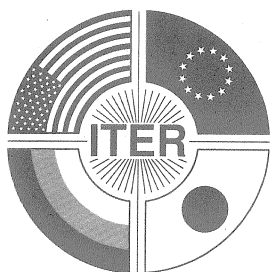


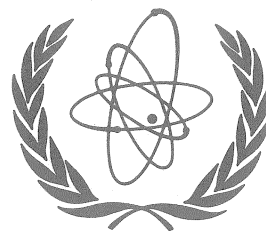
INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR



# ITER EDA NEWSLETTER

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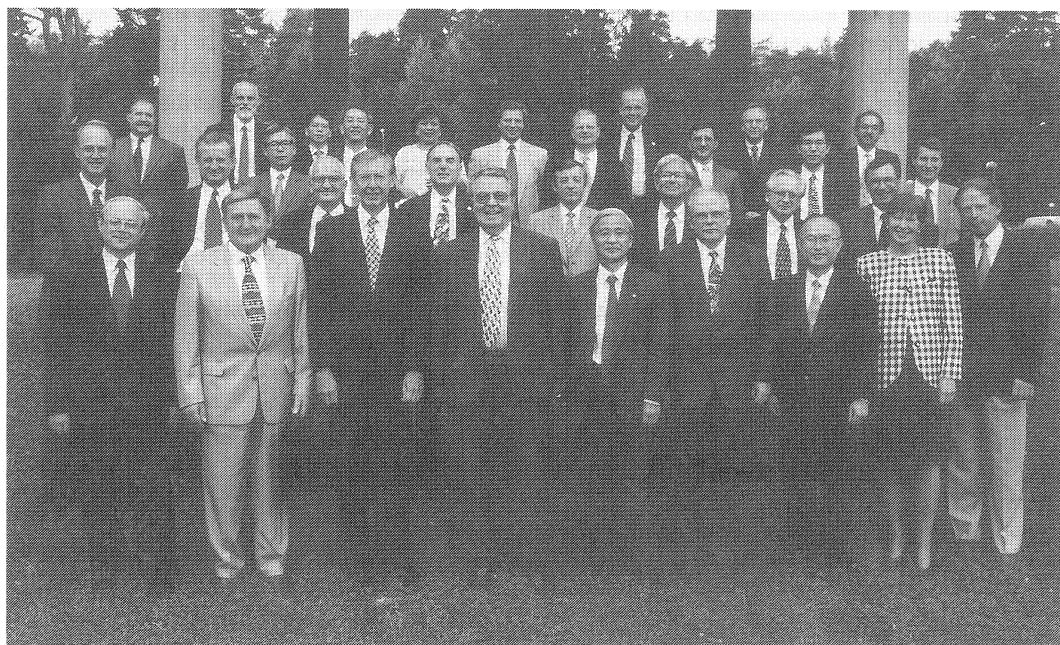
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## TWELFTH MEETING OF THE ITER COUNCIL (IC-12)

by Dr. E. Canobbio, ITER EU Contact Person

The Twelfth Meeting of the Council of the International Thermonuclear Experimental Reactor (ITER) Engineering Design Activities (EDA) was held on July 23 and 24, 1997 in Tampere, Finland. The four delegations that attended the meeting were headed, for the EU, by Prof. Jorma Routti, Director-General for Science, Research and Development of the European Commission, for Japan, by Mr. Naotaka Oki, Deputy Director-General of the Science and Technology Agency, for the Russian Federation, by Academician Evgenij Velikhov, President of the RRC "Kurchatov Institute", and, for the United States, by Dr. James Decker, Deputy Director of Energy Research of the Department of Energy.



*Participants in the Meeting*

The Council received from the Parties positive responses to the Detailed Design Report (DDR) presented by the Director at IC-11. The DDR will be the basis for the continued technical work leading to the Final Design Report in 1998. The Council heard the Parties' statements of their willingness to continue to fulfil their obligations in contributing to the ITER EDA.

The Council endorsed the view of TAC concerning the importance of completing the ITER EDA R&D Programme and of ensuring that the results be properly documented and made available to all Parties, and disseminated widely by the Home Teams among appropriate industrial companies.

