INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR

ITER EDA NEWSLETTER

VOL.5, NO. 10 OCTOBER 1996

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA

ISSN 1024-5642

FIFTH ITER TECHNICAL MEETING ON SAFETY, ENVIRONMENT, AND REGULATORY APPROVAL

by Drs. A. Poucet and G. Saji, ITER San Diego Joint Work Site

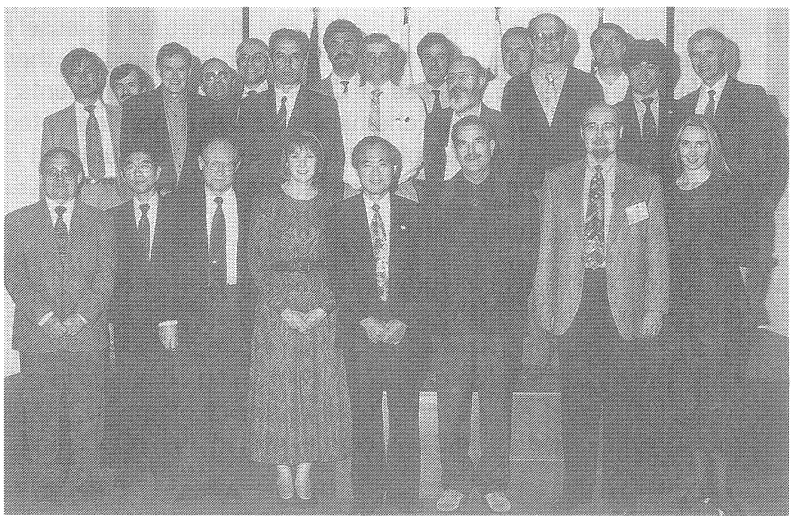
The 5th Technical Meeting on Safety, Environment, and Regulatory Approval was held on September 29 - October 7, 1996 at the ITER San Diego Joint Work Site. The meeting was preceded by a week-long working session with Home Team (HT) Safety Experts in which the draft Non-Site Specific Safety Report (NSSR-1) was reviewed. The list of participants is given at the end of this article.

The main objectives of the meeting were:

(1) To discuss the draft NSSR-1 and ITER Safety Assessment (DDR-Safety) and to ensure that the HT results were correctly incorporated into these documents;
(2) to build consensus before the TAC informal discussion meeting on Safety held on October 4-5, and to follow up on the recommendations that came from this discussion meeting;
(3) to follow progress and harvest results from longer term R&D not specifically programmed for NSSR-1, and
(4) to start planning for NSSR-2 by obtaining input from the HTs on regulatory needs.

The first draft of NSSR-1 (see boxes accompanying this article) was distributed to the HT Safety Experts at the beginning of September.

The overall conclusion of the meeting was that NSSR-1 responds well to the HT needs and provides a good basis to start discussion with regulatory authorities. Although the analysis guidelines were not always 100% compatible with each of the individual HT countries' rules, a good compromise has been achieved which makes the NSSR-1 a valuable source book for developing country-specific reports.



Participants in the Meeting

In the meeting, individual sessions were held to discuss each of the NSSR-1 volumes. The main conclusions from the working meeting conducted the week before were discussed and the actions planned to deal with the comments raised in these reviews were agreed upon.

Many comments, dealing with minor restructuring and suggestions for clarification, will be fixed in the next update of NSSR-1 to be released around the end of 1996. More far-reaching comments were made addressing outstanding issues that need further work. These will be considered in the planning of NSSR-2. It was agreed that, as a starting point, NSSR-2 should continue along the same lines as the current version and be a focused update of NSSR-1, resolving the outstanding issues that were identified in the review process.

The TAC informal assessment on safety focused on the review of the draft executive summary of the NSSR-1. TAC acknowledged the substantial progress made in the ITER safety design and analysis and came up with a number of suggestions for further progress.

