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SARNET: SEVERE ACCIDENT RESEARCH NETWORK KEY ISSUES IN THE AREA OF SOURCE TERM

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ABSTRACT

About fifty European organisations integrate in SARNET (Network of Excellence of the EU 6th Framework Programme) their research capacities in resolve better the most important remaining uncertainties and safety issues concerning existing and future Nuclear Power Plants (NPPs) under hypothetical Severe Accident (SA) conditions. Wishing to maintain a long-lasting cooperation, they conduct three types of activities: integrating activities, spreading of excellence and jointly executed research. This paper summarises the main results obtained by the network after the first year, giving more prominence to those from jointly executed research in the Source Term area.

Integrating activities have been performed through different means: the ASTEC integral computer code for severe accident transient modelling, through development of PSA2 methodologies, through the setting of a structure for definition of evolving R&D priorities and through the development of a web-network of data bases that hosts experimental data. Such activities have been facilitated by the development of an Advanced Communication Tool.

Concerning spreading of excellence, educational courses covering Severe Accident Analysis Methodology and Level 2 PSA have been set up, to be given in early 2006. A detailed text book on Severe Accident Phenomenology has been designed and agreed amongst

SARNET members. A mobility programme for students and young researchers is being developed, some detachments are already completed or in progress, and examples are quoted.

Jointly executed research activities concern key issues grouped in the Corium, Containment and Source Term areas. In Source Term, behaviour of the highly radio-toxic ruthenium under oxidising conditions (like air ingress) for HBU and MOX fuel has been investigated. First modelling proposals for ASTEC have been made for oxidation of fuel and of ruthenium. Experiments on transport of highly volatile oxide ruthenium species have been performed. Reactor scenario studies assisted in defining test conditions for new experiments. Regarding predictability of iodine species exiting the Reactor Coolant System (RCS), which affects its source into the containment, iodine behaviour in the circuit and silver-indium-cadmium release from the core have been reviewed (these absorber elements play a significant role in iodine chemistry). The design of new experiments has been discussed.

Concerning the radioactive aerosol source term, work is conducted in the risk-relevant areas of by-pass accident sequences, transport through cracks in containment walls and revaporisation from previous deposits in the RCS that could lead to a delayed source term. Modelling approaches for aerosol retention in containment cracks and interpretation of experimental results on retention in secondary side of SG are already proposed. Amongst the numerous physical and chemical processes which affect the intense reactivity of iodine in containments, mass transfer phenomena were first addressed in the network, looking at SISYPHE experimental interpretation and associated modelling.

1 INTRODUCTION

SARNET [1] is a 4-year Network of Excellence supported by the 6th Research and Technology EURATOM Framework Programme of the European Commission, and coordinated by IRSN, France. Since April 2004, 49 organisations are networking their research capacities in SARNET to resolve the most important remaining uncertainties and safety issues for enhancing, in regard of Severe Accidents (SA), the safety of existing and future Nuclear Power Plants (NPPs). The project definition considers the need to optimise available means and to constitute sustainable research groups. SARNET tackles the fragmentation between the different R&D national programmes, notably in defining common research programmes and developing common computer tools and methodologies for safety assessment.

To reach these objectives, a joint programme of activities has been defined, which is divided into three main elements:

- *Integrating activities*, to set up and then strengthen links between organisations ; they concern activities such as implementing an advanced communication tool for fostering exchange of information, or developing a SA code – ASTEC [2] - which capitalizes in terms of models the knowledge produced within SARNET;
- *Spreading of excellence*, developing educational courses and text books, promoting personnel mobility between the various European organisations;
- *Joint research*, to solve remaining outstanding issues; it consists of jointly analysing experimental results provided by research programmes to reach a common understanding of the phenomena concerned, in three domains: containment integrity, corium behaviour and source term.

This paper firstly summarises the main results obtained by the network after the first year, then secondly describes in more detail results from jointly executed research in the Source Term area.

