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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

IAEA INTERNATIONAL DATABASE ON IRRADIATED NUCLEAR GRAPHITE PROPERTIES

4TH MEETING OF THE TECHNICAL STEERING COMMITTEE
(16-17 October 2002, IAEA Headquarters, Vienna, Austria)

Prepared by:

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February 2003

IAEA NUCLEAR DATA SECTION, WAGRAMER STRASSE 5, A-1400 VIENNA

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Abstract

This report summarizes the Consultant Meeting "4th Meeting of the Technical Steering Committee for the International Database on Irradiated Nuclear Graphite Properties" held on October 16-17, 2002 at IAEA Headquarters in Vienna. The purposes of the meeting were to review the matters and actions identified in the previous meeting, undertake a review of the current status of the database and to make recommendations for actions for the next year. The purposes of the meeting were fully met. This report contains the current status of the identified actions as well as a summary of the recommendations on enhancements to the database.

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February 2003

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IAEA Consultants Meeting, "4th Meeting of the Technical Steering Committee for the International Database on Irradiated Nuclear Graphite Properties"

IAEA Headquarters, Vienna, Austria
16th-17th October 2002
Executive Summary

Chairman: A.J. Wickham
Scientific Secretary: R.E.H. Clark

Meeting Opening

An IAEA Technical Meeting was held by the Technical Steering Committee for the International Database on Irradiated Nuclear Graphite Properties at IAEA Headquarters, Vienna on October 16th-17th , 2002. Welcoming statements were given by A. Trkov and R.E.H. Clark (IAEA) on behalf of the IAEA, and by A.J. Wickham (UK, Steering Committee Chairman) responding on behalf of the Meeting. Mr. D. Humbert of IAEA attended as the replacement for Mr. J. Stephens who had now returned to the USA. Others committee members present were: G. Haag (FZJ Germany), K. Sawa (JAERI Japan), R. Levinskas (LEI Lithuania) and T. Burchell (ORNL, USA).

Present as observers were: N. Blackburn (UK HSE NSD), M. Srinivasan (USA NRC) and S-H. Chi (Korean Atomic Energy Research Institute, a potential future candidate for database membership). Representatives of the database sponsors were: T. Morita (Toyo Tanso, Japan), S. Fazluddin (PBMR Co., South Africa), F. Gersgrasser and B. Tahon (SGL Carbon) and P. Homerin (Graftech Inc.). Observers from the potential members China and Russia were invited but did not attend owing to conflicting meetings and visa difficulties. C-H Tank (INET, China) sent apologies and good wishes for a successful meeting. Database contractor IDD (Bristol UK) was also invited to be present, but their representative was unavailable. Also unable to attend was Mr. J.G. van der Laan (NRG MMI, Netherlands), representing the Netherland's candidacy for membership in the database, which has already been approved by the Committee and will shortly be in place.

Session 1: Administrative Matters

The notes of the previous meeting were reviewed and found to be accurate.

Mr. Chi advised that Korea was extremely interested in Database membership to support its government's new interest in HTR.

It was also noted that renewed interest in the Database has recently been expressed by colleagues from EdF, France.[1] It was agreed to send copies of these notes to French colleagues and, dependent upon the outcome of unofficial approaches, to send a formal letter from the IAEA.

[1] Chairman's Note. At the subsequent specialist nuclear graphite meeting held in Cleveland, Ohio, USA, J-C Robin of CEA also noted a renewal of interest through CEA's planned work on HTR. An informal meeting to consider the French position will take place with the Chairman during his planned visit to CEA Cadarache in November 2002.

Matters arising and Actions from the previous Meeting were reviewed:

1. IAEA to send a letter to the Netherlands and official invitation to join the database, following receipt of their official application following December 2001. Inform Mr. Wickham of this activity when it occurs.
   Status: Essentially completed.

2. IAEA to inquire with Mr. Kupitz about NENP's plan regarding development of new Russian nuclear reactors. Send copy of present minutes to previous Russian representatives at Steering Committee meetings, as well as China and France.
   Status: Pending

3. Mr.Levinskas to obtain graphite papers from Russian sources, determine what the relevant graphite data is, receive agreement from authors of references or journals edits, translate text, and provide data from papers in a suitable format to Mr. Haag. Funding of this activity to be considered by IAEA.
   Status: It was agreed to commit funding initially for 2 translations, later for 10 at USD 22 per item: IAEA to receive Invoices directly from Russian translation service.

4. Mr. Wickham to research and provide references on Wigner energy to interested meeting participants.
   Status: Completed

5. IAEA to have Bath NMG logo removed from database CD-ROM cover. Issue a new User's Manual with corrections 4-5 months following meeting. Have implemented an updated neutron fluence unit matrix discussed in this meeting in the next release of the database (Version 1.2).
   Status: Completed

6. Mr. Wickham to prepare a summary report to the TWGGCR and to circulate this to permanent members of the Technical Steering Committee for comment. Will include database activities and discussion of proposed graphite irradiation experiment.
   Status: Completed.

7. Mr. Wickham, IAEA to further correspond with SGL Carbon to obtain new database sponsorship in 2002.
   Status: Completed.

8. All Database Users to report any difficulties to Mr. Stephens at IAEA.
   Status: Completed.
9. Mr. Sawa to submit restricted L2 Restricted data category to the IAEA when it is formatted as Excel files.
   Status: Completed at the Meeting.

