specific sites in the ACT.
A survey on the usefulness and efficiency of the ACT will indicate the satisfaction of users with the system. This user feedback will be evaluated, and will provide indications for improvement of existing and implementation of new functionality. For frequently asked questions, e.g. with regard to document management and the use of different browsers and operating systems, the user manual will be extended to cover these topics.

Towards the end of the project, an effort will be undertaken to structure the information accumulated during the project according to its relevance, and to present the main topics of the project, the important documents and the relations to other activities in form of a mapping. This will be useful for dissemination and exploitation of the knowledge gained in the project after the end of the project, and will respond to the Commission's general remark that in the cycle of knowledge production, dissemination and exploitation, the last item is the least developed, particularly after the end of a project.

In parallel in order to widely disseminate information on SARNET life a public Web site has been developed (and open to the public during the first year of SARNET), a continuous effort will then be done to extend it by new information and important documents in parallel to the evolution of the project.

Integral Code ASTEC

29 organizations (including IRSN and GRS) have expressed their willingness to collaborate on the adaptation and qualification of the Integral Code ASTEC. This code, which is developed by IRSN and GRS, describes the behaviour of a whole NPP under severe accident conditions. It is extensively used by IRSN for Level 2 PSAs regarding 900 MWe Pressurized Reactors. It will serve as the main integrator of knowledge in SARNET and contribute to diffuse it to all members. It is important to note that it will be used in 6 Associated Candidate Countries. The ASTEC project is divided into 3 sub-projects, namely:

- Users support/training, model integration and code adaptation,
- Physical model assessment,
- Reactor application and benchmarking.

IRSN and GRS will endeavour, in the limit of their financial capabilities, to offer the support to the users that such a large diffusion will imply.

Sub-project 1: Users Support and Training, Integration and Adaptation (USTIA)

The objective of these activities is:

- To distribute the code versions, their updates and their documentation to code users, provide a support and training for code users and organize information exchange between code developers and users (Users Club).
- To integrate knowledge issued from SARNET into the code, adapt ASTEC to all types of water-cooled NPPs operated in Europe.

An IRSN-GRS team will:

- Analyse the requests of ASTEC users and will propose solutions: code adaptation or users recommendations,
- Make the code updates available for SARNET partners,
- Deliver code versions and documentation.

The ASTEC Web site will be improved and maintained to make easier the exchange of information and documents between the maintenance team and the SARNET users. It will make use of the ACT described previously.

All the organizations participating to the ASTEC JPA will participate to the ASTEC Users Clubs. Users Club meetings will be organized periodically (in average once a year) in order to:

- Exchange information on the code use,
- Examine the code status regarding its development and assessment,
- Examine users requests and discuss their priority,
- Prepare recommendations to be addressed to the Governing Board.

Training sessions will be periodically organized. E-learning will be set up on the Web site in order to allow distant training of new users. All the organizations involved in the ASTEC JPA may participate

to this activity (host, teach or learn). For the next training sessions, skilled ASTEC users from other organizations will be encouraged to participate to the teaching activity besides IRSN and GRS ones.

In parallel, specifications of developments requested by ASTEC users on one hand to model the different systems for SAM and on the other hand to model other NPP types than PWRs will be prepared. For the latter, the involved partners (outside of IRSN and GRS) will be:

- For VVER: INRNE, TUS, UJV, VUJE,
- For CANDU: INR,
- For RBMK: LEI,
- For BWR: KTH.

The corresponding developments will be carried out probably in the next period of 18 months (i.e. in JPA3), combined with the integration of model proposals elaborated in the frame of Joint Research Activities.

Sub-project 2: ASTEC physical model assessment (PHYMA)

This activity will consist of comparisons between ASTEC and experimental data. In a very few cases, experimental data can be replaced by results provided by detailed reference codes, whose models are largely more detailed and assessed than the ASTEC ones (example: CFD codes compared to CPA multi-compartment containment part of ASTEC).

This activity will provide inputs for sub-project 1 above, and for the definition of research priorities in the severe accident domain.

On the medium and long term this activity will use as input the new experimental data produced in the frame of SARNET.

For the short term, the work will consist in be organized as follows:

- End of assessment of ASTEC V1.1,
- Assessment in 2005-06 of the version V1.2 using the large matrix that was defined in JPA1. This phase will last 2 years and lead to a complete and detailed assessment of ASTEC V1 code.

For the longer term, the assessment activity will continue following the same scheme:

- Updates and complements taking into account code evolution and new experimental results generated in the frame of SARNET.
- Full revision of the assessment for major code versions.

This activity will be shared between the different organizations, according to their competences and complementarities (20 organizations, including IRSN and GRS, will participate to the short-medium term activity).

Five domains will be covered:

- In-vessel phenomena (thermal hydraulic and degradation phenomena): BUTE, ENEA, FZK, IUSTT-IKE, IRSN, IVS, JRC Petten, KTH,
- Ex-vessel corium (MCCI, corium cooling, DCH): ARCS, FZK, GRS, IRSN, TUS, UJV,
- Containment behaviour: CIEMAT, UPI, ENEA, GRS, IRSN, JRC Petten, JSI, LEI, RUB, TUS,
- Source term: CEA, CIEMAT, ENEA, GRS, IRSN, JRC Petten, JSI, PSI, TUS, UJV,
- Integral tests (Phébus): GRS, INR, IRSN, JRC Petten.

Sub-project 3: ASTEC reactor application and benchmarking (RAB)

The objective of this sub-project is to evaluate and improve the capability of ASTEC to simulate reactor transients, including safety systems and main Severe Accident Management (SAM) procedures.

This activity will consist of ASTEC reactor applications and benchmarking with other codes. It will provide inputs for the sub-project 1 above, and for the definition of research priority in the severe accident area.

The reactor transients will concern 5 types of reactors: PWR, BWR, VVER, CANDU and RBMK.

ASTEC will mainly be compared to the integral codes MELCOR and MAAP, but also to some specialized codes such as ICARE/CATHARE, ATHLET-CD, SCDAP/RELAP5, COCOSYS, TONUS…

For the short term, the work will be organized as follows:

- End of ASTEC V1.1 assessment to update and complete the benchmarking activity initiated in JPA1.
- In 2005-06 benchmarking activity of plant applications with the version V1.2, using the large reactor sequence matrix that was defined in JPA1. This phase will last 2 years and should lead to an ASTEC V1 evaluation report beginning of 2007.
- In parallel, elaboration of a first set of ASTEC V1 reference input decks for reactor applications (PWR, BWR, VVER, RBMK…). Beyond, the set will be periodically updated.

For the longer term, this activity will continue taking into account code evolution and new reactor concepts or SAM procedures.

This activity will be shared between the different organizations according to their competence (23 organizations, including IRSN and GRS, will participate to the short-medium term programme).

Most of them will contribute to the evaluation of ASTEC applicability for PWR (CEA, EA, EdF, ENEA, Framatome-ANP, GRS, IRSN, IUSTT-IKE, NRG, PSI, TRACTEBEL). The extension of ASTEC applicability for other concepts will be analysed as follows:

- BWR: GRS, KTH
- VVER 440: BUTE, IVS, UJD, VEIKI, VUJE
- VVER 1000: INRNE, KTH, TUS, UJV, UPI
- CANDU: INR
- RBMK: LEI

Level 2 PSA

Level 2 PSA is a powerful tool to assess plant specific vulnerability regarding NPP severe accidents. It aims at evaluating possible severe accident scenarios in terms of frequency, loss of containment integrity and radioactive release into the environment. It integrates the results of R&D programmes on physical phenomena involved in severe accidents (experimental programmes and development of computer codes), in a risk assessment perspective. In particular, it makes it possible to quantify the contribution of prevention and mitigation measures in terms of risk reduction.

Different approaches are used in Europe, derived from what has been implemented in the US. The objective of this activity is to compare, to improve and to harmonize the methodologies used for developing Level 2 PSA within European countries and to share effort to develop advanced tools, as far as they are required.

On the other hand, the identification of the most critical difficulties encountered in Level 2 PSA in terms of level of knowledge can contribute to a better prioritisation of R&D activities within the SARNET, in continuation with EURSAFE. Another aspect is the adaptation of methodologies for their application to the reactor types used in the Associated Candidate countries.

Activities could be set up into three sub-projects performed in parallel, each of them involving some active partners The programme proposed for the first 18 months period is mainly dedicated to the exchange of information and the identification of technical points, where complementary work of common interest will be performed in a second stage.

Sub-project 1: Comparison of Level 2 PSA approaches and identification of improvement needs

Objective:

The objective is to compare the approaches encountered by the partners in elaborating, quantifying and reviewing existing or ongoing Level 2 PSAs, in order to identify the points related to methods or knowledge which appear to be the most critical and for which improvements are needed.

Programme:

In the first one year period of SARNET, the different elements of existing Level 2 PSAs amongst partners have be reviewed and compared:

- Level 1 / Level 2 interface,
- Tools,
- Accident progression event tree (structure, events considered),
- Release categories (grouping method),
- Assessment of physical events (general method, quantification of each phenomenon),
- Assessment of systems and human actions,
- Assessment of radiological releases,
- Results in link with R and D priorities,
- General method for evaluating uncertainties (considered in more details in sub-project 2).

These different topics have been discussed on the basis of papers prepared by the partners. Technical subjects, related to methods or knowledge, where some improvements are considered as necessary, in a risk assessment perspective have been identified. From the list of improvement needs, a selection have been made for the second SARNET period (18 months from April 2005 to September 2006 included):

- Definition of a best-estimate method to take into account hydrogen combustion (taking into account ignition time and location). Recommendations particularly on the necessary degree of nodalisation, possibly supported by other methods, such as CFD analyses will be proposed,
- Definition of a best estimated method to assess, in an integrated way, the effects of a breach at the reactor pressure vessel,
- Detailed comparison of boundary conditions and assumptions made for MCCI assessment. Detailed review of methods used to assess MCCI (parameters considered, consequences analysed…). Recommendations of a best estimated method on this subject will be proposed,
- Detailed comparison of boundary conditions and assumptions made for iodine releases assessment. Recommendations of a best estimated method on this subject taking into account status of knowledge will be proposed
- Comparison of main probabilistic software (KANT, RISK SPECTRUM, EVNTRE).

<u>Sub-project 2: Comparison and improvement of methodologies for assessment of uncertainties</u>

Objective:

From the different improvement needs, the topic concerning the methodologies for the assessment of uncertainties, have been initially identified and is treated by the sub-project 2.

The objective of this project is to identify which types of uncertainties have been considered in existing Level 2 PSA amongst the partners, to compare the methods used to assess them and, in a second stage, to improve them and to achieve a certain level of harmonization amongst the partners.

Programme:

The development of Level 2 PSA involves different sources of uncertainties:

- Uncertainties propagated from the Level 1 PSA, related to the frequencies of Level 1 sequences;
- Uncertainties (approximation) due to the binning of Level 1 sequences in Plant Damage States (variables not considered in the interface, values of continuous interface variables);
- Uncertainties (lack of completeness) related to the structure of the Accident Progression Event Tree (events not considered, order and chronology of events);
- Uncertainties (lack of knowledge) related to the probabilities of stochastic events (system failure or recovery, human actions, some physical phenomena such as ignition of hydrogen combustion or triggering of steam explosion);
- Uncertainties (lack of completeness) related to the modelling of physical phenomena;
- Uncertainties (lack of knowledge) related to the values of the parameters of the physical models;

- Uncertainties (approximation) related to the cut-off frequency used in the probabilistic quantification of the Accident Progression Event Tree;
- Uncertainties (approximation) related to the binning of Level 2 sequences in Release Categories (variables non considered, values of continuous variables).

In the first year of SARNET, it has been identified which types of uncertainties have been considered in the Level 2 PSA performed so far by the partners and the methods used to assess them. Besides, possible methods that could be used to improve the assessment of uncertainties have been reviewed.

For the second period of SARNET, efforts will be concentrated on a detailed review of some specific phenomena. The following sub tasks will be achieved during this period:

- Finalization of the comparison report on the methods used for uncertainties assessment, and of the report about possible methods application,
- Finalization of the D37 deliverable,
- Detailed review of methods used and which could be used for the assessment of the uncertainties on hydrogen combustion (includes the question of ignition time and location, of nodalization…, reference to possible methods identified during first SARNET period..),
- Detailed review of methods used and which could be used for the assessment of the uncertainties for Melt Coolant Concrete Interaction (including basemat failure time, effect of long term pressurization, ex vessel debris coolability…).
- Detailed review of methods used and which could be used for the assessment of the uncertainties for iodine releases assessment.
- Review of additional tools which should be necessary for uncertainties assessment and/or sensitivity studies (to apply possible methods as inventoried in the first period of SARNET).

Sub-project 3: Improvement of event tree methodology using dynamic reliability techniques

Objective:
From the different improvement needs, the development of dynamic reliability method have been initially identified and is treated by sub-project 3..

The event tree technique has been developed mainly to represent different scenarios of accidents, influenced by functional events. It has been used first in Level 1 PSA and extended to Level 2 PSA. A specific feature of Level 2 PSA event trees is that physical variables have to be assessed along each branch of the event tree, in order to identify the mode of loss of integrity of the containment and the radioactive release into the environment. Therefore a strong coupling exists between stochastic functional aspects and deterministic (but uncertain) physical aspects of the accidents, which are difficult to take into account within the classical event tree methodology.

The general objective of this sub-project is to study how the techniques of dynamic reliability could be used in order to improve the event tree approach in Level 2 PSA.

When specifying a possible approach, one should consider the assessment of uncertainties in particular those related to physical phenomena. Moreover, the complementary techniques making it possible to reduce the number of calculations, as importance sampling in Monte-Carlo approach, should be considered.

Programme:

Dynamic reliability techniques have been developed in order to study the reliability or the availability of continuous processes evolving with time in interaction with functional processes. Examples of such techniques are Petri nets, Discrete Dynamic Event Tree (DDET), Monte-Carlo techniques or combinations of the previous ones.

Before SARNET, some works on (Level 1 or Level 2) PSA have been already performed, in particular by GRS (Germany) and CSN (Spain) in collaboration with the University of Brussels.

During the first SARNET period, the current limitations of the classical event tree approach have been identified and the concepts and the state of the art of the dynamic reliability methods have been drawn up. A description of the SDTPD method (Stimuli Driven Theory of Probabilistic Dynamics) and an example of application of the MCDET (Monte Carlo Dynamic Event Tree) for induced breaks on the reactor coolant system have been also provided.

During the next SARNET period (from April 2005 to September 2006) following tasks will be done:

- finalization of the D38 deliverable,
- the benefit of the MCDET approach, compared to classical approach, will be precised on the basis of the example of the induced breaks of RCS,
- another relevant example(s) for dynamic reliability application will be definitively chosen. Themes of tasks WP5.1 (and 5.2) – i.e. hydrogen combustion, effects of vessel breach and MCCI will be considered as priorities as far as possible,
- software development for dynamic reliability methodology application to a selected example will be initiated. The questions of ASTEC or other integral codes "coupling" will be examined as a part of this task,
- the ASTEC block diagram decomposition for SDTPD application will be continued,
- the application on the example chosen of both the MCDET and the SDTDP methods will be started. To achieve this tasks, it will be asked for PhDs or post PhDs in the framework of the mobility programme,
- the review of the possibility of integration in the MCDET and SDTPD approaches of the methods recommended for uncertainties assessment according to WP5.2 sub tasks will be initiated in the continuity of WP5.2 sub tasks.

Implementation of scientific databases

The objective is to develop and maintain an instrument that insures preservation, easy access for codes, exchange and processing of severe accident experimental data, including all related documentation.

The data of concern are:

- Existing experimental data that SARNET partners are willing to share with the other partners in the network;
- All new data produced within SARNET.

No European database exists to host severe accident data in a unified platform for long term storage, sharing and use. A first step towards the development of such a platform was undertaken in WP5 of the EURSAFE project (5^{th} FWP).

