



SARNET NEWS N°9

October 2007

GENERAL INFORMATION AND PROJECT MANAGEMENT (*Thierry ALBIOL*)

A paper entitled "SARNET: Severe Accident Research Network of Excellence" by the SARNET Management Team has been presented at the **ICONE-15 conference**, Nagoya, Japan, 22-26 April 2007.

The second European Review Meeting on Severe Accident Research and management, **ERMSAR 2007**, hosted by FzK in Karlsruhe (Germany) on June 12 - 14, 2007 has been a successful meeting gathering more than 100 participants from 20 European and non-European countries. 32 papers on the SARNET main topics were presented.

The next **ERMSAR** conference is scheduled on September 23 - 25, **2008**, in Varna (Bulgaria), hosted by INRNE. After four and a half years of SARNET, it will allow to highlight the major achievements of SARNET through synthesis papers, while giving also a wider view on Severe Accident Research. A provisional programme and practical information will be available soon on the SARNET WEB site: <http://www.sar-net.org>.

The current SARNET **contract** should be **extended** up to end of September 2008. Now, a draft call for proposals has been issued by the EC, in the frame of the 7th Framework Programme, asking for a network of excellence which should include R&D on key remaining open questions in severe accident research. The answers will have to be officially given on April 15, 2008 and a "**SARNET follow-up contract**" can be expected from early 2009. First iterations to answer this call have started, taking into account a severe reduction of the Network budget in order to fund also R&D as requested by the EC.

Formal contacts have been taken with the **US-NRC**. They could enter the SARNET follow-up consortium and, in a first step, participate as observers to some future SARNET meetings.

ASTEC (*Jean-Pierre VAN DORSSELAERE*)

All 30 partners are currently applying the ASTEC V1.3rev0 version, released in Dec.06, to the work plan defined with the Topical Coordinator:

- Comparison with experimental data, including BWR and CANDU ones for the first time, as well as experiments on in-vessel melt retention such as LIVE in FZK,
- Benchmarks on plant applications with special emphasis on fission product behaviour.

A revised version, ASTEC V1.3rev1, was released during summer 2007 to IRSN users only. IRSN and GRS will release to all partners a new update in the next months. The V1.3rev2 version will account for the feedback of the 2007 maintenance efforts, as well as better models for the pressuriser behaviour, and finally will allow continuing the calculations of scenarios beyond vessel lower head failure.

In parallel, IRSN and GRS completed the general requirements of the next series V2 of ASTEC versions; the report will be soon uploaded on ACT. The efforts focus now on the V2 general specifications and the plan of development that are planned for end of 2007.

The 3rd ASTEC Users Club, hosted by IRSN, is planned in Aix-en-Provence from 21 to 24 April 2008.

PSA2 (level 2 Probabilistic Safety Assessment) ACTIVITIES (*Bernard CHAUMONT*)

The next partners meeting (October 17th and 18th 2007 in VEIKI – Budapest) has been actively prepared. Besides the usual topics of the PSA2 group activities (classical methods harmonization and development of dynamic reliability methods), this meeting is the opportunity to discuss new themes for the group such as expert judgement use in level 2 PSA development, requirements for ASTEC code for level 2 PSA applications, ASTEC coupling with probabilistic codes.

Recent progress concern:

- The preparation of a proposal of good practices to assess in a level 2 PSA molten corium concrete interaction, based on the analysis of the partners' methods,

- The elaboration of a status of the methods used by the partners to assess iodine releases with a proposal for their improvement,
- The analysis of partners' definitions of reactor final states (for a level 2 PSA) and of large releases and large early releases with a proposal for harmonization of those definitions,
- The answers given by different partners to the questionnaire on level 1 and level 2 PSA interface and their comparison,
- The finalisation of the D97 deliverable (available on ACT) concerning the benchmark exercise to compare dynamic reliability methods and classical ones. The first two steps of the benchmark have been achieved (without, then with uncertainties assessment), and the preparation of the third step of the benchmark (improvement of physical modelling, introduction of delays in human actions, separation of the quantification of aleatory and epistemic uncertainties) is under way,
- The preparation of a questionnaire on the present status of the computer codes for level 2 PSA (for the next step to define ASTEC requirements),
- The review of available tools, techniques and protocols for expert judgment use.

