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NUCLEAR ENERGY AGENCY
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

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Working Group on the Analysis and Management of Accidents

SUMMARY RECORD OF THE SIXTH MEETING OF THE WORKING GROUP ON THE ANALYSIS AND MANAGEMENT OF ACCIDENTS (GAMA)

Held at the European Commission, Brussels, Belgium on 29th and 30th September 2003

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SUMMARY RECORD [1]

I. General – Welcome and opening remarks [agenda item 1]

1. A list of participants is given in Annex I. The documents of the meeting can be found on the GAMA-6 Internet site. **The tasks decided at the meeting are recorded in bold characters.**

2. The Chairman, M. Durin, and the Secretary, J. Royen, welcomed the participants and thanked the European Commission for their kind invitation to meet in their premises. A. Zurita welcomed the participants on behalf of the EC.

3. The Chairman welcomed particularly the new members of the group. R. Sairanen, C. Chauliac and M. Zimmermann were no longer members of GAMA; they were replaced, respectively, by H. Holmström (VTT), D. Bestion (CEA, France) and S. Güntay (PSI). K. Müller (JRC Petten) was attending a GAMA meeting for the first time. The Chairman also welcomed two observers: J.C. Wren (AECL, Canada) and D. Magallon (CEA, France)

4. Apologies for absence had been received from G. Sdouz (ARC Seibersdorf, Austria), J. Hyvärinen (STUK, Finland), D. Bestion (CEA, France), J.-C. Micaelli (IRSN, France), F. Kasahara (NUPEC [2]), W.-P. Baek (KAERI, Korea), R. Martinez Fanegas (TECNATOM, Spain), L.E. Herranz Puebla (CIEMAT, Spain), M. El-Shanawany (HSE, UK), and J.E. Rosenthal (USNRC).

5. The Chairman reminded the participants that all documents relating to the sixth meeting of GAMA received in advance of the meeting had been placed on the GAMA-6 Internet site. He asked **all participants to provide the Secretary, immediately after the meeting, with electronic versions of additional documents presented during the meeting.**

6. The Secretary informed the group that the Korean Institute of Nuclear Safety (KINS) had assigned a cost-free expert to the Nuclear Safety Division of NEA, for a period of at least two years. The initial tasks of the cost-free expert, who was expected to arrive at the beginning of 2004, would be to take part in the secretariat of some of the activities of GAMA.

II. Adoption of the agenda [agenda item 2]

7. The agenda was adopted as proposed in document NEA/SEN/SIN/AMA(2003)21], with the addition of the following points:

- a brief report on the September 2003 SETH Workshop on Code Analysis, after item 7,

1. The Rules of Procedure of the OECD clearly specify that meetings of the Committees of the Organisation as well as their working parties, expert groups, etc. only require the drawing up of a summary record of the decisions and conclusions reached by the Committees. This version takes into account comments made on an earlier draft.

2. NUPEC has now been replaced by the Japan Nuclear Energy Safety Organization (JNES).

- a presentation on the German ThAI Code Comparison Benchmark Exercise, after item 19,
- a preliminary proposal for Establishment of an International Centre of Excellence on Containment Iodine Chemistry and Fission Product Behaviour, after item 21,
- a progress report on the establishment of SARNET, and possible links with CSNI activities, after item 29.

III. Approval of the summary record of the previous meeting [agenda item 3]

8. The summary record of the fifth meeting of GAMA (April 2003) [NEA/SEN/SIN/AMA(2003)18] was approved without any change.

IV. Brief report on the May 2003 meeting of the PRG [agenda item 4]

9. B. De Boeck, who is a member of the PRG, presented briefly the highlights of the meeting of the CSNI Programme Review Group (PRG) [summary record NEA/SEN/SIN/PRG(2003)1], emphasising the points of direct relevance to GAMA. The PRG had given positive recommendations regarding the GAMA Integrated Plan and the proposed Status Report on Iodine Chemistry. It had also supported other activities, such as the scope and working plan of the reconstituted Senior Group of Experts on Nuclear Safety Research focusing on Support Facilities for existing and Advanced Reactors (SESAR/SFEAR), an expanded proposal for a CSNI Action Plan in the area of safety Margins (SMAP), a draft CSNI/CNRA Collective Opinion Statement on Safety Research Capabilities and Expertise in Support of Efficient and Effective Regulation of nuclear power plants, a draft CSNI Collective Opinion Statement on Good Practice and Closure Criteria for Safety Research, a working plan on the assessment of the current CSNI Strategic Plan and its update, and a proposal to develop a report on Approaches to the Resolution of Key Safety Issues for Operating Reactors.

10. The PRG had also discussed key safety issues and research needs for advanced reactor designs and possible CSNI activities in the area of fire safety. The following had been agreed:

- with respect to advanced reactor safety:
  - near term activities: *"… the PRG will advise the CSNI [3] to initiate a survey (possibly by GAMA) on the state of development and to explore the possibility and usefulness of benchmarks/ISPs to assess thermal-hydraulics and severe accident code capabilities and development needs for advanced water reactors, HTGR and LMR safety…"*
  - *longer term activities: "… the reconstituted SESAR/SFEAR should consider advanced reactor safety issues and programme/facility/needs."*
  - *"The PRG will also suggest that the CSNI undertake the development of a report on lessons learned from previous HTGR/LMR experience and to produce a "handbook" on HTGR/LMR fundamentals related to designs/features/issues. The revision of the CSNI*

3. At the June 2003 meeting of the Committee.

Strategic Plan should consider whether or not a separate task group on advanced reactors should be established."

- with respect to fire safety:

  – near term activities: *"… the PRG will advise that the CSNI initiate a survey (possibly by GAMA) on the state of development of fire codes and to explore the possibility and usefulness of benchmarks/ISPs to assess fire code capabilities and development needs. The scope should be limited to internal plant fires. A proposal would then be prepared for PRG/CSNI consideration."*

  – *longer term activities: "The long term action should be part of the SESAR/SFEAR group considerations and /or part of the revised CSNI Strategic Plan."*

11. The recommendations made by the PRG had been endorsed by CSNI in June 2003 (see Section V). D. De Boeck and the Secretary answered several questions for clarification.

V. Brief report on the June 2003 meeting of the CSNI [agenda item 5]

12. The Chairman presented briefly the highlights of the meeting, emphasising the points of direct relevance to GAMA. The CSNI had taken note of the GAMA Integrated Plan and expressed its appreciation for the work performed by the group. It had endorsed the proposed Status Report on Iodine Chemistry, and appreciated highly the progress made on the organisation of the THICKET-2004 Seminar. The Committee had also endorsed the PRG recommendations regarding advanced reactor safety and fire safety, and asked GAMA to add these two items to its current programme of work (see Sections XXXI and XXXII), with the following additional recommendations:

- with respect to advanced reactor safety, consider work done by other organisations, including the Generation IV Technology Roadmap and the European Commission; initial work should concentrate on LWR (including supercritical water reactors) and HTGRs; LMRs will be considered at a later stage;

- with respect to fire safety: to the extent necessary, consider risk aspects, in co-ordination with WGRisk.

13. Regarding the PRG proposal to develop a report on approaches taken to the resolution of key safety issues for operating reactors, the CSNI had decided that a pilot version of the report would be prepared for review in December 2003; it would be limited to countries currently represented in the PRG (Belgium, France, Germany, Japan, Korean UK and US; observer; Czech Republic) and cover the following issues only: design basis accidents, severe accidents (RPV integrity, hydrogen control, containment integrity, accident management), and station blackout. With respect to the expanded Action Plan in the area of Safety Margins: a detailed working plan (tasks, expertise needed, workload, resources needed, schedule, etc.) will be submitted to the CSNI in December 2003.

14. The CSNI had decided to devote more time in the future to detailed technical discussions on major safety issues or important parts of its programme of work. It had been agreed that the results of the ISP-46 (PHEBUS FPT-1 Test) would be the first topic selected for such discussions, at the December 2003 meeting of the Committee. The presentation will be made by B. Clément.

15. The Chairman and the Secretary answered several questions for clarification.

VI. Updated GAMA Integrated Plan [agenda item 6]

16. The Chairman presented the modifications that had been made recently to the Integrated Plan, stressing the living nature of the document. The modifications reflected the recent decisions of the CSNI.

VII. Programme of work in the field of thermal-hydraulics and in-vessel behaviour [agenda item 7]

17. F. D'Auria, Co-ordinator for Experimental Thermal-Hydraulics Work presented briefly and in general terms the GAMA programme of work in the field of thermal-hydraulics and in-vessel behaviour, placing it in the perspective described in the Integrated Plan and stressing the links which exist between these activities and several existing or proposed OECD Joint Projects. **It was agreed that at the following meeting F. D'Auria will present an overview of all Joint Projects in the field of thermal-hydraulics, stressing complementarities and gaps between the Projects.**

VIII. September 2003 SETH Workshop on Code Analysis

18. J. Macek said that the purpose of the Workshop, which had been held in Barcelona (Spain), had been to present and discuss results of the PKL and PANDA analytical studies performed by the participants in the SETH OECD Joint Project, and to give the opportunity to present plant application analyses related either to equivalent scenarios or to scenarios helpful to clarify the involved safety issues. The following topics had been covered:

- pre- and post-test calculations related to the SETH OECD PKL Boron dilution experiments
- other pre- and post-test calculations related to SETH OECD PKL experiments
- pre- and post-test calculations related to SETH-OECD PANDA experiments
- calculations and plant applications

J. Macek added that the workshop looked like an ISP comparison workshop but, actually, there had been no intention of performing code comparisons. The following conclusions could be made:

- In spite of a number of differences, all system codes (RELAP, CATHARE, ATHLET) were able to reproduce correctly the experimental results, including the conditioning phases.
- Because of large CPU time requirements, CFD codes should focus on specific aspects, e.g., inlet jet, for limited time periods.
- There had been few attempts at plant applications. Much work needs to be done to validate codes. Moreover, there is a need for more specific tests to confirm that there is no risk of re-criticality under real NPP conditions.
- It was generally agreed that SETH tests will help in further improving computer models.

- A comparison of post-test calculations would be desirable (this will be done at a future workshop).

- There is potential for a future ISP exercise (J. Macek pointed out that this conclusion will need to be discussed further).

- The workshop also reinforced arguments made for a continuation of the PKL programme.

