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Organisation de Coopération et de Développement Economiques  
Organisation for Economic Co-operation and Development

**09-Mar-2004**

**English - Or. English**

**NUCLEAR ENERGY AGENCY  
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS**

**Working Group on the Analysis and Management of Accidents**

**SERENA PROGRAMME**

**SUMMARY RECORD OF THE FIRST MEETING OF THE SERENA TECHNICAL PROGRAMME  
COMMITTEE**

**Held at the USNRC, Washington D.C. on 22 October 2003**

**JT00159540**

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## SUMMARY RECORD<sup>1</sup>

### I. Welcome - Opening remarks

1. Dr. Rosenthal and Mr. Tinkler welcomed the participants on behalf of the NRC. The Secretary, Dr. Royen, thanked the NRC for its kind hospitality.

2. A list of participants is given in Annex I. Apologies for absence had been received from Dr. Allelein (GRS), replaced at the meeting by Dr. Teschendorff; Dr. Scholtyssek (FZK); and Dr. Nakamura (JAERI). VTT had had to withdraw from the SERENA Programme because of urgent work to be done on the fifth Finnish nuclear power plant.

3. Actions decided at the meeting are summarised in bold print in the record.

4. The Secretary reminded the participants of the composition and functions of the SERENA Technical Programme Committee (TPC). The SERENA TPC consists of at least one representative from each of the participating organisations (the Partners) carrying out the work. Its functions are:

- 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 recommendation 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 reached in due time.

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1. The OECD Rules of Procedure 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.

5. The Secretary said that some difficulties had surfaced in recent months:
- Experts engaged in the SERENA Programme had expressed divergent views regarding the objectives of the Programme, the way the programme was managed, future tasks, and the schedule, as demonstrated by the May 2003 meeting.
  - A number of tasks had been submitted late, in spite of commitments renewed during the April 2002 meeting of the Group of Experts.
  - Most submittals did not cover the full range of commitments made by the participants.
  - Members of the Group of Experts worked in isolation. Although dialogue should be continuous to ensure complete and critical analysis of the calculation results, there was essentially no exchange among the members of the Group between meetings; each member focused on his own contributions.

## **II. Election of the Chairman of the SERENA TPC**

6. Following a proposal made by the Secretary, Dr. Teschendorff was elected Chairman of the TPC.

## **III. Adoption of the agenda**

7. The agenda had been distributed in electronic form by the Secretary on 8 October 2002. It was adopted without any change.

## **IV. Presentation of the work performed so far (Tasks 1 and 2) and of the work planned (Tasks 3, 4 and 5)**

8. The SERENA Programme Co-ordinator, Dr. Magallon, first presented a chronological record of the steps which had led to the setting up of the Co-ordinated Programme. The starting point had been a concern expressed by the SESAR/FAP group about de-emphasis of FCI research while uncertainties still exist on some aspects of FCI.

9. Dr. Magallon then summarised progress made in the SERENA Programme. The overall objective of the Programme was to consolidate understanding on FCI phenomenology and obtain technical convergence on

- the FCI key processes and energetics for reactor situations, and
- method(s) for reliable estimation of the magnitude of loading for realistic reactor conditions,

in order to bring understanding and predictability of FCI energetics to desirable levels for risk management. The programme consisted of two phases:

- Phase 1: analytical; the purpose was to analyse in-depth existing knowledge and data. This phase was under way.
- Phase 2: analytical and experimental (in the confirmatory sense). This phase will be entered into if results deduced from Phase 1 require this.

The following organisations participated in Phase 1: CEA/IRSN (joint participation), FZK, GRS (IKE), JAERI, JNES (previously: NUPEC), KAERI/KMU (joint participation), KINS, EREC, and NRC (UCSB, UW).

10. Phase 1 consisted of five tasks:

- Task 1: *Identify relevant conditions for FCI in NPPs*. This task had been completed. The final report was ready for publication (with TPC's approval).
- Task 2: *Identify gaps in premixing understanding, modelling and data through code application to reference experiments and comparison of results*. Calculations had been performed; analysis was in progress.
- Task 3: *Identify gaps in explosion understanding, modelling and data through code application to reference experiments*. Calculations were under way.
- Task 4: *Identify key physics for load assessment under reactor conditions through code application to reference reactor cases*. The definition of the reactor conditions had been initiated.
- Task 5: *Summary and integration of Phase 1 findings and proposal regarding Phase 2, if required*.

11. Dr. Magallon described in some detail the experimental facilities (FARO, PREMIX), the experimental conditions, and the calculations submitted.

