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ITER EDA STATUS REPORT

by J.M. Van Fleet, External Relations,
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The following is a summary of the progress in the ITER Engineering Design Activities as presented by the ITER Director, P.-H. Rebut, and noted by the ITER Council (IC) at its fourth meeting held 29-30 September 1993 at the San Diego Joint Work Site.

The Director's report covered five areas: the Development of the Design, the Work Programme, Task Assignments, the Joint Central Team and the Joint Work Sites.

Development of the Design

The main focus for all members of the JCT continues to be the design, development and defining R&D (including the procedures). The JCT has provided a major report to TAC-3 on the ITER Design Options.

The development of the ITER Process Management System (IPMS) is currently in progress. IPMS is the principal tool for managing the evolution of the ITER design through a geographically distributed computing system via high speed data communications networks connecting the three Joint Work Sites. Pending completion of the electronic system, a manual document control system has been implemented. A uniform document database system has been introduced as well.

The Work Programme

Development of the Work Programme is continuing, taking account of the evolving design of ITER and of the MAC-2 recommendations. As noted in the ITER Director's first statement of Work Programme presented to IC-3, each Division within the ITER JCT management structure has the lead role in the design activities as well as defining and directing the associated R&D activities. Senior Management of the JCT (Deputy Directors and Division Heads) is developing specific work plans for their areas of responsibility for consultation and iteration with the Director. These work plans, which cover both the design tasks and the related R&D activities, will be embodied in the overall work plan and schedule as part of the Work Programme to be submitted to IC-5.

Task Assignments

The Director and Home Team Leaders have agreed on the procedures for the definition of Tasks and award of ITER credit for 1993.

Work has continued in formulating Task Agreements (**TA**) following the normal procedures, e.g., for Tasks that extend beyond 1993. As of mid-September 1993, the JCT had issued 53 Task Agreements, of which 17 were approved, 16 were reviewed at MAC-3, 9 are valued at less than 300 **IUA** (ITER Units of Account), 8 are related to the 1993 Procedures, and 3 are still Requests for Task Proposals (RFTP). Four tasks assigned by the ITER Council under Protocol 1 - "Initial R&D Tasks" - are considered to be complete. Total values of the above in IUA as well as in **PMY** (Professional Man Years) are shown overleaf.

Type	IUA	PMY
TA Work Completed	4,000	0.0
TAs Approved	51,920	4.0
Proposed for Approval	10,805	20.0
<300 IUA		5.8
Under 1993 Procedures	99,946	69.5
RFTPs (not to exceed)	5,400	0.0
Totals	172,071	99.3

The pattern of assignment to Parties is as summarized below:

Party	IUA	PMY
EC	40,966	22.8
JA	52,052	14.3
RF	35,133	20.2
US	38,520	42.0
RFTPs (not yet assigned)	5,400	0.0
Totals	172,071	99.3

The JCT is collaborating with Home Teams in implementing streamlined procedures for task assignments along lines recommended by MAC and approved by the Council at IC-4.

The Joint Central Team

At its first meeting the ITER Council agreed that the Parties should provide a total of 150 professionals to the JCT by the end of Protocol 1 (March 1994), with the build-up being done as fast as possible.

For a number of reasons, the rate of build-up of the Team has been slower than expected, and the selection and assignment process has placed a heavy burden on the senior members of the JCT. This has had an impact on the startup of the technical work and the overall functioning of the JCT, e.g., a particularly heavy burden of travel and meetings.

As of mid-September, of the 110 staff selected, 68 have arrived on site of which 33 have completed their secondment procedures. For comparison, at the time of the IC-3 meeting (April 1993), 88 JCT members had been selected, 40 of whom had arrived on site. The position is summarized in the Table below.

JCT - Status by Joint Work Site and Status by Party

	Total	Garching	Naka	San Diego	EC	JA	RF	US
Selected	110	32	40	38	29	26	21	34
On Site	68	22	20	26	19	22	5	22

Thus at about 70% of the way through the duration of Protocol 1, 75% of the total staffing agreed for the end of Protocol 1 had been selected. The number on site represented 45% of the agreed figure. The tables demonstrate the effort made, within the different constraints and pressures affecting the various Parties, to achieve a reasonable balance between Parties and sites.