19. J. Oliveri pointed out that the purpose of the PKL Project was not to validate codes but to investigate some accident management strategies under specific conditions. J. Macek said that this was one of the objectives, but not the only one.

20. Several participants stressed the interest of the PKL Project, and of the Workshop. F. D'Auria added that, in fact, a large number of data remained to be analysed, in this Project and other Projects. In his opinion, the fraction of experimental data, obtained at high cost through the Projects, remaining unanalysed was much too high. **It was agreed that this point would be discussed further at the next meeting, as well as the possibility of a future ISP based on a PKL test.**

IX. Best-Estimate Methods, Including Uncertainty Methods and Evaluation (BEMUSE Programme) [agenda item 8]

21. F. D'Auria said that the first meeting of the BEMUSE Programme had been held in Cadarache (France) at the beginning of September. Its main purpose had been to discuss preliminary Phase 1 results and to launch Phase 2 of the Programme. Ten countries were now participating in BEMUSE: the Czech Republic (UJV), France (both CEA and IRSN), Germany (GRS), Italy (University of Pisa), Japan (JNES), Korea (KINS, with KAERI support), Spain (Technical University of Catalonia), Sweden (Studsvik Nuclear AB, subject to confirmation), Switzerland (PSI), and Turkey (TAEK). The USNRC had expressed interest in participating but had not yet nominated an expert.

22. As part of Phase 1 of the exercise, the participants in the BEMUSE meeting had described the uncertainty evaluation methodologies they would use in the Programme. J.-C. Micaelli will prepare the BEMUSE Phase 1 report and distribute it for comments by 29 February 2004 (BEMUSE participants should provide him with their revised partial drafts before 31 December 2003). The objective is to complete the Phase 1 report by 31 March 2004.

23. Phase 2 was devoted to the re-analysis of the ISP-13 exercise, post-test analysis of the LOFT L2-5 test calculations. The detailed preparation of the work had been discussed during the meeting. Phase 2 calculation results – reference calculations and sensitivity calculations - will have to be submitted to the University of Pisa by 31 March 2004. A preliminary report will be prepared by 15 May 2004 and discussed during a meeting to be held in Pisa from 7 to 9 July 2004. A revised draft Phase 2 report will be completed and distributed for comments by 31 October 2004. The target date for the final report is 21 December 2004.

24. The July 2004 meeting in Pisa will discuss the preliminary Phase 2 report, launch Phase 3 (Uncertainty evaluation of the L2-5 test calculation – first conclusions on the methods and suggestions for improvement; lead organisation: CEA Grenoble), and have a preliminary discussion on Phase 4 (Best-estimate analysis of the LBLOCA in TMI-1). At the moment only Phases 1, 2 and 3 had been endorsed by the CSNI. Permission would be requested to undertake preparatory work on the subsequent phases of the BEMUSE Programme.

25. The Chairman thanked F. D'Auria for his presentation and all those involved in the BEMUSE Programme (organisers and participants) for their hard work. The discussion was devoted mainly to the selection of a suitable reference plant for performing Phase 4. The advantage of choosing the TMI-1 plant was that all data were available to the international community, and that many organised had performed calculations on that plant. The disadvantage was that the TMI-1 plant is not representative of a U-tube steam generator plant. F. D'Auria said that other options should be explored with a view to discussing the matter further during the July 2004 meeting. In conclusion, the Chairman said that work on Phase 4 was endorsed by GAMA with a strong recommendation to look into a more representative reference plant than TMI-1. TMI-1 will be used as a backup if no better solution is found.

X. CFD Code Guidelines, Assessment, and Extension to Two-Phase Safety Problems [agenda item 9]

26. This activity involved three Writing Groups:

- Writing Group on Guidelines for Use of CFD in Nuclear Reactor Safety Applications (Chairman: J. Mahaffy)
- Writing Group on Assessment of CFD Codes for Nuclear Reactor Safety Problems (Chairman: B. Smith)
- Writing Group on Extension of CFD Codes to Two-Phase Flow Safety Problems (Chairman: D. Bestion)

In the absence of the Chairmen, a brief progress report was presented by the Secretary.

27. The Writing Group on Guidelines for Use of CFD in Nuclear Reactor Safety Applications had met at the beginning of September. It had reviewed existing Best Practice Guidelines, discussed recommendations regarding the need for guidelines specific to the application of single phase CFD nuclear reactor safety problems (NRS), reviewed a preliminary, incomplete first draft of its report (already in reasonably good shape), and agreed on tasks and deadlines to complete the draft. A revised report will be produced by 31 January 2004. If necessary, it will be discussed during a meeting to be held at the beginning of March 2004, the objective being to submit the final draft report to GAMA by mid-March 2004. The Writing Group has very good co-ordination with the second Writing Group.

28. The Writing Group on Assessment of CFD Codes for Nuclear Reactor Safety Problems had met at the beginning of September. It had reviewed critically the list of NRS problems where the use of CFD is required or is expected to result in major progress; safety relevance had been considered in these discussions, which had gone into the details if single-phase CFD NRS applications but also considered NRS applications where two-phase CFD is necessary, without looking at CFD technology extension to two-phase problems. The Writing Group had reviewed critically the gaps in the existing assessment base of CFD needs, discussed the definition of a methodology for establishing reference assessment matrices specific to NRS needs, reviewed a preliminary, incomplete first draft of its report, and agreed on tasks and deadlines to complete the draft. A revised report will be produced by 31 January 2004. The next Writing Group meeting will be held at the beginning of March 2004, the objective being to submit the final draft report to GAMA by mid-March 2004. The Writing Group has very good co-ordination with the two other Writing Groups.

29. The Writing Group on Extension of CFD Codes to Two-Phase Flow Safety Problems had met at the beginning of September. It had reviewed the list of NRS problems that require two-phase CFD analysis, concentrating on necessary extensions of the CFD technology to two-phase applications, and the classification of modelling approaches. It had discussed specification and analysis in terms of both physical and numerical assessment, and had had a preliminary discussion on the selection of numerical benchmarks. It had reviewed a very preliminary, incomplete draft of its report, and agreed on tasks and deadlines to complete it. A revised draft report will be completed by 31 January 2004, and be discussed during a meeting to be held at the beginning of March 2004. The final draft report will be submitted to GAMA during the Autumn of 2004, together with proposals for CFD code benchmarks. The Writing Group has very good co-ordination with the second group.

30. During the discussion, M. Vidard emphasised the need to involve in the Writing Groups experts who have first-hand knowledge of practical applications of CFD codes. J. Rohde was afraid that the Writing Groups included too many "mathematicians" and not enough practitioners. On the other hand, F. D'Auria made the point that many fundamental issues must also be considered, starting with a clear definition of what is meant by computational fluid dynamics; he suggested that all groups should be requested to perform an identical simple CFD calculation on heat transfer.

31. The Chairman thanked the Writing Groups for their fast progress. He asked that one of the Chairmen (at least) attend the next meeting of GAMA.

XI. Progress on Joint NSC/CSNI Computational Benchmark Exercises [agenda items 10 and 11]

32. F. D'Auria and H. Wand presented brief progress reports on four transient Computational Benchmark Exercises:

- OECD/NRC Boiling Water Reactor Turbine Trip (BWRTT) Benchmark. This exercise, based on Peach Bottom-2 data was cosponsored, on the NEA side, by the Nuclear Science Committee (lead committee) and the CSNI. This exercise covered in fact three benchmark exercises (Exercises 1, 2 and 3, including extreme scenarios. Three final reports will be published at the end of 2003 and in 2004. The comparative analysis of the participants' results for Exercise 1 had been completed; the draft report was to be sent for review by the end of September 2003. A special issue of Nuclear Science and Engineering devoted to the BWRTT Benchmark was being prepared.

- OECD/NRC PWR MOX Rod Ejection Benchmark. CSNI had not been asked to co-sponsor this exercise, the objective of which was to compare different core analysis methods and to compare MOX/UO_2 and UO_2 core transient response. The reactivity insertion problem was important for weapons plutonium transient with small β_{eff}. This exercise, that had started in September 2002, should be completed by the end of 2003.

- OECD/DOE/CEA VVER-1000 Coolant Transient (V1000 CT) Benchmark. This exercise was co-sponsored by the CSNI. The aim was to test and examine the capability of the coupled codes to analyse complex transients with coupled core/plant interactions through comparison with actual experimental data and code to code comparison. The reference power plant was Kozloduy-6, a VVER-1000/V320 PWR with 3,000 MW thermal power. The benchmark consisted of two phases, each consisting of three exercises: V1000CT-1 (exercise 1: point kinetics plant simulation; exercise 2: coupled 3-D neutronics/core thermal-hydraulic response; exercise 3: best-estimate coupled core/plant simulation), and V1000CT-2 (exercise 1: calculation of NPP Coolant mixing experiments; exercise 2: MSLB, coupled 3-D neutronics/3-D vessel thermal-hydraulics simulation; exercise 3: MSLB best-estimate coupled core/plant Modelling). The chosen transient for Phase 1 of the benchmark was switching on one main coolant pump when the other three main coolant pumps are in operation. This experiment had been performed by Bulgarian and Russian engineers during the Kozloduy-6 plant commissioning phase as part of the start-up tests. The Phase 1 Final Specification had been published at the beginning of 2003; the draft Phase 2 Specification would be prepared by the end of 2003. Sensitivity studies were performed to clarify the uncertainty of the measured data. An FTP server had been established; all information could be downloaded from 'varna.me.psu.edu'. The second workshop of the exercise will be held in Bulgaria in April 2004.

- OECD/NRC BFBT Benchmark. CSNI has not been asked to co-sponsor this exercise, based on a NUPEC BWR Full-size Fine-mesh Bundle Test. The Benchmark proposal had been endorsed by the NSC in June 2003. NUPEC had performed a series of void measurement tests using full-size mockups for both BWRs and PWRs. NUPEC had also performed steady-state and transient critical power test based on the full-size mockups; these tests provided the first substantial database for the development of truly mechanistic and consistent models for void distribution and boiling transition. The purpose of the benchmark was two-fold: compare currently available macroscopic sub-channel approaches and encourage novel next-generation approaches that focus on more microscopic processes. The benchmark specifications were designed to systematically assess and compare the participants' numerical models using the predictions of detailed void distributions and critical powers. The exercise, to be performed over a period of three years, will consist of two phases: Phase 1 – Void Distribution Benchmark (exercise 1: steady-state sub-channel grade benchmark; exercise 2: steady-state microscopic grade benchmark; exercise 3: transient macroscopic grade benchmark) and Phase 2 – Critical Power Benchmark (exercise 1: steady-state benchmark; exercise 2: transient benchmark).

