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RF-BASED ITER JCT SUPPORT DESIGN TEAM

by N. Kornev, RF MAC Member *)

At its eighth meeting (IC-8), the ITER Council supported the request by the Russian Federation, as ITER Party, to use a larger portion of the Joint Fund for execution of tasks in Russia, such as support of an RF-based ITER JCT support design team working under the direction of the ITER Director. This request, and the subsequent Council's decision, were very timely and appropriate, since they were rightly aimed at solving, to mutual satisfaction, various logistical and design problems.

In accordance with the decision of the Council, the work has started to establish procedures to form the RF Design Office. The Ministry of the Russian Federation on Atomic Energy (MINATOM) assumed the responsibility of co-ordinating the efforts of several institutes participating in that project (Efremov, Kurchatov, ENTEK, etc.). The JCT, in close collaboration with MINATOM, started drafting contracts with these institutes. By now, work is under way under 9 contracts, and several more will be added soon.

*) Nikolai Kornev is leaving the ITER family, who wishes him all the best for his new position in the IAEA.

Staff of Support Design Team at Efremov Institute, St. Petersburg, Design Engineers, Victor Bykov and Anna Arneman, in discussion with Task Co-ordinator, Aleksander Alekseev

THIRD INTERNATIONAL WORKSHOP ON PLASMA DISRUPTIONS

by Dr. A. Hassanein, ANL, and Dr. V. Litunovski, Efremov Institute

The Third International Workshop on Plasma Disruptions was held at Obninsk, Russia, on September 28-29, 1995. The first two international workshops on disruptions were held in Karlsruhe, Germany, in 1992 and 1994, consequently. The main purpose of the Workshop was to discuss and to investigate the behaviour of potential plasma-facing materials (PFMs) during major plasma disruptions, giant ELMs, and high-power excursions in the near-term tokamak devices such as ITER. The Workshop was divided into two parts over a two-day period of presentations, discussions, and future planning.

During the first day results of disruption simulation experiments carried out in various devices and installations at major institutions around the work were presented, including experiments using plasma gun devices, electron beams, and high-intensity laser lights. The second day of the Workshop was devoted to the presentation of numerical modelling and computer simulation of plasma disruption effects in the ITER device as well as in various other simulation experiments. Due to the limited time of the Workshop, the presentations were limited to major contributors in this field:

LIST OF PRESENTATIONS

V. Litunovsky (EI, Russia)	Summary on disruption simulation experiments in EI
A. Zhitlukhin (TRINITI, Russia)	Summary on disruption simulation experiments in TRINITI
P. Rockett (SNL, USA)	Experimental simulation of plasma disruption
H. Bolt (EURATOM-KFA, Germany)	Experimental simulation of disruption
J. van der Laan (EURATOM-FOM/ECN, Netherlands)	Latest results of disruption-like heat load test
V. Chebotarev (Kharkov, Ukraine)	First results on disruption simulation at QSPA-Kh50
A. Burdakov (Budker, Russia)	Explosive material erosion
R. Matera (ITER)	Present concept of ITER divertor
A. Hassanein (ANL, USA)	Modelling of reactor plasma disruption and simulation experiments
H. Wuerz (EURATOM-FZK, Germany)	Status of plasma shield formation modelling and divertor plate erosion for ITER plasma disruption
I. Konkashbaev (TRINITI, Russia)	Melt layer erosion during the disruption

After extensive discussions, the participants in the Workshop came to certain conclusions and to identification of future directions as summarized by Dr. A. Hassanein, Chairman, IWPD-3, at the final session of the Workshop (see box).

Several different and distinct mechanisms are identified to potentially cause material erosion and shorter lifetime during plasma disruptions, ELMs, and high-power excursions. Some of these mechanisms include surface vaporization, melt layer loss, material cracking, and explosive erosion due to electron volumetric heat deposition in some extreme cases of a disruption event.

Because of the importance of the vapour-cloud layer in significantly reducing surface vaporization, issues related to the integrity and stability of such a layer must be addressed and evaluated in current and future modelling studies. Some of these issues include: vapour turbulence, vapour slide-off, and vapour expansion and interaction with other reactor components that are not directly exposed to plasma disruption. This is particularly important for the case of a closed divertor configuration, where the location of disruption damage can be expanded from the divertor plate to other near-by areas due to vapour motion and intense radiation emitted from the hot vapour-front corona. Other effects such as vapour loss due to diffusion across the magnetic field, particularly for longer disruption times, can have serious implications by decreasing the shielding effects, therefore increasing material erosion and critically reducing components lifetime. Most of the issues described above and others must be addressed in fine detail before a final conclusion is reached regarding ITER divertor plate lifetime from surface vaporization during disruption and ELMs. (cont'd.)