SARP (Severe Accident Research Priorities) Activities *(Bernd SCHWINGES)*

The objective of this Work Package 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 makes 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 domains of SARNET.

It makes also use of results obtained in the frame of other international projects (ISTC, OECD...), and the outcome of Level 2 PSA activities carried out in the frame of national programs (risk-oriented research) is regarded. It takes into account the potential capabilities of SARNET and identifies the potential experimental or theoretical programs for resolving the identified important pending issues.

The reassessment of the priority ranking of the EURSAFE Research Items (ERI) issues was intensively discussed in a top-down approach during the 3rd SARP meeting, held at FZK Karlsruhe on February 28th 2007 and later on during the 4th SARP meeting on September 5. As result six issues are regarded to be investigated further with **high priority**:

- combined research on ERI 1,2 (core coolability during reflood and debris cooling);
- combined research on ERI 2,1/2,2 (ex-vessel melt pool configuration during MCCI, ex-vessel corium coolability by top flooding);
- combined research on ERI 3,1/3,2 (melt relocation into water, ex-vessel FCI);
- research on ERI 3,4 (hydrogen mixing and combustion in containment);
- research on ERI 5,1 (oxidising impact (Ru oxidising conditions/air ingress for HBU and MOX fuel elements) on source term);
- combined research on ERI 5,2/5,4 (iodine chemistry in RCS and in containment).

Three issues are re-assessed with **medium priority**; these items should be investigated further as already planned in the different research programs. The risk significance is reduced due to considerable progress of knowledge, but some questions are still open:

- research on ERI 1,1 (hydrogen generation during reflood and melt relocation in vessel);
- research on ERI 1,4 (integrity of RPV due to external vessel cooling);
- research on ERI 4,1 (direct containment heating).

For five issues the current knowledge is considered as sufficient assessing the state and progress of knowledge and the risk and safety relevance and taking into account ongoing activities outside SARNET frame: these issues are assessed with **low priority**, they could be closed after the related activities are finished:

- research on ERI 1,3b (corium coolability in core catcher with external cooling);
- research on ERI 1,6 (corium release following vessel rupture);
- research on ERI 5,3 (aerosol behaviour impact on source term (in steam generator tubes and containment cracks);
- research on ERI 5,5 (core reflooding impact on source term);
- research on ERI 3,5 (crack formation and leakages in concrete containment).

Three issues are marked as '**issue could be closed**'. Due to the risk significance and the current state of knowledge, which is regarded as sufficient in comparison to other issues with greater risk relevance and larger uncertainties, no further experimental program is needed:

- research on ERI 1,5 (integrity of reactor coolant system and heat distribution);
- research on ERI 2,3/2,4 (ex-vessel core catcher and corium-ceramics interaction, cooling with water bottom injection);
- research on ERI 3,3 (FCI incl. steam explosion in weakened vessel).

The description of the issue ranking was confirmed by the SARP group and some comments of the Advisory Committee members and end users were taken into account. The work performed in the SARP group is an attempt to come in a reasonable time under consideration of all useful co-determination to an agreed decision considering all aspects of innovation and economic efficiency. The results are described in more details in the D67 report, which will serve as a proposal to provide the Governing Board of SARNET with arguments for defining the orientations for the further joint activities for research of common interest and high priority.

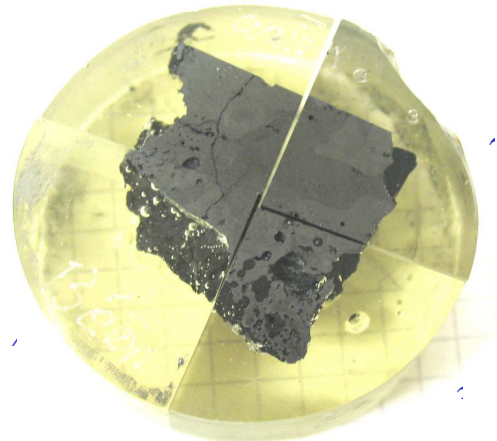
CORIUM (*Christophe JOURNEAU*)