33. The Chairman thanked F. D'Auria and H. Wand for their presentations. The following points were made during the discussion:

- It was not clear why the exercises were called Benchmarks rather than International Standard Problems. F. D'Auria said there was no difference. They might just as well be called ISPs.

- Following a remark, made by F. D'Auria, to the effect that the BWRTT Benchmark had now been essentially completed, that the final report was being prepared by the NSC, and that no further action was requested from the CSNI, B. De Boeck observed that, as the exercise had been jointly sponsored by the NSC and the CSNI, GAMA should have the opportunity to comment on its outcome. I. Toth and the Chairman added that in order to give a meaningful opinion, GAMA members would need a lot more information. At the moment, GAMA was not in a position to endorse, or not to endorse, the final report and its conclusions, including those related to safety issues. On benchmarks relevant to safety issues, especially those

performed under the joint sponsorship of the NSC and the CSNI, the CSNI should have the opportunity to comment on the specification and, even more, on the conclusions. F. D'Auria expressed willingness to ask the NSC to follow this procedure, adding that the NSC was getting increasingly involved in safety-relevant issues, specifically in areas covered by the mandate of GAMA.

- More generally, pointing out that several benchmarks had now been performed, over a period of ten years, the Chairman asked what were the lessons learned with respect to the applicability of the coupled neutronics/thermal-hydraulics methodology. What were the main recommendations? He said that GAMA would need a detailed technical review at its next meeting. F. D'Auria said that the EC was considering a Project in this area, and that results could be made available to GAMA. The Chairman stressed that GAMA would need its own discussion on these issues. **It was agreed that the NSC would be requested, through F. D'Auria, to designate an expert to make at the next GAMA meeting a detailed presentation on the series of relevant benchmarks performed over the last decade and the significant lessons learned with respect to the applicability of the coupled methodology.**

- F. D'Auria asked whether GAMA endorsed the V1000CT Benchmark. The Chairman said that again, on the basis of the information made available by the NSC, the GAMA was not in a position to endorse, or not to endorse. The group could simply "take note".

- The same conclusion was applicable to the PWR MOX Rod Ejection Benchmark.

- The BFBT Benchmark was clearly a two-phase exercise with safety implications, right in the scope of GAMA. The Chairman, supported by other members of the group, said that he could not understand on what basis the NSC was performing this exercise alone as the work was clearly a two-phase exercise with safety implications, right in the scope of GAMA. He could also not understand why the NRC and NUPEC had proposed the exercise to the NSC rather than to CSNI. **It was agreed that the Writing Group on Extension of CFD Codes to Two-Phase Flow Safety Problems should have a look at the proposal and advise GAMA, if more detail could be made available.**

- **More generally, it was agreed that B. De Boeck and the Secretary would raise with the PRG the matter of co-ordination of NSC/CSNI activities.**

XII. Seminar on Transfer of Competence, Knowledge and Experience Gained Through CSNI Activities in the Field of Thermal-Hydraulics (THICKET-2004) [agenda item 12]

34. The Chairman described briefly the progress made in the organisation of the Seminar, to be held in Saclay (France) from 7 to 11 June 2004. The brochure was distributed at the meeting. Additional information and the registration form is available from Internet site 'http://www.nea.fr/html/nsd/workshops/thicket-2004/'.

XIII. Status Report on Progress Made in the Last Ten-Fifteen Years Through Analyses of the TMI-2 Accident Performed in Member Countries – Investigation on the Ability of Current Advanced Codes to Predict Core Degradation (TMI-2 Benchmark Exercise) [agenda item 13]

35. B. Clément said that a draft of the Status report was nearly complete. It had been reviewed by all participants. A new version was being prepared, taking account of the comments made. The final draft version will be ready by the end of 2003, after a last review by the participants.

36. B. Clément presented the main lines of the report, which compared the conclusions of the previous benchmark exercise with the present code capabilities. The conclusion of this work was that further code improvements are needed in the following areas:

- Impact of natural circulation in the vessel, in particular after melt relocation and reduction of the porosity in some parts of the core. This has a strong influence on hydrogen production.

- Impact of more detailed modelling of thermal-hydraulics, heat transfer and oxidation during reflooding. This has an influence on hydrogen production and melt relocation.

- Processes governing melt progression in the core, and the release of molten corium to the lower plenum. This is essential for determining the initial configuration of the debris (particles, compact crust, pool, etc.). This includes a possible debris bed collapse (transition from early to late phase degradation). This has a strong influence on the prediction of pipe or vessel failure due to a pressure peak or steam explosion.

- Debris behaviour in the lower plenum (coolability, oxidation, etc.) Current models are very parametric. Detailed models are not tightly coupled with the thermal-hydraulics and core degradation calculations. Some processes, such as water ingress between the corium and the vessel, are not understood, in spite of available experimental results. This has a strong influence on the prediction of vessel failure.

37. These conclusions underlined the need for a benchmark on an “alternative” TMI-2 transient, in accordance with a proposal made by GAMA in 2001 [CSNI Activity Proposal Sheet GAMA (2001) 9; activity approved by CSNI but postponed so far]. B. Clément proposed the following procedure:

- Before 31 December 2003: Establish the list on interested participants (large participation is desirable).

- End of 2003: Call for proposals by the Co-ordinator. Each participant will propose three scenarios of interest. The scenarios should be designed in such a way that they cover the largest possible range of physical processes (e.g., a starvation phase, a large amount of materials, late quenching, etc.).

- Mid-2004: First meeting, to select the “alternative” scenario, and to harmonise circuit description and input data (preparatory work).

- End of 2004: start of benchmark calculations.

- 2005: Second meeting: intermediate comparison of results, possible modification of the scenario, adjustment of the input decks.

38. The following points were made during the discussion:

- W. Scholtyssek stressed that TMI-2 accident calculations were getting more complicated, and results more uncertain as the accident progressed, in particular in Phase 4 of the calculations. Many questions were raised, without any real explanation at the moment. He felt that another benchmark calculation would be premature.

- J. Rohde stressed that the amount of hydrogen generated during the TMI-2 accident had been estimated, afterwards; uncertainties were very large. He added that he could not see the need to have codes able to predict every detail of the late phase of core degradation, more especially as late phase core degradation depends on stoichiometric processes, totally unpredictable. What matters is risk assessment.

- K. Müller said that the real problem was the steep increase of hydrogen production during the accident, stressing that it was the result not only of cladding oxidation but also of metallic melt oxidation.

- B. Clement agreed that there were many unknowns in the progression of the accident. The status of the core during the transient and at the end was not known. However, model development required experimental data. The benchmark would help clarify which kind of experiment is needed. Moreover, a number of improvements had been made to the codes; they should be checked against quality experimental data.

- W. Scholtyssek wondered how it was possible to prove that results obtained with improved codes were closer to reality, or that better agreement had not been obtained by chance.

- The Chairman stressed that the objective was not to improve models but to find out whether, with a slightly modified scenario, calculation results would still be acceptable.

- I. Toth pointed out that information about the proposed benchmark was too limited at the moment to form a well-founded opinion.

- The Chairman concluded that it would be better to wait for the complete final draft of the report and discuss the matter again at that time.

XIV. Qualitative Presentation on MASCA Results [agenda item 14]

39. W. Frid said that the MASCA Project was part of a series on international Projects aimed at providing data on the behaviour of prototypic materials at high temperature and refining strategies for maintaining reactor pressure vessel integrity in the event of a core meltdown. The Project had addressed the influence of the chemical composition of the molten corium on the heat transfer to the pressure vessel environment. The tests aimed to resolve remaining uncertainties about the heat load on the reactor vessel and thus the possibility of retaining the melt in the vessel. The analytical work is done at the Nuclear Safety Institute (IBRAE) of the Russian Academy of Sciences. The results generated are of relevance to the reactors operating in the OECD member countries as well as to VVERs. The results of the Project are used to further develop computer models. Furthermore, the Project is applicable to both current and future reactors.

40. W. Frid presented an overview of recent progress. The main technical objectives of the Project were the following:

- study of corium potential for stratification,
- expansion of the material properties database,
- study of fission product partitioning between the metallic and oxidic phases,
- large-scale confirmatory test,
- salt test to quantify thermal-hydraulic phenomena in a stratified molten pool (focusing effect).

W. Frid described the experimental facilities, the experimental matrix, and the experiments performed so far. He also presented briefly some of the major results:

- Test results indicated significant interactions between corium components.
- Free zirconium seemed to be the main component which determined interactions
  - with additives such as carbon and boron,
  - with steel and uranium dioxide.
- Boron carbide significantly influences interactions of the main core components.
- Fission products were distributed between metallic and oxidic parts of corium, as it had been anticipated.

Future work would investigate the following topics:

- Investigation of interactions of sub-oxidised corium with iron (stainless steel) at larger corium-to-iron mass ratios.
- Investigation and quantification of the effects of control materials in stratified molten pools containing U-Zr-O-FE(SS)-B_4C.
- Investigation and quantification of the behaviour of the U-Zr-O-Fe(SS) molten pools in an oxidising atmosphere.
- Continuation of material properties measurements to provide complementary data for compositions which are representative of reactor cases.
- Investigation of molten metal alloys interactions with the debris bed in inert and oxidising atmospheres.

41. The Chairman thanked W. Frid for his presentation. Several questions for clarification were asked. J. Martinez Martinez asked whether MASCA had provided information regarding which fission products are released from the molten pool; W. Frid answered that the Project had been more focused on data related to fission product distribution and stratification issues. M. Vidard and W. Scholtyssek stressed

that code validation is a very complex task and that MASCA had resulted in more new questions than in answers. The Chairman agreed that indeed the Project had shown that the situation of a molten core is even more complicated than had been expected.