A plat-form mock-up has been developed in EURSAFE starting from the STRESA structure. Basically, a web connection to a portal hosted by one of the partners (database net administrator) gives access to local servers (nodes) hosted by the other partners. In general, each local server contains the data of the partner who hosts it, but a more centralised storage can be envisaged whenever necessary. A STRESA software is installed on each local server, which is managed by the partner himself who decides and controls access to his data through different authorisation levels as a function of the property rights.

This system is a good candidate to become the SARNET experimental database. The action is carried out in 3 phases:

Phase 1: Evaluation and decision (achieved during SARNET first year)

Partners that already were trained to the use of STRESA have assessed the platform. Recommendations to select STRESA have been confirmed.

Phase 2: Deployment (phase initiated during the first year)

The software will be distributed and implanted on sites of new users. Training sessions will be organised.

Phase 3: Data storing and plat-form maintenance (phase initiated during the first year)

In the continuation of EURSAFE experimental database work package, some data storage is already foreseen by some partners:

- Data from PLINIUS platform: VULCANO, COLIMA;
- Data from Phébus FP and VERCORS;
- Data from KJET, PREMIX, ECO, QUEOS, DISCO;
- Data from FOREVER, KMFCI, POMECO;
- Data from CODEX-VVER: core degradation bundle tests;
- Data from VICTORIA and HORIZON.

Beyond this, data produced in SARNET will be integrated to the platform as they become available.

In parallel the developer of the plat-form will support the users and up-date the software in the frame of so-called maintenance activity.

This platform has been linked to the SARNET Advanced Communication Tool.

Research priority assessment

The objective of this action is to provide the Governing Board of SARNET with guidelines for defining the orientations to give to the JPA in terms of joint research activities of common interest and high priority. This action will make use notably of:

- The outcome of the EURSAFE action (results of PIRT on severe accidents);
- The results of the qualification/benchmarking activities on ASTEC;
- The results of reactor calculations carried out in the other activities;
- The outcome of the research performed in the three thematic sub domains of SARNET (corium, containment, source term);

It will make use also of results obtained in the frame of other international projects (ISTC, OECD…), and will be based in particular on the outcome of Level 2 PSA activities carried out in the frame of national programmes (risk-oriented research). It will take into account the potential capabilities of SARNET and identify the potential experimental or theoretical programmes to undertake for resolving the identified important pending issues.

This action will be performed in close collaboration within 12 participants (those mainly involved in EURSAFE), representing TSO, industry and utilities, including organisations of Associated Candidate Countries. This collaboration between those who perform research and those who use its results is essential to correctly address the problem.

The action will result in a ranking and will allow in fact determining which programme should be initiated or pursued and which should be closed or not started. Following proposals made in the frame of OECD-CSNI working groups, the criteria for ranking will reflect considerations such as:

- the priority of the safety research issue it entails,
- the capacity to address a safety issue in a comprehensive manner,
- the potential for substantial improvements in accident mitigation and management procedures,
- the level of risk involved (when risk assessment is feasible and/or appropriate),
- the extend to which it affect plant operation, if it is an operating plant issue,
- the number of plants affected,
- the programme cost duration,
- the likelihood it will bring conclusive results,
- the relevance it has for maintaining strategic competence and infrastructure.

There are conditions under which closing an issue becomes a necessity; nevertheless, defining generic closure criteria is very difficult. The following principle might be used, and a research issue could be proposed for closure:

- when there is convincing information available that the issue addressed does not constitute a challenge to safety plant,
- or when there is a general understanding that knowledge is adequate and further research is not needed;

- or when it is unlikely that further research will provide end users with results that will augment significantly the knowledge that is already available (for instance because the return of knowledge from a programme has substantially diminished with the time);
- or when there have been important changes in situation (e.g. in industry plans or in regulator priorities), which reduce affect overall priorities.

Since closing an issue and the related programmes may lead to teams of experts to be disbanded or facilities closing, it will be important to weight carefully the consequences, and examine which re-orientation might be propose in order to avoid irreversible loss of strategic competence and infrastructures.

This action will lead every two years to a revision of priorities. The results of this action will be distributed to all participants for comment before their release. They will be transmitted to the scientific coordinators coordinating corium, containment and source term activities, for taking into account in the elaboration of their work proposals.

Integration monitoring

This action consists in the evaluation of progress made by the consortium towards its objectives, and in the definition of corrective actions where necessary.
The members of the management team carry out the action. It consists in:

- collect of information necessary to measure the evolution of progress indicators as defined in the chapter 4 (quality of integration, indicators)
- analysis of results (explanation of indicator evolution, definition of the progress margins)
- proposal of actions (revision of the JPA, proposal of contractor actions beyond the JPA, …).

A yearly report on these indicators is released.

3.2.2. Programme for Jointly executed Research Activities (JPA/JRA)

The EURSAFE project highlighted a number of remaining important safety issues, which need to be investigated experimentally. The critical mass of competence (experimental facilities, experts) necessary to address these issues was identified. This competence has been assembled in the SARNET network with part of their current activities, as far as these activities have a link with the issues to be investigated. This assembly constitutes a promising matter of tight cooperation between participants of SARNET.

The Joint Research Activities programme, which is presented hereafter, is an added element aiming at promoting in sustainable way collaboration within the above assembly, between the main European actors in nuclear safety. The basic elements for such a promotion are:

- reaching a common understanding of issues and phenomena, of their importance in terms of safety and knowledge,
- determining a consensual approach to resolve the remaining uncertainties.

Thus, the JRAs consist of:

- The joint elaboration of syntheses on the interpretation of experimental results and joint elaboration of recommendations for model implementation in ASTEC;
- The joint elaboration of programme proposals; these proposals will address underway programmes (recommendations, re-orientation, …) but also new ones; these proposals will take into account as an input conclusions released by the so-called “research priority assessment”;
- The joint elaboration of work plans aiming at making the best of available competences and means, and their monitoring.

The JRA is clearly linked to the associated activities described in §3.2.1. Indeed, their results, aiming at solving Corium, Containment and Source Term issues, are the basic inputs of the JPA.

The experts of the network jointly analyse and discuss on experimental programmes performed within national programmes activities. They jointly formulate recommendations on test matrix, on test procedures or on instrumentation (practically partners involved in these experimental programmes will provide these experts with

information on facility description, facility capabilities and limitations…). After a first period of work and according to the remaining issues, if new data are required, the experts will have to formulate recommendations on test definition.

Experts have also joint interpretation activities, which consist of analysing the different interpretation works performed within the associated programmes. From the discussions and analysis and comparison work, only possible in such a network frame, a better understanding of physical phenomena is expected. This activity constitutes a feedback for the orientations of the experimental programmes, and is a really integrating activity for sharing in the European Community the knowledge obtained through interpretation of experimental results.

A similar activity has been undertaken for joint modelling, that is to say that experts in the frame of JPAs will analyse, discuss and compare their approach. Such activity has the objective to converge on recommendation on the development of a model. The final outcome is to make recommendation for models implementation in ASTEC.

All the associated experimental programmes are part of the so-called Pre-Existing Know-How (PEKH). The corresponding access rights will be granted following principles defined in the Consortium Agreement:

- the access rights to pre-existing know-how (when not declared as non available) will be granted on a royalty-free basis for carrying work under the JPA;
- the access rights to "protected" data will have to be negotiated.

Thus, when elaborating the JPA, the access rights limitations are identified in order to make possible in a deadline consistent with the timetable the completion of the negotiation.

The results of interpretation of non-European experimental programmes, performed in the frame of for instance OECD or ISTC projects, will be used as inputs of the JRA.

In the particular case of ISTCs (those lying in the domain of interest of SARNET and monitored by CEG-SAM), specific actions will be defined and carried out inside the JPA, and aiming at:

- orientate the corresponding research programmes,
- monitor the progress,
- and carry on the interpretation of experimental results.

These actions will lead to, at least from a technical point of view, to a partial integration of ISTCs in SARNET.

On practical way, the experimental results used in the frame of the project are collected and documented in the SARNET experimental database to be shared easily (with all the guarantee concerning the access rights). Thus, as far as possible the data implementation in the experimental data based is planned consistently with needs of the JRA.

Expert meetings are periodically organised. We can distinguish 2 kinds of meeting:

- The yearly review meeting (one per domain) to present synthesis of the work performed and to discuss for the concerned domain the orientations of the next JPA period;
- Specialized meetings (with no precise frequency), involving a small number of experts and devoted to technical point which could cover a work package or a part of it.

Resolution of corium issues

Eighteen organizations deal with this domain; three work packages have been defined:

- WP9 Early phase core degradation (EARLY)
- WP10 Late-phase Core Degradation and Vessel behaviour (LATVES)
- WP11 Ex-vessel Core Recovery (EXCORE) dealing with MCCI and Debris Coolability.

WP9 addresses the risk of early containment failure, due to rapid generation of hydrogen, which may not be accommodated by re-combiners. It deals with hydrogen generation during core reflooding conditions (esp. oxidation of metal-rich mixtures), B_4C and fuel burn-up impact on core degradation, and more generally the remaining questions in the core degradation early-phase (in particular, oxidation of clad with advanced alloys and hydrogen generation during melt relocation into water present in the vessel lower plenum). It considers various atmospheres including air and air/steam mixture as they have a strong impact on fuel behaviour and fission product release. Experts continue to review experiments such as QUENCH, SETs and MAESTRO plat-form experiments, and jointly propose recommendations on tests design and tests matrix. Interpretations based on main codes calculations (ICARE/CATHARE, ATHLET-CD....), performed by SARNET partners, will be analysed and compared, with the objective to produce a synthesis on joint interpretation of experiments. Proposals of models from partners will also be studied and debated, leading to a synthesis on modelling and to proposals for ASTEC.

WP10 is devoted to late-phase degradation and corium behaviour in lower head, with the objective to improve predictability of the thermal loadings on RPV lower head. After review of main experiments (SIMECO, LIVE, MASCA....) joint recommendations on these experiments (test specifications,..) will be drawn according to remaining issues on corium pool configurations. As for WP9, experts will also have to study the different interpretations produced by partners on these experimental results, and associated modelling proposals. Syntheses are planned to be issued and proposals for ASTEC models improvements will be done..

Activities of WP11 should improve the predictability of axial versus radial ablation up to late phase MCCI for homogeneous and stratified corium pool, in order to determine basemat failure time and loss of containment integrity. Ex-vessel case with water injection will be also part of the activities of this WP: an increase knowledge of cooling mechanisms is expected, in view of being able to demonstrate termination of accident progression. In particular, ex-vessel particulate debris coolability will be investigated. Main experiments on debris coolability (DEBRIS, STYX.…) and on MCCI (MCCI-OCDE, VULCANO...) will be analyse and recommendations will be expressed for new test design. Experts will analyse the interpretation works, and jointly produce a synthesis. A common proposal of models of corium concrete or ceramic interaction and corium debris or melt coolability will be formulated for implementation into ASTEC.

In order to keep a consistent approach in the modelling of corium behaviour for all the different phases of severe accident scenario, the feed back from scenario sensitivity studies in reactor conditions will define the priority and level of details required to developed new models for remaining issues.

Among the different contributions, the experts on thermodynamic or thermo-physical properties are not merged into a specific work-package. They have to play a role in every WP and in every task. Through their participation in these joint activities, they will access to a large experimental database and contribute actively to definition, interpretation or modelling tasks. A part of WP outcomes will contribute to the assessment and development of databases (NUCLEA[1] for Thermodynamic properties and CORPRO for Thermo-physic properties), which contribute to the development of the Material Data Bank of the ASTEC code. Moreover, if some data significant for a given phenomenon are missing specific orientation of existing experimental programs or specific programs may be defined in the frame of the related WP.

In the frame of this project, two trans-national access platforms may be included: the PLINIUS and LACOMERA platforms. Today they are outside SARNET network. In the future we can imagine a joint steering of experiments performed on such a platform taking into account also the needs expressed for SARNET training activities. This will need to define in the frame of the elaboration of a “post contract Consortium Agreement” the mechanisms, which could make possible a common funding.

Some non-European R&D programmes, performed in the frame of OECD and ISTC projects, will provide inputs for the SARNET work on corium issues: MASCA (corium molten pool behaviour), ISTC-1648 and

[1]NUCLEA thermodynamic properties data base is a commercial pre existing know how excluded from SARNET project. It is necessary to buy the data base to use it.

PARAMETER (core quenching), ISTC-METCOR and ISTC-CORPHAD on corium interactions and properties, and OECD-MCCI on molten corium-concrete interactions.

Resolution of containment issues

The research efforts will concentrate on 2 WPs, involving in overall 18 organizations:

- WP12: Investigation of Hydrogen Behaviour in Containment (HBC),
- WP13: Investigation of Fast Interactions in Containment (FIC).

Within WP12, partners are studying the containment atmosphere mixing phenomena, and hydrogen combustion and associated risk mitigation. Experimental activities carried out in national programmes are discussed by experts, and recommendations for the tests specifications of TOSQAN, MISTRA, ThAI or other facilities are formulated. Interpretations based on CFD codes (TONUS, GASFLOW, commercial codes) and Lumped Parameter codes such as COCOSYS, ASTEC or TONUS-0D and other codes, performed by partners, are discussed, in order to propose improvements in modelling capabilities. Analytical or code-to-code benchmarks can also be proposed. From this work, experts will produce syntheses, showing the progress on common understanding of these issues.

WP13 is dedicated to activities concerning the Fuel Coolant Interactions (FCI) and Direct Containment Heating (DCH) phenomena. Numerous experiments such as FARO and ECO for FCI issue, and DISCO for instance for DCH, will be reviewed by experts with the objective to make common proposals to better address these issues. Interpretation of these experiments, with existing models and CFD-codes such as MC3D or MATTINA, respectively AFDM, and performed by partners, will be analysed by experts with the objective to reach a consensus on these interpretations. Experts will give a joint synthesis outlining this consensus. A same process concerning modelling activities will be applied, leading to a joint synthesis as well. Correlations for the use in Lumped Parameter codes will be established. A large portion of the FCI work is done within the OECD-SERENA programme.

Resolution of Source Term issues

Twenty-two organisations cooperate in performing research in the Source Term domain. Research activities in this area are organized into 3 WPs:

- WP14: Investigation of FP Release and Transport phenomena (FPRT);
- WP15: Aerosol Behaviour impact on Source Term (AEROB);
- WP16: Containment Chemistry Impact on Source Term (CONTCHEM).

WP14 activities will improve the knowledge related to FP release and transport. Within the first years, activities will both address the impact of air ingress in a reactor core on source term and the iodine speciation along its transport in the primary circuit. Experiments such as VERDON, RUSET for air ingress effects, and CHIP for iodine speciation will be reviewed by experts and common proposals and comments will be addressed to either re-orient some tests or to propose new ones. Interpretation work carried out by partners on these experimental results will be analysed, with the objective of delivering a joint synthesis. Experts will apply the same approach for the modelling proposals. Concerning the air ingress issue, reactor transients simulated by partners with different integral codes such ASTEC, SATURNE/MAAP and SCDAP/RELAP5 will be also compared and analysed to determine the impact of remaining uncertainties.

WP15 should reduce uncertainties on the quantification of source term for aerosol retention in the secondary side of Steam Generators and leakages through cracks in containment walls. Experiments such as ARTIST, PSAERO, PECA/SGTR and RADSOL will be analysed by experts, as well as related interpretation work and modelling proposals. A joint synthesis on interpretation and modelling should be issued from the experts' work.

Iodine source term is the main issue considered in WP16. Specific experiments such as EPICUR and CAIMAN will be studied; and common recommendations on test specifications or programme re-orientation will be given by experts. Experts will also concentrate on analysis of the interpretation work and associated modelling proposals on iodine behaviour under severe accident conditions in the reactor containment. An iodine data manual, collecting numerous experimental data, will be prepared. A synthesis will be produced taking account of interpretation of experimental results, and suitable modelling, representative of a common understanding of the phenomena. In addition, experiments like Phebus-FPT2 will be simulated so that it will be feasible to assess model predictability.

3.2.3. Activities designed to spread excellence

Education and Training are undeniable avenues to spread Excellence. A dedicated WP (ET) has been created in the SARNET NoE, whose objectives are to:

- Enhance and maintain competence in Severe Accident Research (SAR), contributing to Severe Accident Management (SAM) through education and training of students and young researchers in Europe;
- Impart additional skills to the researchers and analysts in the severe accident risk assessment;
- Foster integration of national programmes through sharing of researchers and work programmes.

