

The project has reached its mid-term. Many partners' joint tasks are progressing, such as common interpretation of new experiments, organization of benchmarks between simulation codes and proposals of improved modelling of the most important phenomena. Stronger links must now be established with end-users through different entities like the Advisory Committee, the European SNETP and the PSA2 Community. In that perspective the Severe Accident Research Priorities group (SARP) is starting to update the 2008 reports to define and rank the priorities of R&D for severe accidents on Gen.II-III plants. These priorities will have to account for the impact of the recent Fukushima accident. Finally an important actor on severe accident R&D, BARC (India), is currently joining the network.

General news

The 5th Management Team meeting was hosted by VTT in Helsinki on March 10th. The main discussion focused on the organization of the next ERMSAR-2012 that will be hosted by GRS in Cologne in March 2012 (see the next article).

The first meeting of the Advisory Committee took place in Paris on February 15th. It is composed of 12 experts, all from end-users (industry, safety authorities...) and mostly non-SARNET partners. Its objective is to advise on strategic orientations of the research activities of the network and on the implementation of the mission to spread excellence. The Committee was satisfied with most current actions of the network. Their first action will consist in reviewing the progress report of the SARNET2 group working on severe accidents research priorities (SARP), to be released before end of 2011.

A 43rd partner is joining officially the network in June 2011: Bhabha Atomic Research Centre (BARC) in India. This big organization is performing a very large R&D programme on severe accidents that covers experimental and modelling tasks. The size of the involved BARC team is about 20 engineers, plus the researchers or students in the Universities. These experiments concern severe fuel damage in real materials, molten corium concrete interaction, debris bed cooling, containment thermal-hydraulics and aerosol behaviour... In-house computer codes are developed and verified against the ASTEC integral code. In a first stage, BARC will contribute to the adaptation of ASTEC modelling to IPHWR¹ core degradation. Later on some exchanges could take place around some of the above Indian experiments.

A general paper on SARNET progress, with the whole MT as authors, was presented at ICAPP-2011 conference in Nice (France). Eight other papers from diverse partners were closely linked to SARNET activities.

¹ Indian Pressurized Heavy Water Reactors

Contact: Jean-Pierre Van Dorsselaere
jean-pierre.van-dorsselaere@irsn.fr



Links with the European PSA2 community

C.Journeau (WP6 MCCI leader) and J.P. Van Dorsselaere (SARNET2 coordinator) have attended the final workshop of the FP7 ASAMPSA2 project on best-practice guidelines on Level 2 Probabilistic Safety Assessment (PSA2), coordinated by E.Raimond (IRSN). This workshop was hosted by Fortum (Finland) in Helsinki from 7 to 9 March. The status of R&D on the most important issues has been discussed on the basis of SARNET knowledge: it was concluded that no major points on R&D were missing in the Guidelines, but nevertheless the SARNET2 MT will send suggestions for update or reformulation of some parts of the text. These guidelines, to be released after summer 2011, will be used as inputs by the SARP group. A possible follow-up of the ASAMPSA2 project has been discussed. Some subjects could still reinforce the strong links with SARNET2.

Contact: Jean-Pierre Van Dorsselaere
jean-pierre.van-dorsselaere@irsn.fr



Next ERMSAR-2012

The next ERMSAR conference will be the first SARNET "open" conference on severe accident research. It means that, beyond usual network partners' joint papers, any organization, even not member of the network, is invited to present papers on their own work on severe accidents. It will be hosted by GRS in Cologne (Germany) from May 21 to 23, 2012. The global objective of this 5th seminar will be to present the recent progress of international knowledge on severe accidents, including of course the work done within the network in the last two years. It will be also an opportunity to discuss future R&D priorities on severe accidents, and in particular how the feedback of the Fukushima accident can be taken into account.

The deadlines are:

Abstracts: July 29, 2011
Draft papers: November 30, 2011
Pre-registration: November 30, 2011
Registration: March 1, 2012

Contact: Roland Zeyen (JRC/IE) 
roland.zeyen@irsn.fr




and Martin Sonnenkalb: martin.sonnenkalb@grs.de

The impact of the Fukushima accident on SARNET

SARNET, as the reference network on severe accidents, must account for the impact of the recent Fukushima accident on the R&D priorities. An internal process is being launched to jointly analyse the phenomenology and the mitigation of consequences (but not the emergency response aspects). Partners will try to reach a joint understanding on the accident progression, either in the reactors themselves or in the spent fuel pools. After setting a common base of available data from the plants, partners will exchange information on their own interpretations, through either calculations with computer codes or hand-evaluations or experts' analyses.