2 SARNET ACTIVITIES

2.1 Integrating Activities

One integrating activity is implementation of an Advanced Communication Tool (ACT) for aiding information exchange. ACT is a key concept to achieve SARNET goals; it provides unified support for efficient communication within the network, concerning:

- Access, search, publication of documents and codes (concept of knowledge storage),
- Contact and communicating with partners (interactive and collaborative services),
- Joint co-ordination of actions/programmes (co-operative management of the network),
- List of links to satellite community projects (R&D projects, related sites).

A platform has been thus developed and deployed. Access is given by Web Browsers, enabling access from any Internet connection. After one year, around 200 users of SARNET have been granted access to this tool and the ACT is now used intensively.

Another integrating activity has been the development, qualification and the maintenance of the SA integral analysis code ASTEC. Thirty organisations collaborate on the adaptation and qualification of this code. Developed by IRSN and GRS, it describes the behaviour of a whole NPP under SA conditions, including SAM engineering systems and procedures. It is extensively used by IRSN for Level 2 PSAs for 900 MWe PWRs. It is the main integrator of knowledge in SARNET.

A close and efficient collaboration between ASTEC users and developers has been set up using ACT and the MARCUS tool for code maintenance. A 1-week training course was held in June 04, with release of code version V1.1 to 25 SARNET partners. The 1st ASTEC Users' Club, held in February 05, was very fruitful for direct discussion with developers.

Model developments are under way by CEA/DEN, in close collaboration with IRSN, on in-vessel late-phase (DIVA module) and on vessel external cooling. Concerning other reactor types, specifications are under way for VVER-440 and VVER-1000, with BWR planned.

Validation progress has also been good. The code has been applied to more than 20 experiments (analytical and integral). Results were good on core degradation and MCCI. Partners independent from the developers confirmed IRSN-GRS results on several ISPs (44, 45, 46, 47) and on the PHEBUS FPT0/1 tests. FZK adopts from now on the code for support of its experiments (QUENCH, DISCO and later on LIVE). Code results compared to containment data of an Ignalina RBMK transient gave preliminary acceptable results.

Harmonization of Level 2 PSA methodology and development of advanced tools is also an integrating activity. Level 2 PSA is a powerful tool to assess plant-specific vulnerability regarding NPP SA. It evaluates possible SA scenarios in terms of frequency, loss of containment integrity and radioactive release into the environment and quantifies 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. A description and comparison of the main elements of methods used by the different partners to develop their PSA has been written. A State on the Art Report on Dynamic Reliability methods has been produced and the limitations of classical methods, which could be exceeded, were identified. Examination of the benefit of one of the possible methods (Monte Carlo Dynamic Event Tree –MCDET- method,) is ongoing on a specific example. The description in "engineer language" of a second potential method achieved (Stimuli Driven Theory of Probabilistic Dynamic -SDTPD) was achieved. The follow-up will include testing the applicability of these 2 dynamic reliability methods.

Construction of DATANET, the SARNET experimental database network, has started. The objective is to develop and maintain an instrument that insures preservation, easy access for codes, exchange and processing of SA experimental data, including all related documentation. The data of concern are both existing experimental data that SARNET partners are willing to share within the network and all new data produced within SARNET. It is based on the STRESA tool developed by JRC Ispra and consists of a network database with several local databases (or nodes). From the central database, it is possible to get connections with other local databases; direct connections to the local databases are also possible, which increases the potential and the power of this type of system. After one year, four nodes already exist (the central one at JRC Ispra, and local ones at FZK, IRSN and CEA); three are under preparation (KTH, FORTUM and AEKI). Training weeks have been organized at JRC Ispra. The results of about 50 experiments have been implemented so far.

Research priority assessment is also an integrating activity. It identifies research priorities and intends to re-orientate progressively the existing national programmes, to contribute to launch new ones in a coordinated way, eliminating duplications and developing complementarities. This activity will be initiated during the second year, and in close collaboration amongst participants (those mainly involved in EURSAFE [3]), representing TSO, industry and utilities, including organisations of Associated Candidate Countries.