The approach followed to achieve the above objectives during the relatively early part of the SARNET NoE will be to:

- Develop educational forums e.g. yearly courses, text (source) books, etc.;
- Develop training forums e.g. laboratory and reactor plant facilities, plant analyser, etc.;
- Promote personnel mobility between the various European institutions;
- Develop user groups for important computer codes e.g. ASTEC;
- Integrate with other education and training work programmes in other networks;
- Develop links with the NEPTUNO Project in 6th FWP.

The three elements of the Education and Training JPA are:

- Education;
- Training;
- Mobility.

The education element involves Ph. D. students and researchers.

The various activities in the education element will be to:

- Provide a comprehensive course on Severe Accident Phenomenology;
- Develop a text book or source book on Severe Accident Phenomenology;
- Develop and provide a course on Level – 2 PSA, with description of codes (mainly ASTEC), for consequence analysis;
- Encourage the NEPTUNO Project to set up a course on Nuclear Power Safety, including an introduction to the Severe Accidents and to Level – 2 PSA.

The training element involves both students and researchers but primarily the latter. The main activities will be to provide training in:

- Experimental methods and techniques e.g. on the PLINIUS and LACOMERA platforms;
- The operation, checking and debugging of computer codes;
- The workings of a plant analyser having severe accident algorithms.

The mobility element involves both Ph.D. students and researchers. This element is of great importance towards the integration of the European National Programmes in Severe Accidents and in the Probabilistic Safety (Risk) Analysis. In this context, coordination of the mobility programme of SARNET with that developed in the NEPTUNO Project would be very desirable. Clearly, the mobility programme of SARNET will require adequate funding for exploiting the long-term integration possibilities offered by the personnel mobility. The joint activities pursued in this programme element will be to:

- Provide summer internships for students;
- Develop a programme of deputing researchers at the facilities of different partners for periods up to one year;
- Develop teams of researchers drawn from different partner countries that have special talents for different generic research activities followed in the SARNET JPA. Thus, one team of researchers may work on small or medium scale simulant material experiments; another on large-scale simulant experiments; another on prototypic material experiments and another on code development. The teams are formed by assignments of national researchers to the teams, which may last 2 – 3 years, in order to achieve some significant results. In this approach some national laboratories or institutes may specialize in different research areas, depending upon the facilities or the infrastructure that they may

have developed over the years. We believe that with this approach the integration of the European National Programmes will be achieved very readily and effectively;

– Develop a training programme for plant operators and interested researchers in the severe accident management procedures. The main idea here is to identify the underlying basis for these procedures for the plant operators so that greater understanding is gained.

The partners who have agreed to work together in making a success of the integration process that will be brought about in the Education and Training sub domain of the SARNET JPA are universities, technical service organizations (TSOs) national laboratories and industrial organizations. They bring enormous talent and experience to the joint programme. They also have the young as well as the more experienced personnel to make education and training a jointly beneficial activity. There are professors from universities who are internationally recognized and who love to teach and there are researchers from national laboratories whose research achievements are well documented. There are participants from the recently jointed and candidate Eastern European Countries who will not only bring the knowledge base needed to deal with the Soviet-designed reactors, but also bring the rigor of education that is practiced in Eastern Europe. The recently jointed and candidate Eastern European Countries also have relatively larger number of young persons enrolled in nuclear engineering profession as students and researchers. They would increase the pool of the future competent persons that are needed for the welfare of the nuclear industry in Greater Europe, which was born in 2004. We believe that we have assembled a great team of participants for the Education and Training JPA.

3.2.4. Management activities

These activities mainly consist in:

- General coordination of the JPA;
- Financial coordination;
- Reporting;
- Diffusing information.

The technical coordination (knowledge generation, knowledge preservation and identification of needs in knowledge) more precisely consist in:

- Monitoring progresses;
- Checking release of deliverables in due time;
- Surveying milestones;
- Organizing technical reviews when necessary;
- Anticipating difficulties in carrying out the JPA and taking appropriate actions to overcome them;
- Making a synthesis of all recommendations coming from current projects for updating yearly the JPA;
- Managing the information system and making sure that access rights are fully respected;
- Implementing the decisions of the Governing Board.

The financial coordination consists in:

- Elaborating estimated budget for coming year;
- Monitoring expenses, in particular those partly or totally covered by the Community funds;
- Allocating Community funds in accordance with the Contract conditions, the Consortium agreement provisions and the decisions of the Governing Board;
- Establishing yearly cost statements for all the expenses of the JPA and funds allocated.

The Management Team yearly reports to the Commission and the Governing Board on the technical progress made in the JPA and on the financial status. It organizes the meetings (preparation, minutes) of the Governing Board, of the Advisory Committee and of the Ad-hoc Scientific Review Committee. A large part of the management activities is also devoted to the dissemination of information and Knowledge inside and outside of the Network:

- Information on the progress made in the JPA;
- Information on main outcomes of the JPA;

- Information exchange between participants on their activities and specificities;
- Promotion of joint publications in open literature;
- Organization of annual conferences and topical seminars.

Beyond these tasks a large effort will be initiated two years after the beginning of SARNET to revise the Consortium Agreement in order to define the conditions, which will make possible the prolongation of the network after completion of the contract with the Commission.

3.3. Plan for using and disseminating knowledge

As the main obstacle to integration of most of the experimental programmes is the need to raise funding at national and extra-national levels, a clear policy in terms of knowledge management, notably regarding access rights to experimental data produced within the network, is proposed to preserve the interests of the different organizations. For instance, data reports on "protected" experimental programmes are only be distributed to those members who need them to perform their part of the Joint Programme of Activities. Generally speaking, these members are already partners as co-funders in these programmes. In addition, it is planned to issue progress reports on these "protected" programmes, so as to provide any member with the opportunity to negotiate with the owners of these programmes the access to the data to participate to the joint research activities around them, or to use the knowledge in application out of SARNET; more, the Consortium members committed to grant the access rights for use outside of SARNET on fair and non-discriminatory conditions. In any case, the outcomes of these programmes are models to be implemented in ASTEC or in qualified databases thereby contributing to diffuse the knowledge to the members.

The dissemination will result from the activities of excellence spreading and efforts made by the organization producing basic knowledge to open data to other organisation especially organisations coming from the recently jointed and candidate Eastern European Countries.

The dissemination of knowledge results also from 2 other activities:

- the distribution of ASTEC by GRS and IRSN to end users under conditions defined in a specific software agreement;
- the publications and participations to conference.

Knowledge management is a key activity of the Management Team. It has the mission to:

- Coordinate the knowledge generation through joint projects of research activities,
- Monitor the knowledge integration in ASTEC,
- Make sure that the access rights and use rights as stipulated in the Consortium agreement are correctly implemented,
- Disseminate appropriate information on the knowledge by using electronic communication links and by organizing conferences/workshops,
- Preserve the knowledge in scientific databases with long-term maintenance capacities,
- Identify the missing knowledge (continuation of EURSAFE action).

Furthermore, at the strategic level, generated knowledge and proposed actions to acquire missing knowledge will be assessed by the Ad-hoc Scientific Review Committee, whereas the Governing Board will decide with the advice of end-user representatives upon the orientations to be taken regarding missing knowledge.

3.4. Milestones

3.4.1. Major Milestones over full project duration

The Major Milestones of the project concern:

- the deployment of linking elements such as ASTEC and the ACT;
- the elaboration of a common research programme addressing important (for nuclear safety) pending issues commonly identified and validated by end users;

- the elaboration of a complete documentation for teaching and training in the domain of sever accidents;
- the revision of the Consortium Agreement in order to make possible the continuation of SARNET after the end of the contract with the Commission.

T_0 + 1 year

MM1: Full deployment of ASTEC. The code has been successfully implemented in all the organizations needing the code to carry on their tasks. Users have been trained (at least one trained user per organization). The corresponding efforts will be provided by the so-called integrating activities (WP2).

MM2: The platform to be used to store experimental data has been defined. The data base feeding has been initiated. The corresponding efforts will be provided by the so-called integrating activities (WP6).

Both milestones have been reached in due time.

T_0 + 2 years

MM3: Full deployment of an ACT. The ACT is working and may be used by the contractors to access to SARNET documentation. The so-called Integrating Activities (WP1) will provide the corresponding efforts.

MM4: Revision 1 of EURSAFE. The research priorities of SARNET have been revised; the associated document describes the topics for which research and development are still required. The so-called Integrating Activities (WP7) will provide the corresponding efforts.

MM5: First edition of an integrated R&D SA programme. This document describes the strategy proposed by SARNET to tackle the pending issues important for reactor safety. A programme is proposed describing the research elements, but also the work distribution making the best of available competence and means. The definition of this common programme will constitute an important step toward the integration of the different national R&D strategies in the domain of severe accidents. The so-called Joint Research Activities (WP9-15) will provide the corresponding efforts.

T_0 + 3 years

MM6: Delivery of a fully assessed version of ASTEC, including developments requested by SARNET users for VVER type reactors. The so-called Integrating Activities (WP2-4) will provide the corresponding efforts.

MM7: Release of a SA book. The so-called Spreading of Excellence (WP18) will provide the corresponding efforts.

MM8: Completion of SA course. The so-called Spreading of Excellence (WP17) will provide the corresponding efforts.

MM9: First draft of the "post contract Consortium Agreement". This point is particularly important since the so-called "post contract Consortium Agreement" will define the conditions in terms of organization and of funding making possible the continuation of SARNET beyond the Commission contract. An ad-hoc working group steered by the Governing Board will carry out this activity.

T_0 + 4 years

MM10: Revision 2 of EURSAFE conclusions

MM11: Update of the integrated R&D SA programme

MM12: Signature of the new CA

4. Quality of integration and performance indicators

By its multidisciplinary structure, SARNET JPA is providing a frame for developing growing associations of complementary expertise towards covering adequately the whole range of the Physics involved in the severe accident area. Thus it is expected that, rather than trying to cover the whole range of phenomena, most organisations will progressively rely on the most competent ones for developing tools or performing tests. Thus, SARNET should lead at mid-term to a global saving at the European level in this area of research.

It is believed that ASTEC, with the strong support of the IRSN-GRS developer team, has all the qualities required to become one of the best codes in the world in reactor severe accident analysis. This is an excellent vector for integrating the research efforts of all participants, diffusing the accumulated knowledge and sharing the experience of each user.

The participants have signed a Memorandum of Understanding, making a commitment towards a deep and durable integration, beyond the period of the Community Contract. This Memorandum of Understanding is appended to this proposal.

To assess the success of the integration, it is proposed to measure the evolution of several indicators.

For monitoring the success of the electronic communication system:

- The number of SARNET member accesses to the SARNET Web site per month (I1);
- The number of collaborative documents elaborated and/or stored using ACT per year (I2);

For monitoring the success in using ASTEC and PSA methodology:

- The number of ASTEC users in SARNET (I3);
- The number of organisations using ASTEC for its own applications (reactor studies or test analyses) (I4);
- The number of industrial applications per year using ASTEC (I5);
- The number of Level 2 PSAs using methodology/recommendations developed by SARNET (I6).

For monitoring the success of developing collaboration in research activities:

- The number of access rights granted by contractors for applications in the frame of SARNET, or new partnerships with ISTC, VVER research programmes and advanced reactor research programmes related to Severe Accidents (I7);
- The fraction (in part of budgets) of research projects carried out in Europe that have been set-up under the aegis of SARNET per year (I8);
- The maximum number of associated organisations in a joint project (I9);
- The number of issues closed (I10);

For monitoring the scientific quality in collaborative research:

- The number of joint publications per year (I11);

For monitoring the success of the Education and Training activities and of the mobility plan:

- The number of attendees to SARNET courses or training sessions (I12);
- The number of researcher detachments (I13).

For monitoring the success of the dissemination of public knowledge:

- The number of presentation of SARNET activities in conferences (I14);
- The number of hours devoted to updating the SARNET web site for diffusing information outside SARNET (I15);
- The number of accesses to the Website from outside the Network (I16).

5. Detailed Joint Programme of Activities N°2 (JPA2) – month 13 to month 30

5.1. Introduction – general description, milestones and measurable objectives

The JPA2 for the month 13 to month 30 period keeps the same structure as the previous one. It is divided in 20 work packages, including 8 on integrating activities, 8 on jointly executed research activities, 3 on spreading excellence and 1 on management.

They are all follow up of actions initiated during the first 12 month period, and will be conducted in parallel. The main measurable objectives of the JPA2 have been connected to milestones. They are:

- the organisation of 2 important events:
    - ERMSAR 2005, European Review Meeting on Severe Accident Research and management, this event will be organised in November 2005 (month 20);
    - First course on severe accident and PSA level 2, this course should be delivered during the first trimester on 2006 (before month 24);
- the release of 2 major documents related to ASTEC:
    - Conclusion on ASTEC V1.1 assessment and evaluation for reactor applications at month 15
    - ASTEC development plan for further versions at month 21.
- the definition of the JPA N°3 (month 25-month 42), with further efforts towards integration of research programmes;
- the revision of research priorities identified in the EURSAFE project, at month 24; this revision will take into account:
    - the accomplishment reached by researchers;
    - the identification of remaining uncertainties highlighted by calculations performed in the frame of safety studies;

  This revision will propose R&D programme orientation to tackle revised remaining important issues.
- first edition of an integrated R&D SA programme at month 30. This document describes the strategy proposed by SARNET to tackle the pending issues important for reactor safety. A programme is proposed describing the research elements, but also the work distribution making the best of available competence and means. The definition of this common programme will constitute an important step toward the integration of the different national R&D strategies in the domain of severe accidents. The so-called Joint Research Activities (WP9-15) will provide the corresponding efforts.
- the first plan for mobility at month 13, and its update 12 months later;
- and the beginning of writing SA courses and book.

5.2. Work package list/overview

WARNING: The lead contractors identified in the following tables may change during the execution of the JPA.

SARNET Work package list (30 months)
The deliverables numbers are in bold when to be produced during the JPA2 period (month 13-30)

In bold N° of deliverables to be produced during the 2nd JPA

Work-package No	Work package title	Lead contractor No	Start month	End month	Deliverable No
	Integrating activities				
WP1	Development of an Advanced Communication Tool (ACT)	23	1	>48	1, 3, **43**
WP2	ASTEC Users Support and Training, Integration and Adaptation (USTIA)	1	1	>48	6,7, **34, 35, 46**
WP3	ASTEC PHYsical Model Assessment (PHYMA)	1	1	>48	6, 8, **30,46, 47**
WP4	ASTEC Reactor Application and Benchmarking (RAB)	1-23	1	>48	6, 9, **31, 46**
WP5	Level 2 PSA methodology and advanced tools (PSA2)	1	1	>48	**36, 37, 38,70,71,72, 73**
WP6	Implementation of Experimental Database (IED)	28	1	>48	2, **39**
WP7	Definition of Severe Accident Research Priorities (SARP)	23	6	42	**40,67**
WP8	Integration Assessment (IA)	1	9	48	10, **49**
	Joint research activities				
WP9	EARLY phase core degradation (EARLY)	7	1	36	11,12,13,14, 15,**49,50,51, 52,53,54**
WP10	Late-phase Core Degradation and Vessel behaviour (LATVES)	7	1	36	11,12,13,14, 15,**49,50,51, 52,53,54**
WP11	EX-Vessel Corium REcovery (EXCORE)	7	1	36	11,12,13,14, 15,**49,50,51, 52,53,54**
WP12	Hydrogen Behaviour in Containment (HBC)	21	1	36	16,17,18,19, 20,**49,55,56, 57,58,59**
WP13	Fast Interactions in Containment (FIC)	21	1	36	16,17,18,19, 20,**49,55,56, 57,58,59**
WP14	Fission Product Release and Transport (FPRT)	36	1	36	21,22,23,24, 25,**49,60,61, 62,63,64**

WP15	AEROsol Behaviour impact on source term (AEROB)	36	1	36	21,22,23,24, 25,**49,60,61, 62,63,64**
WP16	CONTainment CHEMistry Impact on source term (CONTCHEM)	36	1	36	21,22,23,24, 25,**49,60,61, 62,63,64**

SARNET Work package list (18 months - continued)

Work-package No	Work package title	Lead contractor No	Start month	End month	Deliverable No
	Spreading of excellence activities				
WP17	Education and Training (ET)	32	1	>48	**32,** 33**, 41**
WP18	BOOK on severe accident phenomenology (BOOK)	32	1	>48	**42,67**
WP19	MOBility programme (MOB)	32	1	>48	**4, 5,68**
	Management activities				
WP20	MANAGement (MANAG)	1	1	>48	26,27,28,29, **44,65,66,67**
20	TOTAL				28 + **41**

WP1 is essential for making easier the communication between the Coordinator and all the participants and reducing the number of meetings. But its effect will only come into force within the next JPA. The main development effort has been produce during the first year, beyond this year a lower but constant effort will be produced to improve the tool and support users.