The erosion thickness from current surface vaporization models, assuming full shielding of candidate divertor materials, is, however, generally less than or of the order of 10 microns over a wide range of incident particle flux. The melt layer thickness of metallic PFCs can, however, be higher by more than one order of magnitude. Models to include the effect of convective flows during longer disruption durations should also be addressed. Convective heat flows could have the effect of increasing the melt layer thickness, particularly for longer disruption events such as ELMs and high power excursions. During an ITER disruption, the melt layer is exposed to various forces such as electromagnetic, gravitational, mechanical vibration, plasma momentum, surface tension, and ablation recoil. Several mechanisms can cause melt-layer erosion during the thermal quench phase of the disruption. Detailed models to study melt-layer erosion from various mechanisms must be implemented in a self-consistent time-dependent model to accurately evaluate metallic PFCs lifetime due to disruption and ELMs. It is strongly believed that metallic PFCs lifetime will be determined by the extent of melt-layer erosion rather than by erosion from surface vaporization.

The need is urgent for current and planned simulation experiments to be more ITER-relevant to plasma disruption, i.e., deposited energy density of up to 100 MJ/m^2 of a duration of up to 1 ms or higher, plasma particle kinetic energy (>100 eV - 10 keV), and the inclusion of a strong and inclined magnetic field (3-5 T). Candidate materials such as Be or Be-like (Al), W, and graphite should be analyzed by using similar samples and material grades for various simulation experiments. Experiments should address issues of importance to reactor disruptions such as preheating the samples to temperatures of up to 1000°C to study the effects of higher temperature on both surface vaporization and melt-layer erosion. Specific experiments to study melt-layer splashing in a strong (inclined) magnetic field are highly desirable. *In situ* measurements of various vapour-cloud parameters such as spatial variation of vapour density and temperature, emitted radiation intensity, and possible measurement of target surface temperature will greatly enhance the understanding of various physical processes occurring during such experiments. One important issue regarding plasma gun simulation experiments, particularly for gun plasma with low particle kinetic energy (<100 eV), is to estimate the total plasma energy actually reaching the sample surface. Substantial losses from the total initial incident energy can occur due to energy reflected at the target surface as well as hydrogen recycling from the surface (and its subsequent effects) and losses from radiation due to contained impurities. In these cases the actual deposited energy can be much lower than originally thought. Additional simulation experiments to study melt-layer losses due to various erosion-causing mechanisms are highly recommended. This can be achieved by subjecting a liquid layer to external forces to simulate in-reactor forces during a disruption. The experimental groups at both TRINITI (Dr. Zhitlukhin et al.) and Efremov Institute (Dr. Litunovsky et al.) have agreed to seriously examine this problem. Another simple idea suggested (Hassanein) is to use a thin ($\leq$1 mm thick) liquid layer (Li) on the top of a regular target material before plasma-gun exposure and then examine and compare the damaged surface to evaluate the effectiveness of such a protection mechanism.

It was noted that current tokamak disruption experiments can also provide valuable information regarding physics of disruption in ITER such as SOL expansion and particle kinetic energy. In some cases (TEXTOR), specific experiments can provide information on material erosion during the disruption. Similar experiments (DIII-D) are being planned to evaluate melt layer behaviour of metallic materials (Al) during a disruption in a tokamak device. These experiments should continue in close collaboration with the modelling efforts. Detailed modelling of various simulation experiments is critically important in validating the numerical codes in order to enhance the level of confidence in predicting the plasma-facing components behaviour and lifetime during an ITER disruption.

An important issue was highlighted several times during the Workshop, namely that in performing different simulation experiments at various facilities one should use the same grade of target materials and the same surface preparation methods. This is very important in order to correctly identify different physical processes involved in each device and, therefore, to help evaluate their relevance to ITER disruption erosion and physics.

The 4th International Workshop on Plasma Disruptions will be held in Russia during 1998. The exact date and place will be specified in the near future. For information, please contact Dr. A. Hassanein or Dr. A. Zhitlukhin.

IAEA ADVISORY GROUP MEETING ON COMPLETION OF FENDL-1 AND START OF FENDL-2

by Dr. A.B. Pashchenko, Scientific Secretary, IAEA

The FENDL library is a comprehensive collection of high-quality nuclear data, selected from the various existing national data libraries, covering the necessary nuclear input data for all physics and engineering aspects of the material development, design, operation and safety of the ITER project in its current EDA phase and on other fusion-related development projects.

The purpose of the IAEA Advisory Group Meeting (AGM) on Completion of FENDL-1 and Start of FENDL-2 was to review and discuss the results of benchmark validation and quality assurance studies of FENDL-1 working libraries, to review and discuss the availability and the status of processing of candidate replacement evaluations towards FENDL-2 for ITER Design, to agree on the strategy and tasks of the co-ordination of activities in the development of Improved Nuclear Data Library for Fusion, FENDL-2.