The average delay between selection and arrival on site now being experienced is around six months. To this must be added the time necessary for staff to settle with their families in the new environment and to acclimatize to the team.

The Joint Work Sites

Making full use of the professional team members depends in large part on the level of support in relation to the evolving needs of the project. As the volume of technical work increases, so does the need for technical support.

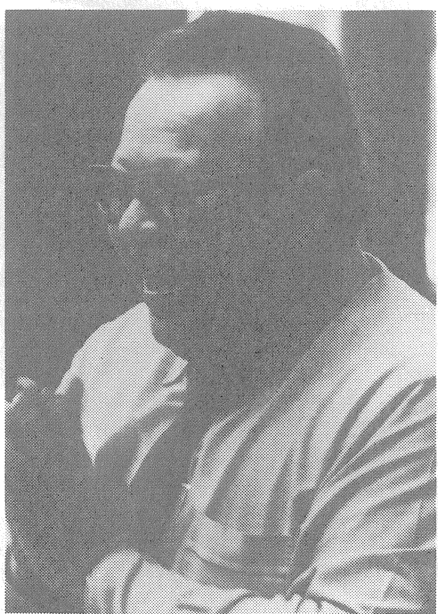
Conclusion

The ITER Director is confident that with the continued build-up of the team and the co-operation of the Parties the objectives and schedule of the ITER EDA will be met.

TO THE READERS

Continuing the introduction of key members of the JCT this issue of the Newsletter features the profile on the ITER Administrative Officer. This position is listed in the ITER EDA Agreement among other JCT key members who shall be appointed by the ITER Council.

Bob Sheldon, ITER Administrative Officer,
ITER Joint Central Team, San Diego Joint Work Site



In October 1993, Bob Sheldon was appointed Administrative Officer of the ITER Project. He is responsible for supporting the Director on the management issues in the administration of ITER. Prior to joining the ITER Joint Central Team, Mr. Sheldon was Associate Project Manager of the Superconducting Super Collider Laboratory in Texas, responsible for International Collaboration. Previously, Mr. Sheldon was at the Princeton Plasma Physics Laboratory, Princeton University, in New Jersey, where he played a key role in the engineering and project management of the Tokamak Fusion Test Reactor. He has also worked at CERN in Geneva, Switzerland; at the Fermi National Accelerator Laboratory in Chicago, Illinois; as well as at the Rutherford Laboratory and at Harwell in the United Kingdom.

His positions included design, installation, research and development management, and various technical and managerial positions in these organizations. He has authored over 40 published scientific and technical papers.

Educated at the School of Science in Oxford, England, he is a Chartered Chemist and a Fellow of the Royal Society of Chemistry.

ITER SAN DIEGO JOINT WORK SITE ENJOYS INTERNATIONAL WINE TASTING
by Dr. C.E. Ahlfeld

On Sunday evening, 26 September 1993, forty-five people associated with the ITER San Diego Joint Work Site gathered at the International Center on the campus of the University of California, San Diego, for an evening of wine, food and good company.

The wines and food from six countries were selected. Each representative gave a short description of their wine before it was poured and described the food as well as other traditions associated with the wine.

The evening started with a German Frankenwein, a Silvaner Trockenkabinett, which was delightful with assorted cheeses and bread. The second wine of the evening representing Russia was actually from Moldavia. Its name, Bouquet of Moldavia, was very descriptive of the beautiful aroma and taste of this very attractive wine.

The third wine, Kura Sake, was specially selected from Nagano, Japan, to accompany platters of sushi. The sushi and the sake, served cold, were a wonderful treat for everyone. Next, an Italian red wine, Poliziano - Vino Nobile di Pontepulciano, was introduced and had a perfect balance of fruit and body. The Romano Pecorino cheese was an ideal complement to this noble wine.

The host country for the evening offered a red wine made from the Zinfandel grape by the Ridge winery in the Santa Cruz Mountains in California. The mature and mellow "Zin" was accompanied by a delightful blue-veined cheese from Wisconsin. The final wine of the evening was from the Rhone valley of France, Chateauneuf-du-Pape. This robust, complex red wine - served, of course, with brie - was a perfect ending to a wonderful evening.

As the evening concluded and everyone was saying good night, the only questions asked were when would be have the next wine tasting to further explore the world of wine - or should we have an international beer tasting?