ASTEC WP2 to WP4 are continuous actions. WP2 is a key one for a strong use of the code and for extending its capacity to most of water-cooled NPPs in Europe. In addition, WP2 is a key node in the integration process of the knowledge generated by the research activities in WP 9 to WP16.

WP3 to WP5 are providing information on which topics the research must focus. WP 7 will use this as an input together with the states of the art and the recommendations issued by research activities, WP9 to WP15, to make appropriate recommendations to the Governing Board on the orientations to be given to the research in SARNET.

WP6 will make easier the access to the data for model qualification (WP3) and also contribute to knowledge preservation and diffusion.

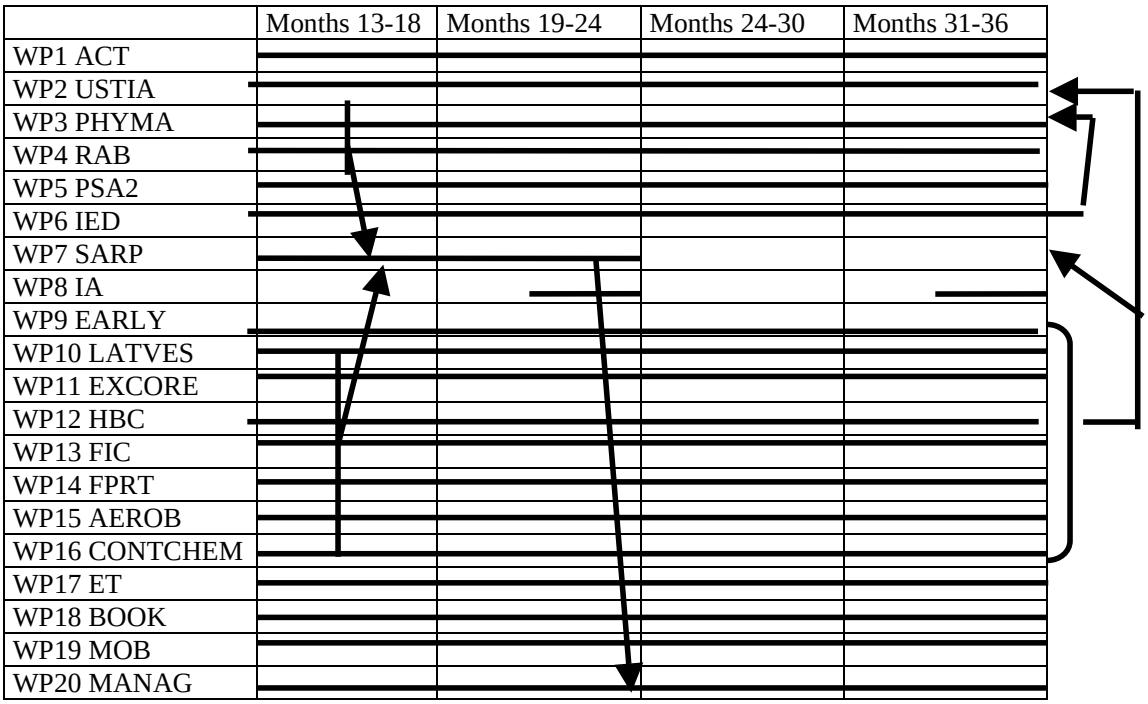
WP9 to WP16 are focused on the issues identified by EURSAFE as being remaining outstanding safety issues. They will contribute to resolve them while promoting the development of collaborations between participants.

WP17 to WP19 have the mission to contribute to the spreading of excellence. They will have links with WP2 on ASTEC, WP5 on PSAs and more generally all research activity WPs.

WP20 will have a strong interface with all the WPs.

5.3. Graphical presentation of work packages

The main links between the WPs are illustrated below:



5.4.Detailed description, planning and time table

The following tables present the different work packages. A summary of the deliverables is given at the end of the section. The person-months per participant are indicated when they correspond to a significant involvement of the contractor (larger than 0.5 m-m).

Development of an Advanced Communication Tool (ACT)

Work package number	1		**Start date or starting event:**								13			
Activity Type	Integrating activities													
Participant id	23	1												
Person-months per participant	*5*													

Objectives

Maintenance of the ACT, user support, evaluation of user's feedback and structuring of the information content of the ACT. Maintenance and extension of the Web Site

Description of work

Note that task 1.1 to 1.4 have been achieved during SARNET first year.

ACT and the SARNET public web site have been developed during the first year of SARNET project. The follow-up described below concerns only the maintenance of ACT and the update of information available on the public WEB-Site.
The work will be split in five tasks:

Task 1.5: Maintenance of the ACT

- Maintenance of the Server (Software upgrades)
- Maintenance of the ACT (user administration, administration of user rights, backup and restore facilities)

Task 1.6: Support of Users

- Extension of online help facility
- Support in handling document management and collaboration features of the ACT
- Help in setting up new shared sites and workspaces

Task 1.7: Evaluation of user feedback and extension of functionality (if required)

- Evaluation of a survey conducted to assess the user satisfaction
- Evaluation of proposals for improvement of existing functionality
- Development of new functionality (if required)

Task 1.8: Structuring and mapping the information content of the ACT

- Classification of information according to relevance
- Construction of an information and knowledge map for facilitating dissemination and exploitation of project results

Task 1.9: Extending the public Web Site

Addition of information and of important, publicly accessible documents as the project evolves

Deliverables

Report on the analysis of ACT users requests at month 21: D43

Milestones and expected result

Continuous updating and improvement of ACT and of public Web site.

Improvements in the ACT according to user feedback (month 24)

ASTEC Users Support and Training, Integration and Adaptation (USTIA)

Work package number	2			**Start date or starting event:**						13			
Activity Type	Integrating activities												
Participant id	1	4	6	7	10	13	14	15	16	18	21	23	24
Person-months per participant	*13.5*	*1*	*1*	*12*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*11.25*	*1*
Participant id	25	26	27	30	31	32	33	35	36	37	42	43	46
Person-months per participant	*9*	*6*	*1*	*1*	*1*	*12*	*7.5*	*1*	*1*	*1*	*1*	*6*	*1*
Participant id	47	49	51										
Person-months per participant	*1*	*1*	*1*										

Objectives

Distribute the code versions and their documentation to code users.
Provide a support for code users.
Organize information exchange between ASTEC users.
Capitalize the knowledge by integration of models proposed in the 3 SARNET thematic topics (Corium, containment and source term).
Improve and adapt the code to meet the users requirements, particularly the extension to most types of reactors.

Description of work

Task 2.1: Code release and support to code users.
The IRSN-GRS team will:

- analyse the requests of ASTEC users and propose solutions (error corrections, minor development)
- update the code and make these updates available
- deliver code versions and documentation: ASTEC V1.2 release in June 05 to all SARNET partners. The next version ASTEC V1.3 should be released in second half of 2006.

Task 2.2. Users Club
All the organizations participating to the Integral Code JPA will participate to the ASTEC Users Club. Periodically Users Club meetings will be organized in order to: exchange information on the code use; examine the code status regarding its development and assessment; examine users requests and discuss their priority; prepare recommendations to be addressed to the Governing Board. During the second 18-months period of SARNET, one Users Club meeting is planned in Spring 2006 (it will also serve as 2nd ASTEC progress meeting).
The ASTEC Web site will be developed and maintained to make easier exchange of information and documents between maintenance team and users (link with ACT in WP1).

Task 2.3. Training and learning
All the organisations involved in the Integral Code JPA will participate to this activity (host, teach or learn). Training sessions will be periodically organized. The e-learning site (on ASTEC Web site) will be opened and maintained. A specific training course could be organized by GRS in 2nd half of 2005 on ATLAS graphical tool for processing ASTEC results.
During the second 18-months period, one training session on code use is planned (if judged necessary by partners) for beginners in Sept-Oct 2006. The organisation of specialized training sessions for experienced users must be discussed with all partners and prepared (period to be defined, probably in JPA3).

Task 2.4: Code developments (in continuity of JPA1 work)

- Completion of specifications of model adaptations requested by ASTEC users to model VVER,
- Specifications for the extension to BWR, CANDU and RBMK (only initiated in JPA1),
- Specifications of models of the different systems for SAM as requested by ASTEC users,
- Permanent synthesis of requests on ASTEC development, issued from outcomes of the Users' Club meetings and of other WP of SARNET (corium, containment, source term, PSA2 requirements). This will be used as inputs for detailed IRSN-GRS specifications of the version ASTEC V2.
- Model developments by partners to improve the existing modelling (including those issued from outcomes of other SARNET Topics)..

Deliverables

Partners' requirements for ASTEC V2 development plan (D34) at 18 months

Specifications of ASTEC adaptation to different types of reactor and to new safety systems (D35) at 18 months

2nd annual general Progress Report on topic ASTEC (D46) at 24 months

Progress Report on ASTEC adaptation to different NPP and new safety systems (D47) at 30 months

Progress Report on ASTEC modelling developments or improvements by partners (D48) at 30 months

Milestones and expected result

Delivery of ASTEC V1.2 in mid-2005

ASTEC V2 development plan end of 2005

Second Users club meeting in Spring 2006

Second users' training session in Sept-Oct 2006

Project Planning Time Table

WP2 Tasks	USTIA	Lead. 1	Months 13 - 18	Months 19 - 24	Months 25 - 30
	MEETINGS			**M**	**M M**
		Part. Id.			
2.1	**V1.2 release of code and user documentation**	*1, 23*	**---→*WP3* →*WP4***	**D46**	
	V1.3 release of code and user documentation	*1, 23*			**---→*WP3* →*WP4***
2.2	**Users clubs**	*1, 23 + Users*			**M**
	ASTEC Web site update	*1*	**----------**	**----------D46**	**---------- →*WP1***
2.3	**Training session**	*1, 23 + Users*		**M**	**---M**
	E-learning	*1*		**----------D46**	**---------- →*WP1***
2.4	**Specifications for adaptation to other reactors and systems**	*1, 23, 25, 26, 32, 33, 43*	**----------D35**	**----------D46**	**----------D47**
	Model developments	*7, 25, 32*	**----------**	**----------D46**	**----------D48**
	Requirements for V2 develop. plan	*1,23*	**----------D34**	**D46**	

⟶ Indicates main dependences between tasks

Users = *1, 4, 6, 7, 10, 13, 14, 15, 16, 18, 21, 23, 24, 25, 26, 27, 30, 31, 32, 33, 35, 36, 37, 42, 43, 46, 47, 49, 51*

ASTEC Physical Model Assessment (PHYMA)

Work package number	3			**Start date or starting event:**					13				
Activity Type	Integrating activities												
Participant id	1	4	6	7	10	13	16	21	23	24	25	27	30
Person-months per participant	*9*	*3.5*	*2*	*1*	*8*	*2*	*9*	*8*	*4.5*	*8*	*3*	*6*	*17*
Participant id	31	32	33	36	37	43	47						
Person-months per participant	*5*	*3*	*6*	*1*	*2*	*8*	*4.5*						

Objectives

Assess the physical models of the ASTEC code through comparison to experimental results.

Description of work

This activity consists of comparison of ASTEC with experimental data; exceptionally experimental data can be replaced by results provided by detailed reference codes, whose models are mainly more detailed and assessed than the ASTEC ones (example: CFD codes compared to CPA multi-compartment containment part of ASTEC).

The work organization during the second 18-months period is:

Task 3.1: Finalization of partners' assessment of ASTEC V1.1.

Task 3.2: Continuous update of ASTEC general validation matrix.

Task 3.3: Assessment for the version V1.2 following the large matrix defined in JPA1. This phase will cover the year 2006 (it could switch on the next version ASTEC V1.3 after its release). An even distribution of work will be searched between all physical phenomena.

This activity will be shared between 20 organisations, according to their competence:

- In-vessel phenomena (thermal hydraulic and degradation phenomena): BUTE, ENEA, FZK, IUSTT-IKE, IRSN, IVS, JRC Petten, KTH,
- Ex-vessel corium (MCCI, corium cooling, DCH): ARCS, FZK, GRS, IRSN, TUS, UJV,
- Containment behaviour: CIEMAT, UPI, ENEA, GRS, IRSN, JRC Petten, JSI, LEI, RUB, TUS,
- Source term: CEA, CIEMAT, ENEA, GRS, IRSN, JRC Petten, JSI, PSI, TUS, UJV,
- Integral tests (Phébus.FP): GRS, INR, IRSN, JRC Petten

Deliverables

Conclusion of the ASTEC V1.1 assessment (D30) at 15 months

2nd annual general Progress Report on topic ASTEC (D46) at 24 months

Milestones and expected result

Finalisation of ASTEC V1.1 assessment at 15 months

Project Planning Time Table

WP3 Tasks	PHYMA	Lead. 1	Months 13 - 18	Months 19- 24	Months 25 - 30
	MEETINGS				**M**
		Part. Id.			
3.1 (with ASTEC V1.1)	**In-vessel corium**	***CIV***	----------	**D46**	
	Ex-vessel corium	***CEV1***	----------		
	Containment	***CCO1***	---------- **D30** → ***WP2***		
	FP	***CFP***	----------		
	Integral tests	***CIT***	----------		
3.2	**Assessment matrix update**	***All***	----------	----------**D46**	----------
3.3 (with ASTEC V1.2)	**In vessel corium**	***CIV***		----------	----------
	Ex vessel corium	***CEV2***		----------	----------
	Containment	***CCO2***		---------- **D46**	----------
	FP	***CFP***		----------	----------
	Integral tests	***CIT***		----------	----------

→ Indicates dependence between tasks

CIV**=** 1, 6, 16, 21, 24, 27, 32
CEV1**=** 1, 4, 23, 47
CCO1**=** 1, 10, 13, 16, 23, 30, 33, 43
CFP**=** 1, 7, 10, 16, 23, 30, 31, 33, 36, 43, 47
CIT**=** 1, 23, 25, 30

CEV2**=** 1, 4, 21, 23, 43, 47
CCO2**=** 1, 10, 16, 23, 30, 31, 33, 37, 43

ASTEC Reactor Application and Benchmarking (RAB)

Work package number	4			**Start date or starting event:**					13				
Activity Type	Integrating activities												
Participant id	1	6	7	13	14	15	16	18	23	24	25	26	27
Person-months per participant	*9*	*6*	*5*	*6*	*6.5*	*3.5*	*8*	*2.6*	*11.25*	*9*	*6*	*12*	*11*
Participant id	32	33	35	36	42	43	46	47	49	51			
Person-months per participant	*3*	*4.5*	*2.7*	*1*	*3*	*4*	*10.4*	*1.5*	*17*	*19*			

Objectives

Evaluate and improve the capability of ASTEC to simulate reactor transients.

Description of work

This activity will provide inputs for the WP2 and WP7. The reactor transients will concern 5 types of reactors: PWR, BWR, VVER, CANDU and RBMK.

ASTEC will be compared on reactor transients with the integral codes MELCOR and MAAP and with some specialized codes such as: ICARE/CATHARE, ATHLET-CD, RELAP-SCDAP, COCOSYS, TONUS …

The work organization during the second 18-months period is:

Task 4.1: Participants carry out assessment works to complete for ASTEC V1.1 the benchmarking activity performed in first year.

