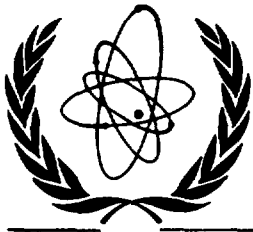




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International Atomic Energy Agency

IWGFR/46

INTERNATIONAL WORKING GROUP ON FAST REACTORS

SIXTEENTH ANNUAL MEETING

Vienna International Centre
12-15 April, 1983

SUMMARY REPORT

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SIXTEENTH ANNUAL MEETING

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SUMMARY REPORT

Printed by the IAEA in Austria
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Foreword

The Sixteenth Annual Meeting of the IAEA International Working Group on Fast Reactors was held at the Vienna International Centre, Vienna, Austria, from 12-15 April 1983.

The Summary Report contains the Minutes of the Meeting and appendices.

Review papers on national programmes in the field of LMFBRs and other papers presented at the meeting are published as a separate report.

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SUMMARY REPORT

Introduction

The Sixteenth Annual Meeting of the IAEA International Working Group on Fast Reactors was held as recommended by the previous Annual Group Meeting at the Vienna International Centre, Vienna, from 12-15 April 1983. All Member States of the group were represented at the meeting: France, the Federal Republic of Germany, India, Italy, Japan, the Union of Soviet Socialist Republics, the United Kingdom and the United States of America. The meeting was also attended by representatives from the Commission of European Communities, the Nuclear Energy Agency of the Organization for Economic Co-operation and Development, the International Atomic Energy Agency and an observer from Switzerland. The meeting was opened by Mr. B.A. Semenov, Deputy Director General of the IAEA, Department of Nuclear Energy and Safety and was presided over by Mr. F. Pierantoni, Italy.

The List of Participants is attached to the Summary Report (Appendix 1). The Agenda and Time Schedule of the meeting are given in Appendix II.

I. Review of IWGFR Activities

a) Approval of the Minutes of the Fifteenth IWGFR Meeting (Item Ia)

The Chairman asked for approval of the Minutes of the 15th Annual IWGFR Meeting. It was so agreed.

b) Report by the Scientific Secretary Regarding Activities of the Group (Item Ib)

The review of the IWGFR activities for the period since the Fifteenth Annual Meeting of the IWGFR was distributed in advance amongst the members of the Group and the Scientific Secretary mentioned only the changes which took place during the time after the distribution of the Review. The final version of the Review is given in Appendix III.

II. Consideration of Conferences on Fast Reactors

a) Third International Conference on Liquid Metal Engineering and Technology in Energy Production, Oxford, United Kingdom, 9-13 April 1984

Mr. R.D. Smith of the United Kingdom reported on the status of preparatory work for this conference. The arrangements for the conference are going ahead well. The members of the IWGFR participated in the nomination of members of the International Steering Committee for this conference and now there is nearly complete representation in this Committee. However, the Organizing Committee of the Conference would like to ask the IAEA to be represented in this International Steering Committee. The letter has been sent to the IAEA by Mr. D.M. Donaldson, the Chairman of

the Organizing Committee, inviting the Agency to be represented at the Committee Meeting in London on 7 and 8 September 1983 and participate in the selection of papers for the conference. Mr. R.D. Smith requested the members of the IWGFR to indicate before September approximately how many people would like to attend the conference, how many papers are expected to be presented and which papers from their countries might be combined if it is necessary.

b) IAEA Symposium on FBR Experience and Future Trends, France, 1985

Mr. H.J. Laue informed the members of the IWGFR that the title for the Symposium which has been approved in the Agency is "Fast Breeder Reactor Experience and Future Trends". The title proposed by the members of the IWGFR on the 15th Annual Meeting is "LMFBR Power and Test Plant Experience and Future Design Trends", which is more narrow than the title approved in the IAEA. The members of the working group agreed that the title "FBR Experience and Future Trends" could be accepted. However, the emphasis of the symposium should be directed towards experience with liquid metal test and prototype liquid metal fast breeder reactors and their design trends. This should be clearly indicated in the call for papers.

The members of the working group discussed the preliminary programme of the symposium, which was prepared during the 15th Annual Group Meeting, additions proposed by Mr. K. Horton to this preliminary programme and a draft programme prepared in France. It was agreed that the programme could be prepared on the basis of the preliminary programme and the French version of the programme. The additions proposed by Mr. K. Horton concerning waste management could only be included into the programme if they are formulated as specific topics for fast breeder reactors to avoid discussion about questions considered at thermal reactor meetings.

c) International Conference on Liquid Metal Fast Breeder Reactor Safety, 1986

Mr. R.D. Smith of the United Kingdom reported that BNES is planning this conference to be held in London in September 1986. The conference was endorsed by the members of the IWGFR at the 15th Annual Group Meeting. Mr. K. Horton distributed during the 16th IWGFR Meeting a copy of the letter sent by ANS to the IAEA, informing that the ANS is planning to organize in USA in April 1985 an ANS/ENS International Meeting on Fast Reactor Safety. The IAEA has been invited to cooperate through its International Working Group on Fast Reactors in the organization of this meeting. After extensive discussions the IWGFR reaffirmed its decision to support the BNES conference and also reaffirmed its belief that there should be intervals of at least three years between major international meetings covering all topics of the safety of fast reactors. It was noted, however, that the experience of the last two major international fast reactor safety conferences in Seattle and Lyon was that the number of different topics covered was too great for optimum treatment at the conference. Many parallel sessions were required leading to some difficulties and inconveniences. It was suggested therefore that the plans to hold fast reactor conferences in the USA in 1985 and in the United Kingdom in 1986 could be advantageous if the subject

matter could be divided into two separate parts which did not overlap to any significant extent. The IWGFR suggests that the ANS and BNES should discuss the topics for the two conferences and arrive at a suitable version.

