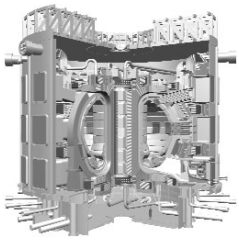

ITER CTA NEWSLETTER

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SEVENTH ITER NEGOTIATIONS MEETING

By Dr. J.-P. Rager, European Commission

The Barcelona World Trade Centre, overlooking the old harbour of Barcelona, Spain, was the venue for a successful seventh ITER Negotiations Meeting that took place on 9-10 December 2002. The European Union hosted the meeting, which was also attended by delegations from Canada, Japan and the Russian Federation. Pablo Fernandez Ruiz, Director for Energy Research of the European Commission's Directorate General for Research, was moderator of the meeting.

Minister J. Piqué, addresses the opening session of the meeting

The delegates were welcomed by Mr. Josep Piqué, Minister of Science and Technology of the Spanish Government, and Mr. Antoni Gurgui, General Director of Industry of the Catalan Government. In his welcoming remarks, Minister Piqué referred to Spain's recognition of the impressive scientific and technological challenge that ITER represents and how close the ITER participants are to making the dream of fusion energy come true.

In their opening comments:

- Canada reported that the current Canadian offer had been put forward in a context that had changed; the Canadian government was therefore reviewing its offer with a view to indicating a revised position early in 2003.
- Japan reported that discussions both on the basic approaches to the safety management of ITER and on the safety regulations for hosting ITER in Japan were continuing; an interim report was to be issued by the end of 2002.
- Europe reported on exchanges between the European Commission and the research ministers of France and Spain concerning their respective site proposals, and on the Joint Assessment of Specific Sites (JASS), which was nearing completion with the assessment in the previous week of the European site at Cadarache, France.
- The Russian Federation reported on a recent review of the status of fusion research by the Governing Board of the Academy of Science that had strongly supported the participation of the RF in the ITER project.

Dr Robert Aymar, the International Team Leader, reported on a mission to Garching by a United States Department of Energy Committee of costing experts to undertake an assessment of ITER cost estimates. (For the Executive Summary of the Committee's report, please see the separate article in this issue.) The Committee's findings, which are now also available on the web (at http://fire.pppl.gov/doe_iter_lehman.pdf), were very positive.

This was the last Negotiations Meeting within the duration of the Co-ordinated Technical Activities (CTA) for ITER. The final report from the CTA Project Board for ITER was presented. The delegations thanked the Chairman of the Board, Academician Evgeny Velikhov, for his leadership and for the important role he has

Deputy Minister Mamiya, Head of the Japanese delegation, responds to the welcome of Jordi Pujol (right), President of the Catalan Government, at a reception held in the Catalan Government Palace. In the background the heads of the other delegations

played in the development of ITER. From January 2003 the "ITER Transitional Arrangements", put in place by the Participants to supersede the CTA, will ensure technical and engineering continuity until the ITER International Fusion Energy Organization is established.

The Negotiators noted the successful completion of the joint assessment of the candidate EU site of Cadarache on December 3-6 2002. The fourth (and last) assessment was be done immediately after the Negotiations Meeting at the other proposed European location of Vandellòs, Spain. A final report on the Joint Assessment of Specific Sites is due to be submitted to the Negotiators in February 2003.

The meeting discussed the draft of the proposed Agreement on Joint Implementation of ITER, settled a number of outstanding points and identified key issues for further development, for instance the management structure of the organization to be established under the Agreement to undertake the ITER project. Progress was also noted on subsidiary documents to the Agreement such as an Annex on Privileges and Immunities. The Negotiators' Standing Sub-Group (NSSG) will continue its development of the draft Agreement and related work.

Participants in the meeting

A report was presented on a visit to China by legal experts from the Participants. This followed up on an informal meeting about Chinese interest in possibly joining the ITER Negotiations held with a Chinese delegation in November 2002 just after the last ITER Negotiations Meeting.

After the end of the meeting the delegations had a similar informal exchange of views with representatives of the Republic of Korea, which has also expressed an interest in possible participation in ITER joint implementation.

FINAL ITER CTA PROJECT BOARD MEETING

by Dr. V. Vlasenkov, Project Board Secretary

The ITER Co-ordinated Technical Activities Project Board (PB) met for its final meeting on 8 December 2002 in Barcelona, Spain.