XV. Programme of Work in the Field of Fission Products, Ex-Vessel Phenomena, Containment Behaviour and Severe Accident Analysis [agenda item 15]

42. W. Scholtyssek, Co-ordinator for experimental Work in the Area of Beyond design Basis Accidents, presented briefly and in general terms the GAMA programme of work in the field of fission products, ex-vessel phenomena, containment behaviour and severe accident analysis, placing it in the perspective described in the Integrated Plan (doing this, he pointed out that at the moment GAMA had essentially no activity in the field of hydrogen combustion, in spite of the high priority given to this topic in the Integrated Plan). The items of the programme of work are described in the subsequent sections.

43. During his presentation, W. Scholtyssek mentioned that a recent large meeting of the nuclear community in Germany had shown that at least half the audience knew very little about severe accidents. His conclusion was that CSNI and GAMA should make efforts to disseminate more effectively the results of their work.

XVI. Final Report on the Second Phase (RTF and CAIMAN Experiments) of the Follow-up to the ISP-41 Exercise – Conclusions of the whole ISP-41 Exercise [agenda item 16]

44. H.-J. Allelein presented the final report on the exercise (the text of the final report had been made available to GAMA members on the Internet site). The work, devoted to iodine behaviour in containment, had to be placed in the context of increasing demand for safety analyses of reactor accident consequences and the trend to move away from bounding conservative estimates towards *best estimates* supported by uncertainty analyses. As a consequence, it was increasingly necessary for iodine codes to demonstrate their capability to provide accurate estimates of iodine volatility for a large range of reactor accident scenario conditions. However, experimental data have only been obtained under a narrow range of conditions, and it is difficult to determine representative accident conditions.

45. This work had been performed in three steps:

- initial ISP-41 exercise: computer code comparison exercise based on a simple RTF experiment
- follow-up Phase 1: parametric calculations
- follow-up Phase 2: computer code comparison exercise based on four more complex experiments performed in the RTF and CAIMAN facilities.

The following conclusions had been drawn:

<u>Step 1:</u>

- simple RTF test (single temperature, controlled pH steps, no organic impurities)

- conclusions:
  - "… all of the codes had the capability to reproduce the experiment …"; in reality, the codes could reproduce the trends of the main species qualitatively, but only more or less quantitatively;
  - iodine codes are extremely dependent upon the judicious choice of user-defined kinetic parameters;
  - except for Canadian codes, all codes had significant problems to extrapolate temperature dependent parameters (80 - 130 °C towards room temperature).

Step 2:

- assessment of the codes over a wide range of accident conditions leading to an understanding of the sensitivity of output to input parameters
- investigated input parameters:
  - pH (4 – 10)
  - temperature (60 – 130 °C)
  - dose rate (0.1 – 10 kGy/h)
  - initial iodide concentration (10^{-6} – 10^{-4} moles/dm^3)
  - condensation
  - presence of silver in the sump
  - organic impurity concentration
- H.-J. Allelein gave examples of the results:
  - pH = 5 $1 . 10^{-3} – 1 . 10^{-1}$
  - pH = 9 $2 . 10^{-4} – 9 . 10^{-2}$

Step 3:

- code comparison against four intermediate scale tests in CAIMAN and RTF, performed over a large range of conditions (pH, temperature, dose rate, painted surface area, …);
- conclusions:
  - in general, the codes are in agreement regarding the trends (e.g., iodine volatility decreases with increasing temperature by about the same amount; the gaseous iodine fraction is rather insensitive to the initial iodide concentration);

- however, the actual amount of volatile iodine predicted varies considerably; the largest source of discrepancies stems from the different sub-models for the formation and destruction of organic iodides;

- parametric calculations cannot show which – if any – of these sub-models are correct.

- for the blind calculations: compared to Step 1 results are in general better; however, no code could predict all four tests with sufficient accuracy (overall, the Canadian codes had the best results);

- for the open calculations:

  - some "hard numbers", recommended by IRSN for the CAIMAN tests and AECL for the RTF tests (mainly for adsorption and desorption rate constants) had been agreed beforehand;

  - comparisons covered not only values at the final time of the test but also the trends (time dependent evolution of the main parameters);

  - criteria to rate the calculated concentrations had been defined:

    - gas phase iodine: factor 3

    - aqueous phase iodine: ± 20 %

    - total organic iodide in the gas phase: factor 3

    - fraction of gas phase in form of organic iodide: ± 20 %

  - conclusions of the open calculations:

    - agreement between calculations and experimental data had been improved thanks to:

      - some change in the models (IMOD, IMPAIR)

      - some modifications in the "hard numbers" (IODE-CIEMAT)

      - better estimations of some input parameters (AIM, IODE-IRSN);

    - however, no code fulfils the above criteria in all four tests;

    - the codes still predict I_2 (aq) differently; as a result, the comparison of organic iodine models is difficult;

    - in order to properly assess I_2 (aq), it is necessary to predict I_2 (gas) and the amount of adsorbed iodine or the total aqueous concentration;

    - it is therefore recommended that each code be validated against the tests ACE RTF4 and PHEBUS RTF2A.

A general conclusion was that the exercise has provided a unique opportunity to compare codes against previously unavailable experimental data.

46. H.-J. Allelein also discussed possible future activities in the area of iodine chemistry:

- Recalculation of the iodine phase of ISP-46 (PHEBUS FPT-1 Test) using measured initial and boundary conditions with codes improved on the basis of ISP-41 experience.
- Based on the very useful insights gained in the first phase of the ISP-41 exercise, it is possible to suggest improved benchmark calculations:
  - multi-compartment calculation
  - different thermal-hydraulic conditions
  - including aerosol deposition
  - realistic sources from reactor coolant circuit
  - walls: steel and painted concrete
- Calculation of a "realistic" accident scenario (perhaps for a real decommissioned plant; BWR specific iodine chemistry).
- Another ISP exercise involving iodine chemistry and containment thermal-hydraulics (e.g., ThAI in 2005).

47. The Chairman thanked H.-J. Allelein for his excellent presentation, and all those who had contributed to the ISP-41 exercise (in particular C. Wren and J. Ball from AECL who had prepared the final reports on the various phases of the exercise, and C. Marchand, IRSN). The following remarks were made with respect to the draft of the final ISP-41 Follow-up Phase 2 report:

- The conclusions refer mainly to codes, not to models. It was understood, however, that making judgements about models is a very difficult task, and ISP exercises are not well suited for such work.
- Data from the TMI-2 accident have not been critically re-examined recently. It was pointed out that because iodine quantities generated in the accident were very small, and because experimental data were obtained a long time after the accident, such a review is very difficult. It might nevertheless be useful to add it to the proposals for future work made by H.-J. Allelein.
- **It was finally agreed that any remarks on the draft of the report should be communicated to the Secretary before 10 October 2003.** After that, the report will be transmitted to the PRG and the CSNI for final approval.

48. The Chairman said that proposals for future work would be discussed later, after hearing the final report on the ISP-46 exercise.

XVII. State-of-the-Art Report on Nuclear Aerosols in Reactor Safety [agenda item 17]

49. H.-J. Allelein said that the Writing Group had not met since the previous meeting of GAMA. However, work was progressing very satisfactorily on most chapters of the SOAR. A more complete report will be presented to GAMA at the next meeting.

XVIII. SERENA (Steam Explosion Resolution for Nuclear Applications) Co-ordinated Programme [agenda item 18]

50. The report was presented by D. Magallon, Programme Co-ordinator, who reminded the participants that the overall objective is to consolidate understanding on FCI phenomenology and obtain convergence on the FCI key processes and energetics for reactor situations and on methods for reliable estimates of the magnitude of loadings under realistic reactor conditions, in order to bring understanding and predictability of FCI energetics to desirable levels for risk management. The SERENA Programmes consisted of two Phases:

- Phase 1: analytical, to analyse in-depth existing knowledge and data (2002 - mid-2005),
- Phase 2: analytical and experimental (of confirmatory nature), if required (depending on Phase 1 conclusions).

Five tasks had been identified:

- Task 1: Identify relevant conditions for FCI in NPPs (completed).
- Task 2: Identify gaps in premixing understanding, modelling and data through code application to reference experiments and comparison of results (analysis in progress).
- Task 3: Identify gaps in explosion understanding, modelling and data through code application to reference experiments (calculations in progress).
- Task 4: Identify key physics for load assessment under reactor conditions through code application to reference reactor cases (definition of reactor conditions initiated).
- Task 5: Summary of the findings of Phase 1, and proposal for Phase 2, if required.

D. Magallon described the calculations that had been performed or were under way, and the agreed working procedures (actually, most Task 2 contributions had been submitted late and incomplete). He summarised the discussions that had taken place during the May 2003 meeting of the SERENA Expert Group, and preliminary insights obtained from Task 2. He then mentioned several difficulties that had been met:

- Different levels of phenomena description and code validation, and different background and motivations, made it difficult to obtain convergence of opinions on objectives, working methods, work programmes, etc.
- There was insufficient interaction among the Partners between meetings.
- Late submission of contributions had introduced significant delays in the Programme.

These problems demonstrated the need to convene, as soon as possible, the first meeting of the SERENA Technical Programme Committee, the functions of which were:

- to assist the SERENA Programme Co-ordinator,
- to provide technical support to the SERENA Programme, as appropriate,
- to provide wide international support to the SERENA Programme,
- in particular, to ensure that the Partners respect the agreed commitments and schedule,
- to discuss difficulties identified by the SERENA Expert Group, proposed changes to the SERENA Programme agreement, or proposed extensions of work, and provide guidance to the Group or make recommendations to the CSNI,
- to review the reports prepared by the SERENA Expert Group (from the point of view of fitness for publication),
- to make recommendations to CSNI with respect to the dissemination of these reports and, more generally, the dissemination of information generated by the SERENA Programme,
- in general, to advise the SERENA Programme on all matters it judges appropriate to ensure that the objectives will be met in due time.

The TPC was scheduled to meet in October 2003. Finally, D. Magallon presented briefly the main lines of Task 3 and Task 4 calculations. He mentioned also that the May 2003 meeting had discussed co-operation between the SERENA Programme and KAERI's TROI Programme.

51. The discussion concentrated on the triggerability of steam explosions, and the explosivity of some materials. D. Magallon stressed that any material, under the right conditions, can induce a steam explosion, and stressed the extreme complexity of the interplay of materials and conditions, and of the resultant energetics. The real issue is the yield of the explosion. J. Rohde mentioned the possible triggering role of chemical interactions resulting from hydrogen generation. W. Scholtyssek was of the opinion that steam explosions are a stochastic phenomenon, and stressed that in a severe accident there will be all sorts of triggers everywhere.