2.2 Spreading of Excellence Activities

The second major type of activity concerns spreading of excellence. The more experienced organisations have started to contribute diffusing the excellence by preparing an educational course on SA phenomenology and on Level 2 PSA, addressing PhD students and researchers. The first course will be hosted by CEA in January 2006, over 4 days. Besides this, the content of a text book on SA phenomenology has been set up. This book covers historical aspects of LWR safety and principles, phenomena concerning in-vessel accident progression, both early and late containment failure, fission products (FP) release and transport; it contains a description of analysis tools, of management and termination of SA, as well as environmental management. It also gives elements on Generation 3 LWRs. The partners who have agreed to work together in preparing the first course and writing this book are universities, technical service organizations (TSOs) national laboratories and industrial organizations that share their great talent and experience within SARNET.

These spreading of excellence activities are complemented by a mobility programme under which students and researchers can go into different laboratories of SARNET for training. A CIEMAT scientist was delegated at PSI for a 4-month period in the first year, and an INR physicist has been proposed for delegation to IRSN for a longer period. In these examples, the delegates are notably trained to specific computer codes, to use them to interpret experimental results available in SARNET or to perform reactor scenario calculations to provide boundary conditions for future experiments. One objective of the latter proposed delegate is for instance to perform studies needed to address better the effect of air ingress into a damaged core. Half a dozen delegations should be initiated soon.

2.3 Jointly Executed Research Activities

These activities constitute the basis of the network. In spite of the accomplishments reached in SA research, some issues remain where research activities are still needed to reduce uncertainties considered important and to consolidate SA management plans. These remaining issues were identified by the Phenomena Identification and Ranking Table (PIRT) action in the EURSAFE 5th Framework thematic network [3]. The PIRT addressed the whole spectrum of SA situations, extending from core uncovery to long term corium stabilization, long term containment integrity, and FP retention or release to the environment. Joint research activities in SARNET are executed to help resolve these remaining issues. They are split into three areas: containment integrity, corium behaviour and source term.

In all three areas, the same method has been adopted: review and selection of available relevant experiments, synthesis of analyses and interpretation of data from these experiments, and model review, synthesis and proposals of models for ASTEC.

The research efforts on energetic phenomena that could potentially threaten containment integrity concern hydrogen behaviour and fast interactions in the containment. For the former, the hydrogen combustion and associated risk mitigation is studied, concentrating on the formation of combustible gas mixtures, local gas composition and potential combustion modes, including reaction kinetics inside catalytic recombiners. Hydrogen distribution within the containment is studied, to assess the risk of high concentrations. The experimental programme on combustion with gradients (ENACCEF) and recombiner kinetics (REKO-3) has been started. The PROCO combustion model, improved using the first experimental results, will be transferred to ASTEC. In ISP-47, data from the TOSQAN, MISTRA and ThAI facilities were used for further validation of lumped-parameter and CFD codes. Limitations of CFD codes (especially commercial codes) were identified with respect to wall condensation modelling and saturation conditions. Specific topics such as mitigation system modelling, sprays and recombiners have been identified as future tasks.

Concerning fast interactions, fuel coolant interaction is studied to increase the knowledge of parameters affecting steam explosion energetics during corium relocation into water, and determine the risk of vessel or containment failure by investigation of specific processes like premixing, melt fragmentation and particle heat transfer mode. The last test in the ECO facility was performed, while the KROTOS facility is being constructed and X-ray imaging for pre-mixing visualisation has been developed. In the OECD programme SERENA reactor case calculations were performed and progress towards synthesis of experiment interpretations achieved. Direct Containment Heating (DCH) processes are studied, including melt dispersion into various reactor compartments, heat transfer and chemical processes such as production and combustion of hydrogen. A DISCO experiment with the geometry of a French reactor was performed in the EC-LACOMERA programme, which will be used as a benchmark for lumped parameter code calculations, to use the improved models for ASTEC. A joint technical report on DCH is in progress.