10. Mr. Burchell to investigate the declassification of Hanford graphite data to the “Restricted Data” Database category, for inclusion in the Database.
    Status: No progress on this Action regarding Hanford data. Mr. Burchell outlined the difficulties in obtaining declassification. It was agreed that the most useful data were

dimensional change on the N reactor (TSX graphite). Mr. Burchell said that some irradiations on this material were undertaken at ORNL and that he would seek to obtain these data for the Database (rewritten as New Action 3).

11. Mr. Metcalfe to facilitate the inclusion of data from Calder and Chapelcross in the L2 Restricted Data category.
Status: New data was now promised from BNFL for the "L2 Restricted" Database.

12. All Members to provide suggestions for the 3rd specialist meeting to Mr. Wickham by January 2002.
Status: Completed.

Session 2: Technical Review of Database Function and Options/requirements for Improvement

The equivalent of one full day of the committee's working time was spent on this very important debate, which was facilitated by on-screen demonstrations of Database functionality after the Observers had agreed to conform to confidentiality requirements.

Mr. Haag explained that, during his work preparing new data for the Database, he had encountered numerous problems with its functionality and with incomplete data. In many cases, these did not represent faults, but rather an inability to complete tasks which he had wished to undertake, such as searching by graphite type, coke, etc. Often, such information was absent, an example being where a whole report was on one graphite type which appeared in the title of the report and had not therefore been copied into data tables. If search facilities were to be improved in line with his recommendations, such information would have to be added respectively.

A note on a meeting between Mr. Haag and Mr. Wickham at FZJ Germany on November 21st 2001 identifying many of these problems was distributed and discussed. It is appended to these Notes as Appendix A.

Two subsequent meetings had been held in the UK with Mr. Haag and Mr. Wickham, one with The University of Bath (original source of the Database development) and a current IT consultant to that University, and one with Mr. Hacker of IDD Bristol (original development consultant whilst at Bath and now responsible for updates). These had identified that a major review was timely, not least because Access 97 would no longer be supported by Microsoft. Improved search facilities were discussed in detail, and it was intimated that IDD could provide such improvements, perhaps in association with the Bath University consultants.

At the TCM there was a lengthy discussion on all of these topics, with valuable contributions from all the observers, of which at least two had significant general database experience.

There was some discussion about how many "improvements" should be left to individual users in order to satisfy their particular requirements. However, it was generally felt that the problems should, in the main, be dealt with centrally.

It was therefore resolved that the following improvements should be undertaken as soon as it is reasonably possible and funded by the Database budget:

(1) Upgrading to Access 2000 (as a minimum) with regular reviews of the need for further upgrades;

(2) Major improvements to database navigational flexibility, including minimizing the number of screens left on the desktop;

(3) Major improvements to database search facilities to allow searching from any reasonable parameter or group of parameters which will require considerable IT development.

(4) Retrospective "fixing" of data gaps to enable such searching, and to ensure that important parameters such as graphite type, source coke, etc., are always included in the data[2]. A formal "check list" of data categories would be drawn up.

At the same time it was agreed that input of new data should continue, as funding permits, but that these new data should be reviewed again to ensure that all data fields appear to enable immediate compatibility with the new standards required for search and navigation.

It was further agreed that it would not be appropriate to update the User Manual until significant work had been completed. Members noted some minor deficiencies with the existing manual – as an example, it is unclear how to recover the "Graphite Toolbar" after it has been inadvertently closed.

Mr. Haag further proposed that the original proposal to archive entire reports and articles should be implemented. He demonstrated an example of a report, scanned in using OCR software, to which he had added hyperlinks to facilitate the checking of references and diagrams. It was agreed that this was a desirable long-term aim, but that it was at this time less important than the other identified activities. There were also concerns over copyright. Mr. Wickham reported that he was investigating the issue for the "Carbon" journal with its Editor-in-Chief[3] and Mr. Burchell commented that any article from the USA which was funded by a US Government Agency would have had the copyright reserved to that Agency.

It was agreed that a scanned copy of each report reaching the Database system for data extraction would be made, in order to avoid recalling the item later if a full archiving programme was to go ahead.

Mr. Haag had also developed his own software for extracting data points from published diagrams where no separate tables were provided. The database contractor may elect to incorporate this programme, but there is similar software available commercially.

The discussion turned to the question of identifying a suitable contractor for the Agency in order to implement these requirements. After some debate it was resolved that the Agency should be recommended to invite the existing contractor IDD of Bristol UK to assess the requirements and to indicate how they would propose to implement them to time and cost.

[2] A number of "must have" descriptions for each data entry were agreed. For irradiated-graphite data these are sample number (unirradiated), sample number (irradiated) with tracking if multiple irradiations occur), irradiation temperature and fluence, and the property value. Also essential are the nature of the irradiated material (graphite type code and, where possible, coke type and source, manufacturer, etc.).

[3] This correspondence has now deferred to Mr. I. Craig of Elsevier Press, who advises that his Company plans an electronic archive of all of its journals in order to address exactly the concerns raised by this committee.

The meeting agreed that the preferred outcome would be to have the work completed in time for the next (2003) committee meeting, with the contractor present to demonstrate the functionality of the improved system and to address questions from users.

Mr. Humbert agreed to participate in the ongoing discussion and specification of the proposed work, and this offer was gratefully received.

As UK representative, Mr. Wickham undertook to agree to a specification of work with the Agency personnel and to inform Mr. Hacker of IDD of this proposal. He would ensure that IDD would indicate to the Agency *by the end of 2002* whether they were in a position to address the package by the specified deadline.

