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TENTH ITER NEGOTIATIONS AND RELATED MEETINGS

Cadarache, France, September 2005 -– With the issue of ITER siting settled at the Ministerial Meeting for ITER in Moscow of 28 June 2005, detailed joint work towards all the other aspects of the agreement on the implementation of the ITER international fusion energy research project resumed as delegations from China, the European Union, Japan, the Republic of Korea, the Russian Federation and the United States of America met at the agreed site of Cadarache in the period 7 – 15 September 2005 for intensive working sessions culminating in the tenth official meeting of the ITER Negotiators.

In a very constructive atmosphere, a full range of legal, technical, administrative and managerial topics, were treated by the Parties' experts, including the form and the structure of the international organization, staffing, resources and risk management, which will form the basis for the Agreement on implementing ITER and the operation of the International ITER Organization.

The major advances made were reported to the Tenth Official Meeting of the Negotiators on 12 September at which all delegations reiterated their intention to proceed together with the construction of ITER at the earliest date, and expressed their satisfaction on progress made in defining the process for designation of top ITER officials. In particular, the delegations expressed the wish to see Japan identify suitably qualified candidate(s) to be designated as Nominee Director General.

Negotiators agreed that substantial progress was made on all topics, and looked forward to an early completion of the negotiations.

In a separate meeting, the ITER delegates had an informal exchange with a delegation from India on India's interest in the possibility of participating in ITER.

It was subsequently agreed that, without any further commitment, an exploratory fact finding mission would visit India to follow up this exchange for future consideration by the ITER delegations.

At the Negotiators Meeting

Directly after the Negotiations, the Parties' representatives came together again in a meeting of the ITER Preparatory Committee, the steering body of the ITER Transitional Arrangements, which provide the framework for the current phase of joint activities pending the entry into force of the ITER Agreement.

The Committee took a number of organizational decisions aimed at preparing for the start of construction. In particular it was agreed to establish, under the Transitional Arrangements, an ITER Joint Work Site at Cadarache. This now provides the institutional frame to start assembling international personnel and to undertake joint technical work at the ITER Site. In addition, the CEA was mandated to represent ITER, in collaboration with the International Team, in the public debate now in progress in France and in the regulatory and licensing process until the ITER Organization itself will be in a position to take the role over.

Negotiators celebrate the opening of the ITER Welcome Centre set up at Cadarache to be the "one stop shop" for newly arriving international ITER staff and their families

ITER DIVERTOR MEETING

by Dr. M. Merola, ITER International Team

The ITER Divertor Meeting was held in Genova, Italy, on 26-28 October 2005 and was hosted by Ansaldo Ricerche in the "Villa Cattaneo dell' Olmo", which is the visitors' facility of Ansaldo / Finmeccanica.

The object of the meeting was to provide the opportunity for the ITER Team and the Participants to be brought fully up to date on the status of the R&D in each Participating Team.

The scope of the meeting covered:

— The procurement plan and policy for the plasma-facing components;
— a review of the divertor design and requirements;
— developments in divertor remote handling;
— an overview of the integration of diagnostics into the divertor;
— the status and issues of the materials for the divertor;

— plasma-wall interaction issues;
— developments in the engineering of armoured high heat flux components, including testing;
— acceptance criteria and non-destructive testing.

This series of meetings represents a continuation of the Large Project 5 meetings, which used to take place during the ITER EDA period. Previous ITER Divertor Meetings were held in Naka, Japan (December 2003), Cadarache, France (June 2002), St. Petersburg, Russia (June 2001) and Naka, Japan (April 2000).

A preliminary "Divertor Procurement Plan" had been sent to all the participants. This described the agreements, procedures and time schedule to be established between the ITER Organization and the future ITER Parties, which will procure the divertor components and will carry out the high heat flux tests.

The procurement is covered by two procurement packages, one for "Divertor Cassette Integration" and the other for "Divertor Plasma-Facing Components". The presently assumed sharing among the Parties was as agreed in 2003 and foresees that the EU will procure the cassette body and the outer vertical target, Japan will procure the inner vertical target and the RF will procure the dome liner and perform the high heat flux tests. The manufacturing of the plasma-facing components (PFCs) of the ITER divertor represents a challenging endeavour due to the high technologies which are involved, and due to the unprecedented series production. To mitigate the associated risks, special arrangements need to be put in place prior to and during procurement to ensure quality and to keep to the time schedule.