Launching a "generic reactor case" benchmark on MCCI

On October 12th, 2007, a new benchmark on Molten Core Concrete Interaction (MCCI) has been launched. MCCI is one of the corium domain issues selected with high priority by the SARP group. Contrary to previous benchmarks, which were dedicated to the calculation of experiments, this benchmark exercise concerns the reactor scale. One of its aims is to apply the codes and fittings that were used in previous benchmarks on European and OECD experiments to the full scale, in order to assess the differences between codes at this scale. The benchmark will be co-coordinated by Michel Cranga from IRSN and Dimitar Dimov from INRNE who will come to Cadarache early next year, thanks to a SARNET Mobility grant.

A round-robin exercise for the corium material analyses

Corium thermo-dynamical database validation relies on the material analyses conducted during post-test examinations. In order to assess the uncertainties of this process, which is quite different from standard analyses due to the very large difference in atomic weight between the constituents of corium (e.g. think of U and O !) and the constraints due to the radioactivity of the samples, there were no data on these uncertainties. A round-robin exercise has been organized in which a VULCANO sample has been analyzed in Cadarache, transported to Karlsruhe where it is being analyzed by ITU and will then be transferred to UJV Rez, where it will be analyzed by their partner, the Institute of Inorganic Chemistry of the Czech Academy of Sciences. Then, the results from these analyses will be compared...



Joint works on the WABE code

Joint activities between IKE, VTT and KTH on the debris cooling code WABE are gaining full speed. After a transfer of the code and training sessions, VTT is now analyzing the STYX experiments while KTH works on DEFOR experiments. Both tests are dealing with the issue of debris formation and coolability, one of the issues with the highest priority, according to SARP group, in the corium domain.

PLINIUS FP6 Call for Proposal

PLINIUS FP6 is an EURATOM FP6 project which is closely linked to SARNET. It funds the realization of experiments in the PLINIUS prototypic corium platform at CEA Cadarache for the benefit of non-French European scientific users. The first call for proposals has been won by a SARNET team from the Source Term domain (DEMOKRITOS, CESI Ricerca and CIEMAT). A new call for proposals is open and will close in March 2008. For more information: www.plinius.eu.

CONTAINMENT (*Leo MEYER*)

WP 12-1 (Hydrogen Combustion) is concentrating on two activities, hydrogen recombiner experiments and modelling, and a hydrogen combustion code benchmark to evaluate the capabilities and weaknesses of the codes used within SARNET for modelling. Experimental activities on recombiners continued as planned as well as recombiner model development. A facility for recombiner testing on

natural convective conditions was commissioned. A hydrogen combustion/explosion benchmark was performed using experimental data from the ENACCEF facility as reference. These experiments are kind of unique as they allow investigating hydrogen combustion with concentration gradients involved. Benchmark results indicate that current combustion models have some weaknesses especially under negative hydrogen gradient conditions.

Within the WP12-2 CAM (Containment Atmosphere Mixing), the 4th workshop took place on May 24 & 25, 2007, in Chatou (near Paris, France). The meeting, which was organized by Electricité de France, was devoted to the following current activities within WP12-2: the spray benchmark, the condensation benchmark and the Passive Autocatalytic Recombiner interaction studies (PARIS) benchmark. The spray benchmark is being coordinated by IRSN (Saclay, France). At the meeting, simulation results of tests TOSQAN 113 and MISTRA MARC2b were presented for the first time, as well as revised simulation results of tests TOSQAN 101 and MISTRA MASP1 and MASP2. Both lumped-parameter and CFD codes are being used for calculations. The condensation benchmark is being coordinated by the University of Pisa (Italy). At the meeting, participants of the benchmark presented and discussed the results of the first phase "Benchmark 0". The next phase, which should involve the simulation of an actual experiment, performed in the CONAN facility at the University of Pisa, was discussed. The PARIS benchmark is being coordinated by CEA (Saclay, France). At the meeting, possibilities for the next phase were discussed, as no sensible progress was made on that issue from the previous meeting in November 2006.