Gathering of international wine tasting

4TH INTERNATIONAL WORKSHOP ON FUSION NEUTRONICS

by Prof. M. Abdou, Director, and Dr. M. Yousef, Senior Research Engineer, Fusion Energy Technology, UCLA

The 4th International Workshop and the USDOE/JAERI Workshop on fusion neutronics were held at the University of California, Los Angeles Campus, during the period October 20-21, 1993. An informal meeting was also held on October 22, 1993, among specialists from ITER Home Teams to discuss the critical issues for the ITER neutronics R&D program. Neutronics specialists, particularly those who are currently involved in the ITER neutronics and shielding R&D program, attended the workshops to discuss and understand the critical needs and effective mechanisms to carry out the foreseen ITER neutronics and shielding R&D. The first day was devoted to discussing and identifying areas where further nuclear data and transport codes validation and development through integral experiment and cross-section measurements are needed for ITER-related design calculations. In particular, recently performed integral experiments and analysis for bulk shielding experiments, nuclear heating, and radioactivity measurements were reviewed by attendees and future plans to extend these activities were discussed. The second day was assigned to reviewing the key results obtained from the decade-long collaboration between the USDOE and JAERI on fusion integral experiments and analysis for tritium breeding, nuclear heating and activation/decay heat. A summary of the workshop is given in the adjoining boxes.

During the third day, an informal meeting was held among the members of ITER Home Teams who were attending the workshop. Among the urgent and long-term items for ITER neutronics and shielding R&D program discussed are:

(a) The need for a comprehensive transport data library for both multigroup and pointwise discrete ordinates and Monte Carlo calculations. FENDL is preferred as the reference library but further effort is needed to complete and test the library against existing benchmarks.

(b) Further updating and testing of existing radioactivity codes and activation libraries are needed and a more comprehensive database is required. Additionally, code modification is required to follow up the pulsed mode operation scenario of ITER.

(c) Measuring techniques need further development, particularly in the areas of nuclear heating and TPR measurements under harsh conditions (e.g. high temperature, large magnetic field, etc.).

(d) Quantification of safety factors for blanket/shield design of ITER through integral experiments is urgently needed. This quantification should include effects such as heterogeneity, existence of void, gap, and openings.

FORTHCOMING EVENTS *)

- TAC-4, San Diego, USA, 10-12 January

- MAC-4, San Diego, USA, 13-14 January

- Assembly & Maintenance Technical Meeting, Garching, Germany, 19-26 January

- Fuelling & Pumping Technical Meeting, Garching, Germany, 19-26 January

- IC-5, Garching, Germany, 27-28 January

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*) Attendance at all ITER Meetings by invitation only.

Accurate nuclear data and calculational methods as well as verification of prediction capabilities through integral experiments and analyses are necessary prior to construction of a large fusion device such as ITER in order to: 1) reduce the high costs associated with large safety factors normally introduced to compensate for uncertainties, and 2) provide the experimental verification required for approval and licensing of the device.

The status of shielding integral experiments performed or planned using 14 MeV neutron source at the Fusion Neutronics Source (FNS), the Frascati Neutron Generator (FNG), and at the Technical University at Dresden (TUD) was reviewed. At FNS neutron and gamma flux measurements in a bulk shield of 1.2 m x 1.12 m length were performed at various depths without and with simulated coolant channels of a ratio ≈80%SS-20% water. Further experiments are needed to eliminate room-returned neutrons in the later test assembly. It is planned to carry out shielding experiments with B_4C/Pb, W, and SCM material located at the back zone of the bulk shield as well as shielding experiments with typical void/gaps sizes. The status of the bulk shield benchmark experiment at FNG for NET/ITER was reviewed. In the frame of the European Technology Program for NET/ITER, ENEA-Frascati and CEA-Cadarache are performing a bulk shielding experiment to obtain accurate experimental data for improving the nuclear database and methods used in the shielding designs. A large SS-316 block is irradiated by 14 MeV neutrons, and neutron fluxes and spectra at different depths, up to 65 cm depth, are measured. The European code and database BISTRO and the JET/EFF libraries were tested and large discrepancies are still found between measurements and calculations. The experimental benchmark of iron data carried out at TUD by performing neutron and photon flux measurements behind a 30 cm-thick region without and with a 5 cm x 5 cm opening indicated an underestimation in the calculated photon flux using the EFF-1 data and that existence of gaps in the assembly produces additional sensitivity to nuclear data, especially to anisotropic components of neutron transport. These discrepancies may be also expected for Cr, Ni, and other structural materials.