The main issues for consideration in NSSR-2, derived from the HT comments and from the TAC informal assessment, include the following:

- Volume II on safety design justification needs to include more designer analysis to show that each system design meets the safety requirements. Also, it needs to identify, for each system, the Instrumentation and Control needed to fulfil the safety functions;
- More work is needed to support the estimation of the tritium co-deposition source term and the dust source term in Volume III, and to account for the cleaning technology that could be relied upon to reduce each of these source terms;
- The Volume IV on effluents needs to be completed with a systematic assessment of all releases due to maintenance activities and minor accidents;
- The sequence assessment, now partially documented in the appendix, needs to be enhanced to provide a transparent case that the reference accidents selected indeed bound the entire spectrum of possible sequences in the risk domain;
- Magnet safety analysis and the analysis of tritium system needs to be better integrated in the overall safety analysis in Volume VII;
- The blanket test program and the Extended Performance Phase (EPP) need to be included in the safety and environmental assessment;
- A more comprehensive seismic design analysis including the assessment of the response of buildings and connecting lines should be included;
- As details become available, some analysis should move from generic assessments to more design-specific studies.

The planning for NSSR-2 is still to be finalized, but the aim is a final NSSR-2 report to be issued in March 1998.

The meeting ended with presentations by the HTs of their on-going R&D efforts. The EU HT presented a broad spectrum of activities with emphasis on development of codes and models for in-vessel transient analysis. The JA HT is focusing on characterization and removal mechanisms for dust, and on thermofluids experiments, namely the LOVA (Loss of Vacuum) and ICE (Ingress of Coolant Event) experiments. Both US and RF are focusing on source term qualification with studies on chemical reactivity of non-irradiated and irradiated Be and Tungsten. The RF R&D also includes investigation of tritium releases from irradiated samples. The US R&D includes analysis of dust from existing tokamak facilities and studies on oxidation driven mobilization for W in air and steam and for SS316 in steam.

The meeting demonstrated again the effective integration in the safety area of JCT and HTs. Early on in the NSSR-1 production process, careful planning of the work and agreement with the HTs on the terms of reference for the analysis contributed a lot to achieving a deliverable that responds well to the HT needs. In developing NSSR-1, the ITER project has clearly demonstrated that, by combining competencies in an international joint effort, results can be achieved that would have been difficult to realize otherwise. NSSR-1 builds confidence that ITER can be constructed and operated without undue risk to the population, the workers and the environment.

NSSR-1 is a 900-page document containing the results of an environmental and safety assessment of the current ITER design. The main purpose of NSSR-1 is to provide sufficient information to potential Host Countries so that they can start negotiations for site selection and draft related regulatory submissions. NSSR-1 is based on assumptions about a hypothetical site. These assumptions are conservative so that only minor design and analysis adjustments will be required once a site is selected.

Non-Site Specific Safety Report

NSSR-1 is subdivided into 9 Volumes and an Appendix as follows:

Volume I:	The ITER safety approach and safety functions
Volume II:	The safety design justification
Volume III:	Radiological and energy source terms
Volume IV:	Effluents and emissions during normal operation
Volume V:	Waste management and decommissioning
Volume VI:	Occupational safety
Volume VII:	Accident analysis of reference events
Volume VIII:	Ultimate safety margins
Volume IX:	Protection against external hazards
Appendix:	Accident identification and selection

Although it is recognized that the design activity is not yet complete, the NSSR-1 assessment provides a strong argument that the ITER design can meet the safety-related requirements that were established. The main safety issues involved in construction and operation of ITER are sufficiently known and characterized and solutions have been implemented into the current design to successfully deal with these issues. NSSR-1 further shows that the facility could be constructed and operated with a high level of protection of the health and safety of the general public, and without significant environmental impacts. It is also concluded that the design could meet the unique safety-related requirements of any of the potential host countries with only minimal modifications required to accommodate the characteristics of the specific site chosen. This conclusion is based on the generally broad international acceptance of the ITER safety-related design requirements that have been established and met in the design.

LIST OF PARTICIPANTS

HT Participants

EU: G. Cambi (EURATOM-Univ. of Bologna)
W. Gulden (EU Task Area Leader [TAL], NET)
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US: J.G. Crocker (Crocker Consulting)
K.A. McCarthy (INEL)
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JCT Participants

R. Aymar (ITER Director)
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Volumes I and II show that safety-related requirements have been fully integrated into the overall design requirements for the facility, systems, and components. These design requirements include limiting of radioactive and toxic releases as a result of normal operation, accidents, and external events (e.g., seismic events). The design incorporates the well-established concepts of Defense in Depth and multiple lines of defense to attain high confidence in the reliability of critical safety features of the facility and ensure protection against postulated accidents.