As an example of how this might be done the first conference could be called "The Fundamentals of Fast Reactor Safety" and cover all experimental and theoretical work leading to an understanding of the behaviour of fast reactors under abnormal conditions including dynamic behaviour, fuel failure, fuel-coolant interactions, HCDA's, structural integrity, detector development, aerosol behaviour and similar topics. The second conference perhaps called "Fast Reactor Design for Safety" would deal with more design related topics including the form of the safety case for presentation to the licensing authorities, construction of fault and event tree sequences, probability risk assessment for fast reactors and the design of engineered safety features for example special control rod systems. If a suitable version of topics could be agreed by the BNES and ANS the overlap between the two conferences would be minimized and the IWGFR would then be prepared to support the ANS meeting in addition to the BNES meeting.

d) IAEA Meeting Which May Be of Interest to IWGFR Members

The Scientific Secretary reported that the IAEA Symposium on Nuclear Power Plant Outage Experience (Karlsruhe, FRG, 1984) might be of interest to the IWGFR Members. Mr. H.J. Laue proposed that the list of all IAEA meetings should be presented to the members of the IWGFR. This list is given in Appendix VI.

e) Coordination of the Schedule for the Major International Meetings Having a Predominant Fast Reactor Interest

It was noted that some overlap exists between the IWGFR Specialists' Meeting on "Properties of Structural Materials" to be held at Chester, U.K. in October 1983 and the International Conference on "Breeder Reactor Core Structural Materials", to be held in Monterey, USA in 1984. Mr. R.D. Smith indicated, that these are different kinds of meetings and there are no difficulties with such overlap. The members of the working group emphasized that the IWGFR will only be able to support any particular conference if the request for the support is submitted 36 months before the date of the conference.

III. Consideration of the Major Recommendations of Some of the IWGFR Meetings for Which the Support of the IWGFR is Requested

The Scientific Secretary of the IWGFR reported to the members some of the recommendations which were made by participants of the following meetings:

- a) Specialists' Meeting on "Sodium Fires, Design and Testing", Richland, Washington, USA, 24-28 May 1982
- b) Specialists' Meeting on "Advances in Structural Analysis for LMFBR Applications", Paris, France 12-15 October 1982

No particular recommendations for which the support of the IWGFR might be required were made by the participants of the Specialists'

Meeting on "Thermal Stratification in Sodium", Grenoble, France, 18-21 October 1982.

The members of the IWGFR reviewed the topics recommended by IWGFR Specialists' Meetings in 1982 for further meetings. The following topics were included in the list of topics proposed by participants of the Specialists' Meetings (Appendix VII):

- a) Effects of Sodium Spills
- b) Realistic Tests of Welded Structures
- c) Guides and Codes for Structural Assessment of LMFBR Components

Two topics were added to the List of Proposed Topics for Coordinated Research Programme in accordance with the Recommendations of the Specialists' Meetings held in 1982:

- a) A comparative assessment of sodium fire codes
- b) A defect assessment of LMFBR structures in elevated temperature range

It was agreed that these topics should be discussed while considering Item 6 b of the Agenda of the 16th IWGFR Meeting.

IV. Consideration of the Schedule for Specialists' Meetings in 1983-1984

a) Specialists' Meeting on Fast Reactor Absorber Materials, Obninsk, USSR, 7-10 June 1983

The status of preparatory work for the meeting was reported by the Scientific Secretary and by Mr. E. Khodarev of the USSR. By the middle of March the participants for the Specialists' Meeting were nominated from France, FRG, Italy, Japan, the United Kingdom and USSR. Mr. K. Horton noted that the USA are also planning to send participants to this meeting. The proposal of Mr. R.D. Smith to exclude from the preliminary programme the item concerning reactor physics, thermohydraulics and mock-up investigations was discussed. It was agreed that these topics need only be mentioned in national position papers but should not be considered in detail during the meeting. It was requested that the participants of the meeting should send one copy of each paper to the IAEA for reproduction at least 3 weeks before the meeting or bring 35 copies of each paper to the meeting.

b) Specialists' Meeting on Properties of Structural Materials Including Environmental Effects, Chester, UK, 10-14 October 1983

Mr. R. Wheeler of the UK reported about the status of preparation for this meeting. The preparation of the meeting is progressing well. The programme of the meeting and participation forms were distributed by Mr. R.D. Smith amongst the members of the IWGFR. The Scientific Secretary informed the members that the official invitation letter will be sent by the IAEA as soon as an official agreement of the UK Authorities is received. It is requested that 30 copies of each paper should be brought to the meeting or one copy should be sent for reproduction to the Meeting Chairman 2-3 weeks before the meeting.

c) Specialists' Meeting on Theoretical and Experimental Work on Steam Generator Safety with Particular Reference to Leak Development and Detection, the Hague, the Netherlands, 9-11 November 1983

The Scientific Secretary and Mr. W. Marth of the Federal Republic of Germany informed the members about the status of preparation of the meeting. An official letter was sent by the IAEA to Authorities of the Netherlands inquiring whether they agree to host the meeting in question. Mr. Marth of the Federal Republic of Germany reported that Mr. Van Westenbrugge of Neratoom is in charge of the organization of the meeting in the Netherlands. The members of the group proposed that the title of the meeting should be changed to the Specialists' Meeting on "Theoretical and Experimental Work on Steam Generator Integrity and Reliability With Particular Reference to Leak Development and Detection".

d) Suggestions of the IWGFR on other Specialists' Meetings and Their Justification

The List of Proposed Topics for the IWGFR Specialists' Meetings and their justifications were distributed for consideration by the members of the group two months before the meeting. It was agreed that additional topics, proposed by the Federal Republic of Germany and France less than two months before the meeting, should not be included into the list for voting this year. Mr. Y. Matsuno of Japan proposed to exclude from the list for voting the topic on "Sodium Boiling Under Decay Heat Conditions" since Japanese specialists believe that this meeting should not be held before 1986. Mr. S. Paranjpe suggested also to exclude the topic on "Design for Strong Motion Earthquakes". As a result of the discussion on the list of topics and voting, it was recommended that the IAEA should sponsor the following Specialists' Meetings in 1984:

1. Prediction and Experience of Core Distortion Behaviour

It was agreed that the meeting should be held in October 1984 in the United Kingdom (preferentially) or in the Federal Republic of Germany.

2. Methods and Tools to Detect Thermal Noise in Fast Reactors

The offer of Italy to host this meeting was accepted. September was indicated as a possible time for the meeting.

3. Maintenance and Repair of LMFBR Steam Generator

Mr. Vautrety informed the members of the group that France might be ready to host this meeting. He will investigate this possibility and inform the members of the group about the results. Japan could be considered as a reserve place for the meeting. May or June 1984 were indicated as possible dates for the meeting.