12. He then described the intended working procedure, which had been approved by all participating organisations as part of the agreement establishing the Co-ordinated programme:

- Partners send contributions (calculations, model descriptions, input parameters) to the Co-ordinator.
- The Co-ordinator checks that contributions fulfil the requirements, assembles the results, and sends the files back to the Partners.
- Each Partner makes a critical analysis of the results (during this part of the work, exchange and interaction among Partners should be extensive).
- The Co-ordinators prepares a tentative summary and integration of the analyses.
- The Partners discuss the results and start developing a common SERENA technical position on premixing understanding at the Task 2 meeting (example based on Task 2).

13. In reality, the actual working procedure followed by the Partners was the following:

- Because of the late submission of the contributions (almost all Partners had missed the Task 2 deadline), it had not been possible to perform in advance of the meeting the summary and integration of the analyses made by the Partners.
- Instead, it had been agreed to perform and discuss the analyses during the meeting.

- This had turned out to be a poor idea as analysis work had not been performed as it should have been.
- In addition, several Task 2 meeting participants had criticised strongly the agreed set of questions adopted as basis for the analyses.

14. These questions were:

- What has been improved in calculating premixing since the ISP-39 exercise?
- Is the description of jet break-up adequate for experiments? For reactor situations?
- Are effects that may impact explosion behaviour adequately taken into account?
- Are effects that possibly reduce water depletion in pre-mixture adequately taken into account?
- How may the choice of parameters influence predictions?
- Are existing data sufficient to answer these questions?
- What work should be done to reduce uncertainties further?

15. The questions had been criticised for the following reasons:

- Some participants felt the questions were too specific to permit consensus at this stage.
- Some participants thought it would be useless to answer these questions before reactor applications have been performed.
- There were too many different approaches for describing the phenomena.

Nevertheless, the Task 2 meeting (May 2003) had attempted to answer the questions. Preliminary conclusions regarding Task 2 had been drawn:

- The understanding of physical phenomena and the robustness of codes had been improved since ISP-39. This made it possible to calculate low pressure cases.
- Codes seemed to over-estimate the void fraction in saturated water. This resulted in over-estimates of water expulsion from the mixing zone, in comparison to the experimental data.
- The key question was therefore whether the flow regime is described properly (or is measured properly). [Should it be confirmed that very highly voided pre-mixture is the rule in saturated water, a direct consequence of this would be that steam explosions can practically be ruled out as an issue for most in-vessel situations.]
- The following phenomena are of first importance: melt length scale evolution, radiative heat transfer, non-equilibrium phase change. They are modelled to various degrees in the codes.

- The following phenomena are of secondary importance: crust behaviour (although this is important for deep pools), hydrogen generation impact on explosion strength. These phenomena are in general not modelled in codes.
- Different views had been expressed regarding the best way to describe these processes.
- So far, analysis of the calculations of the integral experiments had not permitted to determine whether a particular approach would be more appropriate.
- As a consequence, it had been found desirable:
  - To maintain the analysis of the experiments in the background until work on reactor cases is in progress.
  - To report on the progress in this area at the SERENA meetings.
  - To defer definite conclusions until the reactor calculation phase.
  - To apply the same procedure to Task 3.
  - To start immediately defining appropriate reactor conditions.
- At the end of the process, the following documentation will be produced for each task:
  - a critical description of the models,
  - a summary and integration of the results,
  - an analysis of the calculations.

16. A number of difficulties had become apparent:

- Different levels in the description of phenomena and the validation of codes, and different backgrounds and motivation, resulted in divergence of views. E.g.,
  - Some participants wanted to start again the work with more emphasis on basic physics.
  - There were diverging views with respect to the usefulness of calculating or re-calculating experiments, rather than starting directly with reactor applications.
  - There were diverging views with respect to the necessity of reproducing the linear pressurisation observed in experiment FARO L-28.
  - Fitness for purpose required a strong verification basis that most codes do not seem to have (or their documentation is not available); it cannot be ensured simply by calculating a few experiments.
  - It is difficult to eliminate among the Partners the feeling of competition between the codes.
- There is insufficient interaction among the Partners between meetings.

- Deadlines are not met. This has resulted in a significant delay in the progress of the Co-ordinated Programme. Dr. Magallon presented the schedule which had been agreed initially and the actual schedule. Currently, the Programme was running six months behind schedule.