Session 3: Administrative Review

Issue of New CD-ROM:

Mr. Haag had prepared a significant body of data from USA, UK and Germany, and this had now been added to the Database by Mr. Hacker. In response to a suggestion from Mr. Wickham it was agreed to include the "L2 Restricted" Database automatically on each new disk even if there had been no update, for the convenience of users. Mr. Hacker had upgraded the main "Restricted" database to Access 2000.[4]

Issue of the new disk, version 1.3, to users was planned for November 2002.

Mr. Sawa provided a disk containing templated Japanese data for the "L2 Restricted" database. Mr. Wickham agreed to convey this to Mr. Hacker[5]. Further data are becoming available from USA reports, and BNFL is expected to provide further PGA-graphite data shortly.

Funding Status

It was noted that SGL Carbon had agreed Database sponsorship with the IAEA, and that Graftech would shortly complete a similar process. Their support was gratefully acknowledged by the Chairman on behalf of the Committee.

It was also noted that, due to an administrative error on the part of the IAEA, no Invoices had been issued to existing Sponsors for the years 2001 and 2002. Consequently the balance of funds was currently very low (approx. USD 1,480). The position was noted by the Sponsor's representatives, and the Agency agreed immediately to issue such Invoices. It was hoped to recover the missing contributions from 2001, although there may be some difficulties if Company accounts for the previous year are now closed. The meeting expressed the wish that, in this case, a double payment for 2002 may be possible.

[4] Subsequent to this meeting, Mr. Hacker indicated that a short delay would ensue in the issue of the 2002 disk to allow the "L2 Restricted" database to be similarly upgraded.
[5] It may be possible to include this in the 2002 disk issue, given the need to upgrade the L2 files anyway.

Outwith this temporary difficulty, it was agreed that the current funding of the Database was healthy and that it was appropriate to go ahead with the planned improvements even though the short-term expenditure would be much higher than usual.

Data Security

This standing Agenda item was briefly reviewed. There were no issues of concern.

Session 4: Other Technical Issues

Specialist Nuclear Graphite Meetings

The status of the forthcoming 3rd Specialist Nuclear Graphite Meeting[6] in Cleveland Ohio was briefly reviewed. Around 45 delegates were expected from around the world, and a strong technical programme was in place. The meeting was generously sponsored by Graftech Inc.

Mr. Sawa announced that Toyo Tanso wished to sponsor a similar 4th meeting in 2003 at their corporate HQ, and this met with general appreciation and approval[7]. Mr. Wickham said that, with foreknowledge of this offer, he had been liaising with Mr. Suyama of OECD about the 2003 High-Temperature Engineering Review Meeting, which was due to be held in Japan (at JAERI) in October 2003. It was sensible to hold these two events "back-to-back" for the convenience of delegates to both. Mr. Sawa mentioned a third meeting to take place in Tokyo, and it was agreed that all organizers must co-ordinate their plans.

TCM Report to TWGGCR

Mr. Wickham reminded the meeting of the report formally made to the TWGGCR following last year's TCM). This is attached to these notes as Appendix B. The recommendations, raising concerns about the lack of graphite data available to the PBMR Company, had not been well received by the TWGGCR which was in fact hosted by them. As no representative of the Database TCM was present, the report had not been well presented even though Mr. Wickham had spent time with the new and former Scientific Secretaries of that meting to ensure that the context of the recommendation was understood.

Mr. Wickham asked if TCM members continued to hold the view that, as graphite specialists, they should make such recommendations in the future if felt appropriate. Mr. Burchell stated that, although he had been absent at the 2001 TCM, he had been happy to endorse the report and now did so again in person. The meeting agreed that their actions had been appropriate.

Mr. Wickham asked Mr. Clark to obtained the data and location of the next TWGGCR so that, as Chairman, he could prepare the required report.

Any Other Business

[6] 19th - 22nd October 2002: the series was started by this TCM but the events are not formal IAEA events.
[7] This offer was repeated formally by Toyo Tanso representatives at the Specialist Meeting in Cleveland and was accepted by the delegates.

There being no other business, the Chairman thanked Members and Observers for their extensive contributions to the discussions. It was agreed that the meeting had been extremely productive technically and that the development and upgrading of the Database would be an appropriate product of these considerations. The Chairman also thanked IAEA staff for their continued support to meeting delegates, and for their individual participation in the technical work of the TCM.

The next meeting is scheduled for Wednesday-Thursday 3rd-4th September 2003, subject to confirmation by Mr. Clark and Mr. Humbert.

List of Actions

Actions Uncompleted from Previous Meeting

2. IAEA to enquire with Mr. Kupitz about NENP's plan regarding development of new Russian nuclear reactors.

New Actions

1. Copies of the formal record of the meeting to be sent to J-C Robin and D. Barbier (CEA Cadarache) and L. Piotrowski (EdF Chatou) and L. Rahmani (EdF Villeurbanne) in addition to the usual recipients.

2. R.E.H. Clark (IAEA) to write an appropriate letter to CEA after further consultation with the Chairman.

3. Mr. Burchell to investigate the declassification of Hanford graphite data to the "Restricted Data" category, for inclusion in the Database, if circumstances permit, and to seek specific data on TSX graphite behaviour from other sources such as ORNL irradiations.

4. The IAEA to seek to recovered missing Sponsorship payments from Toyo Tanso and PBMR Co. for 2001 and 2002, which had resulted from the Agency's failure to issue Invoices.