Volume III presents the nature and quantification of the radioactive source terms, the chemically toxic or reactive substances and the stored energy sources. The inventories and potential for mobilization are discussed.

The analysis in **Volume IV** shows that the ITER design incorporates many features to ensure that radioactive releases during normal operation will be low. A conservative set of limits for effluents and emissions during normal operation was established. These limits were established in accordance with internationally accepted criteria and the principles of ALARA (As Low As Reasonable Achievable). In Volume IV, the sources of radioactive and hazardous effluents and their release pathways were identified and estimated by analysis of the ITER design and comparison with facility releases from similar technologies. Preliminary estimates show that these releases are within established ITER limits.

Volume VI discusses how the ITER personnel will be protected during normal operation. A preliminary radiation protection program has been proposed based upon the recommendations of the IAEA. As part of this, radiation levels in the facility were calculated for several different operating and maintenance scenarios, and a procedure for establishing radiation and contamination zones was developed.

The reference accident analysis in **Volume VII** gives an in-depth investigation of the transients and consequences of 25 reference scenarios. The analysis demonstrates that the release limits are met with considerable margin and that operation of ITER will not result in any significant risk to the general public.

In **Volume VIII** ultimate safety margins were assessed by analyses of hypothetical event sequences. Analysis shows that safety margins degrade gradually, if at all, for lower frequency events and that the ITER design provides a high level of public protection even for these hypothetical events.

Volume IX shows that ITER is designed such that the release limits are met in case of postulated earthquakes and that any other site-specific hazards could be handled with minimal design changes.

The identification and selection of initiating events is discussed in the **Appendix**. The Appendix also provides qualitative analysis to show that the reference accidents in Volume VII and the analysis in Volume VIII are bounding and envelope the entire spectrum of plausible event sequences.

FIFTH ITER DIAGNOSTICS EXPERT GROUP WORKSHOP AND TECHNICAL MEETING ON DIAGNOSTICS

by Dr. A. E. Costley, ITER Joint Central Team, and
Dr. K.M. Young, Princeton Plasma Physics Laboratory

The 5th ITER Diagnostics Expert Group Workshop was held in Montreal, Canada, on 12 - 13 October 1996, immediately following the 16th IAEA Fusion Energy Conference. The meeting was combined, as usual, with a Technical Meeting.

Members of the Expert Group reported on their observations of results presented at the IAEA Conference from a diagnostics perspective. Highlights included the reversed-shear experiments and the detailed profile measurements, advances being implemented for control, including disruption ameliorization, the possibility of direct measurement of the local electric field, progress in divertor diagnostics and the penetration achieved with a low-field side pellet injector.

The primary goal of this meeting was to consider the draft "ITER Physics Basis and Plasma Performance Assessment" and to prepare comments on it for presentation to the joint TAC/ITER Physics Committee Meeting on 14/15 October. It was felt that the draft contribution on diagnostics needed to reflect better the progress that has been achieved in diagnostic design and to bring out the importance of diagnostics in achieving the ITER goals. Specific recommendations for revisions to the text were made to the JCT.

A list of critical issues for the diagnostics program (see box) was presented by the JCT and accepted. The feasibility of some measurements has still to be demonstrated, and the need for sufficient port access was again emphasized.

A set of eleven Voluntary Physics R&D Activities in diagnostics to help resolve these issues was proposed and approved for presentation to the ITER Physics Committee. There has been good progress in the voluntary physics activity at IPP Berlin in the study of the impact of neutral-particle bombardment of metal mirrors. It is essential that the goals for the next phase of the work should be determined and that the possibility of finding other facilities to contribute to the program should be pursued.

The first set of reports of ITER-relevant diagnostic progress in the Parties was provided by members of the Expert Group. This reporting will be a feature of all Expert Group Workshops to keep JCT and Party Experts informed of progress in measurement capability and diagnostics.

A summary of the Work Plan for the design of the diagnostics was presented showing clearly the current status and the proposed final state at the end of the EDA. Concern was expressed over the adequacy of engineering manpower to meet these goals. Planning documentation for the construction of diagnostics in the Construction Phase is now being generated, and an example was reviewed.