Before procurement can start, an ITER review of the qualification and production capability of each candidate Party is planned. Well in advance of the assumed start of the procurement, each Party, which would like its industry, as a domestic policy, to contribute to the divertor PFC procurement, should first demonstrate its technical qualification to carry out the procurement with the required quality and in an efficient and timely manner. Appropriate precautions, like subdivision of the procurement into stages, are also to be adopted during the procurement phase to mitigate the consequences of possible unexpected manufacturing problems.

Meeting in Session

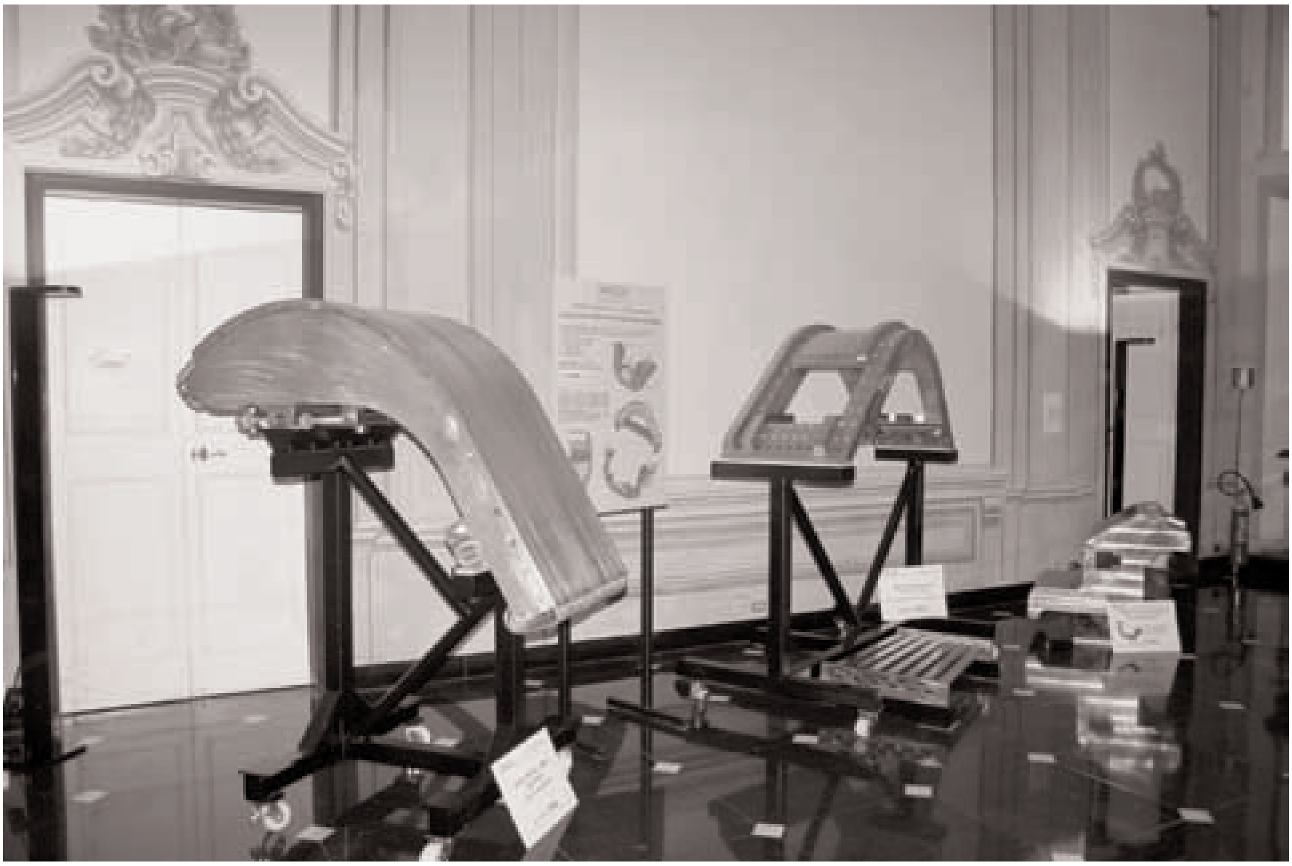
In general, the proposal was well received by the participants. The participants concerned were invited to send any additional comment, with the aim of reaching a consensus at the technical level by the end of the year.

The meeting continued with talks giving an update of the ITER divertor design and requirements.

A new proposal for the design of the dome liner was also presented and discussed. Its main feature is that the plasma-facing panels are not poloidally continuous, thus leading to a significant reduction of the electromagnetic (EM) loads. This alternative design will be further considered by the ITER International Team (IT). Code and standard requirements for the structural parts of the divertor components were also addressed. The divertor is not a “safety important component”, but the highest level of quality needs to be ensured for reliable operation of the ITER machine. The high heat flux units follows a “design by experiment”, whereas the cassette body as well as the structural parts of the PFCs need to conform to “design by analysis” according to already available codes and standards as far as possible. In particular, it is proposed to profit for the on-going work in the vacuum vessel, where an addendum to the RCC-MR (ed. 2002) is being prepared to cover the steel welded structures.

