INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR

ITER EDA NEWSLETTER

VOL. 9, No. 11 NOVEMBER 2000

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA

ISSN 1024-5642

THIRD ITER INTERNATIONAL INDUSTRY LIAISON MEETING

by Dr. D. Dautovich, Managing Director, ITER Canada

Following previous meetings held in 1996 in San Diego and in 1997 in Tokyo, the Third ITER International Industry Liaison Meeting (IILM) meeting was held under European Chairmanship in Toronto, Canada, on 7 - 9 November 2000, with meeting arrangements and facilities provided by ITER Canada (Canada participates in ITER EDA through the EU). Such meetings are intended to provide a forum for industrialists of the ITER EDA Parties and other interested countries to develop common understandings on important issues such as how and when Industry would be involved, and how industry may help to promote and execute the project.

The ITER project has made significant progress since the Tokyo meeting. The ITER Joint Central Team has developed a reduced cost design for ITER that meets the overall programmatic objective to provide all the necessary answers to technical issues and allow a demonstration fusion power plant to be built. During 2000, non-committal Explorations between the Parties have been carried out to prepare for Negotiations towards the realization of the joint implementation of ITER among interested parties. Canada, Europe and Japan each are known to be interested in the possibility of hosting ITER. The Joint Central Team has issued procurement documents for the main ITER systems to the Parties to enable the industrial costing of the reduced cost ITER, and to help the Parties to consider their possible contributions. This excellent progress on ITER design and decision making prompted industrialists of the Parties to convene the 3rd IILM.

Participants in the Meeting

Industry participants from Europe, Japan and the Russian Federation attended the meeting. Participants from Canada and the US were also invited to attend. The participants represented the world's leading companies in systems engineering and supply of high technology. Invited guests included representatives of the respective fusion programs of the current ITER-EDA Parties and the ITER Director. Their role was to provide an update of the status in each of the Parties and current progress.

The participants confirmed the following main topics for the meeting as a focus for industry to provide its advice to the ITER Parties:

- Preconstruction phase including site selection, site-specific design, licensing and safety analysis, construction agreement;

- Construction phase including project structure and organization and industrial involvement within the project structure;

- Cost/benefit sharing schemes including work sharing and intellectual property rights.

The participants took advantage of the proximity of the Clarington site to visit the site including the tritium plant. They found the tour to be very informative and useful. They also commented on the strong support in the surrounding communities for ITER.

Immediately following the site visit, the delegation leaders were joined by elected community officials in a meeting with representatives from local print media and TV. This resulted in positive statements from the media, which in the past have generally been supportive of the possibility of hosting ITER at Clarington.

Industry's Concluding Views

1. Preconstruction Phase

During the preconstruction phase a key event is the choice of the site since it is on the critical path. For the efficiency of the project, the choice of a preferred site, subject to final agreement to terms, should be made as soon as possible and certainly well before the end of 2002, to allow site specific design, licensing, final costs and cost sharing to be established and a final agreement to be negotiated. During the period before site selection, site specific activities should be limited to those necessary to select the site.

2. Construction Phase

The ITER Legal Entity should be established as the owner, licensee and operator of the ITER facility. The ILE would have overall responsibility for the design, licensing, construction, operation, deactivation and financial provisions for decommissioning.

The ITER Legal Entity should have overall responsibility for the project including the following items:

- Achieving overall project objectives
- Project engineering
- Project management
- Procurement package technical specification
- Safety objectives and licensing
- Quality assurance
- Contract management
- Cost and schedule
- Technology transfer and intellectual property rights
- Public relations

Appropriate functions may be delegated to industry.

The participants concurred in the concern that construction of ITER will require many skills not now present in the JCT. The project will be international in scope, will be of truly large and complex scale and will

require assembly of the missing skills in a timely manner. The additional skills required include, but are not limited to, large-scale project management and integration, procurement, and quality assurance.

Many of the skills are well represented in industry. The participants agreed that these skills must be brought into the ITER project structure, but had different views on the preferred method. Two were suggested; the first could be by contract(s) to an experienced company or international consortium of experienced companies to provide project management and coordination of all elements of the construction project, and the second by assignment of personnel from industry to the ILE. Some rules would also be needed to supervise and coordinate the contributions of the Parties.