5. The Chairman to agree with Mr. Clark and Mr. Humbert a suitable specification for the upgrade programme, and to convey this informally to Mr. Hacker of IDD for assessment. Mr. Hacker to be advised that he must respond by the end of 2002 to cofirm whether IDD can meet these requirements by the time of the next (September 2003) committee meeting.

6. Mr. Levinskas to facilitate the translation of Russian documents as agreed by the Members.

7. Mr. Clark to advise the Chairman of the dates and location of the next TWGGCR after consulting Mr. Al-Methnani.

Appendix A

IAEA Consultants' Meeting: "4th Meeting of the Technical Steering Committee for the International Database on Irradiated Graphite Properties"

16th – 17th October 2002, IAEA, Room C07-VI, IAEA Headquarters, Vienna, Austria

Chairman: Dr. A.J. Wickham (United Kingdom)
Scientific Secretary: Dr. R.E.H. Clark (IAEA)

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Appendix B

IAEA Consultants' Meeting: "4th Meeting of the Technical Steering Committee for the International Database on Irradiated Graphite Properties"

16th – 17th October 2002, IAEA, Room C07-VI, IAEA Headquarters, Vienna, Austria

Chairman: Dr. A.J. Wickham (United Kingdom)
Scientific Secretary: Dr. R.E.H. Clark (IAEA)

MEETING AGENDA

Wednesday 16th October

09:00-10:15 **SESSION 1** ADMINISTRATIVE MATTERS

- Welcome and Introductions (Andrej Trkov, R.E.H. Clark, D. Humbert, IAEA; A.J. Wickham, Chairman)
- Adoption of Agenda
- Chairman's Remarks
- Notes of the Previous Meeting (September 27th – 28th September 2001, IAEA Vienna)
- Actions and Matters Arising
- Status of Database Membership
- Status of Database Sponsors and Identification of Potential New Sponsors

10:15-10:45 Coffee Break

10:45-11.30 **SESSION 1 Continued**

11:30-12:30 **SESSION 2** TECHNICAL REVIEW OF DATABASE FUNCTION AND OPTIONS/REQUIREMENTS FOR IMPROVEMENT

- Review of Database Function from User's Perspective *(to be led by Dr. Gerd Haag, FZJ Germany)*
- User Experience with Release 1.2 of CD-ROM

12:30-13:30 Lunch Break

13:30-15:15 **SESSION 2** CONTINUED

- Proposals for Improvements
- Report on Discussions with IDD, Bristol, UK
- Proposals of Other Possible Contractors
- Recommendation to IAEA for Future Contract to Upgrade and Maintain Database

15:15-15:45 Coffee Break

15:45-17:00 **SESSION 2** CONTINUED

Thursday 17th October

09:00-10:15 **SESSION 3** ADMINISTRATIVE REVIEW

- Data added since 3rd Consultants' Meeting
- Review Priorities (Members, Associate Member and Sponsors)
- Proposed Data Provision in next Year (Members and Associate Members)

10:15-10:45 Coffee Break

10:45-12:00 **SESSION 3** CONTINUED

- Funding Status
- Data Security (standing Agenda Item) including notification of interests from other Member States
- Status of new issue of new CD-ROM , Version 1.3

12:00-13:00 Lunch Break

13:00-15:00 **SESSION 4** TECHNICAL ISSUES OF IMPORTANCE

- Status of forthcoming Specialist Graphite Meeting in Cleveland Ohio
- Discussion on the Value and Direction of Specialist Graphite Meetings and Proposal for 2003[8]
- Review Issues of Current Concern to Members

15:00-15:30 Coffee Break

15:30-1600 **CONCLUDING BUSINESS**

- *Any Other Business*
- *Review conduct of meeting*

[8] It is proposed to convene an informal meeting on the afternoon of Tuesday October 22nd at the conclusion of the Specilaist Graphite Meeting, in order to review the proposals for venue and topics for a possible 2003 meeting. All are welcome to participate in this discussion

Appendix C

Notes of a Meeting to Discuss Practical Problems with the Use of the IAEA International Database on Irradiated Graphite Properties

Forschungszentrum Jülich, 21st November 2001

Present: Dr. G. Haag, FZJ – Contract Holder with IAEA for Data Preparation
Dr. A.J. Wickham – UK Liaison Officer and Chairman, Technical Steering Committee

The opportunity to hold this meeting to discuss practical experience with the use of the Graphite Database (release 1.1) was taken during a visit by the author to FZJ for other purposes. Dr. Haag had identified some practical difficulties which he wished to draw to the attention of other users and, particularly, to IDD (Bristol) who now have responsibility for future editions of the Database. Other users are invited to comment upon these difficulties and to add other matters to the list, for attention by IDD ahead of the next Technical Committee Meeting in October 2002.

1. Dr. Haag suggested that a better search function was needed. For example, searching by document title does not identify the graphite type, and the use of multiple categories would enhance the function. Other users are therefore requested to suggest any improvements that they would like to see implemented in this area.

2. We discussed the handling of errors in the data. Frequently, there are errors in the input data because the original documents contained these errors, although it is also possible for errors to arise in transcription. As an example we examined some thermal conductivity data in which the tabulated values of initial and irradiated thermal conductivity did not lead to the indicated value of fractional change. It was not clear in the example whether the calculation was in error or whether there had been mistyping in the original report of one or other of the input data values. Thus, there were in this example three data items which needed identification as "doubtful": in other examples it may be possible to identify a single erroneous number unequivocally. It was proposed that such examples should be highlighted in red in the file. It was also proposed that there should be a space on every template – a column headed "Remarks", for example – in which to record a specific comment about such anomalies. In several cases whilst inputting new data, Dr. Haag had felt the need for columns which were not in the template.