Corium behaviour is a large topic dealing with more than half of the issues selected in the EURSAFE PIRT. The corium area ranges from early phase of core degradation to late phase core degradation and ex-vessel corium recovery, and a major effort is also being aimed at developing the thermodynamic and material databases. Joint activities have been deployed, such as the contribution to the definition and the interpretation of CCI tests around the MCCI programme, with a contribution to the benchmark exercise and the associated model improvement, and a contribution to the definition and interpretation of PLINIUS and LACOMERA tests: QUENCH-10 on air ingress in bundle geometry and COMET-L1 and L2 to study MCCI in 2D geometry, LIVE or VULCANO-COMET tests in preparation. Similar activities have been carried out for ongoing and new ISTC programmes: top flooding models and ISTC PARAMETER, ISTC METCOR and impact on thermo-mechanical vessel behaviour, ISTC CORPHAD and NUCLEA data base qualification. In the International Source Term Programme, FZK and IRSN have started to harmonize their test matrices on Zircaloy oxidation by air/steam mixtures and on B_4C oxidation and degradation.

In Source Term, the main safety-related issues addressed are the effect of air ingress, i.e. the influence of an oxidising environment on release and circuit source term phenomena, iodine volatility in the primary circuit, particularly for silver-indium-cadmium release as these absorber elements play a significant role in iodine chemistry, containment by-pass in the case of steam generator tube rupture, aerosol retention in containment cracks, aerosol resuspension, and aerosol and iodine behaviour in the containment. These are dealt with in several work packages where technical discussion 'circles' clustering participants around specific issues are highlighted, bringing experimentalists and modellers closer together. The main achievements so far are detailed below.

3 PROGRESS ON SOURCE TERM ISSUES

3.1 Fission Product Release and Transport

The main objectives here are to evaluate better the consequences of air ingress on the source term, in particular that associated with Ru under SA oxidising conditions/air ingress, and to improve the predictability of iodine species exiting the RCS to provide the best estimate of the source into the containment for any kind of accident scenario.

Concerning FP (notably Ru) release from irradiated fuel under very oxidising conditions, experimental data mainly originate from AECL, but much of this information is not published. A review of available material has been prepared. Three experimental facilities are involved: RUSET, VERDON and Ru-VTT. RUSET is being run by AEKI to quantify retention of FPs within the fuel pellet. These tests are known to have drawbacks, some of which will be overcome by the experimental programme to be carried out in VERDON. In the Ru-VTT series, several tests have been executed on speciation and transport of Ru oxides in the hypothetical case of refuelling accidents.

The major observed trend in the AECL tests was that there is an incubation period dependent on temperature after which Ru release starts, and that the release is then fast (1%/min at 1400 K; 10%/min at 1800 K). During incubation volatile FP release is significant. The interpretation is that the clad then the fuel must be fully oxidised, after which Ru oxides govern the release. This is supported by results obtained with simulants from RUSET tests, where it was observed that Ru release was delayed by the oxidation of Zry cladding. The latter experiments have also shown that RuO_4 chemical interactions with structural materials could affect release of Ru in the gas phase.

In the VTT Ruthenium facility, transport of Ru in the circuit is studied. Ruthenium vapours generated in a furnace are carried away by gases with different compositions and at different flow rates. It seems that Ru was released primarily as RuO_3 (~95%) and secondarily as RuO_4 (~5%). Most of the released ruthenium (65-88%) was deposited into the piping as RuO_2. Depending on experimental conditions, 11-35% of the released ruthenium was transported through the facility as RuO_2 aerosol particles. The fraction of gaseous Ru reaching the bubbler (i.e. reaching the circuit exit) in a dry atmosphere with a stainless steel tube was 0.1–0.2% of the released amount. In an atmosphere containing water vapour or with an alumina tube the fraction of gaseous Ru in the bubbler was increased to 5% of the release. It was concluded that water vapour likely suppresses decomposition of RuO_4 on stainless steel. This result is of major importance for source term as it shows that depending on conditions, some ruthenium may reach the containment in a stable volatile form.