52. D. Magallon said that the question of triggerability is not central to the SERENA Programme as the assumption is made that a sufficient trigger exists. The Chairman reminded the participants that the objectives of the Programme is to consolidate understanding and obtain convergence on the main key phenomena and processes of steam explosions, and to make a judgement about the applicability of existing codes to reactor conditions. He also said that steps were being taken to re-orient slightly the SERENA programme of work, in consultation with the SERENA Technical Programme Committee who would meet in a few weeks. He added that the SERENA Programme was very complicated to manage, and thanked D. Magallon for the excellent way he had undertaken this difficult task.

XIX. ISP-47 Exercise (TOSQAN/MISTRA AND ThAI Experiments) [agenda item 19]

53. The report was presented by H.-J. Allelein, who reminded the group of the scope of the exercise:

- predict the local distribution of air, hydrogen and steam

- assess the capability of lumped parameter and CFD codes

The exercise was run in two steps (a third step might be added in due course).

54. Step 1 was devoted to tests performed in the TOSQAN (7 m^3, IRSN) and MISTRA (100 m^3, CEA) facilities. Open calculations were performed for the TOSQAN test, blind calculations for the MISTRA test. The geometry was rather simple; the initial and boundary conditions were well-controlled. The following phenomena were investigated: buoyancy, wall condensation, stratification, and turbulence. Step 1 included two phases:

Step 1 / Phase A:

- steady state tests for an air/steam mixture
- the status of the task (which was not considered very challenging) was the following:
  - calculations had been performed
  - the draft of the comparison report was available (but only with very preliminary and general conclusions)
- the following codes participated in the exercise:
  - lumped parameter codes: COCOSYS/ASTEC (6 participants), MELCOR (3), TONUS LP (2), CONTAIN (1), FUMO (1), GOTHIC LP (1) and KUPOL-M (1)
  - field codes/reactor safety specific CFD codes: GOTHIC (2), TONUS (2), DEFINE (1), GASFLOW (1), KUPOL-3D (1)
  - commercial CFD codes: CFX (2), STAR-CD (1)
- preliminary conclusions for TOSQAN calculations
  - Lumped parameter codes predict fairly well pressure, mean temperature and mean steam concentration.
  - Multi-compartment lumped parameter calculations lead to satisfactory vertical and radial profiles for temperatures and steam concentrations.
  - Pressure evolution calculated with CFD codes could be improved sometimes at high condensation flow rate.
  - In general, CFD codes show the ability to reproduce gas distribution in simple containment geometry.
- preliminary conclusions for MISTRA calculations:
  - Differences in total pressure are mainly related to the chosen initial conditions.
  - condensation distributions on the three condensers have been reproduced in some cases but the magnitude needs further investigations (reason is unclear).

- Gas temperature profiles have been calculated accurately.
- There were some experimental difficulties regarding gas concentration profiles: computed gradients are very small along the vertical axes.
- Velocity profiles are calculated quite well with CFD codes.

Step 1 / Phase B:

- air/helium/steam mixture in steady state and transient states
- calculations were just coming to an end; the next meeting of the ISP-47 participants was planned for January 2004.

55. Step 2 characteristics were the following:

- air/helium/steam mixture in a more realistic compartmented geometry
- stratification
- asymmetric injection
- ThAI facility (60 m^3, Becker Technologies) test to be specified at the beginning of 2004
- phase A: blind calculations
- phase B: open calculations

56. In due course, a decision will be made with respect to a possible Step 3, to be performed for instance in the PANDA facility (200 m^3, PSI).

57. The Chairman thanked H.-J. Allelein for his presentation.

XX. German ThAI Code Comparison Exercise

58. H.-J. Allelein presented a short report on a German ThAI code comparison exercise, in order to facilitate discussion on the results of ISP-47 at the next meeting. Four codes had been used in the exercise: COCOSYS, GASFLOW, STAR-CD and CFX. The two commercial CFD codes (STAR-CD and CFX) had produced results in poor agreement with the experimental data (in particular because users had to develop a small condensation model themselves). GASFLOW and COCOSYS had given much better results, of comparable quality. Nodalisation had a major impact on the quality of the results. More details will be given at the next meeting of GAMA.

59. The Chairman thanked H.-J. Allelein for his presentation.

XXI. Phenomena-Based Validation Matrix for EX-Vessel (Containment) Models and Codes [agenda item 20]

60. H.-J. Allelein reported on the second meeting of the group, which had been held in June 2003. Two fields of interest had been discussed: containment thermal-hydraulics and hydrogen combustion. For both, the list of phenomena of interest and the list of parameters to be measured had been finalised, and experiments had been selected for inclusion in the matrix. For some of these, data were openly available, for others data availability needed to be clarified. The results of the discussion had been summarised in document NEA/SEN/SIN/AMA(2003)25. H.-J. Allelein stressed that the main issue now was to find out about the availability of the data which had been selected for inclusion in the Validation Matrix.

61. The Chairman thanked J.-J. Allelein for his presentation. W. Scholtyssek and J. Rohde stressed the need to collect data on hydrogen combustion and strongly supported the proposal made; J. Rohde suggested to include the results of HDR experiments on hydrogen combustion, instead of RUT results. H.-J. Allelein pointed out that boundary conditions in HDR experiments were difficult to interpret. **It was agreed that the Group of Experts would discuss the matter of hydrogen combustion data again and report to GAMA at the next meeting.**

62. More generally, the Chairman asked whether it was really necessary to collect all the data identified as necessary for the Validation Matrix by the Group of Experts. H.-J. Allelein stressed that the collected data should cover the full range of conditions and experiments. Also, it was clear from previous experience (e.g., the collection of data for the CSNI Thermal-Hydraulics Code Validation Matrix) that not all identified data would be made available. Overlap of phenomena had therefore been introduced in the matrix, the content of which was justified from a purely technical point of view. With these explanations, **it was agreed that collection of data could start immediately.** It was suggested to start with "simple" cases, e.g. data in the thermal-hydraulics case, and then build up the matrix progressively from there. Diplomacy would be needed to ensure that all involved member countries participate in this effort.

XXII. ISP-46 Exercise (PHEBUS FPT-1 Experiment) [agenda item 21]

63. B. Clement presented briefly the main lines of the ISP-46 exercise and its conclusions. These had been presented in detail during the previous meeting of GAMA. A peer review group had been set up to review the final version of the report. Some ten experts not belonging to organisations that had participated in the exercise had been approached; three had agreed. Interesting and useful comments had been received; the last ones were expected within a week. The GAMA Co-ordinator for Reports Quality Control (R. Ashley) had also transmitted his observations and suggestions. No delay would be experienced in the preparation of the final version. **It was agreed that last minute comments, if any, should be sent to the Secretary before 10 October 2003.** After that, the report will be submitted to the PRG and the CSNI for final approval.

64. The Secretary thanked B. Clément and T. Haste for the outstanding work they had done throughout the ISP-46 exercise, in spite of a workload that had turned out a lot heavier than expected originally.

XXIII. Preliminary Proposal for Establishment of an International Centre of Excellence on Containment Iodine Chemistry and Fission Product Behaviour

65. J.C. Wren said that what was proposed was the creation of an International Centre on Containment Iodine Chemistry and Fission Product Behaviour based on the model of an OECD Joint

Research Project or Joint Undertaking. The Project would respond to a need to combine the international resources to achieve a consolidated understanding of iodine and fission product behaviour and complete the work in these areas. The high level objectives of the Project would be:

- identification and resolution of common problems, and avoid duplication of efforts and resources,
- convergence on common predictive tools and capabilities,
- maximum effective application of existing test results.

The Project would be built along the lines of a Centre of Excellence (as defined in the SESAR/FAP report).

66. J.C. Wren described the background of the issue:

- the reasons why iodine has been a long-standing concern,
- iodine may no longer be a major concern for accident management, but is still an important issue for accident analysis and mitigation,
- large body of research completed over the years,
- current status of iodine capability,
- a focused effort to develop practical analysis tools based on a common understanding is needed.

AECL was proposing to set up an international joint Centre of Excellence, drawing on all existing staff/facilities in the participating countries to the maximum extent. The primary research institutions, which would host the Project, would be University of Western Ontario and AECL in Canada. The Project would be open to all organisations in OECD Member countries able to contribute significantly to its programme of work. The work would be co-ordinated and directed by J.C. Wren at UWO, acting in liaison with an international Technical Programme Group. The work undertaken would focus on problems of international interest in the chemistry and behaviour of iodine and other fission products.

67. The technical objectives of the proposed Centre would be:

- to assist in developing practical models to meet the needs of funding partners for severe accident assessments and mitigations,
- to provide the theoretical basis for these models and to document the experimental data need to support the model designs,
- to examine and analyse integrated effects tests in large- and intermediate scale tests, made available by participating partners,
- to define, carry out, or co-ordinate necessary supporting experimental work,
- to discuss and assist in applications to reactor safety,

- to co-ordinate model comparison exercises and specialist workshops and to provide specialised lectures and courses.

68. J.C. Wren described:

- the scope of work (the detailed scope would depend on the priorities to be brought to the discussions during an organising meeting),
- the capabilities of the proposed Centre,
- the roles and capabilities of Participating Members, namely:
  - participating in establishing the research direction of the Centre,
  - sharing the existing data and the data to be obtained through the programme co-ordinated by the Centre,
  - disseminating and sharing information through the Centre, applying that information to the purposes of individual organisations,
  - applying data and knowledge to advanced codes,
  - developing international technical consensus in the area of containment iodine chemistry and fission product behaviour,
  - providing staff and a facility for experiments that would be identified as necessary supporting or validation work and as better suited to be performed at such a facility (e.g., CAIMAN, ThAI),
  - participating in R&D to be performed at the Centre,
  - providing resources in preparing and running specialist workshops, and specialised lectures and courses,
- a possible funding structure.

69. In conclusion, J.C. Wren said that a number of iodine experts around the world had expressed support for the proposal. She asked GAMA to endorse it (following modifications, if necessary) for submission to CSNI, and to request the CSNI to take steps towards the creation of the proposed Centre.

