

MEETING REPORT

15th Meeting of the International Working Group on Gas Cooled Reactors 31 August – 3 September 1999

The chairman of the meeting was Mr. B. Marsden, AEA Technology, United Kingdom, and the Scientific Secretary was Mr. J. Kendall of the IAEA. The meeting was attended by the following IWGGCR Members and Observers:

Members

Mr. Y. Xu	China
Mr. R. Lenain	France
Mr. W. von Lensa	Germany
Mr. A. Lasman	Indonesia
Mr. S. Shiozawa	Japan
Ms. A. I. van Heek	The Netherlands
Mr. Y. Sukharev	Russian Federation
Mr. E. Mulder	South Africa
Mr. H. Eisele	Switzerland
Mr. B. Marsden	United Kingdom

Observers

Mr. M. Lecomte	France
Ms. S. Ehster	France
Mr. Y. Tuschie	Japan
Mr. F. Okamoto	Japan
Mr. D. McGarry	The Netherlands
Mr. A. Chudin	Russian Federation
Mr. A. Chevalier	United Kingdom
Mr. T. Wickham	United Kingdom
Mr. A. Shenoy	United States of America

A copy of the final meeting agenda is attached. The recommendations and requested actions of the IWG-GCR developed in the course of the meeting are listed below followed by a summary of the meeting presentations and discussions.

OVERVIEW

The meeting was attended by 20 participants from 11 countries and 2 international organisations. The development of a Global HTR Network has been an interest of the IWG-GCR for several years. After an extended discussion on past activities and current status of the effort, it was agreed that the functions envisioned for the network could be of considerable value, but it would not be pursued further within the framework of the IWG-GCR at this time.

Presentations on participating country HTR programs demonstrated a growing level of interest and activity related to HTR technology. In addition, the European Commission anticipates and substantially expanded activity on HTR technology development in the 5th R&D Framework (2000-2003), with potential total expenditure of 20-30 million Euro. In light of these presentations and discussions the IWG expressed a strong desire for an expanded Agency activity on GCRs in support of expanding international HTR programmes.

Related Agency activities in the areas of Small and Medium Reactors and Nuclear Desalination were presented. In the discussions it was generally agreed that both the PBMR and the GT-MHR designs would fit in the small reactor category (<300 MWe), and the emphasis on inherent and passive features are well suited to developing country needs, thus these designs should figure prominently in the SMR programme. Also, the gas turbine designs were noted to be particularly well suited for desalination applications in a cogeneration mode and should receive strong consideration in the Agency Nuclear Desalination activities.

In discussions of present activities it was noted that the most important near term need was for establishment of licensing requirements applicable to the current generation of HTR designs which fully incorporate the benefits of coated particle fuel and passive design emphasis. This will require a close co-operation between technology development, plant design and safety and licensing activities.

IWGGCR RECOMMENDATIONS AND REQUESTED ACTIONS

- 1) The Gas Cooled Reactor project within the Nuclear Power Technology Development Section should be substantially expanded in 2001, in view of the following developments:
 - a) Two research reactors, the HTTR in Japan and the HTR-10 in China, will be beginning operation, and substantial data will be produced in support of future GCR applications.
 - b) Two reactor development programs, PBMR and GT-MHR will have completed the conceptual design phase and will be proceeding to detailed design and technology development for prototype applications.
 - c) GCRs are ideally suited to serve as economically competitive small reactors for developing countries, due to the institutional, operational and economic benefits of the inherent safety features and coated particle fuel of current GCR designs.
 - d) GCRs are particularly effective for application to cogeneration of electricity and desalination/district heating. The high temperature range is used for electricity production and waste heat is used for desalination and/or district heating.
 - e) The ability to directly dispose of discharged GCR fuel without further modification due to the fission product containment characteristics of the coated particle fuel is an attractive solution for nuclear waste disposal.
 - f) The complex and difficult processes required to reprocess the coated particle fuel make the GCR fuel cycle an attractive proliferation resistant option with regard to deployment in developing countries.
 - g) The European Community is establishing an expanded R&D program on HTRs within the 5th R&D Framework Programme.
 - h) The PBMR project is proceeding with the development and deployment of a prototype gas turbine HTR on a commercial basis, resulting in a substantial increase in world-wide interest in GCR technology.
 - i) The recent proposal of the US and Russia to develop the GT-MHR for plutonium disposition, and the commercial project to develop the GT-MHR concept are likely to substantially expand GCR technology development activities over the next decade.
 - j) The ability of the gas turbine HTRs to consume plutonium from reprocessed LWR fuel, especially in Europe and Japan, will provide added interest and application of GCRs.
- 2) The working group recognises the high value and importance of a global HTR network as a source of information regarding research and development needs, facilities and capabilities of organisations and individuals related to HTR development. It strongly encourages participation in and support for the network by government and private sector organisations.
- 3) HTRs in both steam cycle and gas turbine configurations are well suited for nuclear desalination in a cogeneration mode. Participation of representatives familiar with HTR technology in CRPs and other elements of Agency nuclear desalination activities is strongly advised.