The SARP group will be periodically informed on the progress of these tasks, particularly in the perspective of the final Deliverable on the R&D priorities which is foreseen end of 2012.

Contact: Jean-Pierre Van Dorselaere 
jean-pierre.van-dorselaere@irsn.fr



The 4th ASTEC Users' Club

The 4th ASTEC international Users' Club was organized by IRSN and GRS and hosted by GRS in Köln on October 11-14. During this 4-day workshop, discussion took place on the progress of the technical work done in the WP4 "ASTEC" between IRSN-GRS and 45 users from 24 organizations (some of them being non-SARNET partners, like Kurchatov Institute in Russia). Twenty-seven presentations were performed, along with an on-line demonstration on the ATLAS graphical post-processing tool.

Discussions focused mainly on the assessment of the ASTEC V2.0 version versus experimental data (the Deliverable on the synthesis of this work has been released by the end of 2010). It covered the experiments shown in the following table, plus the 4 phases of the TMI2 accident.

Physical process	Programme name
RCS thermal-hydraulics	BETHSY 9.1b PACTEL ISP33 LOFT LP-FP2
Core degradation	CORA-13 and -W2, QUENCH-03 and -12 Phébus FPT1 and FPT4 LIVE-L1 LOFT LP-FP2
Fission product (FP) release	VERCORS V4 and V5 VERCORS HT1, HT2, HT3 VERCORS RT1, RT3, RT4 Phébus FPT1
FP/aerosol transport in the reactor cooling system	TUBA-D07 FALCON-18 STORM-SR11 VERCORS (HT1 to HT3) Phébus FPT1
Direct Containment Heating	ANL-IET1RR, ANL-U1B
Molten Corium Concrete Interaction	OECD-CCI2, CCI-3, CCI-5 VULCANO VBU5, VBES-U2
Containment thermal-hydraulics	KAEVER (5 tests) LACE-LA4 MARVIKEN Blowdown-16 VANAM-M3 NUPEC M7-1 POSEIDON II (17 tests) MISTRA MASP1 PANDA T9, T9bis, T25
Hydrogen combustion in containment	HDR E12.3.2 ThAI HD-12
Aerosol transport in the containment	KAEVER (5 tests) LACE-LA4 POSEIDON II (17 tests)
Iodine chemistry in containment	SREAS-01 ACE RTF-3B Phébus RTF1, RTF3, RTF6 CAIMAN 97/02 Phébus FPT3

The main conclusions are summarised hereafter:

- For primary and secondary circuit thermal-hydraulics: good results but modelling shortcomings on a PACTEL-ISP33 integral test (VVER design).
- For core degradation: good results for early-phase models (core heat-up, oxidation and hydrogen cumulated production) at least up to the final quenching, if any. Conversely, the

large hydrogen peaks observed during the quenching late phase of CORA-13 and LOFT-LP-FP2 tests and TMI2 are not reproduced. For late phase models, good results have been obtained on Phébus FPT4 (using the magma-debris models in the core region) and LIVE-L1.