R&D activities and strategy for the remote handling (RH) of the divertor were presented. The process of divertor replacement involves removal of the cassettes through maintenance ports at the divertor level using remotely controlled devices known as “cassette movers”.

Since late 2003, the EU has been engaged in the detailed design of a new set of divertor movers relevant to the current ITER design. These movers fall into two types; one that travels along radial rails to remove cassettes positioned directly in front of the RH port (known as the “Cassette Multi-functional Mover” or CMM) and one that travels toroidally around the vessel to deliver/collect cassettes positioned at some distance from the RH port (known as the “Cassette Toroidal Mover” or CTM). Preparations are now under way for the construction of the first prototypes of these new movers followed by subsequent testing in a new RH mock-up facility designated “DTP2”, to be hosted by the Finnish Association TEKES.



The last talk of the first day of the meeting presented an overview of the required diagnostic. More than half of the ITER plasma parameters that must be measured and the related diagnostics are located in the divertor. There are six diagnostic cassettes, located in front of the ports, which are standard cassettes modified to incorporate optical, microwave and neutron diagnostics. There are also ten instrumented cassettes, located on either side of the diagnostic cassettes except one, which are standard cassettes modified to incorporate sensors and cables. All the six future ITER Parties are involved in the procurement of the divertor diagnostic systems. For most of the required diagnostics the related techniques and specifications are defined and agreed. Very few still have undefined specifications, e.g. dust monitors. The engineering of only a few diagnostically critical components has been defined and analyzed, where important interfaces or issues have had to be assessed. The development of these designs and the procurement of diagnostic and diagnostic service equipment must progress in parallel with that of the divertor.

The second day of the meeting started with talks on divertor material issues. During the ITER ITA period, the material activities have been mainly devoted to preparing the procurement specification for the materials of the vacuum vessel and in-vessel components, including the update of the material property database and the required R&D in some critical areas. A summary and discussion of the main features of the materials, which will be used in the ITER divertor, was presented and included the following materials: CFC, tungsten, CuCrZr alloy, 316L(N)-IG steel, NiAl bronze, alloy 718, X-19 steel, pure copper.

According to the talks on plasma-wall interaction issues, the ITER divertor must fulfill several roles: exhaust the SOL power, exhaust the helium ash, and control the plasma density; all without contaminating the core plasma and with a lifetime compatible with the operation of the machine. These roles are reflected in the three areas of study: power handling, pumping, and erosion.

At first glance, power handling should not cause a problem for ITER. The pumping requirement of ITER is fundamental, as without sufficient He pumping the plasma will become contaminated. This requirement is coupled with the requirement to reduce the recirculation of gas from behind the divertor into the main chamber which could affect plasma performance, although this has not been observed in experiments on JET, ASDEX and C-mod. Erosion is a complex subject involving materials, chemistry, and plasma physics. Also the net erosion is the small difference between two large processes, namely erosion and redeposition. To reduce erosion by physical sputtering, the ITER divertor needs to operate in a detached mode, so that the ion energies at the surface are less than the energy threshold for sputtering.

The enormous importance of plasma wall interactions (PWIs) has been increasingly realized during the last few years, but most of the critical problems for ITER (PWI material choice, T retention, and heat exhaust especially in transient phases such as ELMs [edge-localized modes] and disruptions) still remain to be completely satisfactorily resolved. Work in the PWI area is well organized and key experiments are in place, especially in the EU. In particular, it is essential to maintain the effort on present devices (especially JET and ASDEX-Upgrade) in the medium term, and to continue ongoing EU collaborations to exploit unique features of PISCES-B to study beryllium, and on Russian plasma guns to simulate ELM material damage effects. Further effort is needed to align R&D to strategic ITER goals.

Various presentations on the status of technology R&D in the divertor area were shown by the concerned Participants. For the EU, a number of activities are being carried out with EU industry and national laboratories. As far as high heat flux technologies are concerned, the ability to build small, medium and full-scale prototypes has already been demonstrated in the past and reported in previous ITER Divertor Meetings. These components have been high heat flux tested above the ITER requirements. A complete set of full-scale divertor components are being manufactured. Their construction will enable a comprehensive qualification of the manufacturing process, including all the welding procedures, and will provide essential information on the achievable tolerances and their possible build up. After completion, they will be used for the development and qualification of the assembly procedures and for full-scale hydraulic tests. A substantial design effort has also been carried out in collaboration with the ITER IT, with the EU Associations and EU industries. This includes analysis supporting the design of the cassette-to-vacuum-vessel locking system and design and experimental tests of the multilink attachments between the PFCs and the cassette body. A number of EU/RF bilateral collaborations have been established or are being formalized. They include: high heat flux testing of divertor components, study on the effect of ELMs, and EM analysis of the ITER divertor and joint manufacturing of tungsten monoblocks.