3. There are some clear errors in the entries – for example a column of data in which the heading "Country Code" contained a Specimen Number.

4. Dragon Project data (both data from Winfrith and Petten) cover many different graphite types covered by a complex table of reference codes. When accessing the Dragon data it was not easy to find the master table of reference codes. Initially, we considered that it was absent altogether, but subsequent discussion with Dr. P. Hacker, who with Dr. G. Neighbour had been responsible for entering these data during his time at Bath University, established that the table was indeed present. However, to the casual user,

this was not a user-friendly situation and some way should be found to improve it. A "single click" solution to provide the graphite type from a reference code needs to be available when studying a table of Dragon data.

5. In some reports, vital information seems to have been lost or omitted during data entry. As an example, Dr. Haag referred to ORNL/NPR-91/35. A number of codes for graphite grade are given, but the information to decode them seems to have been lost. It was again felt that this kind of information needed to be on the screen along with the data – not in some other location where it cannot easily be found.

6. A general problem with Microsoft Access, and indeed with Excel, is the tendency of the programs to round numbers up or down or to leave out zeros which convey important information about accuracy. One specific example was noted in which the original data report showed two significant figures after the decimal point for numbers less than 10 but one significant figure for numbers above 10. In this case, the program had converted "10.0" to "10.00", leading to an implication of a false accuracy. The reverse also happens, with (for example) "0.30" becoming converted to "0.3", thereby losing accuracy. The author notes difficulties with the version of Excel in the "Office 2000" package, having recently encountered problems in needing to enter numbers with leading zeros in other work. When these occur in columns of data which do not all contain leading zeros, it can be cumbersome to format each of the cells in which the leading zeros need to be retained. Dr. Haag cited data from DPR 556 as a particular example of these problems, particularly those for dimensional change. In the same volume there is a succession of Initial CTE data which reads "4, 4.5, 4.4, 4.96". This raises the question about what we are to conclude about their accuracy – of course it is possible that the numbers were cited this way in the original report, it being one of the guidelines that data should be transcribed as originally presented.

7. Dr. Haag commented that the scanned-in graphs are too small and could not be enlarged. They also appeared longitudinally stretched. Reference back to Dr. Hacker has suggested that this may be a user problem (!) but also that there is some scope for improvement. Dr. Haag also noted that some graphs are identical and have clearly been entered twice. He said that more graphs would be advantageous, especially with improved format and the ability to search.

8. Dr. Haag had developed his own template to extract data points from a graph which had previously been scanned as a .tif file. This includes a sophisticate correction against the possibility of misalignment when scanning the original document.

9. It was also considered that scanned files were too big. These appear to be .htm files. Dr. Haag suggested that scanning as .jpeg, to a standardised procedure, would produce smaller and more user-friendly files.

10. Dr. Haag commented on the "Nuclear Materials" table, and wondered where it came from. There were problems with reading the text in various columns, such as "Experiment". Even if one widened the cell, one could read only a part of the contents.

11. In the "All Volumes" table, there was confusion in data entry. The column headed "Basic property" contains a six-digit number, the Column headed "ID" is empty and the column headed "ID Number" shows all zeros…..

12. The volume BNWL 1540 is empty…

13. Perhaps the most important comment of all arose with some of the data currently being entered. The General Atomics report GA-A13556 is taken as an example:

    In this work specimens were successively irradiated and examined a number of times. Each time the record number for the specimen changes. Consequently one needs the facility to link together up to three rows of data which refer to the same sample, so that they stay together when "sorting". Dr. Haag's own solution is to add a new individual specimen number solely to facilitate the working of the database.

    The successive irradiations took place at different temperatures, and a so-called "mean temperature" has been recorded which does not take account of the different irradiation doses received at each temperature. To the graphite specialist this may sometimes be an obvious problem, but there is a clear danger that users might regard the mean temperature to be characteristic of the overall irradiation effects in these multi-irradiated specimens. The potential solutions here are (i) Exclude the mean temperature from the Database; (ii) Calculated a better one, weighted in an agreed fashion, although this may also prove misleading; or (iii) Include a comprehensive comment drawing attention to the problem. In this case it was felt that the "Remark" about this needed to be close to the data (in an adjacent column) rather than in a single remarks column at one end of the table. The main issue is "You need to be easily aware that there is a remark" – you should not have to remember to check to see if there is a remark. In other words, one needs to make the screen as user-friendly and informative as one possible can, for the avoidance of doubt or potential erroneous interpretation.

14. Dr. Haag had succeeded in some way to transfer all the disk contents to his system such that the password was no longer required, and suggested that the disk should be copy-protected. I thought that it was, and Dr. Hacker subsequently agreed – perhaps Dr. Haag never turns off his system. This will be further investigated.

    Whilst we agreed that a number of these apparent problems may in fact be a consequence of user characteristics and unfamiliarity with the potential of Microsoft Access, it was felt that there were sufficient points here to merit the following actions:

    - a discussion with Dr. Hacker and with IDD (past and present formatters) about the potential for resolving some of these difficulties. This has now taken place with the author and it is perceived that all of these problems either represent a need for better information provision to the user, or can be incorporated with relative ease;
    - share the list with other users through the various liaison officers, asking for a comprehensive list of queries to be drawn up well ahead of the next Technical Committee Meeting where they can be given a thorough airing;
    - seek to have IDD attend the next Technical Committee Meeting in Vienna (through funding by the Database budget) to address these issues and to offer advice and guidance on how the system might best be upgraded to satisfy user requirements. This is seen as the major activity of the next Technical Committee Meeting.