- 4) The GT-MHR is under active development for materials disposition and has very high potential for power generation applications in an international program. It should therefore be included as an option for detailed evaluation by the IEA/NEA/IAEA Study on Future Nuclear Energy Technologies.
- 5) The working group noted that the third RCM of the CRP on HTGR Performance has been deferred from 2000 to 2001. The original schedule for the meeting was in concert with anticipated progress in the HTR-10 and HTTR projects and the intent of supporting these projects through the efforts of the CRP. Deferral of the meeting is expected to result in a loss of value and effectiveness of the CRP. It is strongly recommended that RCMs be held at intervals consistent with optimum conduct of the work scope of CRPs. In recent HTR CRPs, an RCM meeting interval of approximately 12 months has been most effective.
- 6) It is recommended that the Technical Committee Meetings in 2000 be organised as follows:
 - a) A TCM in Vienna in June to address development of HTR specific safety and licensing criteria, in combination with a meeting of the IWGGCR.
 - b) A TCM in the United States in November to address safety systems, equipment classification and safety analysis of HTR designs.
- 7) A CRP on Conservation and Application of HTGR Technology should be implemented in 2000 consistent with the recommended actions of the November, 1998 consultancy on the subject.
- 8) The planned CRP on systems for heat applications should be deferred pending development of future plans for system testing in HTTR and HTR-10.
- 9) The proposed changes in the IWGGCR terms of reference are accepted by the working group.
- 10) The working group strongly supports the planned HTR activities within the Fifth R&D Framework Programme of the European Community.
- 11) The scientific secretary is requested to provide the following information to the working group members:
 - a) A list of General Conference and Board of Governors representatives from working group Member States
 - b) Expected attendance at the AGM on Development of a Strategic Plan for Innovative Nuclear Fuel Cycles and Power Plants from working group Member States
 - c) Information on the CRP and the draft guidebook on nuclear desalination
 - d) A summary of the current and planned IAEA web site functions and capabilities relevant to HTR technology

MEETING SUMMARY

The 15th meeting of the IWGGCR was held at the offices of AEA Technology plc in Risley UK. Mr. Barry Marsden of IAEA, the IWGGCR representative from the UK, served as chairman of the meeting. A list of meeting attendees is provided as Attachment 1. Following opening remarks, introduction of meeting participants, and approval of the draft agenda, the following major topics were addressed:

Global HTR Network – The concept of a Global HTR Network (GHTRN) was discussed extensively during the 13th IWGGCR Meeting and in two subsequent consultancies held in Germany and South Africa in 1996. Following additional discussion at the 14th IWGGCR meeting, a consultancy was held in November 1998 resulting in a recommendation to initiate a Coordinated Research Project on Conservation and Application of HTGR Technology addressing six specific technical issues identified at the meeting. Mr. von Lensa presented a summary of the 1998 consultancy and additional information on the functions of the proposed GHTRN. The primary function of the GHTRN would be

to serve as a basis for individuals and organisations inputting research needs and research facilities and capabilities into a database.