17. Finally, he described the main lines of Tasks 3 and 4, and presented tentative views regarding appropriate conditions for reactor calculations. Dr. Magallon added that, after the Task 2 meeting (May 2003), updated guidance for the SERENA programme had been discussed among the Partners and adopted in July. The following arrangements had been made:

(a) Task 2 / Step 1, the objective of which was to collect sufficient information on all processes affecting premixing and how they are described in the codes, will be performed as described in guidelines distributed on 26 June 2003. Step 1 consisted of the following work. **Each Partner should check and complete the first part of a critical review, prepared and distributed by R. Meignen (IRSN), of the description of the models used in their codes.** Most Partners had already done this work in their individual Task 2 contributions. **R. Meignen was leading this activity. He will ask the Partners directly for complementary information, if needed.** Once completed with Partners' input and comments, the document will be circulated for further remarks. Progress will be discussed at the March 2004 meeting of the Group of Experts, as well as how and when to publish the document

(b) Task 2 / Step 2 work will be a synthesis essentially based on Partners' contributions already submitted with their calculations. **Dr. Magallon will summarise and integrate this information.** No additional work is required. However, as the contributions submitted by the Partners have somewhat different levels of detail, complementary information might be needed from some Partners for the sake of consistency. **Once completed, the synthesis will be reviewed by a Partner (NRC had volunteered), and circulated for comments and finalisation before the March 2004 meeting.**

(c) Task 2 / Step 3 will be an analysis of the calculations in which each Partner should perform his own analysis of the results obtained by the other Partners, and get in touch with them whenever necessary to discuss critical issues. A detailed review performed by M. Bürger (IKE) was a good example of this sort of work. He had analysed all calculations, drawn some conclusions, and raised a number of questions. Thus, rather than producing individual contributions, **Partners are requested to work on this analysis, provide comments, contribute to remove the question marks, provide missing information regarding their calculations/models/parameters, etc.** Further progress and next steps will be discussed during the March 2004 meeting. **M. Bürger will lead this activity.**

(d) The Group of Experts should be ready to start Task 4 for reactor application immediately after the March 2004 meeting. Discussions regarding the calculation conditions, based on the conclusions of Task 1, were under way.

18. The Chairman thanked Dr. Magallon for a very thorough presentation. The initial part of the discussion focused on the seven questions listed in paragraph 14. In answer to Dr. Basu who said that the essence of the questions had been captured in the original (2001) Work Plan accompanying the agreement establishing the SERENA Co-ordinated Programme, but not the specific wording, Dr. Magallon said that several iterations had led to the current wording but that some organisations had not provided comments and suggestions at that time. He added that, in the end, consensus should be reached on the conclusions and recommendations of the work. Mr. Tinkler observed that answers to the questions would depend on the details of the models; there would be no way to provide a single answer. The Chairman said that the matter of the origin of the questions was now largely historical. However, it was important to answer the questions. Some were indeed code specific, others were not. Mr. Tinkler insisted that the fourth question, for instance ("Are effects that possibly reduce water depletion in pre-mixture adequately taken into

account?"), was judgement against a model. He did not see how an analyst could judge someone else's code with which he is not familiar. The questions could therefore only provoke violent reactions from the analysts. The Chairman agreed that some questions could not be fully answered without having detailed knowledge of somebody else's code. Mr. Tinkler added that, contrary to the situation in International Standard Problem exercises where codes are well documented, codes in the FCI field are much less documented. Dr. Scott de Martinville said that the discussion of the answers to the questions during the Task 2 meeting had shown that the questions should be expanded in some areas, e.g. jet diameter. The Chairman said further that answers to the questions obviously do not only develop from SERENA calculations; they come from the whole knowledge base. Mr. Tinkler's advice was to focus the discussion of the calculation results on the goodness of the comparison with experimental data, avoiding unjustified speculation.

19. With respect to the preliminary conclusions on Task 2, Mr. Tinkler suggested to de-emphasise the critical review of the models. Dr. Scott de Martinville said that his interpretation of the conclusions was that one should not really perform a critical review but still check whether descriptions of the models and the physical phenomena are complete. Mr. Tinkler stressed that calculations should be the major products. Critical reviews should not introduce further delays. On the contrary, every effort should be made to get back to the original schedule.

20. Mr. Tinkler felt that the critical review currently performed by IRSN (R. Meignen) would delay the whole exercise, because it was too difficult to perform. Dr. Magallon disagreed with him, pointing out that a review performed by IKE (M. Bürger) had shown that the exercise is feasible. He added that M. Bürger's review did not criticise models; it was essentially asking questions about missing or unclear information. Mr. Tinkler commented that in the absence of sensitivity calculations, which had not yet been provided, it was not really possible to comment on anybody else's calculations. The Chairman added that, maybe, this could be done in the final assessment of the whole Programme. He agreed that it was important at this stage to reach agreement on the schedule of Tasks 3, 4 and 5, avoiding unnecessary delays. **R. Meignen's review should not be too detailed, and it should be ready well in advance of the next meeting of the Group of Experts (scheduled for March 2004).**

21. Regarding Task 3, Dr. Magallon reminded the members of the TPC that each partner was committed to perform at least two calculations. The Chairman said that the TPC would make sure that this commitment is fulfilled. Dr. Magallon said further that, so far, he had received only two reactions (CEA/IRSN and KAERI) to his proposals on Task 4.