A.J. Wickham: *January 2002*

Appendix D

For the attention of the Members of the IAEA Technical Working Group on Gas-Cooled Reactors

16th Meeting, November 2001, South Africa

Report on the IAEA International Database on Irradiated Nuclear Graphite Properties, and Associated Activities

September 1999 – September 2001

A.J. Wickham
Chairman, Technical Steering Committee

1. INTRODUCTION

TWGGCR members may recall numerous presentations at their previous meetings which have covered the initial discussions leading to the creation of the graphite Database. At the time of the 15th Meeting of the IWGGCR, the formal Working Arrangement for the Database had been drafted and was under review, with the expectation that the Database would shortly be formally constituted under the auspices of the IAEA. The present review covers developments since that time.

The Database TCM has taken the view that the activities of the Database members should not be restricted to the acquisition of data and the use of the compiled information. Noting that international carbon conferences no longer provide well for the needs of the nuclear graphite community, two very successful Specialist Nuclear Graphite Discussion Meetings have been held, open to all interested persons whether their member states are formally members of the Database or not. To facilitate attendance from all appropriate parties, these ancillary meetings have not been constituted as formal IAEA events but have nonetheless been arranged by the technical committee which operates the Database itself for the Agency. These two meetings have debating issues of current concern to Database Members and, on the most recent occasion, has led to the Database technical steering committee electing to make a formal representation to the TWGGCR concerning the status of design data on graphite irradiation behaviour with respect to future HTR developments. That representation is contained within this Report.

2. TECHNICAL COMMITTEE MEETINGS (meetings of the Database Technical Steering Committee)

Three such meetings have been held within the review period:

23/24th September 1999; IAEA, Vienna

At this first official meeting of the Steering Committee, the formal status of the Database as an IAEA activity was confirmed. The Agency recognised the large financial contribution from the United Kingdom which had made this possible, and in turn the Members recognised the particular efforts of Prof. Radko Janev (NAPC) which had facilitated the final acceptance of the Working Arrangement by the Agency.

At this point in the project, a significant entry of data had already taken place, using specialists at The University of Bath (United Kingdom) to create the Database software using Microsoft Access, and to prepare the first CD-ROM release which took place shortly after the meeting. At the initiation of the project formally within IAEA, the four Members were United States, United Kingdom, Japan and Germany (through Forschungszentrum Jülich), and sponsorship for the future input of data had been generously offered by the Toyo Tanso company of Japan.

The data present represented large bodies of information from Japan, the United States and the United Kingdom. Most of these data were in the "restricted" category (*i.e.* freely available to other Database members and the Sponsor); some additional data from the United Kingdom reactor operators had been given the status of "Level 2 Restricted", requiring a formal exchange of a written agreement with the data owner on the use of these data before their protecting password would be released. There is also an "Unrestricted" data category.

The TCM recognised the valuable contribution of France to the discussions on data security, although France elected to decline formal membership at this time.

The meeting discussed in detail the draft of an INDC (International Nuclear Data Committee) Report describing the formation of the Database and incorporating a User Manual. This was formally issued by the IAEA in February 2000[9].

At this meeting it was agreed to hold the first Specialist Nuclear Graphite Meeting on an experimental basis: this is reported separately.

7th – 8th September 2000; Oak Ridge National Laboratory (ORNL), Tennessee, USA

At this meeting, Lithuania joined the Database as an Associate Member, offering valuable assistance in interpreting Russian language publications containing useful graphite data. Shortly after the previous meeting, the PBMR Co. of South Africa had offered a period of financial sponsorship alongside that of Toyo Tanso.

The opportunity was taken to review the "wish lists" of each Database Member, together with those of Russia and China who at various times had participated in the development meetings as Observers and had indicated an intent to join the Database in due course.

The principal data added during the previous year had come from the archives of the "Dragon" HTR project and included extensive information extracted from the records of irradiations in the Petten HFR (The Netherlands) together with other results documented in

[9] Burchell T.D., Clark R.E.H., Eto M., Haag G., Hacker P., Janev R.K., Neighbour G.B., Stephens J.A., and Wickham A.J., "IAEA International Database on Irradiated Nuclear Graphite Properties"; International Atomic Energy Agency Report INDC(NDS)-413, February 2000.

formal Dragon Project Reports. The assistance of NRG in The Netherlands in sourcing the Petten data is acknowledged, as is the cooperation of the OECD NEA in Paris in facilitating access to the Dragon reports now held by the EU archiving programme in Florence Italy. A small financial contribution from NNC Ltd in the United Kingdom assisted the extraction of these data.

Smaller additional data inputs came from the United Kingdom and the USA. A new CD-ROM was issued immediately after the meeting.

The success of the first Specialist Nuclear Graphite Meeting, held over two days immediately before the TCM, was evident. The Members agreed to hold this meeting on an annual basis and there was a long discussion on the most valuable discussion topics (see separate report).

The meeting also resolved a number of standard factors for the interconversion of neutron-fluence units used in different Member States.

27th – 28th September 2001; IAEA, Vienna

At this meeting, The Netherlands was present as an observer, having indicated an intent to apply for Database membership within two months. The TCM recommended the Agency to accept this application upon its arrival without further reference to the TCM.