European Commission Joint Research Center - Mr. McGarry presented a summary of the activities at the European Commission Joint - Research Centre on the use of networks for research co-ordination. Several projects involving combined research and network based research co-ordination were summarised. These projects were on specific topics and involved substantial levels of funding at JRC (total of ~10 million dollars over 4 years on three projects) for a combined scope of research work as well as development and maintenance of networks to co-ordinate the research.

HTR Technology European Network (HTRTN) - Mr. Lecomte presented additional information on the European network managed by the JRC. He summarised plans to develop an HTR Technology European Network (HTRTN) with a stable existence and long term strategy and objectives. The HTRTN will be the administrative environment for all work done in the frame of the 5th EU framework program on HTR's, in particular it will be the successor to the INNOHTR project which recommends such work. The text of an agreement for the HTRTN is being examined by prospective partners with an anticipated kickoff on 15 November 1999. The first planned actions would include:

- irradiation of fuel pebbles to 200,000 MWD/THM
- Transfer of an irradiated fuel heatup test facility
- PIE of existing irradiated pebbles
- Retrieval and storage of HTR technology data in Germany

European INNOHTR Programme - Ms. Ehster presented a summary of the results and conclusions of a small exploratory programme, called INNOHTR and conducted within the 4th R&D Framework (1996-1999). This programme concluded that modern HTRs are relying on a sound technology inherited from the past experience. Nevertheless, this technology has on the one hand to be consolidated (core physics, high burn up) and on the other hand, to be restored, saved and made accessible in Europe (fuel, graphite). Modularity and direct cycle appear to be the most promising innovative options which have to be fully developed and tested. The high potential for innovations should improve competitiveness, safety and acceptability. For the 5th Framework (2000-2003), HTRs are explicitly mentioned, with proposals to be submitted in several areas for a project totalling 20 to 30 Million euro. It was noted that the European Commission will not finance the design of a nuclear reactor, but will support technology development.

HTR Project Perspectives on GHTRN – Representatives of the two test reactor projects, HTTR and HTR-10, and the two reactor design projects, PBMR and GT-MHR presented their perspectives on use of a GHTRN. The two test reactor projects stated they would make data available from reactor testing and operating experience as well as past experimental results and safety review data. The two reactor design projects stated that they are defining and addressing their data and technology needs and are looking for available data on a worldwide basis.

Japanese Industry Support for GHTRN – Mr. Tsuchie stated that the Japanese consortium RAHP strongly supports the development of the GHTRN and has provided 1 million yen to the University of Stuttgart to begin development. Mr. von Lensa noted that the RAHP support was used to convert the SINTER site configuration to a GHTRN version.

Ultimate Scope and Resource Requirements for GHTRN – Mr. von Lensa stated that the scope of the GHTRN would evolve to meet the needs of the users. Initial scope would support the use of the GHTRN for individuals to provide data on their interests and capabilities and for organisations to provide data on their data needs, facilities, or capabilities. He proposed that the IWGGCR serve as a steering committee for development of the GHTRN, while support could be provided outside official channels. He recommended the establishment of working groups for a quick start. He estimated about one year to define and optimise the needs of the IWGGCR for the GHTRN and a maintenance cost of \$50,000/yr.

Pending CRP on Conservation and Application of HTGR Technology – Mr. Kendall summarised the background activities in recent years regarding the GHTRN leading to a consultancy in November

1998. The consultancy recommended that a new extrabudgetary CRP be implemented on Conservation and Application of HTGR Technology, and provided guidance regarding the conditions and scope of the CRP. A proposal for a new CRP based on the recommendations of the consultancy was presented and discussed as information for further consideration of the CRP later in the meeting.

Descriptions and Summary Status of National Programmes in Gas Cooled Reactors – Descriptions and status of programmes in the following countries were presented and discussed:

China	France	Germany
Indonesia	Japan	The Netherlands
Russian Federation	South Africa	Switzerland
United Kingdom	United States	

The presentation material summarising the status of the GCR programs will be provided in the Working Material report for the meeting.