- For FP release: very good results that underline a significant improvement with respect to previous ASTEC V1 versions, in particular on release of semi-volatile FPs and SIC (Silver-Indium-Cadmium) materials from control rods.
- For FP/aerosol transport in the primary circuit: reasonable results. Anyway, the crucial importance of gas phase chemistry has been underlined again in the Phébus FPT1 applications, in particular for iodine behaviour. Indeed, though the development of a detailed gas chemistry modelling made the assessment much more complex, SOPHAEROS has proven to be a very useful tool for such analyses of aerosols and vapour behaviour simultaneously with speciation. Work will continue in that direction, in particular with the validation of the new ASTEC V2 chemistry kinetics modelling on the CHIP IRSN experiments (in ISTEP frame).
- For the containment: good results on thermal-hydraulics, behaviour of dry aerosols, and gas combustion in lean atmosphere. To confirm such very promising results, further work has to be done by validating this model against experiments with different conditions like combustion in steam enriched atmosphere and with downward directed flame propagation. Conversely, much less good results about the retention of aerosols in pools have undermined the need of model improvements.
- For DCH: reasonable results but the models are too parametric and too geometry-dependent.
- For iodine in containment: good reproduction of global trends like the effect of pH or silver on iodine volatility but nevertheless in terms of quantity, the RI concentration in gas phase is often underestimated. In spite of that, the RI production model in liquid phase seems to be adequate to reproduce experimental data.
- For MCCI: models at the State of the Art but they showed (like all other codes) a lack of predictability. Anyway, the good agreement with experimental data shows basically the relevance of the set of assumptions and models used; it means that a comprehensive approach using the ASTEC V2 models seems to be able to reproduce the MCCI phenomena on diverse concrete types.

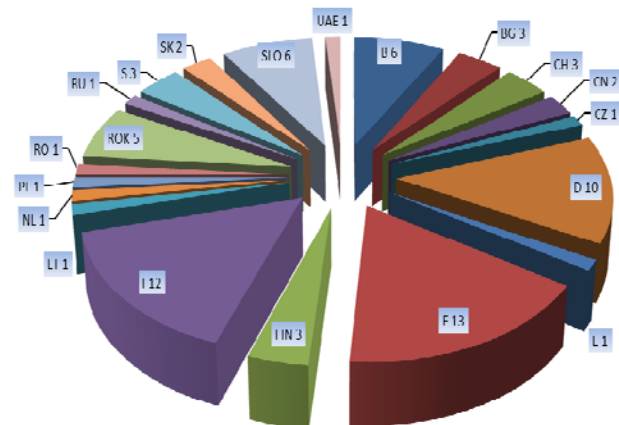
In summary, the main modelling efforts must focus in priority on the reflooding of degraded cores (in particular the corresponding hydrogen production), on MCCI (in particular on the coolability aspects), and in lower priority on DCH and on pool-scrubbing phenomena in the containment. The ASTEC V2 assessment work is continuing during the SARNET2 2nd current period, using the successive code revisions.

Contact: Patrick Chatelard
patrick.chatelard@irsn.fr



Success of the Pisa Course on Severe Accident Phenomenology

As part of the Excellence Spreading activities, the first SARNET2 "Severe Accident Phenomenology Short Course" was successfully organized from 10th to 14th January 2011 by CEA and Pisa University and hosted by Engineering Faculty of Pisa University, with the participation of about 100 students from 20 different countries, which is the highest number from the beginning of SARNET.



Nationalities of the participants to the Pisa 2011 course

This was again a 1-week course on phenomenology, focused on disseminating the knowledge gained on severe accidents in the last two decades to Master-PhD students, young engineers and researchers. The goal was also to refresh participants memories after 5 years and SARNET new outcomes, with a program covering severe accident phenomenology and progression in current water-cooled Gen.II NPPs, but also the different design solutions in Gen.III ones (i.e. the "in-vessel" melt retention concept or the "ex-vessel" core catcher concept). The Pisa course was also presented as an highlight of the SARNET2 Education & Training program at the ENS NESTet Conference in May 2011 at Prague (the poster is available on the SARNET2 web site).

During the course, the severe accident phenomenology has been described through its progression in the core and in the lower head up to vessel failure, followed by the ex-vessel accident progression, with the loadings which can cause early containment failure (i.e. Direct Containment Heating, hydrogen combustion in containment, steam explosion) and the late containment failure (i.e. MCCI, coolability, etc.) The source term with fission products release from the core and transport in the reactor coolant system and in the containment has been specially emphasized.

Lecturers were experts from 8 different countries, with large skills and knowledge on Gen.III plants and on the progression of a severe accident. The presence of lecturers from industry was utilized to describe how the different plants would react during an accident, keeping in mind that an introductory course would not allow lengthy discussions or computer simulations.

The course was open to university students with a strong discount fee (decision improving in a relevant way the participation of young researchers and students) and contributed for 3 ECTS (with a written work) as an advanced course for master students, with a strong link among SARNET2, ENEN & European Master of Science in Nuclear Engineering (EMSNE).