The Council took note of the Director's Report on activities and resources beyond 20 July 1998 until a possible start of physical construction and supported conclusions and summary proposals presented in the paper and

commended them to the Parties for their consideration. The Council reaffirmed the importance of maintaining continuity of ITER activities and of enabling a smooth transition to efficient start of possible future construction activities.

The Council also heard a summary of discussions among the Parties' representatives ("Explorations") concerning the ITER cooperation after July 1998, which led to the consensus that in July 1998 the ITER activities should proceed for an additional three years with a general intent to enable an efficient start of possible, future ITER construction.

## **STATUS REPORT OF THE ITER EDA**

**by Dr. R. Aymar, ITER Director**

This article summarizes the Report submitted to IC-12 on the progress made in the ITER Engineering Design Activities during the period between IC-11 (December 1996) and May 1997.

The overall focus of the Project is towards the next major milestone - the presentation of the Final Design Report (FDR) to IC-13 in early 1998. The seven Large R&D projects are also progressing under their joint HT/JCT management arrangements.

A major emphasis of the preparations for the FDR is the set of cost/schedule/manufacturing studies by the Parties' industries based around "procurement packages" for cost estimation. About 70 such packages have been defined and transmitted to the HTs for distribution to suitable industries.

The procurement packages are designed to elicit realistic and authoritative data on costs, industrial capacity and feasible time-scales for incorporation in the FDR. Each package comprises comprehensive information about an ITER component or subsystem which could be the subject of a major procurement contract or series of related contracts. The packages include, as appropriate, functional requirements, detailed designs, specifications, interfaces and other related data that would be needed by potential suppliers in order to prepare for contracts. In some areas the packages provide for the possibility of technically splitting contracts between several suppliers in case more than one Party might wish to participate in a specific area.

The sensitivity studies of variations from ITER Site Design Assumptions recommended by the Special Review Group have all been completed and the results made available to the Parties for review.

### **Design Work**

The three items noted in the DDR Report (IC-11 ROD Attachment 4) as remaining open at conceptual level have now been settled and incorporated in the design reference, namely:

- The Central Solenoid has not been split into modules; instead the desired increase in triangularity will be achieved by splitting the two smallest Poloidal Field (PF) coils each into two. (All PF coils can now be made from NbTi).
- The blanket modules will be attached by mechanical means;
- Ferritic inserts will be placed in the Vacuum Vessel to reduce field ripple.

As requested, Parties have been providing information on the results from their domestic reviews of the DDR. The general reports circulated to date have been supportive. None has proposed material changes to the design although there have been suggestions to broaden its scope, e.g. to increase the capacity for additional heating. As more detailed technical suggestions and remarks become available, they are being taken into account in the design activities and in the proposals for supporting physics study under the voluntary arrangements.

### **Project Documentation**

Plans for the form and content of the FDR have been presented to Home Team Leaders. The general approach will follow that used for the IDR and DDR; there will be:

- a) a synoptic paper suitable for ITER Council to review explicitly;
- b) a larger "technical basis" document which synthesises and assesses supporting technical information and will provide the main source for TAC review;
- c) an "ITER Physics Basis Document" to be reviewed through the physics community;
- d) a number of stand-alone technical documents on specific topics, e.g. NCSR, reports on the seven large R&D projects, handbooks, manuals and standards documents, indexes of task reports, etc.;

- e) a set of Design Description Documents (DDD) covering all the ITER subsystems and components and which contain the detailed information on the design, interfaces, related R&D results (with references to related task reports), analysis results, etc.

While a), b) and c) above will reflect the position at a specific reference date (end-1997), the DDDs and the main stand-alone documents will be "living" documents to be continually updated and revised in the light of ongoing design and analysis and of new R&D results flowing from the continuing programmes. Indeed, the DDDs are envisaged as continuing to be living documents through to the procurement and installation of the systems concerned. The manuals, handbooks and standards documents such as Materials Properties Handbook, Structural Design Criteria, and Remote Handling & Standard Components Manual will be maintained as living documents which will support regulatory review and compliance.

#### Joint Central Team and Support

The status of the JCT is summarised by Joint Work Site and by Party in the Table below. For the first time in the EDA, the number selected matches the number on site. Since the last status report, 9 (1 EU, 3 JA, 1 RF, and 4 US) members left the team, and 13 new members joined (5 EU, 4 JA, and 4 RF). One of the Canadian members assigned through the EU has transferred from San Diego to Naka JWS.