V. Preparation of the Technical Report on "Status of Fast Breeder Reactor in the World"

The Scientific Secretary informed the members of the group that the draft report is being prepared by the specialists of the Federal Republic of Germany. When this draft report is ready it will be

reviewed in the Agency and sent for comments to the members of the IWGFR. The members of the group noted that they will need at least two working months to review the report and comment on it. The IAEA is planning to organize a Consultants' Meeting for preparation of a final text of the report. The members of the IWGFR are requested to advise which specialists could be invited from their countries to participate in this Consultants' Meeting.

VI. Consideration of Other IWGFR Activities

a) Revision of the Report on "LMFBR Plant Parameters"

The list of parameters and the style of presentation for the preliminary draft of the revised version of the report were discussed. Comments on this draft were prepared by Mr. R.D. Smith, Mr. W. Marth, and Mr. Y. Matsuno. The proposal of Mr. K. Horton, Mr. W. Marth and Mr. Y. Matsuno to include into the report figures or pictures of reactors was accepted. The members of the group did not agree however with the proposal to include into the report information about abnormal events, which resulted in reactor shut-down. It was recommended to take into account the proposals of Mr. Smith to re-design some tables in order to have very short answers to exact questions and his other proposals. If the tables could be rearranged in accordance with the proposals of Mr. Smith in April, the members would be ready to supply additional information necessary for preparation of the report by the beginning of July 1983. If no information were supplied on some items, these items will be omitted. The members of the IWGFR also feel that when the final draft report is prepared by September 1983, it should be distributed once more amongst the members in order to check whether this final version is correct. The report could be submitted for publication late 1983 or early 1984.

b) Consideration of Appropriate Field for Co-ordinated Research Programme

The List of Proposed Topics for Co-ordinated Research Programme was distributed for consideration by the members of the IWGFR. The list was reviewed and discussed during the meeting. It was recommended that the co-ordinated research programme should be organized on "A Comparative Assessment of Processing Techniques for Analysis of Sodium Boiling Noise Detection Data". This programme will be based on a Benchmark Test for the Analysis of Boiling Noise Detection Data. The proposal for this Benchmark Test was prepared by Japanese Specialists and was distributed by Mr. Y. Matsuno during the 16th Annual Meeting of the IWGFR. It was agreed that the consultants' meeting of experts' group for initiating coordinated research programme should be organized in late 1983. The members of the group are requested to recommend specialists from their countries who could participate in this consultants' meeting.

VII. Revision of "General Recommendations Concerning Arrangements for Specialists' Meetings Organized in the Framework of the IWGFR"

The members of the group discussed the draft of "General Recommendations Concerning Arrangements for Specialists' Meetings Organized in the Framework of the IWGFR" which was proposed by the

IAEA. The members noted that in item 4 of this version it is proposed to increase the number of participants of the IWGFR Specialists' Meetings up to 50 participants. It was emphasized that it would be more difficult for IWGFR Member-Countries to host the Specialists' Meeting, if the number of participants is more than 30, and there would be some additional expenditures for the Member Countries if the meeting requires more than 2 or 3 delegates. The version of the "General Recommendations Concerning Arrangements for Specialists' Meetings Organized in the Framework of the IWGFR" which was agreed upon by all IWGFR members is given in Appendix XI.

VIII. Presentations and Discussions on National Programmes on Fast Breeder Reactors

The status of national programmes of all the IWGFR Member States was presented and discussed. They will be issued as a separate report.

IX. The Date and Place of the Seventeenth Annual Meeting of the IWGFR

It was recommended that the next IWGFR Meeting should be held in Vienna on 3-6 April 1984.

APPENDIX I

16th Annual Meeting of the
International Working Group on Fast Reactors

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APPENDIX II

AGENDA of the 16th Meeting of the International Working Group on Fast Reactors

1. Review of IWGFR Activities
 - a) Approval of the Minutes of the 15th IWGFR Meeting
 - b) Report by the Scientific Secretary regarding activities of the Group
2. Consideration of Conferences on Fast Reactors
 - a) Third International Conference on Liquid Metal Engineering and Technology in Energy Production, Oxford, United Kingdom, 9-13 April 1984
 - b) IAEA Symposium on FBR Experience and Future Trends, France, 1985
 - c) International Conference on Liquid Metal Fast Breeder Reactor Safety 1986
 - d) IAEA Meetings which may be of interest to IWGFR Members
 - e) Co-ordination of the schedule for the major fast reactor meetings and other major international meetings having a predominant fast reactor interest
3. Consideration of the major recommendations of some of the IWGFR specialists' meetings for which the support of the IWGFR is requested
4. Consideration of a schedule for specialists' meetings in 1983-1984:
 - a) Specialists' Meeting on Fast Reactor Absorber Materials Obninsk, USSR, 7-10 June, 1983
 - b) Specialists' Meeting on Properties of Structural Materials Chester, UK, 10-14 October, 1983
 - c) Specialists' Meeting on Theoretical and Experimental Work on Steam Generator Safety With Particular Reference to Leak Development and Detection The Hague, The Netherlands, 9-11 November, 1983
 - d) Suggestions of the IWGFR on other specialists' meetings and their justifications
5. Preparation of the Technical Report on "Status of Fast Breeder Reactors in the World"

6. Consideration of other IWGFR activities:
 - a) Revision of the Report on "LMFBR Plant Parameters"
 - b) Consideration of appropriate fields for co-ordinated research programme
7. Revision of "General Recommendations Concerning Arrangements for Specialists' Meetings Arranged in the Framework of the IWGFR"
8. Presentation and Discussion on National Programmes on Fast Breeder Reactors
9. The date and place of the 17th Annual Meeting of the IWGFR

APPENDIX III

Review of the IWGFR Activities for the Period since the Fifteenth Annual Meeting of the Group

The following activities of the International Atomic Energy Agency within the framework of the International Working Group on Fast Reactors have been carried out based on IWGFR recommendations made at the Fifteenth Meeting of the Working Group.

I. Specialists' Meetings

Since the last Working Group Meeting three Specialists' Meetings were held and three Specialists' Meetings are under preparation:

(a) The Specialists' Meeting on Sodium Fires, Design and Testing was held in Richland, the United States of America on 24-28 May 1982. The following items of General Conclusions and Recommendations of the meeting are brought to the attention of the members of the IWGFR.