Tour of AEA Technologies Laboratories – Following the programme summaries, the participants toured facilities in the laboratories of interest to the HTR development. Graphite analysis capabilities, graphite and other material physical properties measurements, and large scale material mechanical properties testing facilities were included.

GCR Test Reactor Programme Status – The current status of the HTTR and HTR-10 test reactor programmes was presented and discussed. Both programmes are proceeding well, with the following status noted.

- **HTTR** - Mr. Shiozawa reviewed the current status of the HTTR project, noting that the rise to power testing at 850°C is expected to begin in September 1999 and be completed in October 2000. High temperatures observed in the concrete surrounding the control rod mechanism housing have been eliminated by a combination of local purge gas injection and increased thermal insulation. Full power is expected to be achieved in September 2000 at 850C core outlet temperature and in September 2001 at 950C.
- **HTR-10** - Mr. Xu presented information on the HTR-10 project, noting that the installation of the core is expected to be complete in December 1999, with initial criticality achieved in early 2000. The fuel has met the performance criteria, with a failure fraction of ~10-5. The current fuel manufacturing capability is ~1500 spheres per month, with ~6000 needed for criticality.

GCR Power Plant Design Projects – The status of the PBMR and GT-MHR design efforts were presented and discussed as summarised below.

- **PBMR** - Mr. Mulder review the PBMR project, focusing on core design activities and results. Analysis of flow and temperature distributions in the core indicate a relatively large differential temperature (~300°C) in the lower core between the helium exiting the inner graphite region and the outer fuel region. Design of the graphite elements in the lower region to accommodate these temperature differentials is proceeding. Analysis results on control rod worth and the depressurised loss of forced cooling were also presented, along with an extended presentation and discussion on control system design and analysis.
- **GT-MHR** - Mr. Shenoy reviewed and discussed the project organisation and recent activities of the GT-MHR project. The participating and sponsoring organisations were identified along with an overview of recent accomplishments. It was noted that ~90% of the work is being performed in the Russian Federation, and that several design reviews have been held, including a review by an international team in June 1999.

IAEA Activities Related to IWGGCR Interests – Mr. Kendall presented information in the following areas:

- **Cogeneration and Heat Applications** – An overview of current activities of the Cogeneration and Heat Applications Project was presented based on excerpts from a paper on the program

prepared for the Global 99 Conference. In reviewing the information it was noted by members of the IWGGCR that GCRs are not well represented in the evaluation of nuclear desalination options. It was also noted that the gas turbine HTR is particularly well suited for desalination applications in a cogeneration mode. It was recommended that members explore participation in the cogeneration and heat application activities to provide detailed information on the performance of GCRs.

- **IEA/NEA/IAEA Study on Future Nuclear Energy Technologies** – Current status and results of the study were presented and discussed. Members of the IWGGCR noted that the GT-MHR was not included in the list of concepts identified for detailed consideration. In light of the difference in design and applications between the GT-MHR and the PBMR and the growing international interest in the GT-MHR, inclusion of the GT-MHR was recommended.
- **TECDOCs** – The recently issued TECDOC on hydrogen production was discussed along with TECDOCs from the GCR project that are currently in process.
- **Initiative on Innovative Nuclear Fuel Cycles and Power Plants** – The background and objectives of the initiative were reviewed along with recent consultancy meetings and the planned Advisory Group Meeting to develop a strategy for an Agency initiative.

Review of Recommendations from the 14th IWGGCR – Mr. Kendall reviewed the recommendations as documented in the meeting report. All recommended actions were completed with the exception of a TCM on Nuclear Graphite Disposal, which will be held in October 1999.

Review of Activities/Meetings Within the Frame of the IWGGCR – The following meetings were summarised:

- Mr. Shiozawa reviewed the results of the **Technical Committee Meeting on Safety Related Design and Economic Aspects of HTGRs** held in Beijing in November 1998.
- Mr. Marsden discussed the plans and status of preparation for the **Technical Committee Meeting on Nuclear Graphite Disposal** to be hosted by the British Nuclear Engineering Society in October 1999.