Progress in the Radiation Effects R&D Tasks was briefly summarized. At the Progress Meeting in June, it was clear that many of the concerns for in-vessel and optical diagnostics have been resolved, provided care is taken in the choice of materials and location. The program must now move forward urgently to testing of specific prototype components.

The list of credited R&D activities agreed, or in negotiation, between the JCT and the Task Area Leaders was presented.

The JCT is in the process of setting parameter categorizations and diagnostic priorities. This activity will establish the sharing of port-space by diagnostics and a potential layout plan for diagnostic port usage is in preparation.

The revised version of the start-up set of diagnostics, prepared in August after review by the Experts, was formally agreed upon. It is now submitted to the JCT as the Expert Group recommendation and the JCT will

provide a response at the next Expert Group Workshop. The principal additions for the revised set were ion temperature and rotation measurement requiring charge-exchange spectroscopy and a diagnostic neutral beam and a single-channel X-ray crystal spectrometer, an H alpha system aligned along the pellet trajectory and the divertor Thomson scattering system. The principal deletions were the vertical neutron camera and the soft X-ray array.

CRITICAL ISSUES FOR THE ITER DIAGNOSTICS PROGRAM

1) Limited number of ports;
2) Obtaining space for and then design of top port access;
3) Magnetic measurements with time response <1 s, which require coils integrated into the blanket and/or backplate;
4) Radiation-induced EMF in prototype magnetic coil;
5) Access for neutron cameras through modified ports;
6) Window location and engineering design together with seal development;
7) Survivability of first mirrors of optical systems in neutral-particle and neutron fields;
8) Lifetime of optical elements in the divertor;
9) Measurement of confined alpha-particles;
10) Measurement of escaping alpha-particles;
11) Survivability and/or development of radiation-hard bolometers;
12) Finding a method of measurement of light impurities in the plasma core (e.g., He ash) which is not dependent on a neutral beam;
13) Developing a measurement of j(r), again not requiring a neutral beam;
14) Design of some diagnostic systems which have to be integrated with ITER vacuum system;
15) Determination of impurities in the divertor, since VUV and XUV spectroscopic measurement will not be possible with many sightlines;
16) Direct measurement of local electric field.

A Working Group on Reflectometry was set up about one year ago and has been working effectively on analyses and review of relevant activities. Information on the progress is available on the ITER WEB site, which has proved to be an effective platform for the work of this group. The charter for a Working Group on Neutron Diagnostics was agreed upon. The members have been nominated, and a Chairman will be appointed shortly so that it can start work.

It was agreed that it is necessary to hold the next Expert Group Workshop in the first quarter of next year. A subsequent proposal was presented to MAC and supported by it. MAC also supported to hold a meeting in September, after the Varenna Workshop, which will provide a good chance to review the final state of the diagnostic design and implementation on the tokamak for the EDA. Two Task Progress Meetings are to be scheduled also in the first quarter of the year. The Chairman and Co-Chairman will propose the dates and locations as soon as possible.

It was agreed to proceed with the plan to publish papers on ITER diagnostic work in Plasma Physics and Controlled Fusion as soon as the work reaches an appropriate stage, and to seek to publish a compendium volume around the time of the end of the EDA.