The PB took note of the comments concerning the status of the International Team (IT) and the Participants Teams (PT). In particular, it was noted with satisfaction that in all four ITER Parties, namely in Canada, the European Union, Japan, and the Russian Federation, appropriate measures are being taken to advise the

EXCERPTS FROM THE REPORT "FROM ITER TO A FUSION POWER REACTOR"

"The present ITER design allows the main issues of an electricity generating fusion plant to be addressed. It has been shown that ITER will probably achieve the plasma parameters needed to operate a power plant, and towards this goal, it will have to reach a fusion power higher than its nominal value and to overcome the same limiting factors as identified for a power plant. If practical solutions are experimentally identified and implemented during ITER operation, there is no doubt that the way to a "first of a kind" fusion reactor would be largely open."

"Besides these essential conclusions, ITER can and will provide a very large amount of practice and know-how from its operational programme, a necessary asset for any fusion reactor following ITER. The official testing programme in ITER of a reactor relevant tritium breeding blanket could probably be enlarged to provide the possibility of testing more power plant technology development."

"The preceding chapters have shown that the plasma operation in ITER should be truly representative of the operational conditions of a fusion power reactor; they have also identified the main challenges to be overcome - density and divertor heat load limiting factors - in order to provide a practical solution in ITER which can be also implemented in the reactor."

"Nevertheless, in addition there will be many other aspects experienced during ITER operation that will have great value for a future power reactor. Without being exhaustive, the list of available experimental know-how will include:

- control of all plasma parameters needed for a reliable operation, associated diagnostics and feedback controllers;
- safe, efficient and reliable operation of a tritium fuel cycle, the size of which is suitable for ITER;
- mastering practical experience in all safety issues, including licensing and operational incidents;
- handling of dust issues;
- reliability database on all components and systems;
- maintenance methodology and remote handling procedures."

"The capacity in ITER to replace components during its lifetime may offer the opportunity to test new technologies. The development of a tritium breeding blanket relevant to a power reactor, through modules introduced into ITER vessel ports, is until now the only case retained officially in the programme. More new cases might be envisaged, such as

i) the testing of new divertor target concepts potentially capable of handling a larger power density than the present ITER design and

ii) similarly, the testing of novel blanket shield designs, using high efficiency materials such as metallic hydrides, which will be situated behind a breeding blanket to complete the necessary shielding factor in a reactor."

"It can be suggested that a review is undertaken to ensure that the maximum advantage is taken of ITER to investigate minor but independent aspects of power plant technology, mostly related to 14 MeV neutron irradiation."

Director General of the International Atomic Energy Agency that these ITER Parties intend to participate in the ITER Transitional Arrangements (ITA) in conformity with the Terms of Reference for the ITA. The ITER ITA are scheduled to start on 1 January 2003, as a logical continuation of the CTA. The ITA will provide the necessary framework to prepare for an efficient start of the Joint Implementation of ITER.

At its previous meeting in Toronto on 16 September 2002, the PB "expressed appreciation to the EU side for presenting the extensive EU Participant Team Report describing the support of the ITER CTA. The PB asked the RF and JA sides to present similar reports to the next PB meeting." At the current PB Meeting, the Board subsequently took note of the requested JA and RF Participant Team Reports. By presenting its PT Report, the RF noted that it is continuing its activities in support of the CTA Work Programme as well as preparations of RF industry for ITER. In particular, the RF plans to develop technology for production of diamond windows.

The PB noted that experts for the Test Blanket Working Group (TBWG) have been nominated by all the Participant Teams and suggested that the TBWG start its activities at the beginning of 2003.

The PB took note of Dr. Aymar's Report to N-7, "From ITER to a Fusion Power Reactor". (For excerpts please see the box overleaf.)

While discussing the record of the final CTA PB Meeting, the participants in the Seventh ITER Negotiations Meeting thanked the Chairman and members of the CTA PB, the IT Leader and Co-Leader, and the members of the IT and PTs for their services during the CTA phase of ITER.

ASSESSMENT OF THE ITER PROJECT COST ESTIMATE

The United States Department of Energy's Office of Science commissioned a review of the ITER Project costing and management process. This task had been carried out by a DOE Committee chaired by Mr. Lehman. The report of this committee is known as the Lehman Report.

The working meeting between the committee and the ITER International Team took place in Garching, on 21–25 November 2002. The assessment was focused on the cost estimate of ITER with a special emphasis on the reasonableness of the project cost and schedule assumptions, and to the extent possible the construction and technical management assumptions.

The following is the Executive Summary of the Lehman Report.