1. Attention should be given to cleanup of debris following a sodium spill and subsequent reactions which may occur. Questions exist regarding the formation of combustible gases or chemical hazards which may be present while attempting to put a cell back into service.
2. The previous recommendation from the 1978 Meeting regarding the chemical evolution of sodium aerosols is still valid. Understanding chemical evolution of sodium aerosols, the influence of convection on aerosol release and behaviour, and the harmful effects of aerosols are considered necessary.
3. A comparison should be made of sodium pool fire codes under IAEA auspices. An international benchmark programme is recommended.
4. The development and application of protective clothing was not discussed again at this meeting. This topic should be considered for the next meeting.
5. The delegates recommended that another meeting on the effects of sodium spills be held in three to four years.

In accordance with item 3 the topic on a comparative assessment of sodium pool fire codes was included into the list of proposed topics for a co-ordinated research programme. Two topics proposed in items 4 and 5 have been included into the list of topics recommended by participants of specialists' meetings.

(b) The Specialists' Meeting on "Advances in Structural Analysis for LMFBR Applications" was held in Paris, France on 11-15 October, 1982. I would only like to mention the following recommendations of participants of this specialists' meeting:

1. There is a need for realistic tests on welded structural features to validate design methods. It is proposed that this subject would be the topic of a future specialists meeting.
2. In several countries organizations are now preparing guides and codes concerning structural assessment for LMFBR components. It seems that some of these codes could be drafted within a few years. It is proposed that this subject should also be the topic of a future specialists' meeting.
3. In order to make a more realistic evaluation of LMFBR structures, defect assessment in elevated temperature range must be considered. It is proposed that a joint action of the International Working Group on Fast Reactors and the International Working Group on Reliability of Reactor Pressure Components should be undertaken in this subject, in conjunction with the action of PVRC.

Consequently two topics were added to the list of topics recommended by participants of specialists' meetings. Discussions with the Scientific Secretary of the International Working Group on Reliability of Reactor Pressure Components did not reveal any particular interest of this working group in the action on a defect assessment in elevated temperature range.

(c) The Specialists' Meeting on Thermal Stratification in Sodium was held in Grenoble, France, on 18-21 October, 1982.

From the presentations of participants of the meeting it appeared that thermal stratification in sodium is an active topic in countries involved in the development of LMFBR. However, it seems that the resulting effects of sodium stratification on an endurance of LMFBR components are still not completely clear. In some countries such as France and Japan it is planned to consider this problem jointly by specialists on thermal hydraulic and on structural analysis. The participants of the meeting did not make any particular recommendations which should be taken into account in the future activities of the IWGFR.

(d) The Specialists' Meeting on Fast Reactor Absorber Materials is under preparation. The IAEA has accepted the proposal of the USSR to hold this meeting in Obninsk, USSR, on 7-10 June 1983. By the middle of March the IAEA was informed about nomination of participants for this meeting from France, FRG, Italy, Japan, the United Kingdom and USSR. The preliminary programme of the meeting was distributed amongst the members of the IWGFR. The proposal of the United Kingdom to exclude from the preliminary programme the item concerning reactor physics, thermohydraulics and mock-up investigations is expected to be discussed at the 16th meeting of the IWGFR.

(e) The Specialists' Meeting on Properties of Structural Materials Including Environmental Effects is under preparation. An official letter has been sent requesting the agreement of the Government of the United Kingdom to host this meeting. The preliminary programme and the information sheet for the meeting have been distributed by Dr. R. D. Smith amongst the members of the IWGFR. The date of the meeting is 10-14 October 1983.

(f) The Specialists' Meeting on Theoretical and Experimental Work on Steam Generator Safety with Particular Reference to Leak Development and Detection is under preparation. An official letter was sent by the IAEA to Authorities of the Netherlands enquiring whether they agree to

host the meeting in question. The meeting is expected to be held in the Hague on 9-11 November 1983. The preliminary programme of the meeting which was distributed in January 1982 has been corrected by the host organization taking into account comments of some of the IWGFR members. This second draft preliminary programme will be also distributed for your comments and approval.

II. Symposia and Conferences

IAEA Symposium on LMFBR Power and Test Plant Experience and Future Design Trends has been approved for 1985 in accordance with the proposal of France and recommendation of the 15th annual meeting of the IWGFR. It is expected that the symposium will be held in July, 1985 in Lyon. Comments, additions and amendments of the members of the IWGFR to the preliminary programme of the symposium would be appreciated.

Since the 15th annual meeting of the IWGFR one international conference which was endorsed by the IWGFR has been held and two such conferences (non-sponsored by the IAEA) are expected to be held in future:

1. International Topical Meeting on Liquid Metal Fast Breeder Reactor Safety and Related Design and Operational Aspects was held in Lyon, France, on 19-23 July 1982.
2. Third International Meeting on Liquid Metal Technology in Energy Production will be held in Oxford, United Kingdom, in April 1984.
3. International Conference on Liquid Metal Fast Breeder Reactor Safety is expected to be held in 1986.

III. Publications

1. With regard to the Summary Reports of the Specialists' Meetings, the following two reports were distributed by the Agency amongst the IWGFR members and participants of the corresponding meetings:

(a) IWGFR/38 (KfK 3203). Proceedings of the Specialists' Meeting on Fuel Failure Detection and Location in LMFBRs, published by the Kernforschungszentrum Karlsruhe (distributed in August 1982)

(b) IWGFR/43. The Summary Report of the Specialists' Meeting on Sodium Fires, Design and Testing (distributed in January 1983)

2. The Summary Report of the Fifteenth Annual Meeting of the IWGFR consisted of two parts:

IWGFR/41. Summary report of the 15th Annual Meeting including Minutes of the Meeting with Appendices (distributed in September 1983).

IWGFR/42. Status of National Programmes on Fast Breeder Reactors, reported at the 15th Meeting of the IWGFR (distributed in September 1982)

In accordance with Recommendations on Preparation and Distribution of Minutes and Reports which were agreed upon at the 15th IWGFR Meeting the reports IWGFR/42 and IWGFR/43 were placed into INIS to be broadly available to all IAEA Member-countries.

For the Summary Reports of the Specialists' Meetings on "Advances in Structural Analysis for LMFBR Applications" and on "Thermal Stratification in Sodium" it was agreed that proceedings of these meetings will be published by host organizations.

IV. Other Activities in Framework of the IWGFR

(a) LMFBR Plant Parameters Report

A preliminary draft of the revised version of the report on LMFBR Plant Parameters has been prepared and distributed amongst the members of the IWGFR for comments, additions and amendments. We hope that the list of parameters and the style of presentation will be discussed and approved at the 16th IWGFR meeting. We would also appreciate it if all additional information necessary for publication of the report could be made available by 1 June 1983.