70. The Chairman thanked J.C. Wren for her very clear presentation, and Canada for the proposal. Starting the discussion, B. Clément said that IRSN, among other organisations, was performing experiments in the field of iodine chemistry (with Framatome ANP, etc.), that there are very few experts in iodine radiochemistry in the world (which made international collaboration necessary), and that some international efforts were under way (e.g., in the EURSAFE Programme undertaken in the framework of EC'S FP-5, the new SARNET proposal). He wondered how all this work could be done at the same time given the small number of specialists in this area.

71. Regarding the SARNET (European Network of Excellence on Severe Accident Research) proposal, H.-J. Allelein asked what its technical content would be with respect to iodine chemistry. B. Clément said that this point was under discussion among the Partners; the proposal should be clarified by

the end of 2003. In answer to another question from H.-J. Allelein, he said that iodine chemistry results obtained so far in the framework of the EURSAFE Programme were not open to non-Partners but could be made available if the Partners agree to do so. J.C. Wren said that the Canadian proposal had of course no intention of duplicating anybody else's work. She stressed that resources were limited everywhere; dispersed, limited efforts were not an efficient way of looking at the safety problems posed by iodine. She also said she was not quite sure how to co-ordinate with the SARNET proposal as information was very hard to obtain. W. Scholtyssek said that, as far as he knew, SARNET would not perform any experimental work; it would simply integrate work performed by the participating organisations, in the European Union. J. Rohde was also of the opinion that the role of SARNET would be limited to the EU; he emphasised that the Canadian proposal was made at the scale of the OECD, and was therefore essentially covering the whole world effort in the area of iodine chemistry. G. Cognet said that the EURSAFE Programme had demonstrated the importance of the safety problems posed by iodine chemistry. SARNET was focusing thinking in Europe about a number of issues. The future course of action was not yet clear, however. The situation should be clarified by the end of the year, both regarding actions within the European Union and actions involving outside collaboration. This point was also made by A. Zurita.

72. G. Cognet said also that the need to maintain competence in the field of iodine chemistry should also be kept in mind. In that respect, the SARNET project and the Canadian proposal were important steps. He added that no time should be wasted as current programmes are being terminated and laboratories dismantled.

73. H.-J. Allelein said that the concept of world-wide Centre of Excellence deserved strong support. So did SARNET. Iodine behaviour is probably the safety issue that raises the largest number of open questions. As the paper supporting the Canadian proposal included a rather comprehensive discussion of the technical background, and as several organisations had expressed interest in the proposal, he was in favour of wasting no time and going ahead with more detailed discussions, including discussions about organisational aspects. H.-J. Allelein added that he did not think SARNET would undertake extensive experimental work. He suggested holding in the next few months, by Spring 2004 at the latest, a technical meeting of countries interested in SARNET to discuss its future programme of work in order to define clearly the borderline between SARNET and the proposed Centre of Excellence. S. Güntay supported these views, and suggested that J.C. Wren should start collecting information about possible contributions (financial and in-kind) by interested participating organisations.

74. G. Vayssier questioned the statement that iodine may no longer be a major concern for accident management, emphasising its role in emergency planning and preparedness. J. Rohde stressed that iodine chemistry research was not the only important aspect; risk should also be discussed. He felt that this aspect should be included in the Canadian proposal.

75. Summarising the discussion, the Chairman made the following points:

- There was general agreement that the Canadian proposal was interesting.
- It had been agreed at the previous meeting of GAMA that a Status report on Iodine Chemistry should be prepared, addressing the current situation, remaining issues, reactor safety relevance, and recommendations to CSNI. He suggested linking the Canadian proposal to the Status Report, which could become the starting point for setting up the Project.
- Necessary links should also be established between the proposal and ongoing and future programmes, such as SARNET, and national activities, in order to have good co-ordination.
- Advantage had to be taken of integral experiments.

- The Chairman was very much in favour of technical discussions among all iodine chemistry experts, and supported the organisation of the meeting proposed by H.-J. Allelein.

- In summary, GAMA expressed strong support for iodine chemistry work and the development of an international Centre of Excellence to maintain, if possible enhance, competence, code capabilities, etc.

- The Chairman encouraged J.C. Wren and AECL to refine their proposal and develop in great detail.

76. J.C. Wren expressed pleasure about this conclusion but also expressed concern about the implied timing: the Status Report will not be available before 18 or 24 months. This delay would be too long for a number of reasons. B. Sanderson stressed that time was important from the Canadian point of view as iodine chemistry activities were winding down quickly; utilities needed quick answers. AECL strongly supported the concept of a COE based on universities, in particular to maintain a training ground for future iodine experts. S. Güntay added that the Status Report would not bring up new issues, and that there was no need to wait for it. The Chairman said that work on the COE proposal and on the Status Report could take place in parallel. He added that the Status Report would not be prepared for the expert community but for managers and decision-makers, who were not aware of the importance of the iodine problem. While many considered the issue closed a few years ago, recent research had shaken that view.

XXIV. Status Report on Iodine Chemistry [agenda item 22]

77. B. Clément reminded the group of the objectives of the Status Report:

- To review insights gained and evaluate the progress made during the last ten years on the understanding of phenomena governing iodine chemistry and release in the case of a reactor severe accident.

- To review iodine aspects of accident management and corresponding accident management strategies.

- To evaluate the current status of iodine chemistry knowledge and tools used for source term prediction in connection with emergency planning.

- To identify remaining weaknesses.

- To discuss reactor safety relevance and make recommendations as necessary.

78. He proposed the following action plan:

- By the end of 2003: set up a small writing group of experts having sufficient knowledge of iodine phenomenology and of safety implications in various situations. Competence would be required for different types of reactors: BWR, PWR, VVER, PHWR.

- Spring 2004: kick-off meeting to collect information (the aim will be to be complete), to agree on the structure of the Status Report, to assign tasks, and to agree on a detailed time schedule (preparatory work to be done by a Co-ordinator).

- By late Summer/early Autumn 2004: complete first draft of the Status Report (work at home according to assigned tasks, co-ordination and exchange of information by e-mail).

- Autumn 2004: Writing Group meeting to review the first draft and amend as necessary; assignment of new tasks to prepare second draft.

- Spring 2005: review of second draft by GAMA; amendments and corrections.

- May/June 2005: submission of the final draft report to PRG and CSNI, respectively.

79. During the discussion, F. D'Auria pointed out that iodine chemistry and its impact on safety are very difficult to understand for non-experts. He asked the authors of the Status Report to include discussions on the connection with previous steps of the accident, impact on the source term uncertainties in predictions, etc. B. Clément said that, indeed, this was the intention. M. Vidard asked who would discuss safety relevance. B. Clément replied that assigning safety relevance had been the first task of the EURSAFE Programme; participants were experts from industry and licensing authorities. M. Vidard expressed surprise that the Programme had identified iodine safety issues of relevance to accident management; G. Vayssier too, adding that safety relevance for risk assessment and off-site consequences was a different story. B. Clément said that all these points would be discussed by the Writing Group.

80. **The Chairman asked participants to nominate experts for the Writing Group quickly, well before the end of 2003.** The Secretary added that if nominations were made early enough, it would be possible to speed up the schedule described by B. Clément.

XXV. GAMA Action Plan in the Area of Accident Management – 2004-2006 [agenda item 23]

81. As agreed at the previous meeting, J. Rohde had reworked the Accident Management Action Plan he had proposed earlier. Further modifications had been made by the Chairman and the Vice-Chairman of GAMA. (Note of the Secretary: the summary below takes into account the changes made to J. Rohde's proposal by M. Durin and B. De Boeck.)

82. The proposed Action Plan, which had special emphasis on severe accident management, was divided into three parts:

(i) Status and Situation Reports, Exchange of Information on Practices:

- Organise a specialist meeting on the current status in OECD Member countries of severe accident management implementation, including the extension of AM/SAM to shutdown conditions in LWR plants, the basis for decision-making and national requirements, criteria, guidelines for implementation of AM/SAM in existing plants. Target date: mid- 2005.

- Update the 1996 SESAM report "Implementing Severe Accident Management in Nuclear Power Plants" (on the basis of recent specialist meetings and a questionnaire on the regulatory status of severe accident mitigation). Target date: mid-2006.

(ii) Workshops, Specialist Meetings, ISP Exercises on Specific Issues Related to AM/SAM:

- Early core degradation and melt progression, including hydrogen production: no proposal at the moment.

- Managing in- or ex-vessel melt coolability: no proposal at the moment.
- In-vessel cooling by external flooding of the vessel: if RASPLAV and MASCA data are made available, workshop or status report in 2006 or 2007.
- Mitigation of potential consequences of H_2/CO combustion: no specific proposal at the moment.
- Effects of in-vessel or ex-vessel FCI on melt coolability: to be discussed at the end of SERENA Phase 1 (2005).
- Longer-term MCCI processes including ex-vessel melt coolability: ISP based on an OECD MCCI experiment (if data are made available). To be started in 2004, completed in 2006.
- Human factor aspects related to response to emergencies (especially, severe accident-type situations). To be discussed further.
- Specific activities of SAM programmes implemented in the plants (make use of experience, practical aspects related to management, difficulties met, programme status, etc.). To be discussed further.

(iii) Special SAM Issues for Discussion in GAMA Meetings:

- AM/SAM measures for containment by-pass sequences
- protection against external hazards (e.g., floods, hurricanes)
- long-term SAM (including containment venting)
- consequences of the use of MOX and high burnup fuel on SAM
- etc.

83. G. Vayssier made a number of comments:

- The subject of AM/SAM remains extremely important. It should provide a focus for most of the work done by GAMA;
- He supported the above Action Plan in general.
- To the extent possible use of recent information should be made in part (i) of the Plan. Information collected at specialist meetings held a few years ago was not valid anymore.
- He had doubts about the need for further research, in the context of SAM (he said there is not much one can do in the case of a severe accident).
- He stressed the importance of the work on hydrogen combustion.
- He suggested to make explicit reference to SAM for VVERs.
- With respect to decision-making: countries implement different rules and procedures.
- Much work is now going on at the IAEA.

84. The last remark was amplified by J. Misak, who said that accident management was now a very active area at the IAEA; he mentioned work on developing safety standards, training, disseminating information, etc. He said that the IAEA was organising in October 2003 a Technical Meeting entitled "Monitor Progress in Implementation of Accident Management Programmes (AMP) at NPPs"; after that meeting, the IAEA could start preparing a detailed report. J. Misak suggested to wait for the conclusions of this meeting before taking any decision. He expressed willingness to present a summary at the next meeting of GAMA.