During the year, the preparation of paper-based data for input into the system had been transferred to Forschungszentrum Jülich. Unfortunately there had been some delays to progress occasioned by a high work load in support of PBMR, but it is hoped that the position will quickly be recovered. A large body of data in electronic format had been received from Japan. Electronic data input and the creation of new CD-ROMs has been transferred by the Agency to IDD (International Database Development Ltd) of Bristol, United Kingdom, making use of the expertise originally available from The University of Bath. A third issue is expected within one month.

With Database administration issues largely resolved, the TCM spent more time on this occasion in debating the status of graphite data with respect to the requirements of both the developing HTR programmes and the requirement to provide robust safety cases for the continued operational life of the existing graphite-moderated plant. This is discussed separately (Sections 3 and 4).

The 2002 Database TCM will be held at IAEA Vienna, probably on Friday October 25th.

Additional Remarks

Despite several assurances about the intention to join the Database activity from Observers at various development meetings and TCMs, applications are still awaited from both China and The Russian Federation. The Database TCM would welcome such applications, and the TWGGCR representatives from these countries are encouraged to facilitate these formal applications if possible. The Ukraine has also been approached formally by the IAEA, without response.

Recently, expressions of interest regarding future sponsorship of the Database have been received informally from SGL Carbon in Germany and UCAR Carbon in the USA. Whilst the

TCM values these offers to enable it to continue its business, it continues to hold the opinion that the Database activity should be funded formally through Agency budgets, especially as it enjoys participation from as many (or sometimes more) Member States than do existing programmes which are so funded. The Agency is asked to keep this matter under review.

3. SPECIALIST NUCLEAR GRAPHITE MEETINGS

5th – 6th September, 2000; Oak Ridge National Laboratory, Tennessee, USA

20 specialists attended this first meeting, representing USA, UK, France, Japan, Germany, South Africa and Lithuania. The topics discussed at the suggestion of the preceding Database TCM were:

- Irradiation Creep and the Use of Creep Data in Reactor Design
- Neutron Fluence Definitions and Interconversions
- Thermophysical Properties
- Prediction of Graphite Strength and Failure, and Graphite Performance

There was also an opportunity to hear a special talk on severe accident codes in graphite-moderated reactors, and to visit the old X-10 reactor. The meeting was generously sponsored by ORNL.

The session on irradiation creep provoked the longest debate, which was carried forward into the second specialist meeting (below). The weaknesses in the understanding led to a need for the following data items, the list being little different from one drawn up in the 1970s as part of the Dragon HTR project:

- Creep Laws at temperatures in excess of 1000˚C
- Flux-density dependence below 2×10^{13} and above 2×10^{14} $n.cm^{-2}.s^{-1}$ EDN
- Understanding of tertiary creep and creep-strain limit
- Biaxial and triaxial creep on large specimens
- Biaxial compressive creep on coated-particle fuel

The discussion emphasised the need, in respect of new engineering requirements for graphite in the forthcoming HTRs, to rely upon experience in other plant to some extent rather than upon carefully tailored new experiments which might not realise the data required on new materials within a useful timescale to facilitate design and construction. An international experiment was suggested which could resolve as many of the Members interests as possible – this discussion continued at the second meeting (*q.v.*). The possible proposal to the TWGGCR of a collaborative research proposal was also debated.

The other sessions provided a valuable update upon dose interconversion (resulting in the incorporation of a look-up Table in the Database) and upon the basic understanding of the behaviour of the coefficient of thermal expansion of graphite under irradiation.

24th – 25th September 2001, Rain, Germany

On this occasion, 40 graphite specialists attended, despite the withdrawal of some delegates at the request of their organisations following the events in the USA on September 11th. This meeting was generously sponsored by SGL Carbon who also offered a tour of their manufacturing facilities in Meitingen, near Augsburg.

Following recommendations from the previous meeting that more time was required for discussion and that there should be fewer topics, the following programme was offered:

- The Most Significant Design Needs for HTR
- Managing of Ageing and Life Extension
- Decommissioning Issues

… together with an introductory presentation on the work of SGL Carbon and a short session featuring two contributions on plasma-irradiation effects.

A wide range of views was aired, particularly in regard to the value of a new irradiation experiment. It was noted that funding had just been granted for an irradiation experiment in Petten to support the European HTR, and this placed previous suggestions in a new light. The arguments for and against creep being prominent in a new experiment were aired, and it was resolved that it would be more expedient to seek to influence the European experiment than to seek funding for another independent irradiation. The basic need, it was finally agreed, was for fundamental irradiation data on the candidate graphites for new HTRs, the dilemma being that these are not currently available to introduce into any MTR programme. There was disquiet about this situation, especially in view of the rapid advance of the PBMR programme. However, any experiment to support PBMR would require temperatures over 700˚C and a high fluence.

The proposed MTR graphite experiment was therefore referred back to the Database TCM, which took the view of seeking participation in the EU experiment, especially if additional funding for a longer irradiation could be negotiated. However it was agreed by all the Database Members and Associate Member that the attention of the TWGGCR should be drawn to their concern about the risks of embarking upon a programme of new reactors without a strong design database on irradiation behaviour of the candidate graphites, and the consequent possibility of repeating the mistakes of the past.

A most useful outcome of the discussion was the realisation that the problems of managing reactor core ageing (and life extension) are not just issues for the operators of existing reactors, but have equal applicability to new build plant – as indeed does the issue of designing for decommissioning. Consideration of all of these issues at the design stage for new plant, and further work on structural codes being developed for existing plant with the specific needs of HTR in mind, were seen as having great value. There is considerable potential, for example, for the experience of the structural modellers for the United Kingdom AGRs being applied to HTR reflector integrity problems.