Since the 4th workshop in Chatou, the following actions have been completed:

- The final report about the modelling of containment sprays used by the participants in the spray benchmark was prepared.
- The closing of the spray benchmark (that is, the possibility to submit additional simulation results of the spray experiments) was defined. Possible further steps to continue the benchmark were also proposed and will be discussed at the next meeting.
- The report of the condensation "Benchmark 0", which contains the comparison and analysis of the participants' results, was finalized.
- The specification for the 2nd phase of the PAR interaction studies (PARIS2) benchmark was defined and sent to WP12-2 members.

The 5th workshop of the WP12-2 CAM will take place in Bled, Slovenia, on February 28 & 29, 2008. The spray benchmark, the condensation benchmark and the PAR interaction studies benchmark will again be the main topics.

Within WP13-1 FCI (Fuel-Coolant Interaction) most of the work aimed at determining the reasons for lower energetics observed in steam explosion with corium melt as compared to alumina melt, which would allow making a significant step towards understanding the role of melt properties on steam explosion energetics and being able to predict the behaviour of real corium in reactor conditions. A technical meeting was held at IRSN, Fontenay-aux-Roses in May 2007 to make a status and exchange views on on-going actions on the subject. As a contribution to understanding the material effect an action was launched concerning the analysis of exploded and non exploded debris from PREMIX, ECO (FZK), MISTEE and DEFOR (KTH) in collaboration with the Czech NRI and Institute of Inorganic Chemistry. Sensitivity calculations performed with MC3D and IKEMIX-IDEMO codes on the basis of past experiments such as PREMIX, KROTOS and FARO complemented work performed in the frame of OECD SERENA-Phase 1 program. Future work will be made in connection with OECD SERENA-Phase 2 program, which will be launched around end of the year.

Within WP13-2 DCH (Direct Containment Heating) the model development is pursued by benchmark exercises among the partners IRSN, GRS and EdF. The first one was concluded with finalizing the synthesis report CONT P09, and the second one was initialized by distributing the experimental data to the participants. First results are expected in November 2007. Work with the codes COM3D and FLUENT was started to model hydrogen combustion at DCH conditions by FZK based on separate effects tests conducted in the DISCO facility.

A document library in the ACT-CONTAINMENT site was set up with up to now 22 publications from journals and conferences by the Containment group. The uploading of all relevant papers from the group will be continued.

SOURCE TERM (*Tim HASTE*)

Good progress is being made overall in the JPA4 programme, while potential activities in a possible FP7 follow-up programme are under discussion. Publication of technical work continues. An overview

of the area was presented at ERMSAR2007 in June, while a lecture on recent progress was given at Newcastle University, also in June.

WP14-1: Oxidising environment impact on the source term

A progress meeting was hosted by VTT in June 2007, followed by a synthesis paper at ERMSAR2007. Experiments are proceeding on UO₂ pellet self-disintegration at INR, while analysis of VTT Ru transport tests is proceeding. Four fission product release tests have been agreed with AECL for distribution in SARNET, and the data are awaited. Four tests have been proposed for VERDON in the ISTP programme, the first test is likely mid-2009, while requirements for micro-analysis of VERCORS samples have been agreed. Validation of ASTEC release models has been performed against available AECL tests, and identified model improvements are under way.

WP14-2: RCS high temperature chemistry impact on the source term

Concerning iodine behaviour in the circuit, the main focus has been on the CHIP experimental programme, with definition of the test matrices for the analytical and phenomenological lines; tests in the first, simpler, series are under way while those in the second are planned to start in May 2008. A meeting of the relevant I-RCS circle was held in March 2007. Preparation of the new VTT revaporisation/speciation test facility is in progress. On the modelling front, rate constants of the {I-Cs-O-H} system have been evaluated by IRSN with a simplified scheme being proposed for ASTEC. An attachment from VTT to IRSN under the mobility programme is under way. Concerning PWR control rod behaviour, PSI, GRS and EdF have cooperated with FZK in providing pre-test calculational support for the PWR reflood test QUENCH-13, and assisting with test definition, aiming amongst other matters to optimise conditions for measurement of control rod aerosol release. PSI and AECL are providing experimental support for the aerosol measurements. The main test is scheduled at the end of October 2007. Five associated small-scale tests have been performed with five more planned. An abstract on this work has been prepared for ICAPP'08 in June 2008.