Participants to the Pisa 2011 course

Contact: Sandro Paci sandro.paci@ing.unipi.it



and Pascal Piluso pascal.piluso@cea.fr

16th International QUENCH Workshop

The 16th International QUENCH Workshop took place during 16-18 November 2010 at Karlsruhe Institute of Technology in Germany. About 60 scientists from 10 countries participated in the workshop.

As every year, the current status of the available experimental data base and the modelling activities in various countries were discussed. The results of the bundle tests QUENCH-14/15 (behaviour of M5 and ZIRLO advanced cladding alloys) and first results of the commissioning test QUENCH-L0 of the new

LOCA series, as well as reports from the PARAMETER program in LUCH (Russia) were presented. Modelling and code applications to the QUENCH and PARAMETER tests were the main topics on the second day. Presentations on the third day were devoted to recent studies on core degradation and chemical interactions of core materials under severe accident conditions, with the oxidation, reaction with nitrogen, hydrogen absorption as well as the application of neutron radiography as topics among others. Future developments of the QUENCH programme have been discussed, too.

Topical Meeting on QUENCH-Debris

In connection with the QUENCH Workshop, a SARNET2 WP5 Topical Meeting on QUENCH-Debris and related experiments was organised. The main goal of this meeting was the presentation of the status of preparation of the QUENCH-Debris bundle tests. Furthermore, the most reasonable scenarios for the two experiments planned to be performed within SARNET2 were discussed taking into account a) most needed information, b) experimental boundary conditions and c) other coolability experiments currently underway (DEBRIS in IKE, PRELUDE/PEARL in IRSN).

The participants agreed that the first test should be performed with hafnium components and including the debris formation phase. The conditions of the second test will be discussed after conduct of the first test, including the option of use of a pre-formed debris bed.



Participants of the 16th International QUENCH Workshop

Contact: Alexei Miassoedov
alexei.miassoedov@kit.edu



Benchmark exercise on core degradation

The objective of the BETMI2 benchmark, organized by OECD/NEA (CSNI/WGAMA group) and coordinated

by ENEA, is to examine three different severe accident sequences involving safety systems failure or their delayed operation with ASTEC, MELCOR, ATHLET-CD and MAAP codes:

- Sequences where reflooding occurs when the core is still intact and no or only local melt formation has already taken place,
- Sequences where reflooding starts after a significant melting has occurred within the core,
- Sequences with possible corium relocation into the lower plenum and vessel failure.

The kick-off meeting was held on 17-18 February 2011 in Paris. The next progress meeting will be organized on 11-12 July 2011 at the OECD Conference Centre, Paris.

Contact: Alexei Miassoedov 
alexei.miassoedov@kit.edu

Activities on Containment issues

Two meetings were organized in the WP7 "Containment" in the past six months. One took place in Aachen (Germany), on February 8-9, 2011, and was hosted by Forschungszentrum Jülich. The following tasks were discussed: modelling of containment sprays, modelling of hydrogen combustion, modelling of steam condensation, hydrogen combustion during Direct Containment Heating, and development of a generic containment model. The other meeting, on the topic of ex-vessel fuel-coolant interaction, took place at Fontenay-aux-Roses (France) on February 11, 2011, within the OECD SERENA2 meeting, and was hosted by IRSN.

Ex-vessel fuel-coolant interaction

At the latest meeting, the status of current actions was discussed. Conclusions were drawn regarding the exercise of comparison of MC3D and IDEMO codes regarding steam explosion strength in 1D situation (analytical exercise). On the overall, the strengths are not so different but both codes show some trends which needs clarification. A report is to be issued soon. The exercise is to be continued to 2D/3D situations. Regarding reactor applications, an exercise of pre- and post calculations of the future LACOMECO DISCO-FCI test has been launched. The test is scheduled for the 3rd quarter of 2011. Finally, it can be noted that, in the frame of WP 5-3 (ex-vessel coolability), an exercise of calculation of some DEFOR experiments (KTH) was launched. The results are of interest to WP7-1 (a strong link exists between the two work-packages).

Modelling of containment sprays

After the successful completion of the first phase of the spray benchmark, the open question is now how to proceed for the second phase. Jeanne Malet (IRSN), who leads the task, presented experiments on containment sprays, performed in the CALIST facility at IRSN, which will be used. As many participants of the first phase expressed a strong interest, this exercise will probably also be successful.