It is anticipated that essentially all components will be procured from industry. As the first option, the participants felt that it was important to minimize 'built-to-print' contracts in order to intellectually engage the best people in industry in the design and manufacture of components and subsystems. As the second option, they confirmed that high technology, novel or first of a kind components would be ordered by the ILE under 'built-to-print' specifications while conventional components would be ordered with engineering included in the industrial contract.

3. Cost/benefit sharing schemes

The participants agreed with the well understood and agreed upon set of principles adopted by the Explorers and in force during the EDA. Central to this is the principle that for technical information developed under ITER, credit should be held by the Joint Central Team (and later by the ITER Legal Entity) and made available to all Parties for fusion energy applications. In addition, technical information developed for ITER but not supported by ITER credit, e.g., that termed "business confidential information" in the EDA, should be subject to the usual protection provided to intellectual property.

The participants commented on the excellent organization and meeting arrangements provided by ITER Canada and expressed their appreciation for this effort.

The participants have manifested their wish to convene a fourth meeting when sufficient progress has been achieved in the planned negotiation phase, likely in the second half of 2001.

LIST OF ATTENDEES

EU

Industry

Mr Alain Vallée, (Meeting Chairman) Point of Contact, Vice President Corporate Research, Framatome, France
Mr Marcel Gaube, General Manager, Belgatom Nuclear Engineering and Consulting Services, Belgium
Mr Alfredo Heinen, Director of Fusion Technology, Ansaldo Ricerche, Italy
Mr Bogdan Bielak, (Organization Committee), Research and Technology Division, Framatome, France

Other

Mr Jean-Pierre Rager, European Commission, Representing the EU Fusion Programme Directorate
Mr Roberto Andreani, Associate Leader for Technology, EFDA, Garching
Mr Harry Tuinder, European Commission, Representing the EU Fusion Programme Directorate
Mr Gerald Newi, Consulectra, Hamburg, Germany
Mr David Maisonnier, EFDA, Garching

JA

Industry

Mr S. Mochizuki, Assistant to Division Manager, Nuclear Systems Tokyo Division, Power and Industrial Systems, Hitachi Ltd, Japan
Mr A. Ozaki, Deputy Senior Manager, Energy Systems Group, Nuclear Fusion Development Department, Toshiba Corporation, Japan
Mr T. Sasaki, Project Manager, Engineering Department, Mitsubishi Fusion Centre, Mitsubishi Electric Corporation, Japan

Other
Mr Y. Hirotani, Point of Contact, General Manager, Department of Project Planning and Promotion, JapanAtomic Energy Industrial Forum, Japan Industrial Forum, Inc., Japan
Mr M. Nagami, Deputy Home Team Leader, JAERI, Japan
Mr K. Kurihara, JAERI, Japan

RF

Industry
Mr Eduard. K. Kolpishon, Head of Department, SC "Izhorskie Zavody", St. Petersburg, Russia
Mr Alexander N. Ogurtsev, Head of Department, AS "Chepetski Metallurgicheskii Zavod", Glasov, Russia
Mr Yury L. Yarovinsky, Deputy Director of Division, Rocket-Space Corporation, "ENERGIA" by S. P. Korolev, Moscow Region, Russia

Other
Mr Lev G. Golubchikov, Point of Contact, Director of Fusion Division, Minatom of Russia

Canada

Industry
Mr C. Andognigni, Ontario Power Generation, Toronto, Canada
Mr B. Murdoch, Canadian Nuclear Utilities Service, Oakville, Canada
Mr S. Smith, Wardrop Engineering Inc., Mississauga, Canada

Other
Mr P. Barnard, ITER Canada, Toronto
Mr D. Dautovich, ITER Canada, Toronto
Mr M. Stewart, ITER Canada, Toronto

USA

Industry
Mr W. R. Ellis, Raytheon, New York, U.S.A.
Mr D.E. Baldwin, General Atomics, San Diego, U.S.A.
Mr S. O. Dean, Fusion Power Associates, Gaithersburg, U.S.A.
Mr C. Hamilton, General Atomics, San Diego, U.S.A.

ITER JCT

Mr R. Aymar, ITER Director

INFORMAL MEETING ON ITER DEVELOPMENTS

by Dr. E. Canobbio, IFRC Chairman

Responding to the wide interest in the ITER developments by the world fusion community, the International Fusion Research Council (IFRC), advisory body of the IAEA, organized an informal meeting on the General Status and Outlook for ITER. The Meeting was held, under IFRC and IAEA auspices, on 9 October, at Sorrento, Italy, in conjunction with the 18th IAEA Fusion Energy Conference. Almost all IFRC members and more than 100 Conference participants were present.