WP15: Aerosol behaviour impact on the source term

Concerning resuspension, cooperation has been arranged between Newcastle University and IRSN for PhD work aimed at improving the modelling in ASTEC/SOPHAEROS. JRC/IE have analysed all resuspension STORM tests and distribution of the report is awaited. On revaporisation, the joining of new organisations to the circle (i.e., FORTUM, AECL and UJV) added significant analytical as well as experimental expertise to the circle. A status paper was presented at ERMSAR2007, and release of relevant data has been agreed with AECL. Preparation for analysis of Phebus FPT3 samples is under way at JRC/ITU. On retention in containment cracks, Demokritos have led a proposal for experiments in COLIMA under the PLINIUS platform, and results of the evaluation are awaited. Recently, IRSN-Saclay has shown their interest to join this COLIMA venture. On SGTR, a CIEMAT/PSI paper has been published in Nuclear Technology, while model developments continue on retention in the secondary side.

WP16 Containment chemistry impact on the source term

The Iodine Data Book was fully delivered on schedule, while a joint paper on iodine mass transfer by CIEMAT and IRSN was presented at NURETH-12, and an extension of the work is considered worthwhile for a journal paper on the matter. On radiolytic oxidation, the EPICUR programme is producing many new data, with test definition and analysis coordinated through the ISTP/CHEMIC circle. Five tests are planned in the period March-December 2007 and the next tests will be discussed in an upcoming meeting. A summary of the programme was presented at NENE2007 in September, led by IRSN. Agreement has been reached on release of data from the RTF P9T3 test by AECL, and delivery of the reports is awaited. On Phebus FPT2, a synthesis paper was presented at ERMSAR2007. On autocatalytic recombiners, ASTEC/SOPHAEROS calculations by IRSN of RECI small-scale tests have reproduced the data quite accurately, while the potential contribution to the source term is being assessed by CFD methods. A comparison workshop on the THal-Iod9 benchmark has been organised by GRS for 19 October, to consider the results submitted. Experimental work on ruthenium behaviour in the containment continues at IRSN (EPICUR) and at Chalmers University. Minutes have been issued for the previous Phebus and ISTP chemistry circles, with which WP16 is closely linked; the next set of such meetings is due in the week starting 15 October 2007 with the following series in early April 2008.

EXCELLENCE SPREADING

Education and Training:

A training course, "Severe Accident Progression (analysis, data and uncertainties)", was held in Cadarache, France, on March 12 - 16, 2007. 19 high level experts provided lectures to 38 participants from various European and non-European countries, and from various type of organisations (Safety authorities, utilities, vendors, research organisations, ...)

A joint SARNET/NEA training course on "Nuclear Reactor Severe Accident Analysis: Applications and Management Guidelines" will be held from April 7 to 11, 2008 at Budapest University of Technology. For more information, please check the SARNET Web site (<http://www.sar-net.org>).

Book:

After a rather slow start, the writing of the Severe Accident text book is now on the tracks. A first draft is expected by end 2007, with the objective of publishing the book in 2008.

Mobility:

For SARNET year 3 (from April 2006 to March 2007), 12 delegations have been performed thanks to the SARNET mobility programme. Currently, seven mobilities are on-going or planned from April 2007 to September 2008

FUTURE EVENTS *(events relevant to specific technical domains are not reported here)*

Advisory Committee Meeting N°3: October 12th, 2007, Paris (France).

SARNET Annual review Meeting: January 21st to 25th, 2008, Bled (Slovenia).

Management Team meeting N°9: February 28th, 2008, Paris (or Fontenay aux Roses) (France).

Governing Board meeting N°5: March 14th, 2008, Bled (Slovenia).

ERMSAR 2008, September 23-25, 2008, Varna (Bulgaria).



ERMSAR 2007 – Karlsruhe – June 12-14, 2007