Modelling of hydrogen combustion

In this task, the open question is also how to continue the hydrogen combustion benchmark after the successful completion of the first phase. Ahmed Bentaib (IRSN), who leads the task, presented the two possible options:

- Further simulation of experiments, performed in the ENACCEF facility in CNRS/Orléans (France);
- Simulation of AECL-EACL (Canada) experiments, performed in the Large Scale Vented Combustion Test Facility (LSVCTF).

Modelling of steam condensation

After the first phase of the steam condensation benchmark was successfully completed, the second phase will consider experiments with lower flow velocities. Walter Ambrosini (UNIPI), who leads the task, presented the modifications of the CONAN experimental facility (UNIPI) that are being carried out with this purpose. The second phase of the benchmark will start as soon as the facility is ready and the necessary experiments are performed.

Hydrogen combustion during Direct Containment Heating

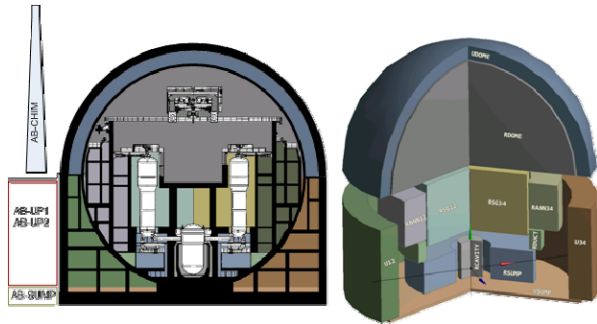
Results of the first experiments on hydrogen combustion at DCH conditions, which were performed in the HYKA A2 experimental facility (KIT), were presented by Giancarlo Albrecht (KIT). The main conclusions of the 9 performed experiments so far are:

- No scaling effect was found in the simple geometry;
- Replacement of nitrogen by steam does not reveal any noticeable differences;
- Only a fraction of available pre-existing hydrogen burned.

Also, Thomas Jordan (KIT) will lead this task from now on, as Leonhard Meyer (KIT) has moved to the International Atomic Energy Agency in Vienna (Austria).

Development of a generic containment model

The first phase of the benchmark on generic containment was successfully completed. The model of the generic containment is based on German 4-loop PWR (see figure below).



Model of generic containment

Stephan Kelm (FZJ), who organised the benchmark, summarized the results. The benchmark has clearly shown the usefulness of such an exercise, as it allows the comparison of lumped-parameter codes without the influence of different simplifications of the same actual containment due to different code users. The benchmark will continue with the second phase, whose specification was also presented at the meeting. The simulated transient will include injections of H₂, CO and CO₂, as well as energy sources which represent fission products decay release and other heat sources. However, hydrogen combustion will not be simulated. Simulations will still be performed using lumped-parameter codes. The possible modelling of non-homogeneous atmosphere using these codes may also be performed as an additional option.

Contact: Ivo Kljenak, ivo.kljenak@ijs.si

 Jožef Stefan Institute, Ljubljana, Slovenia

Forthcoming events

June 27- July 1, 2011: WP5-6 joint meeting hosted by KTH in Stockholm (Sweden)

June 28, 2011: WP7-1 meeting, hosted by KTH in Stockholm (Sweden)

July 11-12, 2011: progress meeting of the BETMI2 benchmark exercise on core degradation, hosted by OECD/NEA (CSNI/WGAMA group) in Paris (France)

October 17-21, 2011: WP8-1, 8-2, 8-3 meetings, THAI benchmark workshop, hosted by IRSN in conjunction with the regular 6-monthly Phebus FP and ISTP progress meetings at Aix-en-Provence (France)

Nov.7-8, 2011: EUROSAFE Forum in Paris, with a poster on SARNET2 progress

Nov.29, 2011: SARP meeting hosted by GRS in Cologne (Germany)

March 21-23, 2012: ERMSAR-2012, hosted by GRS in Cologne (Germany)

March 2012 around ERMSAR dates (location and precise dates to be fixed): 3rd meeting of the Steering Committee, and meeting of the General Assembly.