22. With respect to the delayed schedule, the Chairman said that the delay might lead to budgeting problems as there was no independent funding for the SERENA Programme. The minimum total commitment of each participating organisation was one man-year spread over a period of 3.5 years. **The Chairman asked each participant to check that there would be no budgeting difficulty with the currently foreseen schedule.** Mr. Tinkler suggested shortening the time foreseen for Task 4; he felt that this activity could be completed over a shorter time period. Dr. Magallon pointed out that Task 4 is really two tasks: two reactor calculations with an analysis in between. There was disagreement among the group on this point and on the technical specifications of the work (partly linked to the conclusions of Task 1); Task 4 appeared to be more complex than anticipated. In answer to remarks made by Mr. Tinkler, **Dr. Magallon undertook to check the melt temperatures for reactor calculations, which appeared to be too high, and also other technical issues.** In conclusion, the Chairman said that efforts should be made to try to reduce the length of Task 4 and to get back as much as possible to the original schedule proposed in the SERENA Programme agreement.



23. Regarding deliverables, Dr. Magallon said that the Task 1 report was complete and was submitted to the TPC members for final endorsement. **It was agreed that a brief summary should be added to the report, and that TPC members' comments (if any) should be made available before 30 November 2003.** The TPC endorsed conditionally the publication of the report.

**V. Assessment of work performed so far in relation to the objectives – Identification of difficulties related to the Programme – Actions to be taken – TPC assistance to the Programme and the Co-ordinator**

24. Dr. Magallon said that assessment of the work performed in relation to the objectives and identification of difficulties had already been presented and partially discussed under the previous point of the agenda. Several items were discussed:

(a) Interactions among members of the Group of Experts were insufficient between meetings. This limited the amount of discussion and hampered progress of the work. More active exchange and dialogue should be encouraged, but it was clear that more frequent contacts and more intense debate would result in additional workload. **It was agreed that TPC members will encourage Expert Group members to react to questions posed by other members of the group and keep the dialogue going. As much openness and transparency as possible will also be encouraged.**

(b) Mr. Tinkler still felt that too much emphasis was put on the critical review of codes and models. Dr. Cognet said that the weight currently attached to critical reviews could be reduced if better code documentation were made available. He mentioned the level of detail included in M. Bürger's analysis of Task 2 as very appropriate, adding that he would like to see a similar contribution for Task 3. Dr. Cognet said further that the spirit of such work should be similar to that of ISP exercises. Mr. Tinkler said that rules had been different in the FCI world, since a long time. Dr. Basu suggested again to defer analyses and critical reviews until results on reactor cases become available. In conclusion on this point, the Chairman said that **participants should be encouraged to answer questions raised by M. Bürger in his review.**

(c) These remarks led to a discussion about what can be learned simply from comparing reactor application results. It would probably be too difficult to have every participant analyse everybody else's results but there is a need to be able to understand the reasons for differences. Maybe one participant could do the work for all, assuming that sufficient documentation is made available on every code involved; at the moment, only limited documentation had been made available on one of the codes (MATTINA). In any case, **participants should be encouraged to make sufficient code documentation available.**

(d) Mr. Tinkler also said that **experts should be encouraged to start work on their SERENA commitments at an earlier date, in order to meet deadlines. This suggestion was endorsed by the TPC.**

25. Dr. Magallon said that Partners tended to accept too many commitments considering the resources and time available to them. This had led to several delays. The TPC should make sure that the programme of work is realistic. The Chairman and Mr. Tinkler stressed the importance of keeping the agreed schedule.

26. Summarising the discussion, the Chairman said that the points mentioned above were reasonable and **should be relayed to the members of the Group of Experts, for action, as soon as possible.**

27. Dr. Scott de Martinville said that the French SERENA team had discussed the situation of the Programme and the new guidance discussed in previous paragraphs. The French team approved the current guidelines. Two proposals were made to the TPC as a result of the discussion.