(b) Co-ordinated research programme

A list of proposed topics for a co-ordinated research programme was prepared and distributed for consideration by the IWGFR Members. The list includes a number of proposals by participants of the IWGFR Specialists' Meetings. Proposal of Japanese specialists for a Benchmark Test on the Analysis of Sodium Boiling Noise Detection Data could be used as a basis for co-ordinated action. It is expected that this proposal will be distributed by Mr. Y. Matsuno and discussed at the 16th meeting of the IWGFR.

APPENDIX IV

DRAFT PRELIMINARY PROGRAMME FOR IAEA SYMPOSIUM ON "LMFBR POWER AND TEST PLANT EXPERIENCE AND FUTURE DESIGN TRENDS"

1. Experience in physics and safety of LMFBR cores (large plant)
 - a. power, temperature distributions (calculated, actual)
 - b. control, feedback aspects
 - c. operations with failed fuel (fuel performance)
 - d. experience with meeting licensing criteria

2. Experience in fuel management
 - a. refuelling
 - b. spent fuel storage
 - c. cycle times

3. Plant operations and maintenance
 - a. fission product release
 - b. components performance (valves, heat exchangers, pumps, etc.)
 - c. radioactivity control and transfer
 - d. operations under off-design conditions

4. Trends in:
 - a. fuel type, distribution, burnup, cycle time, etc.
 - b. core configurations
 - c. plant design (sizing, pool, loop, etc.)
 - d. licenseability
 - e. component improvement (maintenance, sizing, etc.)
 - f. economic considerations
 - g. role of FBRs vis-a-vis thermal reactors

APPENDIX V

I W G F R 1 9 8 3

Draft Programme for IAEA Symposium on
"Experience in Power and Test LMFBR and Future Design Trends"
(Lyon - 1985)

1 - Experience in Power and Test LMFBRs

Start-up and commissioning tests
Plant general behaviour
Physics of core and behaviour of fuel
Components performance and maintenance
Control and safety
Fuel management and cycle
Main incidents
Radioactivity control
Releases

2 - Future Design Trends

Role of LMFBRs and economics
General lay-out
Main reactors options
Safety approaches and licensing problems
Fuel and core
Components
Maintenance
In-service surveillance and inspection

APPENDIX VI

List of Meetings on Atomic Energy Sponsored by the IAEA in 1984

1. International Symposium on the Risks and Benefits of Energy Systems
(Jülich, Federal Republic of Germany, 9-13 April, 1984)
2. International Symposium on Nuclear Power Plant Outage Experience
(Karlsruhe, Federal Republic of Germany, 18-22 June, 1984)
3. 10th International Conference on Plasma Physics and Controlled
Nuclear Fusion Research
(London, UK, 12-19 September, 1984)
4. International Symposium on High-Dose Dosimetry
(Vienna, Austria, 1-5 October 1984)
5. International Conference on Radiopharmaceuticals and
Labelled Compounds
(Japan, 15-19 October 1984)
6. International Symposium on the Implementation of the IAEA Codes of
Practice and Safety Guides for Nuclear Power Plants (NUSS¹)
(Vienna, Austria, 29 October - 2 November, 1984)
7. International Symposium on Assessment of Radioactive Contamination
in Man
(Paris, France 19-23 November 1984)
8. FAO/IAEA International Symposium on Food Irradiation Processing
(USA, 1984)

APPENDIX VII

List of Topics Proposed by
Participants of the Specialists' Meetings

1. Repair of LMFBR Components
2. Contamination Problems in LMFBRs including Contamination by Fuel
3. Fuel Failure Detection and Location and a Strategy of Failed Fuel Management in LMFBRs
4. Acoustic Surveillance for LMFBRs or
5. Core Surveillance by Noise Analysis Techniques
6. Effects of Sodium Spills
7. Realistic Tests of Welded Structures
8. Guides and Codes for Structural Assessment of LMFBR Components

APPENDIX VIII

List of Proposed Topics
for the IWGFR Specialists' Meetings

<u>No.</u>	<u>Title</u>	<u>Country</u>
1	Fuel-Coolant Interactions	India
2	Thermodynamics of Advanced Fast Reactor Fuel	India
3	Thermohydraulic Studies and Out-of-Pile Experiments on Nominal and Distorted Fuel Elements Bundles	Italy
4	Methods and Tools to Detect Thermal Noise in Fast Reactors	Italy
5	Thermal Insulation and Preheating for Sodium System	Japan
6	Maintenance and Repair of LMFBR Steam Generator	Japan
7	Heat and Mass Transfer in the Reactor Cover Gas	UK
8	Experience with Water-Side Corrosion of Steam Generator Tubing	USA
9	"3-Dimensional Power Distribution; Requirements for and Status of Computational Methods"	FRG
10	Fast Reactor Cladding and Core Structural Materials (Ferritic Steel and Nickel Alloys for Fuel Cladding and Wrapper Tube)	FRG + USSR
11	Cover Gas Purification	France
12	Prediction and Experience of Core Distortion Behaviour	UK

APPENDIX IX

JUSTIFICATIONS OF PROPOSED IWGFR SPECIALISTS' MEETINGS

1. Fuel Coolant Interactions

Fuel-coolant interactions have been the subject of various theoretical and experimental investigations on account of the theoretical possibility of a very significant fraction of the heat liberated in a nuclear incident manifesting itself as mechanical work and thereby affecting the integrity of the primary containment system. It is felt desirable that a consensus be arrived at amongst the experts from different countries on this vital subject which is linked up with licensibility and acceptability of the fast breeder reactors. In this sense, the subject is not only of interest to IWGFR members but also to other members of IAEA who have some interest in the fast reactors.

2. Thermodynamics of Advanced Fast Reactor Fuel

Utility of fast breeder reactors will increase if they could produce adequate fissionable material part of which could be diverted to thermal reactors which would be more suited for specialized applications like high temperature process heat. Thermodynamics of advanced fuels like carbides or nitrides holds a key to the success or otherwise of these advanced fuels and it is felt desirable that this subject is looked into by experts after pooling their knowledge and judgements.

3. Thermohydraulic Studies and Out-of-Pile Experiments on Nominal and Distorted Fuel Element Bundles

The thermal hydraulics of non-nominal conditions need calculation methods and experimental support. As a first step these problems must be treated by sub-channel analysis. Codes dealing with local effects and their experimental supports are expected to be presented. The attention will be concentrated on testing of distorted geometry for all flow regions.