Other fusion neutronics activities at the Japanese universities were discussed. These include measurements and modeling for nuclear reaction cross-sections of important fusion materials, including neutron emission, DDX, charged particles, activation, and He production cross-sections. Integral benchmark-type experiments on neutron transport and tritium production continued at Osaka University. New approaches are being developed on the neutronics diagnostics measurements for D-T and D-D fusion plasmas. These activities are carried out by the Nuclear Fusion Science Research Institute, University of Tokyo and the Nagoya and Osaka Universities.

The nuclear data measurements at Los Alamos for fusion energy application were also reviewed. The Weapons Neutron Research (WNR) Facility at the Los Alamos Mesons Physics Facility (LAMPF) is the center of a wide range of experimental investigations of neutron interactions and neutron transport with application to fusion energy development. The neutron-induced charged particle measurements, in particular for (n, alpha) reactions, fill in the difficult neutron energy ranges from 8 to 13 MeV and above 15 MeV, with the higher energy data being especially useful for considerations of materials radiation damage programs with D-Li neutron sources. Integral experiments on prototype targets for the accelerator production of tritium (APT) and the accelerator transmutation of waste (ATW) are underway. If ITER is not to breed tritium, then accelerator production of this material might be useful. In relation to the D-Li neutron source, analyses for this type of source were presented for the FMIF (US) and the planned Energy Selective Neutron Irradiation Test facility, ESNIT (Japan).

With regard to the needed codes/data development, there was a discussion on recent development in the radioactivity code, RACC. The decay data library associated with the code has been updated to contain up-to-date information for more than 2680 isotopes. In addition, a recent cross-section data library (EAF-3), which contains 10456 cross-sections for 729 isotopes, has been acquired to be used in conjunction with the new decay data library. The newly developed 3-D Sn code, TORT, was also discussed. The code is available from the Radiation Shielding Information Center (RSIC) and has been tested on Cray mainframe computers and IBM, Sun, HP and DEC work stations. TORT has been used for a diverse range of applications, including the calculation of personnel doses within multistory concrete buildings. Also discussed was shielding integral benchmark archival database, SINBAD, in a development stage at RSIC. It is structured to include specifications of benchmarks for testing the adequacy and quality of basic nuclear data. Plans are set to include in the database many clean benchmark experiments performed worldwide. There is also a plan to convert the FENDL data library, under development at IAEA/NDS, into AMPX format such that multigroup libraries could be generated for variety of transport codes (e.g. ANISN, DORT, TORT, and MORSE). Another code discussed was the SWAN sensitivity/optimization code which can be used to optimize the blanket/shield composition during the design process to meet the enhanced performance requirement for a particular design response.

On the second day, the main achievement of the USDOE/JAERI collaboration on fusion neutronics and its relevance to ITER was discussed. The objectives of this ten-year program were: (a) to establish new experimental techniques for design-related neutronics experiments, (b) to provide experimental data on local and integrated parameters such as tritium production rate, nuclear heating, and activation for the purpose of assessing the accuracies of present nuclear data and calculational methods, and (c) to provide designers with design margins for important responses based on the discrepancies observed between prediction and measurements. The program proceeded from performing local and integrated measurements inside an Li_2O test assembly that is characterized by a simple configuration (one material) to an assembly that includes the engineering features of a prototypical blanket (e.g. SS FW, H_2O coolant channels, beryllium multiplier). Phase I of the program was characterized as an open geometry with a 14 MeV point source and the test assembly as a slab while Phase II is characterized as a closed geometry arrangement with a 14 MeV point source. In Phase III, the first-of-its-kind simulated 14 MeV line source was generated (closely simulating the angular/energy conditions of the incident neutrons from the plasmas in Tokamaks) and the cylindrical test assembly totally surround the source. The complexity of the assembly was varied from a homogeneous system to a heterogeneous one introduced by coolant channels, multi-layers of the multiplier, and large 3-D openings in the assembly. Most of the basic techniques for measurements were developed during Phase I (e.g. Li-glass, Li_2O-pellet, Li-metal detectors for tritium production rate, TPR, measurements, small NE213 scintillation for in-system neutron spectrum measurements in the energy range $E_n > 1$ MeV) and the importance of the accuracy in determining the incident neutron spectrum was realized during that phase. Highly accurate data for various 3-D blanket configurations were obtained in Phase II, particularly the systematic data for various Be configurations. Further development in the measuring techniques was also achieved in this phase (e.g. small argon-filled proton recoil counter for spectrum measurements in the energy range 1 KeV $< E_n <$ 1 MeV, LIF TLD self-irradiation technique for TPR measurements, Zonal TPR measurements). The 3-D geometrical effects of the source conditions and the blanket were enhanced in Phase III with closer simulation to Tokamaks.