Status of Coordinated Research Programs – The following CRPs were discussed:

- Mr. Shiozawa reviewed the current status and plans for the 4th and final RCM on **Design and Evaluation of Heat Utilization Systems for the HTTR**, to be held at Oarai Japan in October 1999. A web site has been established for use in preparation of the TECDOC on the results of the CRP. The TECDOC is planned to be completed in 2000.
- Mr. Xu presented the current status and plans for the 2nd RCM on **Evaluation of HTGR Performance**, to be held in Beijing China in October 1999.
- Mr. Wickham reviewed the status of the work on development of an **International Database for Irradiated Nuclear Graphite Properties**. This activity had been planned as a CRP but is now proceeding as an extrabudgetary task with annual consultancy meetings.
- Mr. Kendall summarised the actions required to establish an extrabudgetary CRP on **Conservation and Application of HTGR Technology**, which had been discussed earlier in the meeting. After further discussion of the scope in relation to establishment of a GHTRN, it was agreed to proceed with the establishment of an extrabudgetary CRP as proposed in the summary of the consultancy on the subject held in Beijing in November 1998, if sufficient participation and support is provided by Member States.

Revision of IWGGCR Terms of Reference – Mr. Kendall noted that the last revision to the terms of reference for the IWGGCR had been made following the second meeting of the working group in 1979, and that changes were needed to reflect subsequent changes in Agency policy with regard to the working groups. Proposed changes to make the terms of reference were presented and discussed. The working group agreed to the changes and requested that the Agency proceed with implementation.

New Activities Within the Frame of the IWGGCR – Mr Kendall summarised plans for 2000 and preliminary planning for 2001. The following areas were discussed:

- **CRP on Design and Evaluation of Heat Utilization Systems for the High Temperature Engineering Test Reactor** – The last RCM will be held in 1999, but the TECDOC reporting the results of the CRP will be completed in 2000.
- **CRP on Evaluation of HTGR Performance** – It was noted that the 3rd RCM, which had been in the 2000 plan, had been deferred to 2001 due to budget constraints. The working group expressed concern with deferral of this meeting at a time when both the HTR-10 and HTRR projects are highly active in their startup programmes. The working group agreed to accept this deferral on the condition that the RCM be held as early in 2000 as possible, and expressed its concerns in item 5 of the Recommendations and Requested Actions.
- **CRP on Conservation and Application of HTGR Technology** – If sufficient support is provided by Member States to proceed, the plan is to hold the first RCM during 2000.
- **CRP on International Database for Irradiated Nuclear Graphite Properties** – It was noted by Mr. Wickham that this is no longer a CRP, but will proceed as an extrabudgetary task through annual consultancy meetings.
- **TCM/Working Group Meeting** – The 2000 plan identified a meeting of the IWGGCR in Vienna in June, 2000. After discussion, the working group recommended that the meeting be held as a combined topical meeting and working group meeting. The development of HTR specific safety and licensing criteria was recommended as the topic of the initial portion of the meeting, with a working group meeting held at the end.
- **TCM** – The 2000 plan identified a meeting in Vienna in October on “HTGR Systems Development”, with a note that the final title was to be recommended by the IWGGCR. The working group recommended that the TCM be held in the United States in November to address safety systems, equipment classification and safety analysis of HTR designs.
- **Small and Medium Reactor Advisory Group (SMRAG)** – It was noted that formation of an advisory group for the Small and Medium Reactors project was under consideration. One of the options was to constitute the advisory group using representatives from the four technology working groups, with perhaps two representatives from each. The IWGGCR will consider nomination of representatives to the SMRAG if this approach is taken.
- **2001 Plan** – It was noted that development of the plan for 2001 is in process. An option under consideration is to consolidate activities within the Nuclear Power Technology Development Section to reduce the number of projects. In this approach, the GCR project is being considered for incorporation within the Small and Medium Reactors project. The working group expressed concern with possible loss of visibility and effectiveness of the GCR activities under this structure. Those concerns were expressed as item 1 of the Recommendations and Requested Actions.