The conditions in future tests (i.e. VERDON) are being defined by pre-test calculations. Through 3D simulations it is estimated that the upper limit of air ingress following a lower head vessel failure due to core melting is 20 mol/s. ICARE/CATHARE calculations have shown that temperatures as high as 2000 K could persist in the core area after the ex-vessel molten core slump and that core degradation could restart due to the presence of an air flow. All these studies agree in emphasizing the importance of modelling the oxidation of UO_2 to get a good prediction of Ru release (magnitude and speciation).

With regard with FP transport in circuits, notably of iodine, the main experiments considered are the ongoing PHEBUS-FP series, the completed VERCORS HT and EMAIC programmes, and the future CHIP programme.

PHEBUS-FP is providing release data under conditions close to those in a reactor SA. Data from FPT0, FPT1 and FPT2 give insights into the effect of control rod materials (Ag-In-Cd and H_3BO_3) on FP release and transport under different conditions. In particular, FPT2 addressed reducing environments. The three tests performed in VERCORS HT as well as the EMAIC experiments (conducted to study PWR control rod degradation), completed those data by studying at a small scale various FP release conditions (from pure steam to pure hydrogen) in the presence/absence of control rod materials. Ongoing FPT2 interpretation points out the significance of chemical speciation of vapours for the in-containment source term. Examples are that the impact of Mo on Rb and Cs transport is high, as is that of Cd on I. Contrarily, the impact of B appears to be minor. Standard (i.e., unmodified) modelling can reproduce the measured global retentions for Cs, I, Te and Mo; however, it does not predict the iodine volatile forms that entered the containment in FPT1.

The CHIP programme will provide kinetic and thermodynamic data on iodine transport to RCS breaks under reactor accident conditions. Two complementary sets of tests are planned, analytical and phenomenological.

IRSN have provided an overall interpretation of iodine chemistry in the circuit. Under reducing conditions, and without absorber material, iodine chemistry seems relatively straightforward, the iodine being transported predominantly as caesium (and rubidium) iodide. In oxidizing conditions the picture is more complicated since Cs take up in forms other than CsI affects iodine chemistry. Hence, iodine can either still be principally CsI or tends to form other metal iodides such as with control rod materials or, if these are not present, conditions become conducive to HI formation. At hot-leg break temperatures, HI and metal iodides would all be significant species whatever the steam-hydrogen mixture or absorber content. At cold-leg break temperatures, the ratio of HI to metal iodides increases for steam-rich mixtures if control-metal release is low. In other words, more hydrogen and more control rod metals appear to lead to lower-volatility iodine species, viz. metal iodides. These observations have however to be confirmed and more analysis is needed.

Modelling of control rod material release has started and the experimental data base is being reviewed. Silver/indium/cadmium (SIC) release is a function of: the temperature, the control rod degradation state, the oxidation potential of the surrounding fluid, the thermal hydraulic conditions, and the relative remaining amount of each element. The dominant mechanism is evaporation from a melt pool contained within the control rod stub, following gross control rod failure. Low-level release before this may be explained by release of vapour through the small hole formed on initial rupture of the cladding at lower temperatures. Relocation of control rod material to lower parts of the core limits overall release. Late-phase degradation leads to loss of a well-defined geometry and a greater variation of the release. Coolant chemistry seems important for In, less so for Cd and especially Ag; the fact that the atmosphere near the molten control rod material may be more reducing than the main gas stream, due to imperfect mixing, needs to be considered. Modelling improvements are generally needed; some specific aspects that should be accounted for are the chemical form of species in the release, the effects of the cladding ballooning as well as the formation of oxide on the cladding rupture, and the vaporisation of Cd before the cladding rupture.

3.2 Radio-active Aerosols Issues

Three scenarios are being addressed: steam generator tube rupture (SGTR) sequences, revolatilisation from RCS deposits and transport of aerosols through containment cracks.

Several facilities have investigated aspects of the aerosol retention within the steam generator under SGTR conditions: PSAERO/HORIZON, PECA/SGTR and ARTIST. The ARTIST facility is the most representative for vertical steam generators.