Task 4.2: Elaboration during the 6 first months of JPA2 of a first set of ASTEC reference input decks for PWR and VVER reactor applications. Then these input decks will be periodically updated. The same thing will be done progressively for RBMK, CANDU and BWR reactors.

Task 4.3: Reactor calculation and benchmarking activity with the version V1.2 using the large reactor sequence matrix defined in JPA1. This phase will cover the year 2006 (it could switch on the next version ASTEC V1.3 after its release).

This activity will be shared between 231 organisations. There will be probably an extension of the scope of accident scenarios to calculate or to other SAM. Most will contribute to the evaluation of ASTEC applicability for PWR (see project time table). Only partial code applications to BWR, CANDU and RBMK will be studied (waiting for further model adaptation in USTIA WP).

The extension of ASTEC applicability for other reactor types than PWR will be analysed as follows:

- BWR: GRS, KTH
- VVER 440: BUTE, IVS, UJD, VEIKI, VUJE
- VVER 1000: INRNE, KTH, TUS, UJV, UPI
- CANDU: INR
- RBMK: LEI

Deliverables

ASTEC V1.1 evaluation for reactor applications (D31) at 15 months

2nd annual general Progress Report on topic ASTEC (D46) at 24 months

Milestones and expected result

ASTEC V1.1 evaluation for reactor applications at 15 months

Project Planning Time Table

WP4 Tasks	RAB	Lead. 1	Months 13 - 18	Months 19- 24	Months 25 - 30
		MEETINGS			**M**
		Part. Id.			
4.1 (ASTEC V1.1)	**PWR**	***CPR***	----------	**D46**	
	VVER-1000	***CV1R, 32***	----------		
	VVER-440	***CV4R***	---------- **D31 →*WP2, WP7***		
	RBMK	***33***	----------		
	CANDU	***25***	----------		
4.2	**Input deck data base**	***1, 14, 23, 25, 32, 33, 51***	----------	----------**D46**	**→ *WP2***
4.3 (ASTEC V1.2)	**PWR**	***CPR, 36***		----------	----------
	VVER-1000	***CV1R***		----------	----------
	VVER-440	***CV4R, 6***		---------- **D46**	----------
	RBMK	***33***		----------	----------
	CANDU	***25***		----------	----------
	BWR	***23, 32***		----------	----------

→ Indicates dependence between tasks

CPR = 1, 7, 14, 15, 16, 18, 23, 24, 35, 42
CV1R = ***13, 26, 43, 47***
CV4R = ***27, 46, 49, 51***

Level 2 PSA Methodology and Advanced Tools (PSA2)

Work package number	5		**Start date or starting event:**							13			
Activity Type	Integrating activities												
Participant id	1	5	7	11	15	19	23	25	30	33	34	36	39
Person-months per participant	*5*	*2*	*2.5*	*4*	*2.5*	*2.5*	*4*	*4*	*2.5*	*4*	*2*	*2.5*	*2*
Participant id	43	44	47	49									
Person-months per participant	*2*	*4*	*2*	*2*									

Objectives

Compare, improve and harmonize the methodologies used for developing Level 2 PSA within European countries and share effort to develop advanced tools, as far as they are required. Identify most critical knowledge difficulties in continuation with EURSAFE for R&D prioritisation.

Adapt methodologies for application to the reactor types used in the recently jointed and candidate Eastern European Countries.

Description of work

Task 5.1: Comparison of Level 2 PSA approaches, identification of improvement needs and recommendations of methods:

- Finalization of D36 deliverable,
- Definition of a best-estimate method to take into account hydrogen combustion (considering ignition time and location). Recommendations particularly on the necessary degree of nodalisation, possibly supported by other methods, such as CFD analyses, will be proposed,
- Definition of a best estimated method to assess, in an integrated way, the effects of a breach at the reactor pressure vessel,
- Detailed comparison of boundary conditions and assumptions made for MCCI assessment. Detailed review of methods used to assess MCCI (parameters considered, consequences analysed…). Recommendations of a best estimated method on this subject will be proposed,
- Detailed comparison of boundary conditions and assumptions made for iodine releases assessment. Recommendations of a best estimated method on this subject taking into account status of knowledge will be proposed
- Comparison of main probabilistic software (KANT, RISK SPECTRUM, EVNTRE).

Task 5.2: Comparison of methodologies for assessment of uncertainties and identification of improvement and harmonization needs:

- Finalization of the comparison report on the methods used for uncertainties assessment, and of the report about possible methods application,
- Finalization of the D37 deliverable,
- Detailed review of methods used and which could be used for the assessment of the uncertainties on hydrogen combustion (includes the question of ignition time and location, of nodalization…, reference to possible methods identified during first SARNET period..),
- Detailed review of methods used and which could be used for the assessment of the uncertainties for Melt Coolant Concrete Interaction (including basemat failure time, effect of long term pressurization, ex vessel debris coolability…).
- Detailed review of methods used and which could be used for the assessment of the uncertainties for iodine releases assessment.
- Review of additional tools which should be necessary for uncertainties assessment and/or sensitivity studies (to apply possible methods as inventoried in the first period of SARNET).

Task 5.3: Improvement of event tree methodology using dynamic reliability techniques:

- finalization of the D38 deliverable,
- the benefit of the MCDET approach, compared to classical approach, will be precised on the basis of the example of the induced breaks of RCS,

- another relevant example(s) for dynamic reliability application will be definitively chosen. Themes of tasks WP5.1 (and 5.2) – i.e. hydrogen combustion, effects of vessel breach and MCCI will be considered as priorities as far as possible,
- software development for dynamic reliability methodology application to a selected example will be initiated. The questions of ASTEC or other integral codes "coupling" will be examined as a part of this task,
- the ASTEC block diagram decomposition for SDTPD application will be continued,
- the application on the example chosen of both the MCDET and the SDTDP methods will be started. To achieve this tasks, it will be asked for PhDs or post PhDs in the framework of the mobility programme,
- the review of the possibility of integration in the MCDET and SDTPD approaches of the methods recommended for uncertainties assessment according to WP5.2 sub tasks will be initiated in the continuity of WP5.2 sub tasks.

Deliverables

Report on Level 2 PSA comparisons and recommended improvements (D 36) at 18 months

Report on uncertainty assessment comparison and recommended improvements (D37) at 18 months

Report on event tree approach limitations and proposed methodological approach (D38) at 18 months

Report of probabilistic software comparison for level 2 PSA application (D 70) at 24 months)

Report on recommendations of best estimated methods to take into account hydrogen combustion, consequences of vessel breach, MCCI, iodine releases in a level 2 PSA (D 71) at 30 months

Report on recommendations on best estimated methods to take into account uncertainties on hydrogen combustion, MCCI, iodine releases in a level 2 PSA (D 72) at 30 months

Status report on dynamic reliability methods application to level 2 PSA (D73) at 30 months.

Milestones and expected result

3 meetings (beginning of the period then about 7 and 14 months later)

First proposal of methods harmonization (D71, D72) at 30 months

Status report on reliability methods application to level 2 PSA (D73)

Project Planning Time Table

WP5 Tasks	PSA2	Lead. 5	Months 13 - 18	Months 19-24	Months 25-30
MEETINGS (see Tasks)					
		Part. Id.			
5.1	**Comparison**	***List 5.1***	**-------M------D36 →*WP2***	**-------M------D70 -------M----------**	**-------M------D71 →*WP2***
5.2	**Uncertainty**	***List 5.2***	**-------M------D37 →*WP7***	**--------M----------**	**-------M------D72 →*WP2***
5.3	**Dynamic reliability**	***List 5.3***	**-------M------D38**	**--------M----------**	**-------M------D73**

List 5.1: 1, 5, 11, 15, 19, 23, 25, 33, 34, 36, 39, 43, 47, 49

List 5.2: 1, 7, 11, 15, 19, 23, 30, 33, 34, 36, 39, 43, 47, 49

List 5.3: 1, 7, 11, 15, 19, 23, 25, 33, 36, 44

Implementation of Experimental Database (IED)

Work package number	6			**Start date or starting event:**				13				
Activity Type	Integrating activities											
Participant id	28	1	3	7	10	17	21	32	50				
Person-months per participant	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*	*4.5*	*3.5*	*4.5*	*4.5*				

Objectives

Provide SARNET with, develop and maintain an instrument that ensures preservation, easy access for codes, exchange and processing of Severe Accident experimental data

Description of work

Task 6.2: Introducing in the network organisations that were not part of the EURSAFE activity on the data base (VTT and CIEMAT), and support to the others:

- Creation of local STRESA nodes for the newcomers
- Organisation of one-week training for these organisations

Providing support for establishing the links with communication tool developed in WP1.

Task 6.3: Completing the existing EURSAFE database network developed from STRESA structure with the other available severe accident data of the participating organisations.

- Data from PLINIUS platform: VULCANO, COLIMA (CEA)
- Data from KJET, PREMIX, ECO, QUEOS, DISCO (FZK)
- Data from FOREVER, KMFCI, POMECO (KTH)
- Data from Phébus.FP (FPT0, FPT1) and VERCORS (IRSN)
- Data from CODEX: core degradation bundle tests (AEKI)
- Data from VICTORIA and HORIZON: Helium and aerosol experiments (FORTUM)

Deliverables

Data base catalogue (D39) at 18 months

Milestones and expected result

Project Planning Time Table

WP6 Tasks	IED	Lead. 28	Month 13 - 18	Month 19- 24	Month 25 - 30
		MEETINGS	**M**		
		Part. Id.			
6.2	**Deployment by partners 10 and 50**	***List 6.2***	----------	-----	
	Deployment continuation and user support	***28***	----------	----------	----------
6.3	**Data Base Completion**	***List 6.3***	----------**D39**	----------	----------

List 6.2: 28, 10, 50

List 6.3: 28, 1, 3, 7, 10,17, 21, 32, 50

Definition of Severe Accident Research Priorities (SARP)

Work package number	7		**Start date or starting event:**					13					
Activity Type	Integrating activities												
Participant id	23	1	7	15	21	32	43	50					
Person-months per participant	*4.5*	*3*	*3*	*3*	*3*	*3*	*3*	*2*					

Objectives

Prioritise the research to be performed in the field of severe accident phenomena and management, notably using the results of EURSAFE, and ASTEC and Level 2 PSA work packages

Description of work

- Agree on methodology
- Review issues resulting from EURSAFE not appropriately covered by SARNET
- Analyse R&D progresses and results from Level 2 PSA studies
- Review issues ranking
- Review potential experimental and theoretical programmes to address these issues
- Make recommendations for R&D programme revision

Deliverables

Updated version of EURSAFE conclusions and proposals (D40) at 21 months (a preliminary version will be internally distributed at Month 18)

Milestones and expected result

SARNET Integrated R&D elaborated in the frame of Joint Research Activities WPs at 24 months: D67

Project Planning Time Table

WP7 Tasks	SARP	Lead. 23	Month 13 -18	Month 18-24	Month 24 - 30
	MEETINGS		**M**		
		Part. Id.			
7.1	**Methodology definition**	***List 7***	**----------**		
7.2	**Revision of EURSAFE conclusions/ proposals**	***List 7***	**---------**	**----------D40** ***JRA→***	

List 7: 23, 1, 7, 15, 21, 32, 43, 50

The JRA (Joint Research Activities) provide inputs during the revision process.

The revision leads to recommendations to be integrated in the update of the JRA.

Integration Assessment (IA)

Work package number	8		**Start date or starting event:**						21				
Activity Type	Integrating activities												
Participant id	1	7	21	23	28	32	36						
Person-months per participant													

Objectives:

To monitor the progress of the network and propose corrective actions in order to reach the SARNET objectives.

Description of work

Task yearly carried out, 3 months before the release of the annual report.

The Coordinator, concerned Scientific Coordinators and some WP leaders carry out the work.

The work consists in:

- Collect the information necessary to measure the evolution of the 16 indicators defined in chapter 7;
- Analyse the results, and propose if necessary JPA corrective actions;
- Propose the revision of the list in order to make easier the assessment.

For the second year, the evolution of only one part of the indicators will be significant:

- I1: number of member accesses to the Web site
- I2: number of collaborative documents elaborated and/or stored using ACT
- I3: number of ASTEC users in SARNET
- I4: The number of organisations using ASTEC for its own applications
- I7: the number of access rights granted to contractors for application in SARNET
- I11: the number of joint publications/communications
- I12: the number of attendees to SARNET course or topical trainings
- I13: the number of researcher detachment
- I14: the number of presentations of SARNET
- I15: the number of hours devoted to updating SARNET WEB site
- I16: the number of access to the Website

Deliverables

Annual assessment report D49 at 24 months

Milestones and expected result

Continuous improvement of the process leading to fulfil SARNET objectives.

Early-phase core degradation (EARLY)

Work package number	9		Start date or starting event:							13			
Activity Type	Other specific activities												
Participant id	21	1	15	16	23	25	29	36	41	47			
Person-months per participant	*3.3*	*3.85*	*1.8*	*4.5*	*2.25*	*2.4*	*4.5*	*4.5*	*1*	*3.38*			

Objectives

These issues result from:

- Selection of the research issue N°1.1 in 5th FWP EURSAFE project with following selection rationale: rapid generation of hydrogen which may not be accommodated by re-combiners and risk of early containment failure; improve knowledge about the magnitude of hydrogen generation.
- Conclusions of the COLOSS 5th FWP project and preparation of Phébus FPT3 test which showed needs of improvements of understanding and modelling of B_4C impact on core degradation. Same conclusions for irradiated fuel dissolution.
- For oxidation and hydrogen production in a damaged core, oxidation by air has been stressed during EURSAFE PIRT exercise. Ranked at level 2 for core degradation there is nevertheless a strong impact of oxidising environment on the fuel and on the fission products release especially for Ruthenium. Initially addressed in WP14, the Zircaloy oxidation by air or by steam-air mixtures issue will be identified separately within WP-9 and constitute the initial conditions fuels rods behaviour and fission products release. The phenomenon of air oxidation may also occur during abnormal fuel management operations.

A more complete understanding is needed on the following physical processes: hydrogen generation during core reflooding conditions (esp. oxidation of metal-rich mixtures), B_4C and fuel burn-up impact on core degradation for various atmosphere conditions (steam, air and steam/air mixtures), and more generally the remaining questions in the core degradation early-phase (in particular, oxidation of clad with advanced alloys and hydrogen generation during melt relocation into water present in the vessel lower plenum).

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programs and on their interpretation.
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 9.1. Continuation of review and selection of available experiments/models for interpretation and modelling activities. Joint recommendations on the test specifications (design and test matrix…).

Main experiments (separate-effect tests or integral tests): QUENCH (incl. ISTC-1648 frame), SETs, experiments of dissolution of fuel (UO_2, MOX) by Zry, MAESTRO plat-form, INR experiment and ISTC-PARAMETER.

Task 9.2. Synthesis of analyses and interpretations of selected experiments from above Task, using different models and/or codes (or thermodynamic databases such as NUCLEA).

Main codes: ICARE/CATHARE, SCDAP/RELAP5, SCDAPSIM, ATHLET-CD, MELCOR, ASTEC.

Task 9.3. Model synthesis and proposal of models to be implemented into ASTEC..

Deliverables

Progress report on CORIUM topic (D50) at 24 months

Progress report on review of experiments of the CORIUM topic (D51).

Progress report on synthesis of experimental result interpretation for CORIUM topic (D52).