85. W. Scholtyssek stressed the need to take into account in accident management not only technical considerations but also more "political" ones, reflecting the point of view of regulators, utilities, etc.

86. F. D'Auria and W. Frid stressed the strong influence of plant specific characteristics on accident management.

87. B. De Boeck suggested to prepare a CSNI Activity Proposal Sheet taking into account not only the GAMA discussions but also the outcome of the IAEA Technical Meeting, and to differ further discussion until the next meeting of GAMA. The Chairman agreed with the suggestion. **So, it was decided that a few members of the group should be designated before the end of 2003 to prepare a detailed CAPS before the next meeting of GAMA.**

88. It was necessary to designate a new GAMA Co-ordinator for Accident Management Work, as J. Rohde was now retired. Preliminary contacts taken by the Secretary had established that O. Sandervag would be a good candidate for the task. O. Sandervag confirmed his willingness, all the more that his future responsibilities will include emergency preparedness and accident management work at SKI. His designation was endorsed by GAMA. **His first duty will be to co-ordinate the preparation of the above-mentioned CAPS.**

XXVI. Collection of Information on the Status of Relevant Facilities and Programmes in the Areas of Thermal-Hydraulics and Beyond Design Basis Accident Research [agenda item 24]

List of Severe Accident esearch Facilities and Projects:

89. W. Scholtyssek had updated the list, which was now ready for publication.

List of Thermal-Hydraulic Research Facilities and Projects:

90. F. D'Auria had decided to defer the compilation of the list until the next meeting of GAMA, because of initiatives being taken regarding several facilities: PKL, ROSA/LSTF, PACTEL, etc.

Information About Selected Facilities:

91. The Secretary said that an official letter had just been sent to CSNI members requesting them to review the draft agreement for the PKL-2 Project, and asking them to confirm, before 31 October 2003 if possible, whether their country would participate in the Project.

92. H. Holmström said that Finland intended to propose the PACTEL facility for an OECD Joint Project. Details will be communicated to the Secretariat at a later date.

XXVII. Preliminary Informal Proposal for an OECD ROSA Project [agenda item 24]

93. H. Nakamura said that Japanese authorities were considering the possibility of making the ROSA/LSTF facility available for an OECD Joint Project. He presented a preliminary draft of a proposal entitled "Background and Description of the OECD ROSA Project to Resolve Water Reactors Thermal-Hydraulic Safety Issues through LSTF Experiments". The proposal first described the background situation regarding thermal-hydraulics computer codes, their development and verification, necessary experimental data, available experimental facilities, the unique features of JAERI's ROSA/LSTF facility, and the advantages of its continued used in the framework of an OECD Project. The overall objective of the Project would be to investigate issues in thermal-hydraulics analyses relevant to water reactor safety, in particular the verification of models and simulation methods for complex phenomena that can occur during reactor transients and accidents.

94. The key objectives of OECD ROSA Project would be to:

(i) Provide integral and separate-effect experimental databases to validate code predictive capability and accuracy of models. Especially, phenomena coupled with multi-dimensional mixing, stratification, parallel flows, oscillative flows and non-condensable gas flows are to be studied. The experimental programme will be defined in consultation with OECD Member countries in order to provide a valuable and broadly usable database for code and model validation.

(ii) Investigate the predictability of codes currently used for thermal-hydraulics safety analyses as well as of more advanced codes presently under development, thus creating a forum among OECD Member countries who share the need to maintain or improve competence in thermal-hydraulics for nuclear reactor safety evaluations.

95. The tentative proposed plan includes six types of experiments, including both integral and separate-effect tests. The experiments are intended to provide data for the development and verification of models and correlations, aiming to increase the level of details and accuracy in the analyses of the key phenomena during transients and accidents. Several measurement instruments such as temperature and non-condensable gas detectors need to be added to the facility in order to perform high-quality parameter measurement campaigns. The following types of experiments are proposed (more detailed information can be found in the complete preliminary proposal):

1. Temperature stratification in horizontal leg during ECCS injection
2. Water hammer-like phenomena (suitable to separate-effect tests)
3. ATWS -- severe condition experiments
4. Natural circulation with super-heated steam -- severe condition experiments
5. Non-uniform parallel channel flows in steam generators
6. Reactor accident issues

96. The Project's schedule would be the following:

- Start in 2005, experiments for about three years and data evaluation for one year, four experiments in a year (average)

- Analyses and code capability assessments will be conducted in parallel with the experiments.

The total estimated cost is 484 million yen (US$ 4.14 million).

97. The Chairman thanked H. Nakamura for his presentation, and for the proposal. F. D'Auria said that the proposal was most welcome, considering the unique characteristics of the plant; M. Vidard mentioned that EDF's initial reaction was also positive. O. Sandervag added that SKI was also interested. H. Nakamura said that a preliminary proposal sent to some ten organisations in advance of the GAMA meeting had received very favourable comments. The Chairman summarised the discussion by saying that GAMA was taking note very favourably of the proposal, which it supported technically and found important and very useful. The Secretary said that NEA was committed to provide all necessary assistance to set up the Project and make it a success.

98. F. D'Auria said that it would be very interesting to establish links between ROSA/LSTF and PKL, PSB, PANDA and PACTEL and to develop a co-ordinated matrix of experiments. He added that he would be willing to take the lead of the small group charged with the task of thinking on how this could be done and making a proposal to that effect (e.g., a joint consortium of all Projects). The Chairman agreed that increased technical co-ordination of the thermal-hydraulic Projects would be of general benefit, e.g. it would allow advanced investigation of scaling effects, and it would allow to investigate a wider range of conditions. There were also problems, however, in F. D'Auria's suggestion: it would complicate the management of the Projects (including the problems of availability and dissemination of results), and make funding issues very complex, Several members advised a pragmatic approach, rather than the ambitious approach proposed by F. D'Auria. They added that informal co-ordination would be more efficient than a complicated formal scheme. **In conclusion, the Chairman said that GAMA should discuss at its next meeting, informally, possible technical links between the thermal-hydraulics Projects and possibilities of increased co-operation. The discussion will be prepared by F. D'Auria.** This action is an extension of the task already agreed under Section VII of this record.

XXVIII. Future Plans Regarding the PHEBUS Facility [agenda item 25]

99. B. Clément said that current future plans of the PHEBUS-STLOC (Source Term - Loss of Coolant) covered both severe accident aspects and design basis LOCA for irradiated fuel. The following steps had been decided:

- The first test (STLOC-1) will investigate the consequences of air ingress on fuel degradation and source term.

- The European Commission will fund the experiment.

- A specific working group "Air Ingress Working Group" (AIWG) had been set up; it had met in March 2003.

- A second AIWG meeting would be held in October 2003, to discuss detailed objectives.

B. Clément summarised the main conclusions of the first AIWG meeting and described the planned air ingress test (air ingress in the reactor core after RPV lower head failure), to be conducted in 2007. He added that loss-of-coolant tests, and the whole issue of future plans regarding the PHEBUS facility, would be discussed during a technical meeting to be organised by the NEA in October 2003.

XXIX. Joint GAMA/WGOE Workshop on Debris Impact on Emergency Coolant Recirculation [agenda item 26]

100. The Secretary reported that there were a number of difficulties with the organisation of the meeting (e.g., the participation of key authors was still doubtful, so far, industry participation seemed to be quite low, especially from the US where the workshop had perhaps not been sufficiently advertised, changes in the local organisation, etc.). Efforts would be made to improve the situation.

XXX. Updated Guidelines for Improving the Efficiency of Future International Standard Problem Exercises [agenda item 27]

101. As a result of a survey on updating CSNI Report No. 17, Revision 3, J.-C. Micaelli had prepared a revised version of the document. The updated document was approved by the group. It will be distributed as CSNI Report 17, Revision 4. (**It was agreed, however, that additional minor comments could be made until 10 October 2003.**)

XXXI. Advanced Reactor Safety Research Work [agenda item 28]

102. It had been hoped that the NRC and CEA would prepare contributions to launch the discussion on this item. As the NRC representative was not able to attend the meeting, it had been agreed to postpone the discussion until the next meeting. **The Chairman asked CEA and the NRC, and any other interested members, to prepare written contributions.**

XXXII. Fire Safety Work [agenda item 29]

103. The Chairman said that six answers had been received to the GAMA survey on fire activities, distributed in July 2003. Some key organisations had not responded. Given the poor response, it was not clear that the survey was meaningful. Among the answer received, there was general support for a status report. The Chairman stressed that this would be possible only with the participation of a sufficient number of organisations really active in fire safety research work. **In order to determine a course of action in this area, the Chairman asked the members of GAMA to answer two simple questions, by 10 October 2003:**

- **Do you plan to answer the July 2003 survey (if not already done)?**
- **Do you think that fire safety work is relevant to GAMA activities? If not, what is your recommendation to CSNI?**

104. H.-J. Allelein described the activities of the International Collaborative Fire Model Project (ICFMP). NRC, IRSN, GRS, VTT, NII and EdF participated in the Project, along with industrial firms and universities in a few countries. The objective was to share the knowledge and resources of various organisations to evaluate and improve the state-of-the-art of fire models for use nuclear power plant fire safety and fire hazard analysis. The Project was divided into two phases. The objective of the first phase was to evaluate the capabilities of current state-of-the-art fire models for fire safety analysis in nuclear power plants. The second phase will implement beneficial improvements to current fire models that are identified in the first phase, and extend the validation database of those models.

105. WGRisk had also been active in the area of fire risk assessments. A workshop had been held in 1999. The Chairman pointed out that the work expected from GAMA was different from the work performed by WGRisk. G. Cognet added that, from the scientific point of view, the models and codes developed for fire safety studies are of the same nature as models and codes used for containment thermal-hydraulics.

106. During the discussion, W. Scholtyssek that it would be useful to examine possible impact of fires on safety systems, instrumentation, SAM, etc.