4. Methods and Tools to Detect Thermal Noise in Fast Reactors

Temperature noise analysis is a potential means of detecting local blockages and related faults in fast reactor sub-assemblies. It has an important early warning capability being able in principle to indicate the early stages of the sub-assembly incident and thus permitting shutdown systems to operate before boiling and significant damage or escalation occurs.

The meeting should consider the following aspects:

- i. Experimental data from rig including the sensitivity of the technique and the influence of sub-assembly geometric factors.
- ii. Data from operating reactors notably on background noise level, band-widths and variability.

- iii. Theoretical development on the generation of temperature noise in the turbulent fields of the sub-assembly coolant stream and the effect of thermal conductivity on dissipation processes and the optimization of sub-assembly design to enhance signal characteristics, e.g. turbulence promoters.
- iv. Instrumentation response time.
- v. Data analysis technique to increase sensitivity and/or level of information on fault characteristics.

5. Thermal Insulation and Preheating for Sodium System

Because of high melting point of coolant sodium well above room temperature, it is a characteristic feature of FBR to be necessarily equipped with preheaters as well as thermal insulators. Improvements of properties of thermal insulators and of reliability of preheating system will contribute to the economization of FBR plants.

Discussion at this meeting should include:

- Selection of insulators and preheating methods
- Optimization of heating rate
- Accuracy of temperature control of preheating system
- Methods of temperature control of preheating system
- Comparison of predicted and measured temperature
- Experiences with sodium loops and reactors

6. Maintenance and Repair of LMFBR Steam Generator

Sodium water reaction due to tube failure is a major concern of LMFBR steam generator, since it utilizes single thin wall tube as a barrier between the secondary sodium circuit and the high pressure water/steam circuit.

If such a failure takes place, restart of the plant would be greatly affected by the effectiveness of prompt inspection and repair of the failed steam circuit.

Several sodium water reaction incidents have been reported in the past and useful experiences of repair and maintenance of LMFBR steam generators seem to be accumulated in various countries.

Discussion of the meeting should be devoted mainly to:

- In-service inspection of tube bundle
- Identification and inspection of failed tubes
- Repairing of failed tubes
- Cleaning of failed steam generator
- Restarting conditions for failed steam generator based on the experiences gained.

7. Heat and Mass Transfer in the Reactor Cover Gas

An inert gas blanket is a feature of sodium cooled reactors separating the reactor roof and associated structures from hot sodium. The extent of heat transfer from the reactor through the top shield area is important. The temperatures of the upper reactor structures and components passing from the containment boundary to the sodium must be reliably predicted to ensure adequate integrity. Whilst achieving this

objective, the sodium vapour/aerosol laden atmosphere presents a number of novel engineering situations.

A number of these novel situations are encountered in the design of insulation in this environment. The insulation must perform its function by either preventing sodium ingress or draining sodium condensate before freezing. Heat transfer involves not only convection but also radiation from surfaces which have been contaminated with sodium. The emissivity of the stainless steel under these conditions is a source of uncertainty, as is also the effect of sodium aerosols on both radiative and convective heat transfer.

Some reactors employ sampling, circulation and venting systems requiring filtration of sodium aerosols and fission product gases. It is also desirable to maintain the gas blanket at or near to atmospheric pressure through the range of operating conditions and this can be achieved by a variety of means.

Establishing the required level of confidence in the designs requires experimental programmes often supported by detailed analysis.

Topics to be included in this Specialists' Meeting are:

- Insulation design concepts
- Heat transfer in the cover gas and reactor cover penetration
- Mass transfer, annuli condensation and freezing
- Experimental studies in sodium aerosol laden inert gas atmospheres
- Use of simulant fluids for experimental work
- Emissivity of surfaces which are or have been contaminated by sodium

8. Experience with Water-Side Corrosion of Steam Generator Tubing

The aim of such a meeting should be discussions on stability of the magnetite layer on the steam/water side of steam generators at start-up and load cycling; extrapolation of corrosion rates to long term operation etc.

9. 3-Dimensional Power Distribution; Requirements for and Status of Computational Methods

3D-calculations in large breeder cores show certain difficulties (large computing times, bad convergence). On the other hand those calculations are necessary in order to determine with sufficient accuracy the power distribution, which is more sensitive to perturbations in large cores than in small cores.

The following subjects are proposed:

- Comparison of the various methods in development or application in respect to state of development, convergence properties, computing time, accuracy, comfort of handling
- Discussion of the requirements for 3D-calculations (which effects should be calculated in 3D).

10. Fast Reactor Cladding and Core Structural Materials

There is a great interest to increase the fuel burn-up so as to reduce the fuel cycle cost of fast reactors. Presently the limit of the burn-up is imposed by the damage dose of the steel and not by the fuel itself. The main purpose of the meeting would be to consider and discuss problems of the choice of cladding and core structural materials for LMFBRs. The main points discussed will be:

- Behaviour of fuel cladding and wrapper tubes under irradiation in fast breeder reactors.
- Swelling and creep and their interaction for structural materials in fast reactor core.
- Mechanical properties of structural materials under different testing conditions.
- Mechanical interaction and interaction due to corrosion of mixed oxide and advanced types of fuel with cladding material.
- Impact of fabrication technology and procedures on physical and mechanical properties and behaviour of structural materials.

11. Cover Gas Purification

Argon has to be purified:

- to eliminate any impurity which could be damageable to the sodium circuits,
- to eliminate fission products in case of important pin failures.

This meeting should cover the possible methods and devices to eliminate fission products and chemical impurities.

12. Prediction and Experience of Core Distortion Behaviour

This meeting would cover the following topics:

- a) Methods for mechanics and reactivity calculations
- b) Verification or clarification of methods by:
 - (i) bench mark calculations
 - (ii) evaluation and recalculation of out-of-pile experimental and reactor operation data
- c) Concept studies, evaluation of mechanical and nuclear properties of different restraint systems
- d) Requirements and criteria for core restraint system
- e) Operating experience

APPENDIX X

List of Proposed Topics for Coordinated Research Programme

1. Development of non-destructive examination methods for in-service inspection of LMFBRs
(Development and testing of a coupling liquid for ultrasonic methods of in-service inspection of LMFBRs)
2. Development of interpretive methods for results from larger scale tests of material properties in LMFBR.
3. Development of cladding failure models for LMFBR fuel with a high burn-up.
4. Development of models and codes for fuel failure evolution and DN precursors release from breached pins in LMFBR cores.
5. Modelling behaviour of fission gas and delayed neutron precursors in a LMFBR reactor system.
6. Development of DND methods for LMFBRs.
(Development of a standard method for the calibration of delayed neutrons monitors in LMFBRs.)
7. Sodium boiling detection in LMFBR core.
(A comparative assessment of processing techniques for analysis of sodium boiling noise detection data.)
8. Development of methods for prediction of mechanical and reactivity effects due to bowing behaviour of fast reactor cores with different restraint systems.
9. Modelling Sodium fires
(A comparative assessment of sodium pool fire codes.)
10. Assessment of impact of defects on LMFBR structures behaviour in elevated temperature range.