In his introductory remarks, the IFRC Chairman said he was gratified to see the breadth of interest represented in the meeting, in particular, members of scientific communities from countries not currently involved in ITER. He encouraged those interested in pursuing possible participation in ITER in the future to make their interests known to their governments.

Following this introduction, three well-known scientists, one from each of the present ITER Parties, presented their personal views on the issues related to the ITER General Status and Outlook. The following is a compressed version of their presentations.

Speaking on the ITER General Status, **Professor V. Smirnov (Russian Federation)** gave a brief history of the ITER Engineering Design Activities (EDA), specifically referring to Article 2 (e) of the EDA Agreement. This Article indicates what Activities the ITER Parties shall conduct jointly during the EDA. Among those

Activities, as contained in Point (e) of the Article, is "to develop proposals on approaches to Joint Implementation for decisions by Parties on future construction, operation, exploitation and decommissioning of ITER."

For that purpose, a Special Working Group (SWG-P2) was established by the ITER Council (IC) in 1999 under Protocol 2 to the EDA Agreement. After four Meetings, the SWG-P2 confirmed:

- A shared single vision of the ITER goal and of the means to realize it;
- recognition of the technical and social impact of ITER for the realization of fusion energy;
- the common desire to promote construction of ITER through international co-operation;

The Group also stated in its report to the IC that the time is now ripe for initiating international efforts with governmental involvement with the aim to establish a firm international legal framework for Joint Implementation of the ITER Project.

Referring to the Activities in Russia related to the ITER EDA, Prof. Smirnov said that a domestic review of the ITER Status and Outlook had been carried out. The issues were discussed in depth in the Scientific Councils of the five leading fusion institutions; at a Special Meeting of the Russian Academy of Sciences; in the Committee for Science of the Russian Parliament (Duma); and in the Collegia (Ministry Board) of Minatom.

The ITER Project was supported at all these meetings. This support was based on the general understanding that this Project is the optimal way to realize fusion as a source of energy. Subsequently, the Russian Government took the decision to send a Russian Delegation to the "Explorations", which are pre-negotiation (exploratory) discussions among the current ITER Parties interested in preparing for possible Negotiations.

In accordance with the invitation by the Russian Minister for Atomic Energy, E. Adamov, the first Explorers' Meeting (EX-1) was held on 13-14 April 2000 in Moscow, with participation of Explorers from the European Union, Japan and the Russian Federation.

In the Explorers' discussions, high priority is laid on the legal framework, cost/benefit sharing scheme, and preparatory joint technical activity, and the international framework after 2001.

The Explorers' Interim Report was adopted at EX-2 in June in Moscow. The Final Report will be ready by the end of 2000.

The Reference Schedule towards Joint Implementation, according to Prof. Smirnov, is as follows:

- End of Explorations - December 2000
- Start of Negotiations - March 2001
- End of EDA and start of the Co-ordinated Technical Activities (CTA) - July 2001
- Site Proposal - during 2001
- End of CTA - 2002
- Signing of the Agreement of Construction, Operation, Exploitation and Decommissioning Activities - beginning of 2003

In concluding his presentation, Prof. Smirnov emphasized that

> "The importance of fusion as a power source and its physical and technical basis have been discussed in the excellent presentations of Prof. Rubbia, Acad. Velikhov and Dr. Aymar. Many papers at this IAEA Conference confirm the high probability of an ITER-FEAT success."
>
> "Nevertheless, it is important to emphasize once more the urgent necessity for the fusion community to prove 50 years of research with real results."
>
> "Today, ITER is the only option to satisfy this challenge. Any other choice would mean some more decades' delay in reaching the goals of the fusion community."

"For the Russian fusion activities, stopping the ITER Project implementation would shortly lead to a drastic decay. It seems quite likely that more or less the same would occur in any of the other national fusion programs. At least, the scope of fusion research would be strongly reduced."

Finally, he stated that now the most critical point is to receive a site proposal with governmental support.