The JCT staffing is now almost at the peak level of 167 assumed in the Work Programme approved by IC-11 and expected to remain in place through July 1998. If staff numbers remain unchanged, total PPY for the six-year period to July 1998 will reach between 715 and 720.

JCT - Status by Joint Work Site and by Party at 21 May 1997

	Garching	Naka	San Diego	EC	JA	RF	Total
Selected	52 <sup>1</sup>	59 <sup>1</sup>	55 <sup>1</sup>	54 <sup>1</sup>	47	28 <sup>2</sup>	166 <sup>1,2</sup>
On Site	52 <sup>1</sup>	59 <sup>1</sup>	55 <sup>1</sup>	54 <sup>1</sup>	47	28 <sup>2</sup>	166 <sup>1,2</sup>
Seconded	50	57	50	48	47	28 <sup>2</sup>	157

<sup>1</sup> includes five Canadians provided through the Canadian association with the EC Party.

<sup>2</sup> in addition, 13 RF professionals have worked at the Joint Work Sites under special VHTP arrangements.

As noted in the Work Programme approved by IC-11, the performance of the Work Programme also depends on maintaining the Home Team design resources and the CAD, technical and secretarial support at the levels now reached for the period to July 1998 at least.

#### Visiting Home Team Personnel (VHTP) Scheme

Operation of the VHTP scheme was outlined in the Status Report to IC-10. The scheme continues to function well as a means to enhance JCT/Home Team interaction and to offer some flexibility. Following the offer made by the RF Party, thirteen new RF VHTPs have been or are on assignments at the Joint Work Sites of about two to four months each; further assignments are planned for the remainder of 1997.

#### RF Design Support Contracts

Following approval at IC-11 of the extended budget for RF Design Support Contracts, the RF Design Centre and JCT have drawn up a series of proposals for design support work during 1997, valuing, in total, about \$500,000. Following the established management procedures, the initial stages of these contracts have been released and work is progressing satisfactorily. The electronic transfer of drawings between the JCT and Design Centre institutes and exchange between AutoCAD and CATIA formats is well established and working routinely. Further stage releases in 1997 will be authorized subject to the acceptance of the earlier stage reports and the availability of funds.

#### Task Assignments

The updated task status is summarized in the tables below. The total R&D resources and design task PPYs now expected in the period to July 1998 at present stand at 583kIUA and 715PPY respectively. These figures include some tasks which have been assigned and committed but which may not be completed because of budgetary constraints.

From a total of about 750, some 400 tasks, including both design and technology R&D, have been completed and the final reports have been submitted by the HTs. Total values of task allocations to date, including the VHTP tasks, are as shown on the next page.

Type	IUA	PPY
TA Work Completed	144,080	291.65
L7 Tasks	315,700	
Other Tasks Committed/Ongoing	122,688	415.32
Tasks Newly Reported	400	8.50
<b>Totals</b>	<b>582,868</b>	<b>715.47</b>

The pattern of assignment to Parties is summarized below:

Party	IUA	PPY
EC	192,706	201.45
JA	171,577	170.93
RF	93,042	157.95
US	125,543	185.14
<b>Totals</b>	<b>582,868</b>	<b>715.47</b>

### ITER Physics

During the first half of 1997, considerable attention was focused on ITER physics issues by the extensive reviews of the Detailed Design Report by the four ITER Parties. In fact, the *1997 Priorities for ITER Physics Research* had anticipated many of the physics issues raised in the reviews and plans were proceeding to address them in the four Parties' physics research programs. As noted above, the proposed insertion of ferromagnetic inserts into the vacuum vessel for the purpose of reducing field ripple has been incorporated into the reference ITER design. One review proposed that ITER should have the capacity to upgrade auxiliary heating power up to 200 MW, should this prove to be required to operate ITER in H-mode. Continued physics studies to increase the definitiveness of physics design requirements and to reduce uncertainties in ITER performance projections are being planned and carried out through the ITER Physics Expert Groups.