The analyses of the experiments were performed independently by US and JAERI using their own codes/databases (US:MCNP, DOT5.1, ENDF/B-IV and -V; JAERI: MORSE-DD, DMVP, DOT3.5, JENDL3-PR1, -PR2, 3T and -3.1). A wide range of the calculated-to-experimental (C/E) values were observed in all these experiments for local TPR from Li-6(T_6), from Li-7(T_7), and from Li-natural (T_n). A methodology was developed to quantify design margins from the observed C/E for the line-integrated TPR (closer to TBR in a blanket). Associated with each design margin/safety factor is a confidence level that the calculations are in agreement with measurements. The mean values of the prediction uncertainties (C/E-1) in T_6 are ≈5% (US) and ≈2% (JAERI). However, the spreads around these mean values are δ≈8-9%. For T_7, the mean prediction uncertainties are ≈5% (US) and 1% (JAERI) with a spread of δ≈11% (US), ≈9% (JAERI). When the spread around mean values of the prediction uncertainties is considered, the correction/safety factors for T_6 and T_7 calculations are 1.24 (US) and 1.14-1.17 (JAERI), based on discrete ordinates calculation. Based on Monte Carlo calculations, these corrections factors are 1.2-1.21 (US) and 1.4-1.9 (JAERI). The associated confidence level is ≈95% that calculations are in agreement with measurements.

A substantial amount of data were generated during the program on radioactivity/decay heat calculations and measurements as well as nuclear heating in ITER-relevant materials. Irradiated materials have included the following: Fe, Ni, Cr, Mo, Si, SS316/AISI316, Al, MnCu alloy, Cu, Ti, V, Ta, W. Nb, Sn, Zn, Ag, Pb, Mg, In, Au, $YBa_2Cu_3O_7$, and $ErBa_2Cu_3O_7$. The samples were placed at key locations of the first wall and inside the breeder of Phase II and III experiments. The γ-spectroscopy obtained at various cooling times showed the contribution from radioactive products with half-lives ranging from few minutes to few years. Several activation/decay code systems were used in the analysis (e.g. THIDA-2, REAC*2&3, DKR, RACC, FISPACT, etc.). Wide divergences between the computations and the measurements for a number of materials were found showing the need for updating decay data and cross-sections of the associated libraries used in activation calculations. Serious disagreements were observed even for important reaction products (e.g. $^{58}Ni(n,p)^{58m+g}Co$). The JENDL activation file and the REAC3 (175-g) give the most preferable results among libraries tested.

Nuclear heat deposition rates in ten different materials, Li_2CO_3, graphite, Ti, Ni, Zr, Nb, Mo, Sn, Pb, and W have been measured by the microcalorimetric technique during Phase IIIC. It is remarkable that the lowest measured rates have been as low as 40 μW/g. The need for such measurements and comparison with calculations for kerma factors verification are self-evident. Each of these materials was subject to spaced D-T neutron pulses from the intense rotating neutron target (RNT). The overall experimental error for each material was estimated to be less than 10%. Two codes, MCNP and DOT3.5, and five data libraries - BMCCS, ENDL85, ENDF5T, and RMCCS with MCNP, and JENDL-3 with DOY3.5 - were employed for analysis of these measurements. Large discrepancies have been found between calculations and measurements. The C/E values lie in a band extending from 0.5 to 2.0 for the range of materials considered.

Items to be considered for inclusion in the ITER Newsletter should be submitted to B. Kouvchinnikov, ITER Office, IAEA, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: 43 1 237762 (phone 23606392).

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