The next speaker at the meeting was **Professor C. Varandas (European Union)**. His chosen topic was "From now to Joint Implementation", and he concentrated on the Co-ordinated Technical Activities (CTA), which are deemed necessary to prepare for ITER Joint Implementation. Such activities will build on the results of the EDA and be conducted by participants, considering the specific conditions of the offered construction site(s) and under the auspices of the IAEA. The term "Participants" here means Parties that have been involved in the ITER Engineering Design Activities (EDA) and wish to participate in the CTA as well as qualified third countries that have presented to the negotiating parties a specific construction site offer with governmental endorsement.

The scope of the CTA, whilst assuring the coherence of the ITER project, will include:

- Design adaptation to the specific site(s) conditions
- Safety analysis and licensing preparation based on specific site offer(s)
- Evaluation of cost and construction schedule
- Preparation of procurement documents
- Other technical issues raised by the Negotiators collectively.

The organizational structure for the CTA will consist of:

- Project Board (PB) set up with with executive functions to guide and to co-ordinate the Participants' contributions to the CTA. The Board will consist of a Senior Scientist from a 'non-hosting' Participant, as Chair of the PB; the Leader of the International Team and the Leaders of each Participating Team.
- International Team (IT), to which each Party will contribute staff and which will use the current Garching and Naka Work Sites.
- Participants' Teams (PT) will be established in order to undertake activities described above as entrusted to it by the PB. The Team of the Participant(s) offering a specific construction site will play a leading role in developing details of the design adaptation and conducting licensing preparation for its specific site.

Each Participant will bear the costs related to its contribution to the CTA, within its budgetary appropriations. The Participants hosting IT work sites shall make their best efforts to provide to the IT the necessary support and facilities.

Interested third countries which possess relevant specific capabilities and which can contribute significantly to the ITER Joint Implementation may join in the CTA under terms to be unanimously approved by the Participants.

The CTA will be initiated after the start of Negotiations and following the receipt of site offers with governmental endorsement and terminated by the end of 2002.

The last speaker at the Meeting was **Dr. H. Kishimoto (Japan)**. He expressed his views on the ITER Joint Implementation. Considering that the term "Implementation" includes Construction, Operation, Exploitation and Decommissioning Activities (COEDA), the issues to be negotiated by the participating Parties and to be incorporated in the ITER Joint Implementation Agreement are:

- Opening Provisions (Parties, purpose and scope, Device)
- Institutional Structure
- Legal Personality, Establishment and Management, Structure of Legal Entity
- Cost/Benefits Sharing Schemes
- Budget and Accounts

- Staffing
- Procurement Schemes
- Information and Intellectual Property
- Site Support Arrangement
- Privileges and Immunities
- Applicable Laws and Regulations of the Host Country
- Decommissioning Scheme
- Liability
- Participation and Accession of Third Countries
- Closing Provisions (Territorial Application with regard to Euratom, Entry into Force, Amendments, Consultations, Duration and Withdrawal).

Following the initial investigations in the SWG-P2, the ITER Explorations (Informal Governmental Consultations) are now in progress among the current ITER Parties. The Governmental Negotiations will be initiated at the beginning of 2001 and the formal signing of the Agreement is expected at the beginning of 2003.

The purpose of the Project is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. The Parties are expected to be the current EDA Parties and qualified Third Countries. Qualified Third Countries could join the COEDA by unanimous agreement of the ITER Parties. An "Associate Membership" could also be considered for lesser conditions and status in the collaboration and participation of a "Consortium" might be accepted.

Two options are now considered for the COEDA Institutional Structure: A Legal Entity established by International Law and a Legal Entity established by Domestic Law.

As it is expected now, the Management Structure during the COEDA will consist of the Council and the Director General. The Council (Project Board), composed of Parties' representatives, will be responsible for the promotion and overall direction of the activities. It will supervise the overall execution of the Project. The Director General, as an executive officer and representative of the Legal Entity, will execute the activities in compliance with the direction of the Council and be responsible to it for the execution of the Project.

The approach to the sharing of the Project costs among the Parties will be as follows:

Each Party shall make a significant contribution to the total cost of the Project in each phase of the COEDA. The cost for construction will be divided into two areas: a common area and a non-common area. The cost of the common area will be shared among the Parties in a way which is as balanced as possible. The non-common area will include the cost of the following parts of the Project:

- Non-transportable items,
- Items where the provider needs specific experience and detailed knowledge of the site conditions and the national and local regulations and standards,
- Labour-intensive work, e.g. assembling of the Tokamak, to be carried out on site,
- Items where a high percentage of low-tech work has to be provided on site, thus discouraging or preventing firms from non-host countries from participating.