ITER Expert Groups play a key role in formulating experimental plans to address outstanding physics issues and a framework in which to establish commonality of physics across several devices - an essential step for reducing uncertainties in projections. The principal goal of the remainder of 1997 is to provide agreed inputs to the *ITER Physics Basis* and the associated sections in the FDR and Plasma DDDs. Where the Heads of the Parties' fusion laboratories have given a constructive response to requests for input on the main issues, the physics programmes are generating results oriented towards ITER's priority needs.

ITER Physics Group Meetings continue to serve as a key channel to convey ITER physics issues to the Parties' physics research programmes, to provide the JCT with recent research results, and to coordinate research among various tokamak facilities.

## SIXTH ALL-RUSSIAN CONFERENCE ON ENGINEERING PROBLEMS OF THERMONUCLEAR REACTORS

by Dr. O.G. Filatov, EPTR-6 Programme Committee Chairman, Efremov Institute

The Sixth All-Russian Conference on Engineering Problems of Thermonuclear Reactors (EPTR-6) was held in Saint Petersburg from 27-29 May, 1997. The Conference was organized by the D.V. Efremov Research Scientific Institute of Electrophysical Apparatus (NIIEFA) and supported by the RF Ministry of Atomic Energy. The Organizing Committee was headed by the NIIEFA Director Academician V.A. Glukhikh.

About 150 specialists from 40 institutions (scientific research institutes, design departments, universities, firms) including 11 scientists from 4 foreign countries and 3 representatives of the ITER Joint Central Team participated in the work of the Conference. About 150 reports were presented covering the main engineering problems of controlled fusion. The presentations were arranged into the following nine sections:

- Concepts of reactors and thermonuclear facilities;
- First wall, divertor, vacuum vessel;
- Auxiliary plasma heating systems;
- Magnet systems;
- Power supply and protection systems;



- Control and diagnostics systems;
- Fuel and tritium cycles, exhaust gas pumping;
- Blanket, shielding, energy conversion systems;
- Safety, environment, waste management.

A brief summary of the sections' work is given as follows:

#### **Concepts of reactors and thermonuclear devices**

Within the frame of this section twelve reports were presented including the ITER Project review (V.A. Chuyanov), the R&D status in RF in its support (O.G. Filatov), the concept of the Russian reactor DEMO (Yu.A. Sokolov), the review of the project of the new tokamak with superconducting magnetic field coils HT-7U now underway in China, new proposals on tokamaks with small aspect ratio (JUST-2, Selena). It should be noted that steady interest is shown in the neutron sources based on different concepts (tokamaks with average and small aspect ratios and a mesocatalytic source in a magnetic trap with strong field). The role and application of these sources were analyzed in detail in the report presented by M. Abdou (UCLA, US).

The review of R&D now underway in RF, within the framework of ITER, has shown that the RF activities are concentrated on four of the seven ITER Large Projects. These activities are the following:

- development of the TF conductor insert coil for the central solenoid;
- development and manufacture of VV equatorial port extension;
- development and manufacture of small-scale models of the first wall and shielding blanket;
- manufacture of liners for the divertor model cassette.

Apart from these main activities, the Russian Federation takes part in development of other ITER components - gyrotrons, plasma neutralizer for neutral injector, switching equipment, power supply system, etc.

Among alternative projects interest was raised by new concepts of the plasma trap with the spatial axis and straight portions and the Galatay traps, where magnetic fields are used as a "crust" confining the plasma.

#### **First wall, divertor, vacuum vessel**

Much attention was given to the problems associated with the development and production of ITER plasma-facing structural materials and components (PFC). In a number of reports the manufacturing technology of the joints Cu/CuCrZr, BeCu, Cu/SS, CuW and Cu/Be, as well as the results of their thermal, thermocyclic and radiation tests were presented. Further, the specific experimental installation was reported. It was developed and manufactured at the NIIEFA specially for manufacture and testing of high-heat flux components of a fusion reactor, including elements of the ITER divertor cassette liner now being manufactured in Russia. The problems relating to radiation resistance of beryllium coatings and the technique of their recovery directly in the reactor were also discussed. In addition, the thermal shield and cooling of the vacuum vessel with special porous coatings, and the use of liquid metals for plasma-facing elements were described. Interest was raised by the reports, in which the analysis was made of the effect of energy loads, emerging under plasma current disruptions, on the divertor and first wall elements.