Synthesis Progress report of the CORIUM topic on proposals of models for ASTEC (D53)

Definition of the joint R&D programme in the next JPA period for the CORIUM topic (D54) Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

Project Planning Time Table

(Here example for WP9 but valid for WP 9 to 16)

WP9 Tasks	WP 9	Lead.	Months 13 - 18	Months 19- 24	Months 25 - 30
	MEETINGS			**M**	
		Part. Id.			
1	**Joint review of experiments**	***All***	----------	----------D51	----------
2	**Joint interpretation**	***All***	----------	----------D52	-D11, D15- ------ → ***WP7***
3	**Proposals of models for ASTEC**	***All***		----------D53	---------- →***WP2***
4 (Depends on WP)	**Synthesis of plant applications**	***All***	----------	----------D51	---------- → ***WP7***

LATe-phase Core Degradation and VESsel behaviour (LATVES)

Work package number	10			**Start date or starting event:**					13			
Activity Type	Other specific activities											
Participant id	32	1	7	15	21	22	23	24	27	37	40	41	
Person-months per participant	*3.15*	*2.5*	*2.85*	*0.9*	*1.5*	*4.5*	*1.65*	*1.2*	*4.5*	*4.5*	*1.5*	*1.0*	

Objectives

The rationales for these issues result from 5th FWP EURSAFE project:

- For late-phase degradation and corium behaviour in lower head, Research issue N°1,3 with following selection rationale: Improve predictability of the thermal loadings on RPV lower head (or corium catcher devices) to maintain their integrity. It is also related to the Research issue N°1.4 "External vessel cooling and RPV integrity" for in-vessel melt retention strategies.
- For vessel integrity and corium release to cavity, Research issue N°1,6 with following selection rationale: Improve predictability of mode and location of RPV failure to characterise the corium release into the containment. This addresses also part of Research issue N°3.1 "Melt relocation into water and particulate formation" through the melt relocation from core region into water filled space.

A more complete understanding is needed on the following physical processes:

- For coolability of a molten corium pool in the lower plenum or in an external core-catcher: in case of dry cavity, initial corium characteristics from the core region when relocating to the lower plenum, and behaviour of molten pool in the lower plenum (segregation/stratification, heat transfers to boundaries…); in case of external vessel cooling, critical heat flux and external cooling conditions in order to evaluate and design AM strategies for in-vessel melt retention.
- For vessel integrity and corium release to cavity: in conditions of dry cavity, vessel mechanical failure (mode, instant, location) due to thermal and mechanical loadings, and breach opening processes and characteristics of corium release to the cavity.

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programs and on their interpretation.
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 10.1. Continuation of review and selection of available experiments/models for interpretation and modelling activities. Joint recommendations on the test specifications (design and test matrix…).

Main on going experiments:

- for late-phase degradation: SIMECO, LIVE….
- for vessel integrity: FOREVER, analytical tests on plate fissuring, Vessel external cooling…

Other inputs may come from international projects: MASCA, OLHF, ISTC METCOR, ISTC 2936, ISTC INVECOR (at proposal state)….

Task 10.2. Synthesis of analyses and interpretations of experiments from above Task with existing models or codes (or thermodynamic databases such as NUCLEA).

Main codes: ICARE/CATHARE, ATHLET-CD, CFD codes, ANSYS, ASTEC.

Task 10.3. Synthesis of reactor scenario studies in order to improve the evaluation of initial or limit conditions or to determine the impact of remaining uncertainties on accident evolution, using different codes (ICARE/CATHARE, ATHLET-CD/KESS, ANSYS).

Task 10.4. Model synthesis and common proposal of models on late-phase degradation and vessel integrity to be implemented into ASTEC.

Deliverables

Progress report on CORIUM topic at 24 months (D50)

Progress report on review of experiments of the CORIUM topic (D51).

Progress report on synthesis of experimental result interpretation for CORIUM topic (D52).

Synthesis Progress report of the CORIUM topic on proposals of models for ASTEC (D53)

Definition of the joint R&D programme in the next JPA period for the CORIUM topic (D54)

Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

Ex-vessel Corium Recovery (EXCORE)

Work package number	11		**Start date or starting event:**						13			
Activity Type	Other specific activities											
Participant id	24	1	7	15	19	21	23	32	37	41	47	48	50
Person-months per participant	*4.05*	*2.35*	*4.35*	*1.8*	*4.5*	*1.5*	*0.75*	*2.1*		*1.0*	*2.32*	*4.5*	*0.9*

Objectives

The rationales for these issues result from 5th FWP EURSAFE and EUROCORE projects:

- For ex-vessel case w/o water injection (EURSAFE items N°2.1 “MCCI: molten pool configuration and concrete ablation" and N°2.3 “Ex-vessel corium catcher: corium ceramics interaction and properties”: improve predictability of axial versus radial ablation up to late phase MCCI to determine basemat failure time and loss of containment integrity; demonstrate the efficiency of specific corium catcher designs by improving the predictability of the corium interaction with corium catcher materials.
- For ex-vessel case with water injection (EURSAFE items N°2.2 and 2.4): increase knowledge of cooling mechanisms by top flooding the ex-vessel corium pool to demonstrate termination of accident progression and maintenance of containment integrity; demonstrate efficiency of water bottom injection to cool corium pool and its impact on containment pressurization.
- The scope of the work-package is extended also to particulate debris coolability for in-vessel situation (EURSAFE item N°1.2): termination of the accident by re-flooding of the core while maintaining RCS integrity. Increase predictability of core cooling during re-flooding.

A more complete understanding is needed on the following physical processes:

- For corium behaviour during interaction with concrete or ceramic and for ex-vessel pool corium coolability: pool stratification and layers stability under gas sparging; heat transfer mechanism, power distribution and ablation homogeneity; fission product remaining in the pool; ceramic dissolution mechanisms; cooling mechanisms with water on top of the melt (bulk cooling, water ingression or melt ejection); crust anchorage phenomena in reactor pit and consequence for melt ejection mechanism; porosity formation during cooling by bottom injection of water into the melt and consequences for water management and steam production.

- For core coolability: behaviour of ex-vessel particulate debris beds in water present in the cavity. thermal hydraulics of debris beds, without or with water injection, coolability of debris beds (in- and ex-vessel), coolability of the molten pool within the core, fuel rod collapse and molten pool crust failure.

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programs and on their interpretation.
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 11.1. Continuation of review and selection of available experiments/models for interpretation and modelling activities. Joint recommendations on the test specifications (design, test matrix…). Contribution to new OECD program proposal.

Main on going experiments:

- for debris or corium pool coolability: DEBRIS, STYX, POMECO, DECOBI, COMET, VULCANO, COMECO ….
- for MCCI: ARTEMIS, VULCANO, COLIMA, COMETA, FRA-ANP GmbH….

Other inputs may come from international projects: OECD-MCCI, CHESS ISTC, …

Task 11.2. ***Synthesis of analyses and interpretations of experiments from above Task with existing models or codes (or thermodynamic databases such as NUCLEA).***

List of codes:

- for debris coolability: ICARE/CATHARE, KESS and ATHLET-CD, WECHSL, ASTEC, TOLBIAC-ICB, THEMA, CROCO 2D, WEX, COCOSYS, MELCOR, MC3D….
- for MCCI: WEX, WECHSL, ASTEC, TOLBIAC, TOLBIAC-ICB, CROCO 2D, MELCOR, MEWA, COSACO…

Task 11.3: Synthesis of plant applications in order to determine the impact of remaining uncertainties on accident management.

Task 11.4. Model synthesis and common proposal of models of corium concrete or ceramic interaction and corium debris or melt coolability to be implemented into ASTEC.

Deliverables

Progress report on CORIUM topic at 24 months (D50)

Progress report on review of experiments of the CORIUM topic (D51).

Progress report on synthesis of experimental result interpretation for CORIUM topic (D52).

Synthesis Progress report of the CORIUM topic on proposals of models for ASTEC (D53)

Definition of the joint R&D programme in the next JPA period for the CORIUM topic (D54)

Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

Hydrogen Behaviour in Containment (HBC)

Work package number	12	**Start date or starting event:**							13		
Activity Type	Other specific activities										
Participant id	1	7	13	20	21	23	30	31	32	33	35
Person-months per participant:	*2.3*	*5.3*	*4.5*	*4.5*	*2.7*	*1.05*	*6.8*	*2.3*	*2.3*	*1.5*	*1.5*
Participant id	37	40	43	47	48	49					
Person-months per participant:	*3.5*	*1.5*	*1.5*	*4.5*	*4.5*	*4.5*					

Objectives

This WP concerns two main issues:

- Containment atmosphere mixing and hydrogen distribution in the containment, with respect to risk of high concentration,
- Hydrogen combustion and associated risk mitigation.

A more complete understanding is needed on the following physical processes:

- For containment atmosphere mixing, it is essential to determine with good confidence the hydrogen distribution in the different parts of the containment, taking account of containment geometry (multi-compartment), mass and energy exchanges coming from phenomena as wall condensation, spray and sump evaporation. During the first 12th months of SARNET, a review of the knowledge and the identification of modelling and validation needs was made, taking account in particular the on-going work of ISP-47. In the second JPA this activity will be continued but will be more focussed work on recombiner modelling, spray modelling and generally, applicability of CFD codes to containment thermal-hydraulics will be made.
- For hydrogen combustion and associated risk mitigation: formation of combustible gas mixtures in containments, its local gas composition and potential combustion modes. The investigations take into account the containment geometry (multi-compartment), mass and energy exchanges (wall condensation, spray and sump evaporation), local multidimensional effects of hydrogen combustion and the reaction kinetics inside catalytic recombiners.

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programs and on their interpretation, and the organisation of workshops.
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 12.1. Review and selection of available experiments/models for interpretation and modelling activities. Discussion of experimental activities and recommendations for the specification of experiments/programmes: TOSQAN, MISTRA (OECD and national), ThAI (OECD).

Task 12.2. ***Synthesis of analyses and interpretations of experiments from above Task with existing models or codes (CFD codes, TONUS, COM3D, REACFLOW, ASTEC, COCOSYS….).***

Task 12.3. Further work on specific containment related models for CFD (spray, recombiners…) and applicability of CFD to real plants (review of issues related to code performance, meshing, scaling effects...).

Task 12.4. Model synthesis and common proposal of models to be implemented into ASTEC but also recommendations for implementation of containment-related physical models for CFD codes.

Deliverables

Progress report on CONTAINMENT topic (D55) at 24 months

Progress report on review of experiments of the CONTAINMENT topic (D56).

Progress report on synthesis of experimental results interpretation for the CONTAINMENT topic (D57).

Synthesis Progress report of the CONTAINMENT topic on proposals of models for ASTEC (D58)

Definition of the joint R&D programme in the next JPA period for the CONTAINMENT topic (D59)

Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

Fast Interactions with Corium (FIC)

Work package number	13	Start date or starting event:						13		
Activity Type	Other specific activities									
Participant id	1	7	15	19	21	23	24	31	32	37
Person-months per participant:	*8.3*	*1.5*	*3*	*0.8*	*9.3*	*2.25*	*7.5*	*2.2*	*2.2*	*1*
Participant id	43									
Person-months per participant:	*4.5*									

Objectives

The diverse interaction modes of corium, ejected into the reactor cavity after RPV failure, may lead to high temperature and pressure loads on the containment or vital components. Depending on the conditions at failure and on reactor geometry, fuel-coolant-interactions (FCI) or direct containment heating (DCH) can take place.

A more complete understanding is needed on the fluid-dynamic, thermal and chemical processes, for model development and validation, especially for the application to the reactor case that requires a scaling in dimension and from model fluids to corium.

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programs and on their interpretation.
- Development of adequate models, for the DCH only, for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 13.1. Review and selection of available experiments/models for interpretation and modelling activities. Define important phenomena for which models have to be improved or developed on the basis of the EURSAFE tables. Discussion of experimental activities and recommendations for the specification of experiments/programmes for the DCH issue (DISCO facilities) and the FCI issue (exp. facilities: MICRONIS, DROPS, MISTEE and KROTOS). Delineate the necessary data to be measured. As for FCI, a close link with the OECD-SERENA programme exists.

Task 13.2. Synthesis of analyses and interpretations of experiments from above Task with existing models or codes (MC3D, MATTINA, IKEJET/IKEMIX, IDEMO-2D, SIPHRA3D, COMETA for FCI, and CONTAIN, MAAP4, COCOSYS and RUPUICUV for DCH).

Task 13.3. Model synthesis and common proposal of models to be implemented into ASTEC.

Deliverables

Progress report on CONTAINMENT topic (D16) at 24 months

Progress report on review of experiments of the CONTAINMENT topic (D17).

Progress report on synthesis of experimental results interpretation for the CONTAINMENT topic (D18).

Synthesis Progress report of the CONTAINMENT topic on proposals of models for ASTEC (D19)

Definition of the joint R&D programme in the next JPA period for the CONTAINMENT topic (D20)

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

Fission Product Release and Transport (FPRT)

Work package number	14	**Start date or starting event:**				13						
Activity Type	Other specific activities											
Participant id	1	3	7	15	16	21	23	25	30	36	45	50
Person-months per participant:	*6*	*3*	*3.5*	*3.6*	*3*	*0.75*	*1.2*	*1.8*	*1.5*	*1.5*	*1.5*	*3*

Objectives

The rationales for these issues related to fission product release and transport in the RCS result from the 5th FWP EURSAFE project:

- Quantification of the source term, in particular for Ru, under oxidation conditions / air ingress;
- Improvement of predictability of iodine species exiting the RCS to provide a best estimate of the source into the containment.

The main WP objective will be the progressive integration of the R&D capabilities on these issues, in order to coordinate better the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programmes and on their interpretation;
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 14.1. Review and selection of available experiments/models for interpretation and modelling activities. Discussion of experimental activities and recommendations for the specification of following experiments/programmes: VTT Ru speciation tests, UCL analytical tests, VERDON, RUSET, VERCORS, release experiments for In and Cd by IRSN, FZK Zr/air oxidation tests and Phébus-FP.

Task 14.2. Synthesis of analyses and interpretations of the above experiments with existing models or codes.

Task 14.3. Synthesis of plant applications in order to determine the impact of remaining uncertainties.

Task 14.4. Model synthesis and common proposal of models to be implemented into ASTEC.

Deliverables

Progress report on SOURCE TERM topic (D60) at 24 months

Progress report on review of experiments of the SOURCE TERM topic (D61)

Progress report on synthesis of experimental results interpretation for SOURCE TERM topic (D62)

Synthesis Progress report of the SOURCE TERM topic on proposals of models for ASTEC (D63)

Definition of the joint R&D programme in the next JPA period for the SOURCE TERM topic (D64)

Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

AEROsol Behaviour impact on source term (AEROB)

Work package number	15	**Start date or starting event:**			13						
Activity Type	Other specific activities										
Participant id	1	7	8	10	12	17	23	29	36	45	50
Person-months per participant:	1.5	1	4.5	6	2.25	1.5	1.05	4.5	2.25	3	1.5

Objectives

The rationale for the issues related to aerosol behaviour result from the 5th FWP EURSAFE project:

- Quantification of the source term for aerosol retention in the secondary side of steam generator and leakage through cracks in the containment wall;
- Quantification of the source into the containment due to re-volatilisation in the RCS.

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programmes and on their interpretation;
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 15.1. Review and selection of available experiments/models for interpretation and modelling activities. Discussion of experimental activities and recommendations for the specification of following experiments/programmes: ARTIST, PSAERO, HORIZON, RADSOL, PECA/SGTR, and JRC re-vaporisation tests.

Task 15.2. Synthesis of analysis and interpretations of above experiments with existing models or codes.

Task 15.3. Model synthesis and common proposal of models to be implemented into ASTEC.

Deliverables

Progress report on SOURCE TERM topic (D60) at 24 months

Progress report on review of experiments of the SOURCE TERM topic (D61)

Progress report on synthesis of experimental results interpretation for SOURCE TERM topic (D62)

Synthesis Progress report of the SOURCE TERM topic on proposals of models for ASTEC (D63)

Definition of the joint R&D programme in the next JPA period for the SOURCE TERM topic (D64)

Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

CONTainment CHEMistry impact on source term (CONTCHEM)

Work package number	16	**Start date or starting event:**							13			
Activity Type	Other specific activities											
Participant id	1	2	9	10	15	19	23	30	36	43	52	
Person-months per participant:	1.5	3	3	6.8	0.9	4.5	1.5	4.5	2.25	2.25	3	

Objectives

The rationale for the issues related to iodine chemistry in the containment result from the 5th FWP EURSAFE project that drew conclusions on needs for improvement of predicting iodine chemistry in the containment, to reduce the uncertainty in the iodine source term.