It is expected that the non-common area will comprise up to 15-25 % of the total direct capital cost.

The Host Party will bear the cost for the non-common area and its part in the shared common area. In addition, site preparations will be undertaken, in principle, by the Host Party at its cost. The annual cost during the operation phase will be shared among the Parties, in principle, in a way as compatible with the sharing of the construction cost as possible.

The procurement of the ITER components/systems should primarily be focused on technical performance, quality, schedule of delivery and cost. Components/systems could be procured, according to each Party's preference, either as contribution in-kind or, by fund. However, some parts of a Party's contribution should be provided in funds.

All information generated in the execution of the COEDA will be available to each of the Parties. When protectable subject matter is created by the ITER Legal Entity (ILE) personnel, the ILE could obtain all rights, title and interest to intellectual property in any country, or in some countries upon Council decision. In all cases, where intellectual property is obtained by a Party's personnel seconded to the ILE, that Party ensures that the ILE can freely use the protected subject matter.

The possible privileges and immunities during the COEDA are very important for the effective execution of the Project. Therefore, such issues as facilitation of the movement of personnel, import and export of materials, equipment and other goods, transfer of currencies, etc. are under discussion.

At the end of his presentation, Dr. Kishimoto emphasized that success in fusion is critically dependent on ITER and, therefore, world wide efforts should be focused on this Project.

THIRTEENTH MEETING OF THE ITER PHYSICS EXPERT GROUP ON DIAGNOSTICS

by Dr. A. E. Costley, ITER JCT, and Dr. A. J. H. Donné, FOM Institute for Plasma Physics 'Rijnhuizen'.

The Thirteenth Meeting of the ITER Physics Expert Group on Diagnostics was held in Naka, Japan, on 21 and 22 September. The meeting immediately followed a Workshop on 'Diagnostics for Burning Plasma Experiments' organized under the IEA Three Large Tokamaks arrangements, held at Naka on 18 - 21 September. This article covers ITER-related issues discussed at both meetings.

The main objectives of the IEA workshop were to consider the diagnostic needs of burning plasma devices, to review recent relevant diagnostic developments, and to identify areas where further developments are necessary. The topics included measurement requirements and diagnostic choices for burning plasma experiments, relevant experience on existing machines, radiation effects on key diagnostic components, diagnostic engineering, and developments of specific diagnostic techniques. About 40 specialists attended from eight countries.

The main objectives of the Expert Group meeting were to review and update the requirements for measurements on ITER-FEAT in the light of the discussions at the IEA workshop, to review the progress and plans in meeting the goals of the "Voluntary R&D" tasks within the ITER Parties, as approved by the ITER Physics Committee, and to agree on future actions. Recent progress in relevant diagnostic developments in the Parties was also reviewed.

Participants in the Meeting

The principal conclusions of the meetings are as follows:

- The measurement requirements have been reviewed and a limited number have been changed: in particular, measurements of q(r) and the vertical speed of the current centroid have been updated.

- The plasma and first wall parameters that have to be measured in order to support the different planned operating scenarios of ITER-FEAT have been determined. The next step in this work is to determine the detailed requirements (parameter ranges, resolutions and accuracies) for each scenario.

- The trend at present devices towards simultaneous control of multiple plasma parameters is important and should be carefully followed in the future to ensure that the diagnostics being prepared for ITER-FEAT will meet the developing measurement needs.

- The use and reliability survey of diagnostics has been extended and an international database established. The first analysis of data shows that this will be a very useful aid in the choice and design of diagnostic systems for new devices and in efforts to improve existing systems. Information on more diagnostics and more machines is being sought.

- Work on radiation effects is steadily progressing. The variable results observed in an experiment in which prototype magnetic coils were irradiated in a test reactor are not yet understood. The results could be due to RIEMF (radiation induced electromotive force) occurring in the MI cables used in the coils, but the magnitude and reactor power dependence of the results are not consistent with measurements made independently on straight cables. There are indications that the origin of the variable results could be due to other sources of voltages, e.g. thermoelectric effects, occurring in the experiment, or to integrator drift due to pick-up. Further experiments are planned in which more detailed measurements will be made.