#### **Methods of auxiliary plasma heating**

The reports devoted to the development of powerful gyrotrons intended for electron-cyclotron resonance plasma heating were presented, including the promising developments for auxiliary high-frequency heating in ITER. The problems relating to the development of the components of Neutral Beam Injection (NBI) auxiliary heating system were also discussed. A report was presented on the development of the plasma neutralizer of negative ions now under development in Russia. Other methods of auxiliary heating were reported, i.e. ion-cyclotron resonance heating, low-hybrid wave, ion Bernstein wave and fast magnetoacoustic wave heating.

#### **Magnet systems**

One of the most prolific was the section "Magnet systems". The report was presented on the design of the Toroidal Field (TF) conductor insert coil now under development at the NIIEFA. The insert coil is made as a single-layered solenoid with the full-scale TF coil conductor. TFCI will be tested in the 13 T outer field produced by the Central Solenoid (CS) model coil manufactured jointly by the USA and Japan. Thereby, the conductor will be tested under conditions approximating as much as possible the conditions assumed in ITER. In addition, in this section a number of reports were devoted to the results from numerical simulation of time-spatial characteristics of electric and magnetic fields produced by the poloidal system of the TEXTOR facility and to the development of the TF and Poloidal Field (PF) systems of the Chinese tokamak HT-7U. Problems relating to the calculation of energy losses in superconductor and the methods of their minimization, the diagnostics of the superconductor state, their insulation and strength characteristics were

considered in some reports. The results from testing of the Globus-M central solenoid, the projects of superconducting switches intended for switching of storage devices and for protection of various superconducting systems were also reported.

#### **Power supply and protection systems**

All reports presented in this section were devoted to the development of the ITER power supply system. On behalf of the ITER Joint Central Team and Home Teams a report was made on the status of the power supply system for superconducting coils of the magnet system (consumed power - 650 MW, a.c.-d.c conversion system power - 2.9 GVA). Results were also presented on the development of special switching and other electrotechnical equipment for the ITER power supply system (commutation equipment, protective make switch, protective breakers, special protection resistors, valves).

#### **Fuel and tritium cycles, exhaust gas pumping**

In this section main attention was paid to the problems relating to the development of fusion reactor cryosorption pumps and the systems of fuel pellet injection into the reactor vessel. The results were reported on investigation into the effect, tritium has on the operation of these systems, their parameters and characteristics.

#### **Blanket, shielding, energy conversion systems**

In this section the problems relating mainly to ITER were discussed, such as the development and production of promising materials for the ITER blanket, the problems associated with the design of particular blanket units such as a demountable joint of blanket module coolant pipeline and the methods for blanket fastening to the back side of the reactor. An unconventional technique for blanket drainage and drying was proposed. Interest was raised also by the reports presenting the design version of the Russian DEMO reactor blanket based on the use of lithium-content ceramics as a tritium breeding material, with helium coolant, as well as other reports devoted to the use of liquid metals as coolants for fusion reactors.

#### **Safety, environment, waste management**

A number of reports in this section were devoted to the creation of the database on safety and selection of the safety criteria for ITER. The reports concerned mainly the elaboration and substantiation of the norms for limiting magnetic field induction, the content of oxygen and ozone in air. The report regarding seismic action on the entire reactor and on its separate components was also presented. Further, the problems relating to elaboration of the strategy for management of tritium- and beryllium-content wastes were discussed.

During the Conference an open discussion aimed at considering the ITER Detailed Design Report took place. The Report was appraised as positive, but the discussion went beyond the scope of the announced subject matter. Problems referred to were the degree of Russian participation in ITER, the future of controlled fusion in the country on the whole. The common opinion was that despite certain financial difficulties the activities on ITER must not, under any circumstances, be terminated.

Furthermore, the participants in the discussion appreciated the concentration of funds on the technological developments Russia is responsible for under the ITER project. Moreover, the proper choice of the directions of these developments was appreciated. It was emphasized that participation of Russia in the ITER Project does not only enable many scientific teams to continue their activities effectively, but also to develop technologies that can be used in other fields.

Items to be considered for inclusion in the ITER Newsletter should be submitted to B. Kouvcinikov, ITER Office, IAEA, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: +43 1 237762, or e-mail: basaldel@rip01.iaea.or.at (phone +43 1 206026392).

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