Planned Meeting for 2002

UCAR Carbon have offered to host a third Specialist Nuclear Graphite Meeting at their plant in Parma, Ohio, and the probable dates for this will be 21st and 22nd October 2002, subject to confirmation. The 2001 Database TCM defined the following topics as being of most use:

- Neutron Dosimetry
- Developing Nuclear Carbon Materials for the Future
- Life Extension and Ageing (developing the 'Design through Experience' theme)

4. RECOMMENDATION TO TWGGCR

The following statement has been reviewed by the Liaison Officers of the Database Member States[10] and is now provided to the TWGGCR for its ***consideration***:

"In 2000, following the First Specialist Nuclear Graphite Meeting held at Oak Ridge National Laboratory in Tennessee, it had been recommended to the Graphite Database TCM that a new graphite irradiation experiment should be considered. At that time, the most favoured topic had been a new investigation of irradiation creep effects at high fluence. Accordingly, the Database TCM requested an opportunity to propose a CRP on this topic at the next available meeting of the TWGGCR.

"Since September 2000 there have been a number of new developments. Two United Kingdom operators of Magnox and AGR reactors respectively have initiated small MTR irradiation programmes of their own in order to satisfy some of their own requirements in respect of reactor ageing and life extension. Separately, an application to the European Union for funding under the Fifth Framework Programme to initiate a new graphite irradiation programme in the Petten reactor in The Netherlands has been successful, with funding for the first stage of this programme granted in September 2001. Germany and the United Kingdom are also associated with this programme.

"In a separate development, the Second Specialist Nuclear Graphite Meeting held at the Dehner Blumen Hotel, Rain, Germany in September 2001 also debated the proposal for a new irradiation experiment. In these discussions, it became clear that the more immediate problems of the graphite-reactor community world-wide would not be best served by a creep experiment, although it remains desirable to achieve this experiment also. Unfortunately, such an experiment could not now produce useful data to support plant already in operation, and hence this could not be supported by the United Kingdom reactor operators.

"It was therefore considered that it is of much more immediate concern to evaluate as speedily as possible the candidate graphites for new HTRs to a fluence which goes beyond 'turnaround', allowing an assessment of the graphite lifetime and a comparison of different candidate materials. Unfortunately, the new experiment funded by the EU does not cover these specific objectives (particularly in terms of the PBMR and its development timescale): nor, as yet, does the new irradiation offer a sufficiently high fluence although it is hoped that once the experiment has started, an extension to a higher fluence will be possible. A possibility may exist to include up to five existing graphites which best match the requirements of the HTR in the first stage of this irradiation, subject to EU approval for this amendment of the project specification.

"The Graphite Database TCM therefore advises the TWGGCR of the following recommendations:

[10] T. Burchell, Liaison Officer for the United States, was absent from the TCM and has not responded to the request to review the statement at the date of this mailing. The prospective Database Member, The Netherlands, represented at the TCM by Mr. Van Der Laan, indicated a desire to be associated with this Recommendation.

(1) "It is not appropriate to propose a CRP for a new graphite irradiation experiment at this time, since sufficient funding cannot be guaranteed to achieve the objective

(2) "The right is reserved to raise this possibility to the TWGGCR on a future occasion, with the precise objectives of the experiment to be determined in the future: the TCM is of the opinion that new irradiation experiments to achieve creep data and other data at high fluence are urgently necessary, but cannot be achieved at this time

(3) "Acting upon advice from graphite specialists from the world-wide community meeting in Rain, the TCM draws to the attention of TWGGCR its strong concern that it is planned to construct a large programme of PBMRs, perhaps at a rate of two reactors per year for twenty years, without any accompanying irradiation data on the graphites which will be employed. An immediate consequence of this situation is the re-design of PBMR to accommodate a mid-life change of the reflector blocks. Whilst the TCM understands the reasons whereby this unfortunate position has been reached, it recommends that the TWGGCR give urgent consideration to the full implications of repeating the mistakes of the past by embarking upon a new reactor programme without adequate graphite design data, and reviews the possible mechanisms by which such data could be obtained as quickly as possible for the candidate graphites: the potential reward, at the cost of some delay in the construction programme, would be to eliminate the need for costly component replacement part-way through life, with a consequent improvement in plant availability."

The TWGGCR should also *note*:

The PBMR Co., through Mr. Mark Davies, has indicated that it does not agree with this recommendation and considers that there is considerable disagreement amongst graphite specialists. He points out that an 8 – 10 year irradiation programme in Petten would be needed to secure the PBMR lifetime fluence, and therefore that there is no choice but to design without prior data. The intended ability to replace the reflector graphite, should it be necessary, offers a potential solution to any difficulty subsequently encountered with graphite irradiation behaviour.

Recommendation prepared by the TCM Chairman, A.J. Wickham (representative of The United Kingdom) on behalf of:

G. Haag (representative of FZJ, Germany)
R. Levinskas (representative of Lithuania)
K. Sawa (representative of Japan)
J. van der Laan (prospective representative of The Netherlands)
and (in absentia)
T. Burchell (representative of The United States)
and supported by the following Observers to the 2001 TCM:
T. Morita (Toyo Tanso, Japan); T. Oku, (University of the Air, Japan), M. Davies (NNC Ltd. UK), M. Metcalfe (BNFL, UK) and N. McLachlan (BEGL, UK)

In attendance:
R.E.H. Clark and J.A. Stephens, IAEA

21st October 2001

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