- Work on diagnostic first mirrors has been continued. It is believed that solutions now exist for situations where the dominant potentially damaging mechanism is erosion due to the charge exchange flux of energetic neutrals. This is likely to be the case for many mirrors mounted in the equatorial and the upper ports. In other locations, and especially for mirrors mounted in the divertor region, it is expected that deposition is likely to be the dominant potentially damaging mechanism. Only limited information is available for this case. Relevant experiments need to be carried out and models of the deposition developed. A proposal for investigations in this area has been prepared by the First Mirror Specialist Working Group.

- The magnetics system for ITER has been reviewed. A new back-up set of steady-state magnetic probes mounted inside the double structure of the vacuum vessel has been proposed. The probe designs and the related requirements (insulator, conductivity, inductance, etc.) are not yet complete.

- Good progress was reported on many action items and voluntary physics tasks. Many new action items and follow-up activities have been defined. Some new diagnostic techniques have been proposed to access some of the plasma parameters where there are presently measurement difficulties. Also, good progress was made on several ITER relevant diagnostic developments in the ITER partner countries.

- Considerable progress has been made in the measurement of confined alpha particles and fast ions. Fast alphas have been measured in JET by observation of the alpha knock-on neutrons using Neutron Emission Spectroscopy. Furthermore, it was reported that the fast-ion collective Thomson scattering system at TEXTOR-94 has become fully operational and can be used to make routine measurements of fast ions generated by IC heating or NB injection. The signal/noise is high and the time resolution in the measurement is ~ 2 ms.

- The Specialist Working Groups reported progress in their specific fields (Neutron Diagnostics, Thomson Scattering, Reflectometry, and Diagnostic First Mirrors) since the previous meeting.

- A paper on the measurement requirements and diagnostic designs for ITER-FEAT has been presented at the 18th IAEA Fusion Energy Conference, Sorrento, October, and will be published in the proceedings. A paper on the diagnostics designs has been presented at the 13th Topical Conference on High-Temperature Plasma Diagnostics, Tucson, June, and will be published in Rev. Sci. Instrum, January 2001.

- It is proposed to hold the 14th Meeting of the ITER Physics Expert Group on Diagnostics in March 2001 in Jülich, Germany. This meeting will follow a progress meeting on ITER credited design and R&D work, and ITER relevant diagnostic work ongoing in the EU. A decision when and where a subsequent meeting of the EG will take place will be postponed until it is clear under what format and framework the EG's are going to be continued.

All the participants agreed that both meetings were highly productive and sound plans were made for making progress with the key issues in ITER diagnostics. The organization of the meetings was excellent and we thank JAERI for its hospitality and for providing excellent facilities. We are especially indebted to Dr. T. Sugie and his supporting staff for their care and attention to the details of all aspects of the organization, which went a long way to ensuring the success of the meetings.

ATTENDEES AT 13TH ITER PHYSICS EXPERT GROUP MEETING ON DIAGNOSTICS

Members of the Expert Group

Alan Costley (Naka JWS, ITER)
Tony Donné (FOM, Netherlands, EU)
Anatolij Kislyakov (Ioffe, RF)
Anatolij Krasilnikov (TRINITI, RF)
Yoshinori Kusama (JAERI, JA)
Francesco Orsitto (EFDA JET-CSU, EU)
Vyacheslav Strelkov (Kurchatov, RF)
Tatsuo Sugie (JAERI, JA)
Hideki Zushi (Kyushu University, JA)

Guests and Attendees

Henrik Bindslev (FOM, Netherlands, EU)
Katsuyuki Ebisawa (Naka JWS, ITER)
Ruggero Giannella (CEA, France, EU)
Jan Källne (Uppsala Univ., Sweden, EU)
Satoshi Kasai (JAERI, JA)
Artur Malaquias (Garching JWS, ITER)
Per Nielsen (RFX, Italy, EU)
Takeo Nishitani (JAERI, JA)
Tatsua Shikama (Tohoku Univ., JA)
Leonid Shmaenok (Phystex, Netherlands, EU)
George Vayakis (Naka JWS, ITER)
Konstantin Vukolov (Kurchatov, RF)
Chris Walker (Garching JWS, ITER)
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Printed by the IAEA in Austria
January 2001

01-00048