XXXIII. Progress Report on the Establishment of SARNET - Possible Links with CSNI Activities

107. B. Clément described the proposal of a "Network of Excellence for a sustainable integration of European Research on Severe Accident Phenomenology and Management (SARNET)". Complementary information was given by A. Zurita. The total programme, co-ordinated by IRSN, would involve about 200 researchers and 20 doctoral students. It was expected to start in April 2004 and last four years. There were six main objectives:

- Related to resolution of issues and optimisation of resources:
  - Tackle the fragmentation of existing research in defining and carrying out research programmes;
  - Tackle duplication/disparity in performance of national research programmes;
  - Resolve remaining issues.
- Related to the development of codes and methodologies:
  - Integrate the state-of-the-art in an advanced integral code,
  - Harmonise and improve Level 2 PSA methodologies.
- Related to excellence and knowledge spreading:
  - Efficiently disseminate knowledge, in particular to the EU New Member States more efficiently,
  - Strengthen Europe's excellence on severe accident phenomenology and management and spread excellence activities.
  - Bring together top scientists in severe accident research so as to be a world leader in advanced computer tools for severe accident risk assessment.

SARNET should have very strong links to the various ongoing projects financed by the EU, i.e. programmes ISTC, PHARE, TACIS, etc.

108. B. Clément described the major integrating and dissemination elements of the total programme to be supported by the European Union in the frame of a 6th Framework Programme Joint Programme of Activity (JPA) aimed primarily at creating a gradual durable integration of the research capabilities of the Network Partners while at the same time advancing knowledge on the topic with identified deliverables:

- Integrating activities related to the distribution of tools:
  - Development and maintenance of a Scientific Database,
  - Adaptation of ASTEC, user support,
  - Development and use of advanced communication tools.
- Jointly executed research activities:
  - Definition/assessment of priorities (periodically updated, first reference will be provided by EURSAFE)
  - Harmonisation of Level 2 PSA methodologies,
  - Common definition of experimental programmes,
  - Common interpretation of results, derivation of models,
  - Capitalisation of derived models in ASTEC, assessment and benchmarking.
- Spreading of excellence activities:
  - Education (course, textbook)
  - Training of researchers and other key staff
  - Mobility of staff, teams and equipment

SARNET will be based on national funding complemented by a "grant to the integration" of the European Commission.

109. The main characteristics of SARNET will be the following:

- SARNET will be built:
  - Around a small group of about six organisations, stable and well funded, producing ASTEC and nearly all the experimental data,
  - Complemented and supported by several organisations mainly contributing to interpretation, model improvement, code assessment, code specifications.

- Collegial analysis and identification of most important issues of common interest:
  - SARNET will be the place where reference opinion will be produced.

SARNET will consist of a dense, hard core providing basic data and tools to a large circle for common development and finalisation of end products. The main research topics will be in the fields of corium (hydrogen generation, core and debris coolability, molten corium concrete or ceramic interaction, etc.), containment (containment atmosphere, hydrogen combustion, etc.) and fission products (oxidising environment impact on source terms, aerosol behaviour impact on source term, containment chemistry impact on source term, etc.).

110. A consortium agreement is in preparation. It will define the organisation of the work, organisation of the management, rights and obligations (property, access, etc.), withdrawal of partners, intellectual property, etc.

111. Connection with external programmes will take place in the following way:

- In the steering committee of external programmes: the SARNET consortium will be represented by the organisations of SARNET which take part in these programmes.
- In SARNET: discussion and development of commonly agreed positions, regarding the orientations of these programmes, to be submitted to the steering committee.
- Existing external large programmes is already taken into account in the definition of the JPA (OECD MCCI, ARTIST, ISTC, etc.).
- External programme results will be analysed in the frame of SARNET Work Packages:
  - without opening the data to members who have no access right,
  - but with making available end products such as assessed physical models or codes available to all participants.

112. Possible connections with GAMA had not yet been discussed. Following elements might be taken into account:

- The network could be open to non-European members (this should be based on long-term integration, justified by complementary competence brought by the candidate).
- There should be no duplication of actions such as State-of-the-Art Reports, technical opinion Papers, etc. These will be input material for SARNET.
- Programmes developed by SARNET partners could be proposed as OECD programmes.
- There should be no duplication of ISPs:
  - Participation in CSNI ISPs should be encouraged.
  - SARNET data should be made available for CSNI ISPs (to promote the excellence of the Network)
- There should be regular information on SARNET activities.

113. During the discussion, M. Vidard pointed out that it would be useful to discuss such an ambitious programme with industry.

XXXIV. Election of Chairman and Vice-Chairman (Period 2004-2006) [agenda item 30]

114. M. Durin and B. De Boeck were re-elected, respectively, Chairman and Vice-Chairman of GAMA, for the period 1 January 2003 – 31 December 2006.

XXXV. Selected Reports on National/International Activities [agenda item 31]

Paks-2 Incident:

115. I. Toth described the incident that had occurred in April 2003 at Paks-2 during fuel assembly cleaning. Magnetite formed a deposit on the fuel assemblies of three of the four Paks units. The reason was that a change of corroded feedwater distributors in steam generators necessitated the decontamination of steam generator tubes. The deposits had three effects: degradation of fuel assembly cooling, power reduction, and risk of pin failure. To solve this problem, the utility had adopted ex-core cleaning based on the Siemens CORD UV process. A cleaning tank with a capacity of 7 fuel assemblies had been used successfully since 2000. Because the number of fuel assemblies to be cleaned increased, a larger cleaning tank (capacity: 30 fuel assemblies) had been installed in February 2003, and put in operation in March. The cleaning tank had been used from Framatome ANP and licensed by the HAEA. Cooling problems leading to sever fuel damage had occurred on 10 April 2003. I. Toth described the events that had followed completion of the fuel assembly cleaning and switching to "Cooling Mode B":

- after 2 hours: level rise of cooling pond
- after 5 hours: activity increase in the cooling circuit
- after 10 hours: opening of the cleaning tank lid
- high activity release in the reactor hall
- cooling pond level back to the original value.

116. Analyses had been performed using the codes RELAP-5 (Framatome ANP), ATHLET and FRAP-t (AEKI), and ATHLET-CD (GRS). All these investigations had come to the conclusion that cooling of the fuel assemblies in cooling mode B had been insufficient. The origin of the problem is that VVER fuel assemblies are fully shrouded. During cleaning (flow rate: 170 t/h) most of the coolant passes through the fuel assemblies. In Cooling Mode B (20 t/h), the hydraulic situation changes drastically: most of the coolant bypasses the fuel assemblies. I. Toth presented the results of the calculations supporting this conclusion. During the heat-up phase, fuel rod ballooning had started under the effect of inner pressure, leading to rod failure and first activity release. Temperature had remained stationary at 1200 °C during 4 to 5 hours, resulting in strong oxidation of the channel box upper part. When the tank lid had been opened, there had been sudden quenching of the overheated fuel assemblies, intense steam production and condensation. Severe fuel damage had been confirmed later by visual observations.

117. A contract had been signed with TVEL (Russia) for removing the damaged fuel elements. There were discussions about the possibility of setting up an OECD Joint Project to investigate the fuel.

118. During the discussion, I. Toth confirmed that no measurement had been made inside the tank during the incident. Several clarification questions were asked.

Reactor Safety Research Activities in the Sixth EURATOM Framework Programme:

119. The presentation was made by A. Zurita, who covered the following points:

- Background
- Ongoing specific calls of the EURATOM 5th FP
- the FISA-2003 Symposium
- ISTC CEG on Corium Management / Severe Accidents
- EURATOM 6th FP commencement
  - specific instruments
  - proposals under negotiation (after Call 2003)
  - next calls
  - actions on "Human Resources and Mobility".

120. A. Zurita described briefly some of the 5th FP Projects:

- PLINIUS: Platform for improvement in nuclear industry and utility safety
- LACOMERA: Large-scale experiments on core degradation, melt retention and coolability
- RENION: Reactor neutronic investigations on the LR-0 reactor
- ISTC CEG-CM: Contact Expert Group on corium management
- FISA-2003.

121. He also presented briefly the 6th FP programme, which covers the period 2002-2006. A wide range of instruments will be used: integrated projects (IP), networks of excellence (NoE), specific targeted research projects (STREP), co-ordination actions (CA), specific support actions (SSA), and actions to promote and develop human resources and mobility: fellowships, training courses, grants and transnational access to large infrastructure (TALI). Several Projects will start in 2004:

Sub-area Education and Training:

- NEPTUNO: Nuclear European Platform of Training and University Organisations (CA)
- CETRAD: Co-ordination Action on Education and Training in radiation Protection and Radioactive Waste Management (CA)
- EURAC: Securing European Radiological Protection and Radioecology Competence to meet the Future Needs of stakeholders (CA)

Sub-area Safety of Existing Installations:

- PERFECT: Prediction of Irradiation Damage effects on reactor Components (IP)
- SARNET: Network of Excellence for a Sustainable Integration of European Research on Severe Accident Phenomenology and Management (NoE)
- HOTLAB: European Network on Hot Laboratories (CA)
- JHR-CA: Jules Horowitz Reactor Co-ordination Action (CA)
- CND: Co-ordination Network of Decommissioning of Nuclear Installations (CA)

Next meeting:

122. **Following a suggestion made by W. Scholtyssek, it was agreed that all organisations would prepare short written reports of their activities, to be compiled and placed on the Internet site for the next meeting.**

XXXVI. Other Matters [agenda item 32]

123. None were mentioned.

XXXVII. Next Meeting [agenda item 33]

124. The Chairman said that consideration had been given to have longer intervals between meetings but this would lead to difficulties with the heavy programme of work of the group and reporting to CSNI. Six-month intervals between meetings will therefore remain the rule for the near future.

125. At the invitation of W. Scholtyssek, the 7th meeting of GAMA will be held on 26-27 April 2004 at Forschungszentrum Karlsruhe (FRZ), Germany. The Chairman thanked FZK and W. Scholtyssek for this kind invitation.

126. The following items will be included in the agenda:

- ten years of NSC Computational Benchmarks: lessons learned for safety
- iodine chemistry
- final proposal on the Accident Management Action Plan
- advanced reactor safety work
- fire safety work
- two CFD final draft reports
- summary of IAEA Technical Meeting on AM Implementation

127. **Suggestions for other points should be sent to the Secretary, if possible well in advance of the meeting.**

XXXVIII. Close of the Meeting [agenda item 34]

128. On behalf of the group, the Chairman thanked the European Commission, A. Zurita in particular, for their kind hospitality and the arrangements made.

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