US DEPARTMENT OF ENERGY ASSESSMENT

of the

ITER PROJECT COST ESTIMATE

November 2002

EXECUTIVE SUMMARY *

The Department of Energy (DOE) Assessment of the ITER Project Cost Estimate was conducted on November 21-25, 2002, at the request of Dr. Raymond L. Orbach, Director of the DOE Office of Science. The purpose of this review was to assess in summary fashion the cost estimate that has been prepared by the ITER Team **, emphasizing reasonableness of project cost and schedule assumptions and, to the extent possible, the construction and technical management assumptions.

The mission of ITER is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. Fusion energy is a potential major new source of energy with attractive features of no greenhouse gas emissions, no production of long-lived radioactive products, abundant and widely distributed

* The full text of the Assessment is posted on the web at http://fire.pppl.gov/doe_iter_lehman.pdf.

** The term "ITER Team" in this document means "ITER International Team" (IT). The ITER National Teams of the ITER Parties provided the IT with the results of their work.

sources of fuel (seawater and lithium), inherent safety features to shut down easily with no possibility of fuel meltdown, continuous mode of operation to meet demand, and manageable waste.

Currently, the ITER project is at the stage where the final design is essentially complete, and the R&D that provides the technical basis for the design and for hardware fabrication is also essentially complete. Four government "Parties", namely, the European Union, Japan, the Russian Federation and Canada, are negotiating necessary international arrangements and terms for proceeding with ITER construction, and they are assessing candidate construction sites at Cadarache, France; Vandellos, Spain; Rokkasho, Japan; and Clarington, Canada. Decisions on these matters by the participating governments are expected in 2003.

The Committee concluded that the ITER Team has prepared a complete cost estimate that is based on sound management and engineering principles, and is credible as a basis for establishing relative contributions by the Parties to the construction of ITER. The estimate is a synthesis by the ITER Team of multiple international industrial cost estimates for each of 85 procurement packages covering essentially the entire project; it includes a normalization of material and labor cost rates in various countries, and it emphasizes the value of individual components relative to each other. It is not comparable to a traditional DOE construction project cost estimate. The credibility of such a value estimate is supported by the design and R&D results that are unusually mature for a science project facing the decision to fund construction.

Because multiple Parties would construct the ITER project, with each responsible for procurements of in-kind hardware in its own territory with its own currency, a direct conversion of the ITER value estimate into a single currency is not particularly relevant; nevertheless, it is possible. Converting to U.S. dollars, the total would be about $5 billion (constant 2002 dollars) for the base estimate consisting of about $4 billion for ITER hardware, initial spares, buildings, and installation and assembly of the hardware into the buildings plus about $1 billion for project management and engineering support during construction, R&D during construction, and commissioning. The U.S. considers commissioning to be part of the project period while the current ITER Parties consider it to be part of the operation period.

Several of the current Parties have gone beyond the direct conversion process and prepared their own full cost estimate. European Union personnel presented the conclusions of their cost estimate to the Committee. Their analysis indicated close agreement with the ITER value estimate to within a few percent, although individual component costs varied by somewhat larger percentages.

The current ITER Parties agree that the ITER value estimate is appropriate for establishing relative contributions by the Parties to the construction of ITER. They are now negotiating an arrangement for sharing project scope on that basis, with the understanding that each Party would be financially responsible for their in-kind hardware contributions.

In light of the above, the Committee concluded that in the event the U.S. decides to join the current negotiations, it should prepare, as soon as possible, its own cost estimate for a set of procurement packages for components the U.S. would be interested in providing. Such a cost estimate should conform to current DOE project management procedures, including appropriate contingency and escalation cost. In addition, similar cost estimates should be prepared for the other types of potential U.S. contributions to ITER for common expenses such as personnel assigned to the Central Team and Field Team and common procurements. These latter estimates should also include appropriate contingency and escalation cost.

The proposed construction schedule for the project is ten years beginning with establishment of an ITER legal entity * and ending with first plasma. A critical path has been identified, and tasks not on the critical path have been scheduled to level the spending profile. The construction schedule seems generally reasonable; however, there is inevitable uncertainty in estimating the duration of the governmental approval process that is a prerequisite to starting the construction of the project.

The Committee was informed of some of the options being considered by the negotiators for management of the ITER construction project. These include roles for a government level Council, Director General, various advisory groups, Central Team, Field Teams that provide technical management of procurements in the Parties' territories, and Domestic Agencies that award contracts. The results of the ongoing negotiations will

* It was decided that this legal entity should be named the ITER International Fusion Energy Organization.

establish the management and organization structure to be used for project construction. Since management will be the key to the ultimate success of the project, the Committee believes that for a complex international project such as ITER, a strong line-management approach will be in the best interest of the Parties.