APPENDIX XI

ANNEX I to Terms of Reference, IWGFR (1977)

General Recommendations concerning Arrangements for Specialists' Meetings organized in the Framework of the IWGFR

1. Specialists' Meetings of the IWGFR are an important part of the Programme of the IAEA and are organized in accordance with the approved rules of the Agency for technical committee meetings. In addition to the general rules, the following recommendations are made to facilitate the planning and organization of Specialists' Meetings by the Member States, host Government, local organizers and the Secretariat.
2. Topics for Specialists' Meetings are proposed by the IWGFR Member States and the IAEA Secretariat, selected by the IWGFR at its Annual Meetings and approved by the IAEA Secretariat. In accordance with the IAEA criteria for Technical Committee Meetings, the topics should cover the subject matter in which a number of Member States have a significant interest.
3. Participants of the meeting are designated by the Member States of the IWGFR and by the international organizations represented in the IWGFR. Experts from countries which are not members of the IWGFR may participate if these experts are specialists actively working in the relevant field. Each country's experts will be expected to make a technical presentation. The names of all the participants of the meeting should be sent to the IAEA through official channels.
4. No limit is set for the size of a Specialists' Meeting but for organizational and practical purpose it is usually limited to 30 participants. For a Specialists' Meeting each participating country should send one to three experts who are fully informed about all the activities of their country in the particular field and each international organization, which has its representative in the IWGFR, can send one or two experts actively working in the field of the proposed meeting or one observer. The host country can send additional observers.
5. The Scientific Secretary and the member of the IWGFR from the country interested to host the Specialists' Meeting should prepare a preliminary agenda or programme of the meeting and should dispatch it amongst the IWGFR members at least eight months before holding a meeting. An official agreement between the Agency and the host Government should be made six months before the start of the meeting.
6. The host country should appoint for the purpose of helping the Scientific Secretary one or two experts qualified in the subject to serve as recording secretaries and who will jointly prepare, within a short time, a professional and thorough summary report of the meeting including relevant data.

7. The host country should propose a scientist or expert actively working in the subject of the meeting or having broad responsibilities for programmes in this field for nomination as a chairman of the meeting.
8. Normally, the working language is English, but if the host country can provide simultaneous interpretation services at its own expense, it is desirable to have interpretation for participants who need it.
9. Unless otherwise decided by the Director General, the IAEA will not bear the cost (travel and per diem) of attendance of participants as well as simultaneous interpretation to other Agency official languages, if provided, at Specialists' Meetings.

APPENDIX XII

LIST OF MEETINGS SPONSORED BY THE IWGFR

1. Consultants' Meeting on Fast Reactor Problems (March 1967, Vienna)
2. The First Meeting of the IWGFR (March 1968, Vienna)
3. SM on Sodium-Water Reactions (November 1968, ANL, USA)
4. The Second Annual Meeting of the IWGFR (March 1969, Vienna)
5. International Conference on Fast Reactor Irradiation Testing (April 1969, Dounreay, UK)
6. International Conference on Physics of Fast Reactor Operation and Design (June 1969, London, UK)
7. SM on Plutonium Alpha (June - July 1969, Winfrith, UK)
8. SM on Core Instrumentation for Sodium - Cooled Fast Reactors (October 1969, Karlsruhe, FRG)
9. The Third Annual Meeting of the IWGFR (March 1970, Cadarache, France)
10. SM on Sodium Vapour Control (March 1970, Cadarache, France)
11. IAEA Symposium on Sodium - Cooled Fast Reactor Engineering (March 1970, Monaco)
12. SM on Failure Cladding Detection (October 1970, Cadarache, France)
13. SM on Fast Reactor Spectrum Measurements and their Interpretation (November 1970, ANL, USA)
14. SM on Operational Safety of Sodium Circuits (March 1971, Risley UK)
15. The Fourth Annual Meeting of the IWGFR (May 1971, Vienna)
16. SM on Sodium - Water Reactions (May 1971, Melekess, USSR)
17. Fourth Geneva Conference on Peaceful Uses of Atomic Energy (September 1971, Geneva, Switzerland)
18. SM on Fission and Corrosion Products Behavior in Primary Systems of LMFBRs (September 1971, Bensberg, FRG)
19. The Fifth Annual Meeting of the IWGFR (19 - 21 April 1972, Vienna)
20. SM on Handling and Transportation of LMFBR Spent Fuel Elements (April 1972, Rome, Italy)
21. SM on Sodium Fires (Sodium Combustion and its Extinguishment - Techniques and Technology), (May 1972, Richland, USA)