The RF contribution to the R&D in the divertor area includes studies on C_xH_y transport aimed at developing methods to suppress hydrocarbon deposition in the divertor area and in the pump duct. Experimental simulations of plasma transients have been performed and are planned in the QSPA plasma gun facility, which provides adequate pulse durations and energy densities, and in the MK200UG facility, which can provides relevant ion energies and a magnetic field. Work on technology development covers manufacturing and testing of divertor mock-ups. A number of small scale mock-ups with tungsten armour and CuCrZr heat sink have been manufactured and tested well above the dome liner requirements.

For Japan, the manufacturing and testing of a mock-up with tungsten armour was presented. Tungsten pins were pressed at 900°C into a pure copper heat sink by a hot-press method to form rod-shaped armour. The copper heat sink was then joined onto a DS-copper tube via brazing at 850 °C using a silver-based brazing filler. High heat flux testing was performed in the JEBIS electron beam facility. The mock-up could successfully withstand 2,700 cycles at 10 MW/m^2. A finite element analysis was also carried out in support to the experiment.

In preparation for writing the procurement specification for the vertical targets, the topic of setting acceptance criteria was addressed. This activity, which is being carried out by the ITER IT in close collaboration with the French Association, CEA, has the objective of defining workable acceptance criteria for the PFC armour joints. Regarding metallic joints, namely Cu/CuCrZr and W/Cu, ultrasonic examination ensures the best accuracy and reliability. Therefore, it ought to be the preferred method for them. The CFC/Cu joint is more complex. The main non-destructive inspection technique for this joint is the infrared examination ("SATIR" test). The practicality of using the presently assumed postulated acceptance levels is to be assessed during the second part of this activity, before the values can be finally set.

During the third day of the meeting, the design analysis of the cassette body/vacuum vessel locking system was discussed. A preload of about 400 kN is required to cope with the EM forces expected during the thermal quench of vertical displacement events (VDEs). ITER IT analysis is on-going to determine the effects of eddy-current-induced moments on the outer attachment. In 2006, a complete review of the supporting design analysis will be carried out taking into account the latest divertor design and requirements. It will be jointly performed by the EU and RF Participants.

Talks were also given on the latest high heat flux testing campaigns carried out at the EU facilities FE200 (Le Creusot, France), JUDITH (Jülich, Germany) and GLADIS (Garching, Germany). A new 200 kW electron beam facility, namely JUDITH-2, is expected to enter into operation early in 2006. The electron beam facility TSEFEY (St. Petersburg, Russia) will be upgraded to a similar beam power level.

The last two talks of the meeting summarized the divertor activities being carried out on other fusion devices like JET (Culham, UK) and W7-X (Greifswald, Germany) which will bring important feedback and valuable experience into the ITER project.

In conclusion, this three-day meeting provided an important opportunity to overview the ITER divertor procurement, design and R&D and made it possible to have an exchange of views between the ITER IT and the future Parties on various topics and issues. The participants are grateful to Ansaldo Ricerche for its hospitality.

It is proposed to hold the next meeting in about a year at the Efremov Institute in St. Petersburg (Russia).

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FORTY-NINTH REGULAR SESSION OF IAEA GENERAL CONFERENCE AND EIGHTH SCIENTIFIC FORUM