28. The first proposal was that if a computer tool is modified between the completion of Tasks 1, 2 and 3 and the beginning of Task 4 (reactor applications), the participant should be required to perform again the calculations on Tasks 2 and 3 with the modified version, and make available the new results and comments on any changes. He asked the TPC to endorse the proposal. The Chairman observed that some code versions were developed for specific experiments; they could not be used on the reactor cases. Dr. Scott de Martinville said that this was precisely the point. If code versions cannot be used on reactor cases, the reasons must be made clear. The Chairman suggested taking the proposal as a recommendation, rather than a rule. The best practice would of course be to use the same version of the code throughout Phases 2, 3 and 4. Dr. Magallon pointed out that the proposal had already been adopted, as a rule, in the November 2001 final Detailed Work Plan (see page 11 of the document). The proposal was adopted; its implementation will leave room for reasonable flexibility.

29. Dr. Scott de Martinville said that IRSN was making a second proposal, related to scaling effects. These should be discussed as part of Task 5. Statements should be made with respect to extrapolation between experiments and reactor applications, and uncertainties should be discussed, including the two following questions:

- Which phenomena have a lower uncertainty at reactor scale?
- Which phenomena have a higher uncertainty at reactor scale?

During the discussion, Mr. Rosenthal pointed out that the scaling issue was related to the previous proposal: the same nodalisation should be used throughout the calculations. Mr. Tinkler said that individual participants could provide their own analysis on scaling effects, adding that any request for sensitivity studies should be made early. The Chairman observed that any answer to the questions on uncertainties would not be generated by the SERENA Programme; it would have to come from other considerations. Using a systematic approach would be very demanding, involving expert judgement, etc. Dr. Magallon said that participants had refused to answer such questions at the end of Task 1. It was agreed, however, that it could be useful to have a report addressing explicitly these issues. **The matter will be discussed further at the next meeting.**

## **VI. Impact on the programme of work and schedule**

30. These items had been discussed earlier. The current delay was recognised. Efforts should be made to recover at least part of it.

## **VII. Publication of SERENA results: review of reports, report dissemination, etc.**

31. This point had also been discussed earlier (see paragraph 23).

## **VIII. Preservation of data generated by the Programme**

32. Dr. Magallon said that a large amount of information was generated in the SERENA Programme, from individual reports to group reports. He also pointed out that experimental data should be preserved for possible future calculations. The benefit of storing calculation data was less clear, although such data should clearly be preserved at least some time after the completion of the Programme. He proposed to set up a data bank to collect and distribute that information. He recalled that an Internet site had already been opened and functioned well (although its usefulness could be increased by organising a SERENA discussion group, or a SERENA archives group). That Internet site would of course be terminated at the

completion of the Programme. Placing reports on the site was an easy matter. Preserving data in digitised form, however, was more complicated. Extra specialised work was involved; this had not been budgeted for in the SERENA Programme. The Chairman suggested to investigate the possibility and cost of transferring SERENA information to CD-ROMs which should be cheap to produce - although the Co-ordinator would not have enough time to deal with this work - and required no maintenance. This would mean adopting a specific format (Dr. Magallon was already converting all data to the EXCEL format). Reports could be converted to the PDF format and preserved on an Internet site. Another possibility would be to store SERENA digitised information in a data bank making use of the STRESA platform. **Dr. Magallon was asked to investigate these options, discuss them with the Group of Experts, and report at the next meeting.**

#### **IX. Collaboration with the TROI Programme and other programmes**

33. As demonstrated by discussions during the May 2003 meeting of the Group of experts, held at KAERI, Daejeon, Korea, collaboration between the SERENA Programme and the TROI Programme was quite good. Future co-operation will be defined on a case-by-case basis.

#### **X. 2005 CSNI specialist meeting on fuel-coolant interactions - Selection of host**

34. The Chairman's view was that 2005 would be too early, considering the completion date of Task 4. He recommended moving the planned meeting to 2006. This view was endorsed by the TPC. FZK Karlsruhe, or Cadarache, could be suitable meeting places.

#### **XI. Reporting to the GAMA, the CSNI Programme Review Group and the CSNI**

35. Ad hoc solutions for reporting to these groups would be defined as necessary, involving the Chairman of the TPC, the SERENA Programme Co-ordinator, or the Secretary of GAMA (and members of the Group) present at the TPC meeting.

#### **XII. Other matters**

36. None was mentioned.

#### **XIII. Next meeting**

37. It was agreed that the second meeting of the TPC would be held at the NRC, Washington DC, USA in conjunction with the 2004 Nuclear Safety Research Conference (tentative date: 20 October 2004).

#### **XIV. Close of the meeting**

38. The Chairman and the Secretary thanked the NRC for their kind hospitality.

## Annex I:

**LIST OF PARTICIPANTS**

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