22. Conference on Engineering of Fast Reactors for Safe and Reliable Operation (9 - 13 October 1972, Karlsruhe, FRG)
23. SM on Sodium Impurity Measurements and Control (14 - 17 November 1972, Cadarache, France)
24. SM on Decontamination of Plant Components from Sodium and Radioactivity (9 - 12 April 1973, Dounreay, UK)
25. The Sixth Annual Meeting of the IWGFR (9 - 11 May 1973, Vienna)
26. SM on Development and Application of Absorber Materials for Fast Reactors (4 - 8 June 1973, Dimitrovgrad, USSR)
27. IAEA Symposium on Fuel and Fuel Elements for Fast Reactors (2 - 6 July 1973, Brussels, Belgium)
28. Symposium on Physics of Fast Reactors (16 - 23 October 1973, Tokyo, Japan)
29. IAEA Panel on Hot-Channel Factor Calculations (22 - 24 November 1973, Karlsruhe, FRG)
30. Conference on Fast Reactor Power Stations (11 - 14 March 1974, London, UK)
31. The Seventh Annual Meeting of the IWGFR (18 - 20 March 1974, Winfrith, UK)
32. SM on Handling of the Design for and Mitigation of Thermal Transients in LMFBR Plants (17 - 21 June 1974, Canoga Park, USA)
33. SM on Operating Experience and Design Criteria of Sodium Valves (23 - 27 September 1974, Richland, USA)
34. IAEA Study Group on Steam Generators for LMFBRs (14 - 17 October 1974, Bensberg, FRG)
35. The Eighth Annual Meeting of the IWGFR (15 - 18 April 1975, Vienna)
36. SM on the Reliability of Decay Heat Removal Systems for Fast Reactors (28 April - 1 May 1975, Harwell, UK)
37. SM on Fuel Failure Mechanisms (12 - 16 May 1975, Seattle, Washington, USA)
38. SM on Fission and Corrosion Product Behaviour in Primary Circuits of LMFBRs (8 - 11 September 1975, Dimitrovgrad, USSR)
39. IAEA - IWG - NPPCI - FR SM on Core & Primary Circuit Instrumentation of LMFBRs (27 - 29 January 1976, Risley, UK)
40. SM on In-Service Inspection and Monitoring of LMFBRs (9 - 12 March 1976, Bensberg, FRG)
41. The Ninth Annual Meeting of the IWGFR (30 March - 2 April 1976, Vienna)
42. SM on Cavitation in Sodium and Studies of Analogy with Water as Compared to Sodium (12 - 16 April 1976, Cadarache, France)
43. SM on High Temperature Structural Design Technology (27 - 30 April 1976, Champion, Pa., USA)

44. SM on Aerosol Formation, Vapour Deposits and Sodium Vapour Trapping (13 - 17 December 1976, Cadarache, France)
45. SM on Fuel and Cladding Interaction (21 - 25 February 1977, Tokyo, Japan)
46. The Tenth Annual Meeting of the IWGFR (29 March - 1 April 1977, Vienna)
47. SM on the Role of Fission Products in Whole Core Accidents (27 June - 1 July 1977, Harwell, UK)
48. SM on LMFBR Flow Induced Vibrations (20 - 23 September 1977, Argonne, Illinois, USA)
49. SM on Properties of Primary Circuit Structural Materials including Environmental Effects (17 - 21 October 1977, Bergisch Gladbach, FRG)
50. SM on Sodium Removal and Decontamination (14 - 16 February 1978, Richland, Washington, USA)
51. Symposium on Design, Construction and Operating Experience of Demonstration LMFBRs (10 - 14 April 1978, Bologna, Italy)
52. The Eleventh Annual Meeting of the IWGFR (17 - 20 April 1978, Bologna, Italy)
53. SM on Leak Detection and Location in LMFBR Steam Generators (6 - 9 June 1978, Dimitrovgrad, USSR)
54. SM on Equation of State of Materials of Relevance to the Analysis of Hypothetical Fast Breeder Accidents (19 - 23 June 1978, Harwell, UK)
55. SM on Sodium Fires and Prevention (20 - 24 November 1978, Cadarache, France)
56. SM on Thermodynamics of Fast Breeder Reactor Fuel Sub-Assemblies under Nominal and Non-nominal Operating Conditions (5 - 7 February 1979, Karlsruhe, FRG)
57. The Twelfth Annual Meeting of the IWGFR (27 - 30 March 1979, Vienna)
58. SM on Theoretical Modelling of LMFBR Fuel Pin Behaviour (28 May - 1 June 1979, Fontenay-aux-Roses, France)
59. Symposium on Fast Reactor Physics (24 - 28 September 1979, Aix-en-Provence, France)
60. SM on Bellows for Sodium Systems (5 - 9 November 1979, Tokyo, Japan)
61. SM on Carbon in Sodium (27 - 30 November 1979, Harwell, UK)
62. The Thirteenth Annual Meeting of the IWGFR (9 - 11 April 1980, Vienna)
63. SM on In-service Inspection and Monitoring of LMFBRs (20 - 23 May 1980, Bergisch Gladbach, FRG)
64. SM on Demonstration of Structural Integrity under Normal and Faulted Conditions (3 - 5 June 1980, Chester, UK)
65. The Fourteenth Annual Meeting of the IWGFR (31 March - 3 April 1980, Vienna)

66. SM on Fuel Failure Detection and Location in LMFBRs (11 - 14 May 1981, Karlsruhe, FRG)
67. SM on Design Features Affecting the Dynamic Behaviour of Fast Reactor Cores (2 - 5 June 1981, Rome, Italy)
68. SM on Sodium Boiling Noise Detection (9 - 11 June 1981, Chester, UK)
69. The Fifteenth Annual Meeting of the IWGFR (30 March - 2 April 1982, Obninsk, USSR)
70. SM on Sodium Fires, Design and Testing (24-28 May 1982, Richland, USA)
71. SM on Advances in Structural Analysis for LMFBR Applications (11-15 October, 1982, Paris, France)
72. SM on Thermal Stratification in Sodium (18-21 October, 1982, Grenoble, France)
73. Sixteenth Annual Meeting of the IWGFR (12-15 April, 1983, Vienna, Austria)

APPENDIX XIII

LIST OF MEETINGS RECOMMENDED BY THE IWGFR
TO BE HELD AFTER THE 16TH ANNUAL GROUP MEETING
(From April 1983 through 1984)

1. Specialists' Meeting on Absorber Materials and Control Rods for Fast Breeder Reactors (7-10 June, 1983, Obninsk, USSR)
2. Specialists' Meeting on Properties of Structural Materials Including Environmental Effects (10-14 October, 1983, Chester, United Kingdom)
3. Specialists' Meeting on Theoretical and Experimental Work on Steam Generator Safety with Particular Reference to Leak Development and Detection (9-11 November, 1983, The Hague, The Netherlands)
4. 17th Meeting of the IWGFR (3-6 April, 1984, Vienna, Austria)
5. Specialists' Meeting on Maintenance and Repair of LMFBR Steam Generator (May - June 1984, France)
6. Specialists' Meeting on Methods and Tools to Detect Thermal Noise in Fast Reactors (September 1984, Italy)
7. Specialists' Meeting on Prediction and Experience of Core Distortion Behaviour (October 1984, United Kingdom)

APPENDIX XIV

INTERNATIONAL WORKING GROUP ON FAST REACTORS

LIST OF MEMBERS, ALTERNATES AND REPRESENTATIVES

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