At the IAEA General Conference, 26 – 30 September 2006, Vienna, several delegates' statements contained the mention of the ITER project, as for example the statement made on 27 September by H.E. Mr. R. Schaller, Ambassador of Switzerland in Vienna, or on 28 September by Mr. C. Cleutinx, Director Nuclear Safeguards, European Commission ("….I would like to express the Commission's sincere gratitude to the IAEA for the support that the Agency has provided to the ITER program to date and, in particular, for the instrumental role played by the Agency staff in facilitation a resolution of the ITER site issue. The Commission looks forward to a continuing fruitful relationship among the prospective ITER Parties and the IAEA in the coming phases of co-operation….."), Mr. A. Bugat, Chairman of the French Atomic Energy Commission ("….2005 saw the decision to locate the ITER reactor in Cadarache, France. On June 28, the members of ITER met in Moscow to announce their choice of a site in Europe. We are now faced with a daunting technological and organizational challenge and all of the partners involved in the project are already busy working on the preparations for this initiative, which represents a decisive step on the road to the production of electricity by controlled thermonuclear fusion. As the debate on the selection of the site was still going on, work continued on the preparation of the ITER Joint Implementation Agreement. The Agency supported these discussions and frequently hosted meetings between the Parties and I would like to thank the IAEA for the contribution that it made to getting this vast and ambitious project off the ground…."), and Mr. A. Shichijo, Senior Vice-Minister for Science and Technology Policy of Japan ("…It is also important to consider nuclear energy in the long term. The ITER project, which aims at the energy utilization of nuclear fusion, made firm steps forward this year. Japan became what could be called the sub-host country as an important nuclear fusion energy research center. We are determined to accomplish our role through close cooperation with the other Parties...").

Further, in its Resolution No. 12 (*www.iaea.org/About/Policy/GC/GC49/Resolutions/gc49res12.pdf*) under point A. "Strengthening the Agency's activities related to nuclear science, technology and applications", the Agency refers to the "28 June 2005 ITER Meeting in Moscow announcing the agreement on Cadarache as the site for the ITER facility" as an important milestone.

Parallel to the formal proceedings of the IAEA General Conference, on 27 and 28 September, the Agency held its 8th Scientific Forum on the theme of "Nuclear Science: Physics Helping the World". This theme was chosen to highlight the important role of physics in the development of science and technology and to mark the celebration of the year 2005 as the International Year of Physics. There were four sessions on the following topics: Meeting Energy Needs; Developing Advanced Materials and Technologies; Advancing Radiation Medicine; and Supporting Nuclear Safety.

The Scientific Forum was chaired by Prof. Burton Richter, Director Emeritus at the Stanford Linear Accelerator Centre (SLAC). In his report to the General Conference he said on 29 September (*www.iaea.org/About/Policy/GC/GC49/ScientificForum/index.html*) that "…as far as fusion is concerned, the decision to build ITER at Cadarache is a very positive development. ITER must succeed in demonstrating a burning plasma for fusion energy to become practical. Even if it does, the earliest commercial deployment of fusion is anticipated around 2040 to 2050, setting fusion development into the same timeframe as Generation IV Reactors.”

In Session I of the Forum, Academician E.P. Velikhov (Director, Kurchatov Institute), as a key speaker, gave a presentation (*http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=138*) on ITER under the title “Industrial Production of Fusion Energy will be the Next Step”, focusing on

— Where are we in fusion?
— ITER – the fastest way to burning plasma study
— ITER objectives
— ITER engineering
— Future of world fusion research and power development
— Conclusions

OBITUARY

Dr.Hiroshi Kishimoto, a long time member of ITER technical meetings including negotiations on ITER contruction, suddenly passed away in September 2005 at the age of 63, when he was climbing an almost vertical rock wall near the summit of Mae-Hotaka, one of the highest mountains of Japan.

Dr. Kishimoto graduated from Osaka University in 1964 and worked in an industry laboratory for several years. He was then called back to the university and in 1976, joined the Japan Atomic Energy Research Institute (JAERI) where he played the key role in construction and operation of JT-60. He proved his great ability to manage and encourage people by resolving a number of unexpected problems encountered in the construction and operation of JT-60. JT-60 was modified to a large D-shape tokamak under his direction, and attained many world firsts such as achieving the highest temperature of 520 million degrees, finding the internal transport barrier (ITB), etc. From the very start of his work in JAERI, he had the foresight to put a high priority on long pulse operation of the tokamak with a view to its great benefit in a commercial fusion reactor.

From the start of the ITER EDA, he became involved in the ITER activities. At the end of the original 6-year EDA, he made the proposal that ITER be redesigned at about half the cost, based on experimental results of JT-60, a proposal which ultimately rescued the ITER activities. He continued his efforts to realize the construction of ITER. He was not fully delighted at the site decision because it was not in Japan, but as a scientist, he was satisfied that the decision had been made with all ITER Parties’ agreement. In April 2005, he became the president of the Research Organization for Information Science and Technology (RIST), and he was working actively on his new job when the tragedy happened.

From 1998, Dr. Kishimoto was a member of the Fusion Council of the Japanese Atomic Energy Commission which was succeeded by the Fusion Sub-Committee of JAEC in 2001. In 2000, he was given the Science and Technology Agency (STA) Director General’s award.

Items to be considered for inclusion in the ITER ITA Newsletter should be submitted to C. Basaldella, 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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