The main WP objective will be the progressive integration of the R&D capacities on these issues, in order to better coordinate the research activities and optimise the available competences and resources. This will be done particularly through:

- Joint investigation of the physical processes in order to reach a common understanding through syntheses on experimental programmes and on their interpretation;
- Development of adequate models for the above physical processes to be implemented into ASTEC.

This will lead to the definition and proposal of a joint R&D programme (models, experiments) to solve this issue, either by re-orientation of existing programmes or by launching new ones.

Description of work

Task 15a.1. Review and selection of available experiments/models for interpretation and modelling activities. Discussion of experimental activities and recommendations for the specification of following experiments/programmes: EPICUR, CAIMAN, SISYPHE, Chalmers tests, PARIS, Phébus-FP.

Task 15a.2. Synthesis of analyses and interpretations of above experiments with existing models or codes.

Task 15a.3. Model synthesis and common proposal of models to be implemented into ASTEC.

Deliverables

Progress report on SOURCE TERM topic (D60) at 24 months

Progress report on review of experiments of the SOURCE TERM topic (D61)

Progress report on synthesis of experimental results interpretation for SOURCE TERM topic (D62)

Synthesis Progress report of the SOURCE TERM topic on proposals of models for ASTEC (D63)

Definition of the joint R&D programme in the next JPA period for the SOURCE TERM topic (D64)

Contribution to SARNET Integrated R&D Plan at 24 months: D67

Milestones and expected result

Second period conclusion meeting, assessment of work and definition of future joint R&D at 24 months

Education and Training (ET)

Work package number	17	**Start date or starting event:**							13		
Activity Type	Other specific activities										
Participant id	32	1	7	10	12	22	23	36	37	43	41
Person-months per participant:	*1.5*	*1.5*	*1.5*								

Person-months will be precised later (around 1.5 m-y), after identification of teachers in the candidate organisations (only, the topical coordinator (KTH), and CEA and IRSN as co-organisers of the first course sessions are identified).

Objectives

Develop Courses on Severe Accident Phenomenology and the PSA, Integrate with the NEPTUNO Project

Description of work

The Education and Training programme in SARNET is focusing on raising the competence level of the students and researchers engaged in severe accident research. Towards this purpose a course will be developed on the various areas of severe accident phenomenology. This would include topics such as the early and late phase of in-vessel core degradation, fission product release, aerosol transport, vessel failure, DCH, hydrogen combustion and detonation, MCCI, containment loading etc. The teaching will not be a survey but an in-depth treatment so that the students and researchers will be able to (a) understand (b) develop the methodology in the topics further and (c) use analysis tools (e.g. ASTEC) more effectively.

The PSA course will be developed to provide the students and researchers a hands-on experience with the Level 2 PSA of PWR, BWR and VVER plants. The description of the scenarios with event trees and of the failure rates with fault trees will be demonstrated and efforts will be made to determine the probabilities of the various events occurring. The consequences analysis is performed in codes like ASTEC, MELCOR, MAAP and their phenomenology will be explained. In particular, the models in the ASTEC code will be explained. The best estimate analysis will be supplemented with an uncertainty analysis. It will be used to demonstrate the margins that are available in the plant designs and operations.

A course on Reactor Safety in which Introductory Severe Accident phenomenology is taught will be proposed to the NEPTUNO Project for the European Masters in Nuclear Engineering programme.

Deliverables

Course on Severe Accidents (SA) will be available for delivery at 21 months (D32).

Course on PSA will be available for delivery at 21 months (D41).

Milestones and expected result

Finalization of the programme of a first teaching session on SA Phenomenology at 15 months

Finalization of the programme of a first teaching session on PSA at 15 months

Completion of a first version SA Phenomenology Course at 24 months

Completion of a first version of PSA Course at 24 months

BOOK on severe accident phenomenology (BOOK)

Work package number	18	Start date or starting event:							13		
Activity Type	Other specific activities										
Participant id	32	1	10	12	23	33	37	43	7		
Person-months per participant:	*1.5*										

Person-months will be precised later (around 1.5 m-y), after identification of writers in the candidate organisations (only, the topical coordinator: KTH is considered in this table).

Objectives

To develop a text (source) book on Severe Accident Phenomenology.

Description of work

At present there is no text (source) book on severe accident phenomenology, which can be used by the students and researchers to learn the subject area. A textbook is quite essential in terms of providing knowledge in a concise and focussed manner along with the references, which could be used by a student or a researcher to perform independent and more detailed studies. The textbook should deal with the whole progression of the severe accident including the initial transient leading to a severe accident caused by additional faults. This textbook, probably, would be quite voluminous due to the large body of material and the large number of papers and studies in Severe Accidents. The text should be reviewed by a set of peer reviewer. The intent should be to provide not only the methodology but also an assessment of the research results. The textbook should be addressed to students and researchers beyond the level of Masters in Nuclear Engineering. An abbreviated version may be addressed to the students, who enrol in the European Masters in Nuclear engineering Programme under the NEPTUNO IP.

Deliverables

SA Book skeleton with some chapters ready D 42 at 21 months.

Book draft at 30 months

Milestones and expected result

Initial meeting and decisions on the principal and the supporting authors at 15 months

The first draft of the book should be completed in 2006.

MOBility programme (MOB)

Work package number	19	Start date or starting event:							13		
Activity Type	Other specific activities										
Participant id	32	1	7	10	12	13	23	24	25	43	
Person-months per participant:	*0.75*										

Objectives

To develop the Mobility and Training Programme for students and researchers, to form teams of researchers and to develop training for reactor operators in severe accident domain.

Description of work

At present there is no organized programme in Europe under which students and researchers could go to different laboratories for education and training in the severe accident area. One element to develop is the summer internship programme under which a student spends a summer at another University (than his own) to learn about the severe accident work ongoing there.

The second element of this WP would be the development of the deputation programme in which a researcher from one laboratory will spend a year at another European Laboratory where he / she would participate in an area of the severe accident research ongoing there. In this mobility programme, the long term goal is to build teams which would engage together in a certain activity of the NoE e.g. code debugging, code validation, simulant material experiments, real material experiments, etc.

The third element of this WP is to develop a training programme for plant operators and interested researchers in the severe accident management procedures with, or without, a simulator. Here, the emphasis should be in identifying what these procedures are based on and why they are effective.

Deliverables

Completion of a development plan and cost to SARNET for student summer internship at 13 months (D4)

Completion of a development plan for researcher deputation and placing of 2 – 3 researchers for 1 year at 13 months (D5)

Update of the 2 development plans at 25 months (D68)

Completion of a development plan for operator training in SA management procedures at 36 months

Milestones and expected result

Placing of 2 – 3 students on summer internships at 15 months, and again at 27 months

Placing of 1-2 researchers for deputation at other laboratories at 15 months, and again at 27 months

MANAGement (MANAG)

Work package number	20	Start date or starting event:									13
Activity Type	Other specific activities										
Participant id	1	7	21	23	32	36					
Person-months per participant:	*22.5*	*4.5*	*4.5*	*3*	*3*	*4.5*					

Objectives

Coordinate the JPA technically and financially

This activity involves mainly the Coordinator and the topical coordinators

Description of work

- Monitor progress of JPA
- Check release of deliverables and survey milestones
- Organize technical reviews when necessary
- Anticipating and examining possible difficulties in JPA execution
- Making synthesis for JPA update (12 months after SARNET beginning) for Governing Board approval
- Elaborate budget for the second JPA (month 13 to month 30)
- Distribute community funds as decided in the Consortium agreement;
- Organize meetings of Governing Board, Advisory Committee and Ad-hoc Scientific Review Committee.
- Establish cost statement for the first year
- Organize information diffusion (newsletter, progress reports, …)
- Organize periodically a general conference (to be coupled with ASTEC users club meeting), every 18 months

Deliverables

International seminar ERMSAR 2005 at month 20: D44

At 24 months:

Annual progress report (D65)

JPA update proposal (D66)

First edition of an integrated R&D SA programme. This document describes the strategy proposed by SARNET to tackle the pending issues important for reactor safety (D67)

Milestones and expected result

First SARNET conference (2005)

5.5. Deliverable list

The JPA for the second 18 months is divided in 28 work packages, including 8 on integrating activities, 16 on jointly executed research activities, 3 on spreading excellence and 1 on management.

(In Italics deliverables produced during the first 12 months of the contract)

Deliverables list
Joint programme of activities (18 months period, month 13 - 30)

Del. no. [2]	Deliverable name	WP no.	Lead particip-ant	Estimated indicative person months	Nature[3]	Dissemination level[4]	Delivery date[5] (proj. month)
1	*SARNET WEB site*	*1*	*23*	*2*	*O*	*PU*	*6*
2	*Data Base Proposal*	*6*	*28*	*10*	*R*	*CO*	*6*
3	*ACT specification*	*1*	*23*	*3*	*R*	*CO*	*9*
4	Student mobility plan	18	32	1	R	PU	9->13
5	Researcher mobility plan	18	32	1	R	PU	9->13
6	*Progress report on ASTEC Activities*	*2-4*	*1-23*	*20*	*R*	*CO*	*12*
7	*ASTEC WEB site*	*2*	*1*	*3*	*O*	*RE*	*12*
8	*ASTEC Assess. Matrix*	*3*	*1*	*15*	*R*	*RE*	*12*
9	*ASTEC Bench. matrix*	*4*	*1-23*	*15*	*R*	*RE*	*12*
10	*Indicator Assessment.*	*8*	*1*	*4*	*R*	*CO*	*12*
11	*Progress report on CORIUM Activities*	*9-11*	*7*	*3*	*R*	*CO*	*12*
12	*CORIUM Exp. Recom*	*9-11*	*7*	*10*	*R*	*CO*	*12*
13	*CORIUM Interp Synth.*	*9-11*	*7*	*28*	*R*	*CR*	*12*
14	*CORIUM Model Recom*	*9-11*	*7*	*18*	*R*	*CR*	*12*
15	*CORIUM Prog. Revision*	*9-11*	*7*	*10*	*R*	*CO*	*12*
16	*Progress report on CONTAIN. Activities*	*12,13*	*21*	*3*	*R*	*CO*	*12*

[2] Deliverable numbers in order of delivery dates: D1 – Dn

3 Please indicate the nature of the deliverable using one of the following codes:

R = Report
P = Prototype
D = Demonstrator
O = Other

[4] Please indicate the dissemination level using one of the following codes:

PU = Public
PP = Restricted to other programme participants (including the Commission Services).
RE = Restricted to a group specified by the consortium (including the Commission Services).
CO = Confidential, only for members of the consortium (including the Commission Services).
CR = Confidential, parts of the reports only for members of working on the same subject (including the Commission Services)

[5] Month in which the deliverables will be available. Month 1 marking the start of the project, and all delivery dates being relative to this start date.

17	*CONTAIN. Exp. Recom*	*12,13*	*21*	*10*	*R*	*CO*	*12*
18	*CONTAIN. Interp Synth.*	*12,13*	*21*	*28*	*R*	*CR*	*12*
19	*CONTAIN. Model Recom*	*12,13*	*21*	*18*	*R*	*CR*	*12*
20	*CONTAIN.Prog. Revision*	*12,13*	*21*	*10*	*R*	*CO*	*12*
21	*Progress Report on Source Term (ST) activities*	*14-16*	*1-36*	*3*	*R*	*CO*	*12*
22	*ST Exp. Recom*	*14-16*	*1-36*	*10*	*R*	*CO*	*12*
23	*ST Interp Synth.*	*14-16*	*1-36*	*28*	*R*	*CR*	*12*
24	*ST Model Recom*	*14-16*	*1-36*	*18*	*R*	*CR*	*12*
25	*ST Prog. Revision*	*14-16*	*1-36*	*10*	*R*	*CO*	*12*
26	*Annual progress report*	*20*	*1*	*6*	*R*	*CO*	*12*
27	*JPA update*	*20*	*1*	*4*	*R*	*CO*	*12*
28	*Budget Revision*	*20*	*1*	*1*	*R*	*CO*	*12*
29	*Cost statements*	*20*	*1*	*1*	*R*	*CO*	*12*
30	ASTEC Assessment Report	3	1	100	R	CR	15
31	ASTEC Evaluation Report	4	1-23	100	R	CR	15
32	SA Course	17	32	12	R	PU	15-> 22
33	NEPTUNO Particip.	17	32	2	R	PU	15-> >30
34	Requirements for ASTEC V2 dev. plan	2	1-23	12	R	RE	18
35	Specifications of ASTEC adaptation to different NPP and systems	2	1	30	R	CO	18
36	Status Report on PSA2, methodology	5	1	15	R	RE	18
37	Status Report on PSA2, uncertainty assessment	5	1	15	R	RE	18
38	Status Report on PSA2, event tree	5	1	15	R	RE	18
39	Experimental Data Base Catalogue	6	28	21	R	CO	18
40	Revision of EURSAFE Conclusions	7	23	30	R	PU	18->21
41	PSA2 Course	17	32	12	R	PU	18->22
42	Book, skeleton	18	32	12	R	RE	18
43	Synthesis of requests from ACT users	1	1	3	R	PU	18
44	ERMSAR 2005	20 + all		10	O	PU	20
45	Revision of Mobility plan	18	32	2	R	PU	21
46	Progress report on ASTEC Activities	2-4	1-23	20	R	CO	24

47	ASTEC Adaptation to different NPP and systems (Prog. Rep.)	2	1	15	R	RE	30
48	ASTEC New Models	2	1-23	15	R	RE	30
49	Indicator Assessment.	8	1	4	R	CO	24
50	Progress report on CORIUM Activities	9-11	7	3	R	CO	24
51	CORIUM Exp. Recom	9-11	7	10	R	CO	24
52	CORIUM Interp Synth.	9-11	7	28	R	CR	24
53	CORIUM Model Recom	9-11	7	18	R	CR	24
54	CORIUM Prog. Revision	9-11	7	10	R	CO	24
55	Progress report on CONTAIN. Activities	12,13	21	3	R	CO	24
56	CONTAIN. Exp. Recom	12,13	21	10	R	CO	24
57	CONTAIN. Interp Synth.	12,13	21	28	R	CR	24
58	CONTAIN. Model Recom	12,13	21	18	R	CR	24
59	CONTAIN.Prog. Revision	12,13	21	10	R	CO	24
60	Progress Report on Source Term (ST) activities	14-16	36	3	R	CO	24
61	ST Exp. Recom	14-16	36	10	R	CO	24
62	ST Interp Synth.	14-16	36	28	R	CR	24
63	ST Model Recom	14-16	36	18	R	CR	24
64	ST Prog. Revision	14-16	36	10	R	CO	24
65	Annual progress report	20	1	6	R	CO	24
66	JPA update	20	1	6	R	CO	24
67	First version of R&D programme	20+all	1	6	R	PU	24
68	Update of Mobility Plan	18	32	2	R	RE	25
69	Book first draft	18	32	12	R	RE	30
70	Probabilistic software comparison for PSA2	5	1	3	R	RE	24
71	Recommendation on BEM for events in PSA2	5	1	5	R	RE	30
72	Recommendation on BEM for uncertainties in PSA2	5	1	5	R	RE	30
73	Status report on reliability methods application to PSA2	5	1	5	R	RE	30
TOTAL for deliverables to be produced during the JPA2				702			

6. Project resources and estimation of incurred eligible costs

6.1. Efforts for the full duration of the project (as defined at the beginning of the project)

Net work Effort Form 1[6] – Indicative efforts for full duration of project

Project Number (acronym) - 509065 (SARNET)

Figures followed by a * concern the organisations responsible for coordination of Topics in SARNET (during the duration of the project, these responsibilities may change, and this will modify the efforts provided by concerned organisations).