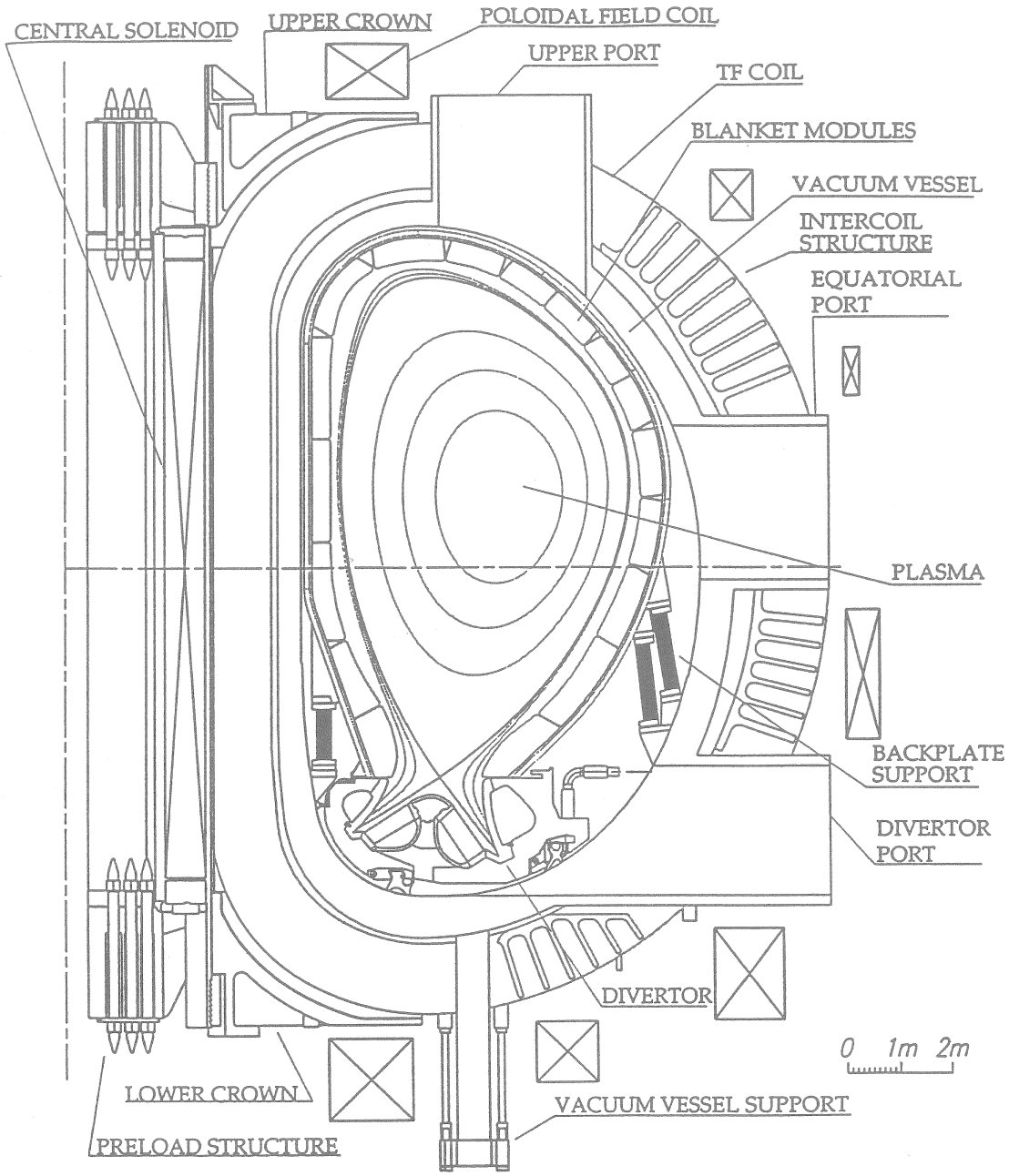
ATTENDEES AT 5TH ITER DIAGNOSTICS EXPERT GROUP MEETING AND TECHNICAL MEETING

Members of Expert Group

R. Bartiromo (IGI Padua, EC)
A.E. Costley (JCT San Diego)
L. de Kock (JCT Garching)
K. Muraoka (Kyushu Univ., JA)
A. Nagashima (JAERI, JA)
M. Petrov (Ioffe, RF)
P.E. Stott (JET, EC)
V. Strelkov (RRC, RF)
K.M. Young (PPPL, US)

Guests and Attendees at the Technical Meeting

D. Johnson (PPPL, US)
S. Kasai (JAERI, JA)
O. Mitarai (Kyushu Tokai Univ., JA) - part-time
T. Nishitani (JAERI, JA)
D. Pinsonneault (CCFM, Canada, EC)
J. Sanchez (CIEMAT, EC)
G. Vayakis (JCT San Diego)
C. Walker (JCT Garching)
G. Wurden (LANL, US)
V. Zaveriaev (RRC, RF)



ITER Tokamak Cross-Section

Source: ITER Detailed Design Report, Cost Review and Safety Analysis

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, or e-mail: basaldel@ripo1.iaea.or.at (phone +43 1 206026392).

Printed by the IAEA in Austria
January 1997

97-00074