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HTR-M WP2.1 – Carbon-Carbon composite control rods.
Re-assessment of the remaining program

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**HTR-M WP2.1 – Carbon-Carbon composite control rods.
Re-assessment of the remaining program.**

Document, 15/10/03
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The aim of this HTRM WP2.1 task was to establish a material database on possible materials for HTR control rods with a view to select a material with superior high temperature properties, compared to metallic alloys.

1. Initial description of work (issued from HTRM contract)

“The work program is based on a preliminary design analysis, defining for each component a range of operating conditions and specific requests for HTR application. According to this design analysis, it consists of:

- (i) identification of the materials having a high potential interest and the compilation of their existing data.
- (ii) a selection of the most promising grades for further R&D efforts, a precise view of missing properties will be given.
- (iii) development and testing of available materials to meet HTR requirements.

The test work will concentrate particularly on the control rod cladding material. Mechanical tests to be performed on candidate materials at temperatures up to 1100°C (carbon reinforced by carbon fibers foreseen) in facility at CEA. Creep tests are also foreseen”

This work is shared between several partners with the following effort allocations:

CEA-Grenoble	2 PM
NNC	5 PM
Framatome	3 PM
JRC	4 PM
Siemens (now FRA-GmbH)	1 PM

2. Decision for changing the program objectives.

In November 2002, the first design specifications were available (from Framatome-ANP) and a review had already been completed by NNC. Discussions were in progress with two graphite manufacturers (Snecma and SGL) with regard to material supply.

A decision was taken during the HTRM Mid-term meeting (November 2002, at Framatome) to re-assess the program after the following discussion :

“The use of C/C composite materials for control rods is not a proven technology. The material sits permanently in a neutron field accumulating fast fluences that change its structure and properties. For the test programme there was clearly a need to further define the properties needed. B. Riou (FRA) said that the selection of the material for the tests is very important and given its specialized (and expensive) manufacture and the significant

*influence of irradiation on properties, **it would be better to channel the remaining resources into material selection rather than performing non-irradiated tests on material that may not be finally chosen for the application.** This increased emphasis on selection could involve **direct discussions with manufacturers** both of our needs and for assessing the potential benefits of different available materials. Such an approach may provide a greater long term benefit to the HTR programme. This matter was discussed further in the presence of the graphite manufacturers (inc. SGL) and R. Moormann of FZJ and it was agreed that such an approach may be more beneficial. It was concluded therefore that **the remaining part of the programme should be reassessed** and consideration be given to realigning the remaining resources towards selection rather than testing.”*

3. Remaining activities and deliverables.

It was agreed that the work on Carbon-Carbon composites should focus on:

- a) Continuation of data collection.
- b) Collect details of past experience from Jülich.
- c) Identify potential suppliers in Europe.

Activity a) is a continuation of data base activities. At the moment NNC, CEA, NRG, JRC, FZJ are identified in the data base guidelines document. FZJ and JRC would prefer to use Alloys-DB as their data on turbine materials as their data already been inserted in this. The review of Alloys DB as the eventual home for the data base is being investigated as part of the overall database activities.

Activity b) looks at FZJ experience, CEA proposes to lead this work and write a report (deliverable 2.3). Kerstyn Kuhn of FZJ is the contact for this work : e-mail: k.kuehn@fz-juelich.de.

In order to reassess the program, each partner involved in this activity was asked to re-define their involvement (technical work and manpower) for the last two years of HTRM program.

The remaining deliverables were re-defined as following :

- 2.3. Materials for the core and internals : Report on past experience from FZJ
→ **new proposed deadline 12/03, to be issued by CEA.**
- 2.4. Materials for the core and internals: Report on discussions with manufacturers
→ **new proposed deadline 04/04, to be issued by NNC/CEA**
- 2.5 Materials for the core and internals : Final report on material grade and processing, synthesis of further R&D efforts needed.
- → **unchanged deadline 1/11/04. (all partners)**

4. Remaining partners efforts.

NNC proposal (from D Buckthorpe, 9/09/03) :

NNC is already participating in the data collection activity, and where possible would also wish to participate in the discussions with the manufacturers.

In terms of available effort NNC had originally allocated 5 man months to this activity most of which was intended and has been used on the review and data base.

NNC has issued a deliverable on the review work and is currently compiling information for the database.

NNC estimate that the remaining effort could be order of 1.0 - 1.5 man months. (to be confirmed) which could be split for the time being as:

task a) 1.0 man month

task c) 0.5 man month

If NNC was to be involved in compiling the review of FZJ past experience there will be less work on the data base.

CEA proposal (from R Couturier, 18/02/03) :

The remaining manpower is estimated at 1.5 PM (0.75 for 2003, 0.75 for 2004).

CEA has already done some bibliographic work on R&D performed in Japan on C/C composites for control rods. We have also engaged discussions with Snecma and now SGL on a possible supply of C/C tubes.

Following the last discussions with Framatome on C/C composites, it seems that more bibliographic data are also needed on the SGL material.

We propose to continue to collect data on C/C materials properties :

- C/C materials selected for fusion applications
- C/C from aerospace industry
- C/C from nuclear programs (Jülich, JAERI)

If needed, we would participate to meetings organized between HTRM partners and possible C/C suppliers in Europe, but we do not wish to organise new meetings with French manufacturers that we have already contacted.

FRAMATOME-ANP and FRAMATOME-Gmbh proposal (from O Gelineau, 21/3/03) :

Characterization tests on a C/C composite were initially foreseen in the HTR-M frame. A SGL 2D C/C composite was in particular chosen by CEA to perform such tests.

In our opinion this is too early, because, in order to have useful information, a comparison between different C/C materials must be done (2D, 3D, with different types of fibers...). At first a document has to be issued showing what are the C/C used today for new HTRs, for fusion, what has been possibly done by the past for other reactors and generally what kinds of C/C composites exist on the market has to be done prior to any supplying of materials. This will permit to list the most relevant materials for our need and to select a few of them for further testing.

In this objective, the data that are already available shall be collected. It seems in particular that FZJ has worked on C/C (at least on CC-2001-G from SGL), and an investigation has to be done. On the other hand, manufacturers like SGL have devices to perform test and normally should have a part of the information we need (see also other manufacturers like Snecma, Dunlop...). See also C/C tested for ITER project at CEA and probably elsewhere.

Moreover, it has to be noted that the choice of a C/C composite, as for graphite, will be done by comparing its behaviour under irradiation and in an oxidising situation. It is therefore necessary to consider a larger frame of characterisation including tests before, after irradiation and under oxidation (even if these tests are not counted in HTRM contract) in order to have a consistent European program.

5. Conclusion.

This document gives the reasons for a reassessment of HTRM WP2.1 work program. Re-defined technical tasks are proposed with the corresponding deliverables.

This new program has to be agreed during the next HTRM meeting (NOV. 2003) and submitted to the European Commission for agreement and approval.