Network Activity Type	**Joint Programme of Activities[7]**			**Management activities**	TOTAL per PARTICIPANT
	Integrating Activities[8]	Jointly executed research activities[3]	Spreading of Excellence activities[3]		
1. IRSN *	158	36	8	72	274
2. AEAT		12			12
3. AEKI	12	12			24
4. ARCS	12				12
5. AVN	8				8
6. BUTE	48				48
7. CEA *	78	48	8	12	146
8. CESI		12			12

[6] Indicate effort in person months
[7] 'other specific activities' according to Article II.25 of Annex II to the contract
[8] except management of the consortium activities

9. Chalmers		12			12
10. CIEMAT	24	12			36
11. CSN	24				24
12. DEMOKRITOS		2	8		10
13. UPI	48	12			60
14. EA	20				20
15. EDF	24	36			60
16. ENEA	48	24			72
17. FORTUM	12	4			16
18. FRA ANP SAS	10				10
19. FRA ANP-Gmbh	8	24			32
20. FZJ		12			12
21. FZK *	72	36	8	12	128
22. FZR		12	4		16
23. GRS *	102	36	8	4	150
24. IUSTT-IKE	52	24	8		84
25. INR	54	12	4		70
26. INRNE	48				48

27. IVS	36				36
28. JRC-ISPRA *	12				12
29. JRC-ITU		24			24
30. JRC-PETTEN	54	24			78
31. JSI	24	12			36
32. KTH *	65	24	12	8	109
33. LEI	54	12	8		74
34. NNC	8				8
35. NRG	12	8			20
36. PSI	6	24	4		34
37. RUB		24	8		32
38.					
39. SWEDPOWER	12				12
40. TA		12			12
41. THERMODATA	3	12			15
42. TE	16				16
43. TUS	54	24	8		86
44. ULB	12				12

45. UCL		12			12
46. UJD	28				28
47. UJV	30	24			54
48. UPM		24			24
49. VEIKI	48	12			60
50. VTT	8	24			32
51. VUJE	50				50
52. BTech		24			24
TOTAL per ACTIVITY Type	1404	692	96	108	
Overall TOTAL efforts					2294

WARNING: This table has been established with the assumption that during the duration of the contract there is no changing in organizations (*) responsible of coordinating domains or managing databases or information systems.

6.2.Efforts for the second JPA 18 month period (month 13-month 30)

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 1 IRSN	Participant 2 AEA-T	Participant 3 AEKI	Participant 4 ARCS	Participant 5 AVN	Participant 6 BUTE	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	13.5			1		1	
PHYMA	9			3.5		2	
RAB	9					6	
PSA2	0.75				2		
IED	4.5		4.5				
SARP	3						
IA *	0						
Jointly executed research activities							
CORIUM	8.7						
CONTAINMENT	10.5						
SOURCE TERM	9	3	3				
Spreading of Excellence activities							
ET	1.5						
BOOK	0						
MOB	0						
TOTAL JPA	69.45	3	7.5	4.5	2	9	
Management Activities							
MANAG	22.5						
TOTAL Management	22.5						
TOTAL per PARTICIPANT	91.95	3	7.5	4.5	2	9	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) – 509065 (SARNET)

	Participant 7 CEA	Participant 8 CESI	Participant 9 Chalmers	Participant 10 CIEMAT	Participant 11 CSN	Participant 12 DEMOKRITOS	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	12			1			
PHYMA	1			8			
RAB	5						
PSA2	2.5				4		
IED	4.5			4.5			
SARP	3						
IA *	0						
Jointly executed research activities							
CORIUM	7.2						
CONTAINMENT	6.75						
SOURCE TERM	4.5	4.5	3	12.8		2.25	
Spreading of Excellence activities							
ET	1.5						
BOOK							
MOB							
TOTAL JPA	47.95	4.5	3	26.3	4	2.25	
Management Activities							
MANAG	4.5						
TOTAL Management	4.5						
TOTAL per PARTICIPANT	52.45	4.5	3	26.3	4	2.25	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 13 UPI (Pisa Univers.)	Participant 14 EA	Participant 15 EDF	Participant 16 ENEA	Participant 17 FORTUM	Participant 18 FRA ANP SAS	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	1	1	1	1		1	
PHYMA	2			9			
RAB	6	6.5	3.5	8		2.6	
PSA2			2.5				
IED					4.5		
SARP			3				
IA *							
Jointly executed research activities							
CORIUM			4.5	4.5			
CONTAINMENT	4.5		3				
SOURCE TERM			4.5	3	1.5		
Spreading of Excellence activities							
ET							
BOOK							
MOB							
TOTAL JPA	13.5	7.5	22	25.5	6	3.6	
Management Activities							
MANAG							
TOTAL Management							
TOTAL per PARTICIPANT	13.5	7.5	22	25.5	6	3.6	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2- 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 19 FRA ANP-Gmbh	Participant 20 FZJ	Participant 21 FZK	Participant 22 FZR	Participant 23 GRS	Participant 24 IUSTT-IKE	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT					5		
USTIA			1		11.25	1	
PHYMA			8		4.5	8	
RAB					11.25	9	
PSA2	2.5				4		
IED			3.5				
SARP			3		4.5		
IA *							
Jointly executed research activities							
CORIUM	4.5		6.3	4.5	4.65	5.25	
CONTAINMENT	0.75	4.5	12		3.3	7.5	
SOURCE TERM	4.5		0.75		3.75		
Spreading of Excellence activities							
ET							
BOOK							
MOB							
TOTAL JPA	12.25	4.5	33.5	4.5	52.2	30.75	
Management Activities							
MANAG			4.5		3		
TOTAL Management			4.5		3		
TOTAL per PARTICIPANT	12.25	4.5	38	4.5	55.2	30.75	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 25 INR	Participant 26 INRNE	Participant 27 IVS	Participant 28 JRC ISPRA	Participant 29 JRC ITU	Participant 30 JRC PETTEN	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	9	6	1			1	
PHYMA	3		6			17	
RAB	6	12	11				
PSA2	4					2.5	
IED				4.5			
SARP							
IA *							
Jointly executed research activities							
CORIUM	2.4		4.5		4.5		
CONTAINMENT						6.75	
SOURCE TERM	1.8				4.5	6	
Spreading of Excellence activities							
ET							
BOOK							
MOB	0						
TOTAL JPA	26.2	18	22.5	4.5	9	33.25	
Management Activities							
MANAG							
TOTAL Management							
TOTAL per PARTICIPANT	26.2	18	22.5	4.5	9	33.25	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 31 JSI	Participant 32 KTH	Participant 33 LEI	Participant 34 NNC	Participant 35 NRG	Participant 36 PSI	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	1	12	7.5		1	1	
PHYMA	5	3	6			1	
RAB		3	4.5		2.7	1	
PSA2			4	2		2.5	
IED		4.5					
SARP		3					
IA *							
Jointly executed research activities							
CORIUM		5.25				4.5	
CONTAINMENT	4.5	4.5	1.5		1.5		
SOURCE TERM						6	
Spreading of Excellence activities							
ET		1.5					
BOOK		1.5					
MOB		0.75					
TOTAL JPA	10.5	39	23.5	2	5.2	16	
Management Activities							
MANAG		3				4.5	
TOTAL Management		3				4.5	
TOTAL per PARTICIPANT	10.5	42	23.5	2	5.2	20.5	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 37 RUB	Participant 38	Participant 39 SWEDPOWER	Participant 40 TECHNICATOME	Participant 41 THERMODATA	Participant 42 TRACTEBEL	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	1					1	
PHYMA	2						
RAB						3	
PSA2			2				
IED							
SARP							
IA*							
Jointly executed research activities							
CORIUM	4.5			1.5	3		
CONTAINMENT	4.5			1.5			
SOURCE TERM							
Spreading of Excellence activities							
ET							
BOOK							
MOB							
TOTAL JPA	12		2	3	3	4	
Management Activities							
MANAG							
TOTAL Management							
TOTAL per PARTICIPANT	12		2	3	3	4	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 43 TUS	Participant 44 ULB	Participant 45 UCL	Participant 46 UJD	Participant 47 UJV	Participant 48 UPM	TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	6			1	1		
PHYMA	8				4.5		
RAB	4			10.4	1.5		
PSA2	2	4			2		
IED							
SARP	3						
IA *							
Jointly executed research activities							
CORIUM					5.7	4.5	
CONTAINMENT	6				4.5	4.5	
SOURCE TERM	2.25		4.5				
Spreading of Excellence activities							
ET							
BOOK							
MOB							
TOTAL JPA	31.25	4	4.5	11.4	19.2	9	
Management Activities							
MANAG							
TOTAL Management							
TOTAL per PARTICIPANT	31.25	4	4.5	11.4	19.2	9	
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

Network Effort Form 2 - 18 months period, month 13 - 30

Project Number (acronym) - 509065 (SARNET)

	Participant 49 VEIKI	Participant 50 VTT	Participant 51 VUJE	Participant 52 BTech			TOTAL ACTIVITIES
Joint Programme of Activities							
Integrating activities							
ACT							
USTIA	1		1				
PHYMA							
RAB	17		19				
PSA2	2						
IED		4.5					
SARP		2					
IA *							
Jointly executed research activities							
CORIUM		0.9					
CONTAINMENT	4.5						
SOURCE TERM		4.5		3			
Spreading of Excellence activities							
ET							
BOOK							
MOB							
TOTAL JPA	24.5	11.9	20	3			
Management Activities							
MANAG							
TOTAL Management							
TOTAL per PARTICIPANT	24.5	11.9	20	3			
Overall TOTAL EFFORTS							

* the corresponding efforts are counted in the coordination tasks of each topic.

6.3. Project management level, description of resources and grant

The two following tables describe the resources needed to carry out the Joint Programme of Activities, respectively for the second 18 months period and for the total duration of the contract (48 months).

For the JPA2 (18 months)

3 kinds of expenses are considered:

- manpower, it has been evaluated starting from the estimation given in § 10.2, with a lump value of the man-year cost (125000 €/year)
- travels for mission, with an average cost of 750€ per mission
- other expenses related to:
    - support of ASTEC users, one part of this activity will required a subcontract of 1m-y/y (125000€)
    - a sub contract for maintenance and specific development for the ACT, including the improvement of ASTEC web site (provision of 40000€)
    - the organisation of one SARNET conference (50000€)
    - the organisation of a SA phenomenology and PSA course (30000€)
    - mobility; it has been evaluated to 60000 €/year

The total expenses will be around 9.8 M€.

For the total duration of the contract

The evaluation is that made at the beginning of the contract, with the following assumptions:

- no significant changes (/JPA1) in the investigated domains, and in the number of organisations participating to each one;
- 1 m-y/y for the coordinator;
- 2 m-y/y for support, training of users and model implementation in ASTEC (1 of the 2 m-y is provided via a sub contract);
- 1.5 m-y/y for the coordination of scientific and excellence spreading activities;
- 0.25 m-y/y for the management (and user-training) of the experimental data base;
- 0.25 m-y/y for the management of the information system (ACT);
- 0.66 m-y/y/participant to ASTEC activities;
- 0.25 m-y/y/participant to each one of the following activities: Corium, Containment, Source Term,
- 0.15 m-y/y/participant for Research priorities
- 0.15 m-y/y/participant to level2 PSA activities;
- 0.15 m-y/y/participant to excellence dissemination activities

We kept the same assumption as above for ACT possible sub-contract.
We assumed the holding of 2 SARNET conferences.

The total expenses will be around 24M€.

JPA COST FOR THE SECOND 18 MONTHS PERIOD (JPA2)

Activities	Nb of organisations	Nb of correspondents per organisation	Nb of meetings within the first 18 months	Meeting cost	Nb of men-months	Manpower cost	Other costs	Total	
ACT development				0		0	40000	40000	
Electronic network administration	1	1	2	1500	5	52085		53585	
ASTEC user support	2				18	187506	187506	375012	
ASTEC WPs	29	1	3	65250	352,7	3674075,9		3739325,9	
Level 2 PSA	17	1	3	38250	50	520850		559100	
Exp. Data Base Administration	1	1	1	750	4,5	46876,5		47626,5	
Exp. Data Feeding	8	1		0	34,95	364074,15		364074,15	
Research priorities	8	2	2	24000	24,5	255216,5		279216,5	
Integration Monitoring	7			0	0	0		0	
				0					
Corium WPs	19	2	3	85500	91,35	951592,95		1037092,95	
Containment WPs	18	2	3	81000	97,3	1013574,1		1094574,1	
Source Term WPs	22	2	3	99000	92,6	964614,2		1063614,2	
								0	
Education & training	12	1	2	18000	42	437514	30000	485514	
Mobility programme	10	1	0	0	0,75	7812,75	90000	97812,75	
Management team	7	1,5	3	23625	42	437514		461139	
Governing board meetings	49	0,66	2	48510				48510	
Advisory committees meetings	10	1	2	15000				15000	
SARNET CONFERENCES (1)							50000	50000	
Total				500385	855,65	8913306,05	397506	9811197,05	

Lump cost of one man-month (€)	10417
Lump cost of one participation /meeting €	750

SARNET JPA COST (€)	9811197,05

JPA FULL COST FOR THE CONTRACT DURATION (4 years)

Activities	Nb of organisations	Nb of correspondents per organisation	Nb of meetings per year	Meeting cost	Nb of men-years/year	Manpower cost	Other costs	Total
ACT development				0		0	50000	50000
Electronic network administration	1	1	1	3000	0,25	125000		128000
ASTEC user support	2				1	500000	500000	1000000
ASTEC WPs	28	1	2	168000	18,98	9490000		9658000
Level 2 PSA	17	1	2	102000	2,55	1275000		1377000
Exp. Data Base Administration	1	1	1	3000	0,25	125000		128000
Exp. Data Feeding	5	1		0	1,25	625000		625000
Research priorities	8	2	1	48000	1,2	600000		648000
Integration Monitoring	7			0	0	0		0
				0				
Corium WPs	18	2	2	216000	4,75	2375000		2591000
Containment WPs	19	2	2	228000	5	2500000		2728000
Source Term WPs	21	2	2	252000	5,5	2750000		3002000
								0
Education & training	12	1	1	36000	1,45	725000		761000
Mobility programme	10	1			0,5	62500	60000	122500
Management team	7	1	2	42000	2,5	1250000		1292000
Governing board meetings	49	0,66	1	97020				97020
Advisory committees meetings	10	1	1,5	45000				45000
SARNET CONFERENCES (2)							100000	100000
Total				1240020	45,18	22402500	610000	24352520

Lump cost of one man-year (€)	125000
Lump cost of one participation /meeting €	750

SARNET JPA COST (€)	24352520

Appendix A- Consortium description, new contractors

A.1 Update of the list of partner organizations and of scientists involved in the network

No new candidate will enter the consortium for the execution of the second JPA.

A.2 Sub-contracting

The activity consisting in supporting ASTEC users will be sub-contracted. The reason is that experts in ASTEC will be mostly involved in tasks aiming at improving and assessing the code.
The company that which is contractually in charge of supporting ASTEC users (maintenance and Web site) will carry the corresponding activity. After a call for tenders in 2001, the contract has been initiated in December 2001 and will last up to December 2004. In order to support the SARNET ASTEC users, an amendment of this sub-contract has already been decided to extend the duration of 1 year, thus covering the whole year 2005.
Thus, the contract will finish in December 2005. During the year 2005, a new call for tenders will thus have to be set up for the following years, with the milestone of sub-contractor selection end of 2005.
IRSN will be responsible for the subcontracting, the amount of the sub-contract is around 125 k€/year.
The improvement of the ASTEC web site within ACT requires in 2005 a subcontract of 10 k€.

The development and maintenance of ACT and of the public SARNET Web site require a subcontract. GRS is responsible for the subcontracting, the amount of the sub-contract for the whole duration of the project is around 80k€, subject to some extensions to increase its user-friendliness.

The training for using STRESA tools (necessary for data implementation) may punctually require the support of external organisations. JRC-ISPRA or trainee organisation will be responsible for these subcontracts.

The translation of VVER documentation from Bulgarian to English requires a subcontract (to be launched in 2005). TUS is responsible for the subcontracting, the amount of this sub-contract is around 3.3k€.

A.3 Third parties

The participation of AEA-T to SARNET will be co-funded by BRITISH ENERGY, and by BNFL (in-kind contribution in Joint Executed Research Activities).
The participation of VTT to SARNET will be co-funded by the State Nuclear Waste Management Fund (VYR), the Nordic Nuclear Research Programme (NKS) and Finnish Nuclear Safety and Radiation Authority (STUK).
The participation of GRS to SARNET will be financially supported by the German Federal Ministry of Economy and Labour.