The IAEA AGM was hosted jointly by the ITER Joint Central Team at San Diego and the TSI Research on behalf of the U.S. Government and was held at Del Mar, California, USA, from 5-9 December 1995, in conjunction with the International Workshop on Nuclear Data for Fusion Reactor Technology which was also organized in co-operation with the Agency. The combined FENDL/Workshop sessions were organized during two overlapping days in order to maximize the interaction between the data developers and users and to economize the costs involved.

The meeting was attended by 51 nuclear data experts from 11 IAEA Member States (Austria, France, Germany, Hungary, India, Italy, Japan, Russia, Spain, UK and the USA), including eight local participants from the ITER San Diego Joint Work Site, University of California, General Atomics and TSI Research.

Six overview lecturers were delivered by invited speakers at the combined FENDL/Workshop Plenary Session on Nuclear Data Requirements and Status of Data for Fusion Reactor Technology and on Priorities for ITER and Role of FENDL. ITER participants confirmed the value of the FENDL activities in extending nuclear data beyond the fission neutron spectra (up to a few MeV) towards the 14 MeV range involved in fusion development. The FENDL-1 library is being used in ITER in particular for safety analyses for the first Non-Site Specific Safety Report (NSSR-1) through neutron transport calculation. Once the FENDL/A-2 activation data are issued, the JCT will apply the data for the NSSR-2, so that safety analyses shall be performed by using validated nuclear data to assure a quality level necessary for regulatory review.

After presentation of papers, during the meeting three Working Groups (WGs) were organized:

- WG1: Benchmarking of FENDL-1 and FENDL-2 Data
- WG2: Activation
- WG3: FENDL/E-2 Selection

WG1 reviewed the integral data test of FENDL-1 data against available benchmark experiments performed in the framework of an international co-ordinated effort. With regard to data quality, it was summarized that fusion nuclear data have reached a high confidence level with the available FENDL-1 data library. With few exceptions this holds for the materials of highest importance for fusion reactor applications. As a result of the performed benchmark analyses, some existing deficiencies and discrepancies have been identified and will have to be removed in the forthcoming FENDL-2 data file.

WG2 made final recommendations for the selection of evaluations for FENDL/A-2 activation data sublibrary and agreed on the procedure, responsibilities and time schedule for the production of FENDL/A-2 and FENDL/D-2 decay data sublibrary.

WG3 organized the process by which the final FENDL/E-2 library of basic evaluated data for coupled neutron-photon transport calculations will be selected. This process includes the selection of the candidate evaluations, organization of the schedule for submission of evaluations and associated documentation, and the scheduling of a Consultants' Meeting in Karlsruhe, Germany, for organization of data testing results and final evaluation selection.

A closeout meeting for the final approval of the full FENDL-2 library was scheduled to be held at IAEA Headquarters in Vienna in November 1996.

Distribution of the FENDL Library - It was agreed that the master copy of the FENDL-1 library resides with the Nuclear Data Section of the IAEA. To facilitate user access to the library, the official copy of FENDL-1 was distributed in February 1996 to the major nuclear data centres in Europe (NEA Data Bank, Paris), Japan (JNDC, Tokai-mura), Russia (CJD, Obninsk) and the USA (NNDC, Brookhaven and RSIC, Oak Ridge). In this way, it is guaranteed that the recipients receive identical products from all above centres. The data are available and may be further distributed to the user community according to the customer service options given below on 8 mm tape, 6 mm tape, 4 mm tape, standard 9 track magnetic tape (6250 bpi or 1600 bpi), or CD-ROM. Interested scientists may request FENDL-1 (or parts of it) directly from IAEA/NDS or from one of these centres.

FENDL CUSTOMER SERVICE OPTIONS

MEDIA	FORMAT	BY WHOM
Electronic	FTP	IAEA, NEADB, NNDC
4 mm tape	UNIX TAR	CJD, IAEA, NEADB, NNDC, RSIC
	VAX BACKUP	CJD, IAEA, NEADB, NNDC
	ASCII	NEADB
6 mm tape	UNIX TAR	NEADB
	VAX BACKUP	NEADB
	ASCII	NEADB
8 mm tape	UNIX TAR	NEADB, NNDC, RSIC
	VAX BACKUP	NEADB, NNDC
	ASCII	NEADB
9 track	ASCII	CJD, IAEA
	EBCDIC	CJD, IAEA
CD-ROM	UNIX TAR	RSIC
	ASCII	NEADB

CJD = Russian Nuclear Data Centre, Obninsk, Russia
IAEA = IAEA Nuclear Data Section, Vienna, Austria
NEADBC = NEA Data Bank, Paris, France
NNDC = National Nuclear Data Centre, Brookhaven, N.Y., USA
RSIC = Radiation Shielding Information Centre, Oak Ridge, TN, USA

NOTE: NNDC will distribute FENDL unprocessed data; RSIC will distribute FENDL processed data; RSIC offers cost free service to ITER customers.

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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 +43 1 206026392).

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