Revolatilisation tests are being performed in the small-scale REVAP facility where samples from PHEBUS are being tested under different conditions. These tests show that the extent of Cs revaporisation is very high (~95%) on flat metallic substrates. During slow ramping under flowing steam, it starts at 550°C and is rapid until 750°C; it continues to 1000°C but it is practically finished by then. Radiotracer testing confirms that CsOH deposits on stainless steel have the same behaviour as that of the FPT1 deposits.

Concerning aerosol retention in cracks, the facility involved is MAEVA, which investigates crack progression in containment concrete walls. The mock-up is a cylinder of 16m diameter and 5m height, with a pre-stressed concrete wall of 1.2m thickness, made of the same High Performance Concrete used in the Civeaux containment. A supporting small-scale facility is also being operated to get insights on aerosol penetration through well-characterised cracks in walls of a few centimetres thickness.

PSAERO/HORIZON tests have shown that resuspension is important in aerosol retention within horizontal tubes and that sudden velocity changes enhance resuspension. The PECA/SGTR tests showed that in the break stage, under all conditions tested, the mass retained was less than 20% of that injected. For flow rates above 100 kg/h, the higher the gas velocity, the lower the total mass depleted on tube surfaces, but at lower flow rates this trend is not maintained. These results were consistent with the small decontamination factors (DFs) measured under similar conditions (dry secondary side) in ARTIST. The decontamination capability of flooded bundles was even three orders of magnitude higher.

Modelling aerosol retention in the break stage is underway based on the filter concept (the ARISG platform). It is considered that the structure and major hypotheses could be kept in upcoming versions. Presently, inertial impaction and turbulent deposition are accounted for, but it is foreseen to extend it to other processes such as resuspension. Another approach of a more generic scope (complex structures) has been implemented in ASTEC (in the SOPHAEROS module) and is presently being tested. It is a semi-empirical, global approach that considers the main phenomena occurring in the complex structures, and it is based on the notion of enhanced turbulence induced there.

On aerosol deposition in cracks, models are being developed by different partners. The most advanced tool relies on a Lagrangian particle approach, and it calculates a global decontamination factor. It is being compared with the Eulerian approach implemented in the ECART code.

3.3 Containment Chemistry

The experimental facilities involved are: PHEBUS FP, CAIMAN, SISYPHE, the Chalmers facility, PARIS and EPICUR. Particular attention is being given to the interpretation of some PHEBUS observations:

- Similar amounts of gaseous iodine were measured in the containment during the early stages of FPT2 and FPT1. The very different sump conditions rule out radiolytic oxidation in the sump as the source. If the gaseous iodine were produced in the circuit, or by rapid decomposition of unstable iodide aerosols on entering the containment, this would imply that the chemical composition of the iodine passing through the circuit is practically identical in both tests, despite the differences in circuit conditions. Another possible explanation, the radiolytic oxidation of iodide aerosol dissolved in water droplets on the condenser, would be less sensitive to the chemical form of the iodide aerosol, but the uncertainties in the boundary conditions make it impossible to conclude on the importance of this mechanism.
- Iodine was present mainly in a soluble form in the FPT2 sump, and not as insoluble AgI as in FPT0/1. This behaviour could be explained by thermal or radiolytic

reduction of AgI in the sump. Decomposition is favoured under the high pH, high temperature conditions of the FPT2 sump. Other possible explanations could be linked to the lower Ag to I ratio in this test, or to less favourable conditions for silver oxide formation which would be necessary for AgI formation under alkaline conditions. Even though the sump chemistry and iodine speciation are very different in the tests, iodine is anyway effectively retained in the sump.

- Iodine was released from the containment walls during the aerosol and chemistry phase in FPT2. A suggested mechanism for the wall release is decomposition of iodide aerosols such as CdI_2 or InI, releasing I_2. The stability of these compounds under containment conditions depends on the relative rates of various reactions and cannot be assessed by thermodynamic calculations.