In summary, the Committee concluded that the ITER Team has prepared a complete cost estimate that is based on sound management and engineering principles, and is credible as a basis for establishing relative contributions by the Parties to the construction of ITER. The proposed schedule developed by the ITER Team is reasonable. The management arrangements now being negotiated are critical to the project's success.

THIRD MEETING OF THE ITPA TOPICAL GROUP ON DIAGNOSTICS

by Drs. A.E. Costley, ITER International Team, and A.J.H. Donné,
FOM Institute for Plasma Physics 'Rijnhuizen'

The Third Meeting of the International Tokamak Physics Activity (ITPA) Topical Group (TG) on Diagnostics was held at the National Institute for Fusion Science (NIFS), Toki, Japan, from 18 to 21 September 2002. The meeting was combined with a progress meeting on diagnostic developments in progress in Japan which are relevant to ITER and, more generally, to burning plasma experimental (BPX) devices. A joint session with representatives from all the other ITPA TGs was organized with the aim of having detailed discussions on the measurement requirements for ITER. In total 48 participants attended the ITPA and/or progress meetings and all four ITPA partners were represented.

The key topics reviewed and discussed at the TG meeting were:

- the detailed measurement requirements for ITER along with their justifications;
- the overall status of diagnostic development for ITER and the US BPX device, FIRE;
- the progress in the research on the designated high priority topics;
- the progress with some key ITER/BPX relevant diagnostic developments in progress in the ITPA participant laboratories;
- the progress and plans for the work of the specialist working groups.

A joint session with representatives from each of the other TGs was devoted to reviewing and developing the detailed ITER measurement requirements and the justifications for the measurements. Many detailed comments were received which will be analyzed in the coming weeks, but it is clear that the trend is in the direction of calling for more detailed measurements – better spatial and temporal resolutions, etc. However, the justifications for these improvements were not always clear and this aspect needs to be developed.

A report was given on the outcome of the recent meeting held in the USA - the Snowmass meeting - at which the options for the next step in the US fusion energy science programme were reviewed. At the Snowmass meeting, individual assessments were made of ITER, FIRE and another BPX proposal, IGNITOR, and their plans and provisions for diagnostics. The results are available on the Snowmass web page (http://web.gat.com/snowmass/).

Good progress has been made in the tasks designated as high priority:

1. The requirements for plasma and target measurements in the ITER divertor region have been further developed in collaboration with the ITPA TG on Divertor and Scrape-Off Layer Physics. The discussions on many of the issues have now closed with revised measurement requirements having been agreed and justified. System designs have also advanced and there is now a closer match between requirements and anticipated measurement capability for a number of divertor parameters, although some significant discrepancies still remain. Current design work is concentrating on these.
2. Progress has been made on the radiation induced electromotive force (RIEMF), which is an effect that can cause systematic errors in the measurements made with the magnetic diagnostic system, including the measurement of the plasma position and shape. Measurements have been made on a prototype coil in Japan under gamma irradiation at the Fusion Neutron Source, and measurements have been made on irradiated single-ended cables and coils by a group at the Belgian Nuclear Research Center. The Belgian group has also developed a model that gives encouraging agreement between prediction and measurement. Several measures for minimizing the effect have also been identified.

3. The requirements for the measurement of the density of current in the plasma have been discussed with a number of the other TGs. For many potential applications, it is now thought that the present requirement for the spatial resolution in the measurement is marginal and an improvement is recommended. In particular, a high resolution is recommended in the vicinity of special regions in the plasma such as internal transport barriers and in the edge region. Much detailed work has been carried out on the diagnostic systems selected to measure the plasma current density; these are the Poloidal Polarimeter system and the motional Stark effect system. It is believed that workable solutions have now been found to most of the difficult implementation issues and that it will be possible to measure the current profile in ITER by a combination of these two systems, although the precise measurement capability has yet to be determined.
4. Progress continues with the development of the first mirrors for optical diagnostics. These mirrors will have to face the plasma and will be exposed to potentially damaging radiations. Several experiments have been carried out and others are presently being prepared. A mirror test duct will be implemented in the JET divertor and sample mirrors will be installed in the TEXTOR tokamak in Germany, in the Tore Supra tokamak in France, and in a plasma simulator device in Germany. Some of the mirrors will also have to withstand multiple pulses of high power laser radiation which can also potentially damage the mirrors. Extensive testing of the laser damage threshold of candidate mirror materials is being carried in the Russian Federation.
5. The fusion process leads to the formation of a population of high energy alpha particles in the plasma. The energy in this population heats the plasma but also can potentially drive plasma instabilities. It is necessary to measure the population of fast alpha particles but this measurement is difficult under ITER conditions. One technique which has been used on existing machines is to measure the plasma fast ions by scattering with high power laser and/or microwave radiation (collective Thomson scattering). There are difficulties with implementing and interpreting the results of this technique under ITER conditions but work is in progress on these issues. At the meeting, a new concept for measuring the confined alpha particles was presented. The technique is an active spectroscopic technique and would utilize a tangentially injected high energy beam of neutral helium atoms. The initial feasibility study has shown that measurements of the confined alpha particles may be possible in principle although implementing the technique on ITER would be difficult.