The CAIMAN programme gave several interesting results: in the presence of paints, irradiation and high temperature, organic iodide can be the dominant form of volatile iodine; in alkaline conditions, gas concentrations decrease by several orders of magnitude; the rate of adsorption of I_2 onto paint in the gaseous phase is about 10^{-3} m/s in CAIMAN conditions (and almost irreversible), while it is 100 times less for stainless steel (with large desorption); a similar rate of adsorption of I_2 onto paint in the aqueous phase was found, while no iodide ions were trapped; the nature of mass transfer regime between sump and gas more or less influences steady-state iodine gas concentrations (evaporation flow rate is a key parameter). This last phenomenon has been specifically addressed in SISYPHE, where tests showed that evaporation speeds up mass transfer kinetics from the sump to the gas phase and decreases the equilibrium concentrations in the sump. This observation has been encapsulated in a two-film model that can interpret the mass transfer experiments performed in natural convection without evaporation, but for evaporating conditions it is no longer valid. Correlations have been implemented in ASTEC (the IODE module) for calculation of individual mass transfer coefficients, and a specific model was developed for evaporating conditions.

The two-film theory models have been proved to be capable of simulating I_2 and CH_3I mass transfer between sump and atmosphere under no phase change conditions. If evaporation takes place, a heat-mass transfer analogy model is proposed. SISYPHE experiments are particularly suitable to assess this model.

Most models of I_2 adsorption/desorption in codes are based on the Langmuir isotherm. The user must supply the adsorption/desorption coefficients. A peer review indicates that this approach does have substantial drawbacks and they show noticeable inconsistencies when compared to data. In short, a model that describes all the important phenomena that were identified in I_2 deposition and resuspension experiments on steel surfaces does presently not exist. This lack impairs the predictability of iodine behaviour in the containment.

Existing models for Ag/I- interactions consider the reactions of Ag with I_2 and I_- in the sump. All consider that the interaction Ag/I- goes through previous oxidation of Ag, and they all are very sensitive to the amount of oxidised Ag ready to react. The major weakness is the uncertainty in the initial conditions for the reactions, particularly those related to Ag (i.e., amount and oxidised fraction). The OrgI formation models are based on a simultaneous consideration of thermal and radiolytic mechanisms both in gas and liquid phases. There are however discrepancies in the aqueous modelling, essentially concerning the organic sources. Data from the EPICUR programme will be suitable for validation of these models.

The effect of radiation on the nature of containment atmosphere and the effect of metallic impurities in the sump have been investigated in the PARIS and Chalmers experimental programmes, respectively.

AEA Technology has started the compilation of an Iodine Data Book which aims to provide a critical review of the data used in the development and validation of iodine chemistry models. The first part, covering aqueous inorganic iodine radiation chemistry, was produced in the first year of the project.

4 CONCLUSION

The four-year SARNET Network of Excellence started in April 2004 with the ambitious but highly important objective to provide an appropriate frame for achieving within a couple of years a sustainable integration of the European severe accident research capacities.

By capitalizing the acquired knowledge in ASTEC and in Scientific Databases (DATANET), SARNET has started to produce conditions necessary for preserving the knowledge produced by thousands of person-years of research, and diffusing it to a large number of end-users. The ASTEC code is being actively used and DATANET being used to store experimental data.

By fostering collaborative work in the PSA2 domain, SARNET has started to create the necessary conditions for harmonizing the approaches and making Europe a leader in SA computer code and risk assessment methodology.

Through an education and training programme, concretised by a first 4 days educational courses and a text book foreseen started 2005, addressing young scientists, SARNET has started to develop synergies with educational institutions to keep attractive this domain of activity for students. Through detachments of young researchers in the first year, the mobility process has been initiated and expansion is expected.

By fostering collaborative work in the technical domains of containment integrity, corium behaviour and source term, SARNET has started to provide modelling recommendations for ASTEC to solve remaining outstanding issues. Proposals have been elaborated for the modelling of ruthenium release under oxidizing conditions, for the modelling of retention of aerosols in containment wall cracks. Several recommendations are expected in the coming years from the different specialized collaborative groups.

Finally, SARNET clearly intends to become a reference, in terms of research priorities in the field of SA, having impact on national programmes and fund allocations. Progressively all the research activities in this field will become strongly coordinated by the Network, which contributes to an optimised use of European resources.

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