Detailed design work has shown that the present vertical viewing neutron camera has some complicated interfaces with other tokamak systems and it may not be possible to implement the system as proposed. Consequently it may not be possible to measure directly the spatial dependence of the birth profile of the alpha particles and so the need for this measurement needs to be reviewed. This work will be a high priority topic in the forthcoming work of the TG.

Several other TGs have made recommendations for high spatial resolution in the measurement of key parameters to support the advanced tokamak type of operation. These measurements are difficult to make under ITER/BPX conditions and so a new high priority investigation will be undertaken in this area. The task is to determine the minimum measurement requirements necessary to support this type of operation.

The Parties reported steady progress for many diagnostic systems that are relevant to a BPX. A very productive progress meeting on ITER/BPX relevant diagnostic developments in Japan was held, with many excellent contributions. The Specialist Working Groups reported progress in their specific fields since the previous meeting.

Since the second meeting of the TG on Diagnostics, a number of fusion teams have joined the International Diagnostic Database (IDD) by contributing information on their diagnostics. In addition, the information on a number of other diagnostics has been updated.

It is proposed to hold the fourth meeting of the ITPA TG on Diagnostics in Padua from 17 to 21 February 2003. The meeting will be combined with a progress meeting on ITER/BPX relevant diagnostic developments in Europe. A special session will be devoted to alpha particle physics and the need for measurements of the confined and escaping alpha particles.

Both meetings ran very smoothly and the participants are grateful to NIFS for its hospitality and express their special gratitude to Prof. Mamiko Sasao and Prof. Shigeru Sudo and their colleagues for their care and attention to all the meeting arrangements.

Attendees at the Third ITPA Topical Group Meeting on Diagnostics

Rejéan Boivin (GA, USA)
Alan Costley (ITER Int. Team)
Tony Donné (FOM, Netherlands, EU)
Anatolij Kislyakov (Ioffe, RF)
Anatolij Krasilnikov (TRINITI, RF)
Yoshinori Kusama (JAERI, JA)
Mamiko Sasao (NIFS, JA)
Vyacheslav Strelkov (Kurchatov, RF)
Tatsuo Sugie (ITER Int. Team)
Victor Zaveriaev (Kurchatov, RF)

Guests and Attendees at the Topical Group Meeting

David Campbell (EFDA-CSU, EU)
Ricardo De Angelis (ENEA-Frascati, Italy, EU)
Takeshi Fukuda (JAERI, JA)
Takaki Hatae (JAERI, JA)
H. Iguchi (NIFS, JA)
I. Guchi (Nagoya Univ., JA)
Masao Ishikawa (JAERI, JA)
Kiyoshi Itami (ITER Int. Team)
Y. Kamada (JAERI, JA)
Toshiuki Kashiwagi (Kanagawa Univ., JA)
Kazuo Kawahata (NIFS, JA)
Yasunori Kawano (JAERI, JA)
Hisato Kawashima (JAERI, JA)
Takahi Kondoh (ITER Int. Team)
Artur Malaquias (IST-Lisbon, Portugal, EU)
Atsushi Mase (Kyushu Univ., JA)
Yukitoshi Miura (JAERI, JA)
Kenrou Miyamoto (Univ. Of Tokyo, JA)
H. Nakanishi (NIFS, JA)
Nobuhiro Nishino (Hiroshima Univ., JA)
Takeo Nishitani (JAERI, JA)
S. Ohdachi (NIFS, JA)
S. Okajima (Chubu Univ., JA)
Byron Peterson (NIFS, JA)
Tatsuo Shikama (Tohoku Univ., JA)
Shigeru Sudo (NIFS, JA)
George Vayakis (ITER Int. Team)
M. Wada (Doshisa Univ., JA)
Chris Walker (ITER Int. Team)
Ken Young (PPPL, USA)

Participants in the meeting

Items to be considered for inclusion in the ITER CTA Newsletter should be submitted to B. Kuvshinnikov, ITER Office, IAEA, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: +43 1 2633832, or e-mail: c.basaldella@iaea.org (phone +43 1 260026392).

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