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INSIDE

ITER COUNCIL MEETING

by P. N. Haubenreich, ITER Council Secretary

Notable progress in conceptual design, encouraging results in ITER-related R&D and a good beginning on development of information for use by the Parties in consideration of possible Engineering Design Activities (EDA): these were highlights of of an ITER Council meeting at IAEA, Vienna on 30 November - 1 December 1989.

Encouraging progress and promising outlook

Presentations by the ITER Management Committee (IMC) were largely based on the draft, completed earlier in November, of the ITER Conceptual Design Interim Report. Prepared at the midpoint of the 1989-90 Design Phase of the ITER Conceptual Design Activities, this is necessarily an interim report. However, progress had been sufficient to enable conclusions to be drawn concerning performance, requirements for supporting R&D, and preliminary estimates of cost and schedule for a possible international effort to design, procure and construct the ITER. The 1989 summer session of joint work had developed solutions to some difficult design problems and distinct improvements in performance and convenience without increasing the overall size of the tokamak device. The principal parameters of the device are shown in Table 1.

Design follows technical objectives

The main characteristics and parameters derive from the technical objectives set for ITER. The requirement for ignition of deuterium/tritium plasma lead to choices of plasma current and approximate size. Extended fusion burn requires superconducting magnet systems. Design targets for neutron flux and fluence at

Table 1. PRINCIPAL PARAMETERS OF ITER TOKAMAK

Plasma major radius, R (m)	6.0
Plasma half-width at midplane, a (m)	2.15
Elongation, 95% flux surface	1.98
Toroidal field on axis, B_o (T)	4.85
Nominal maximum plasma current, I_p (MA)	22
Nominal fusion power, P_f (MW)	1000

the first wall set the minimum shielding requirements. Combination of these requirements with considerations of plasma stability, impurity control and current drive determine the general features of the reactor. A design objective has been to provide flexibility for incorporation in the design of those scientific and technological innovations that may become available during the course of the project. Safety considerations have been integral to all design work and safety is being enhanced by the use of passively safe systems wherever possible. Within the constraints set by project objectives, the design philosophy has been to control size and minimize cost.

Preliminary cost estimate

Plans for 1990 include an analysis of the costs that the Parties would incur if they decide to continue with design, procurement, construction and operation of ITER. In order to provide early information to the Parties, the Council had asked the IMC to make a preliminary estimate of capital costs. Because of the incomplete state of the Conceptual Design Activities and unresolved matters related to a project plan, this estimate necessarily rested upon some assumptions which, while reasonable, could change. The preliminary estimate of the construction capital cost, in January 1989 US dollars, is $4.9 billion. The Council authorized publication of this figure but only in conjunction with clear notice of its preliminary nature.

Positive assessment by ISTAC

The ITER Scientific and Technical Advisory Committee (ISTAC) reported to the Council their conclusion, based on in-depth review, that the conceptual design had progressed to a reasonably high level of overall optimization. The ISTAC endorsed steps that had been taken and recommended study of others. (See December 1989 issue of the ITER Newsletter.)

Discussion of schedule focussed on aspects related to timing of site selection. On that schedule, proposals from prospective Hosts, assessments and final selection by the Parties would take place during the Engineering Design Activities. The EDA, which would precede commitments for major procurement and construction, was estimated by the IMC to require about five years.

Progress in R&D and longer-term plans

Review of ITER-related R&D showed unimpeded and gratifying flows of scientific and technical knowledge into the conceptual design from the extensive fusion programmes of the four Parties. Plans for co-ordination of longer-term R&D that would be needed for completion of ITER are in an advanced stage of development.

CSSR to contribute through the USSR

The Council was informed that the Government of Czechoslovakia had officially expressed the desire to contribute to the efforts of the USSR Party. As provided in Section 9 of the Terms of Reference, the Council and the IMC consulted and concluded that the participation would be of significant benefit to the joint activities.

For use by the Parties in their considerations of possible future collaboration on ITER, the Council prepared a concise report that summarizes the status and outlook at the end of 1989. This report refers readers to the Conceptual Design Interim Report for technical details.

"...with a view toward negotiation..."

In view of the gratifying progress and promising outlook, the Council has suggested to each Party and the IAEA that they "consider entering discussions with a view toward negotiation of an instrument for conducting Engineering Design Activities." Information that is necessary for such discussions is to be provided to the Parties by the end of April 1990.

ITER SPECIAL GROUP ACTIVITY

by C.A. Flanagan and A. Kostenko, ITER Special Group

An ITER Special Group was designated by the ITER Management Committee to be stationed at the Technical Site in Garching, FRG following the Joint Work Session that ended on October 20, 1989.

Purpose and goals of the Special Group

The primary roles of the group were to conduct specific technical design and analysis work, focussed mostly on design integration issues, and to assist the remainder of the ITER Design Team, at their home institutions, in the implementation of their work programmes during this interval between Joint Work Sessions. The period for the performance of this work was from 20 October until 20 December 1989.

Organization and operation

Two members from each of the four Parties comprised the Special Group. Dr. A. Kostenko was the Chairman. The members represented a broad spectrum of disciplines covering the major design areas of the project.

A work plan was prepared in which individual technical tasks judged to be of high importance were adopted by the group and responsibility then assigned to individual members. Regular weekly meetings were held to discuss the status of the assigned tasks and to decide upon further action; special meetings were held as needed between cognizant persons. Based on the design and analysis performed on these tasks, letters were prepared documenting the work and forwarding recommendations to the cognizant Project Unit Leaders, Design Unit Leaders, or other ITER members at the home institutions.

In performing these tasks, the Special Group benefitted considerably from good collaboration with several members of the European Community (EC) ITER team who reside permanently at the Technical Site in Garching. These members frequently attended the Special Group meetings and provided significant input to many of the tasks.

Three computer-aided designers (CAD) were provided by the EC team to support the Special Group activities. On occasion, the Special Group used the services of a fourth CAD operator from the EC team. The group also enjoyed very good secretarial support.

Task areas

The task areas can conveniently be divided into three areas:

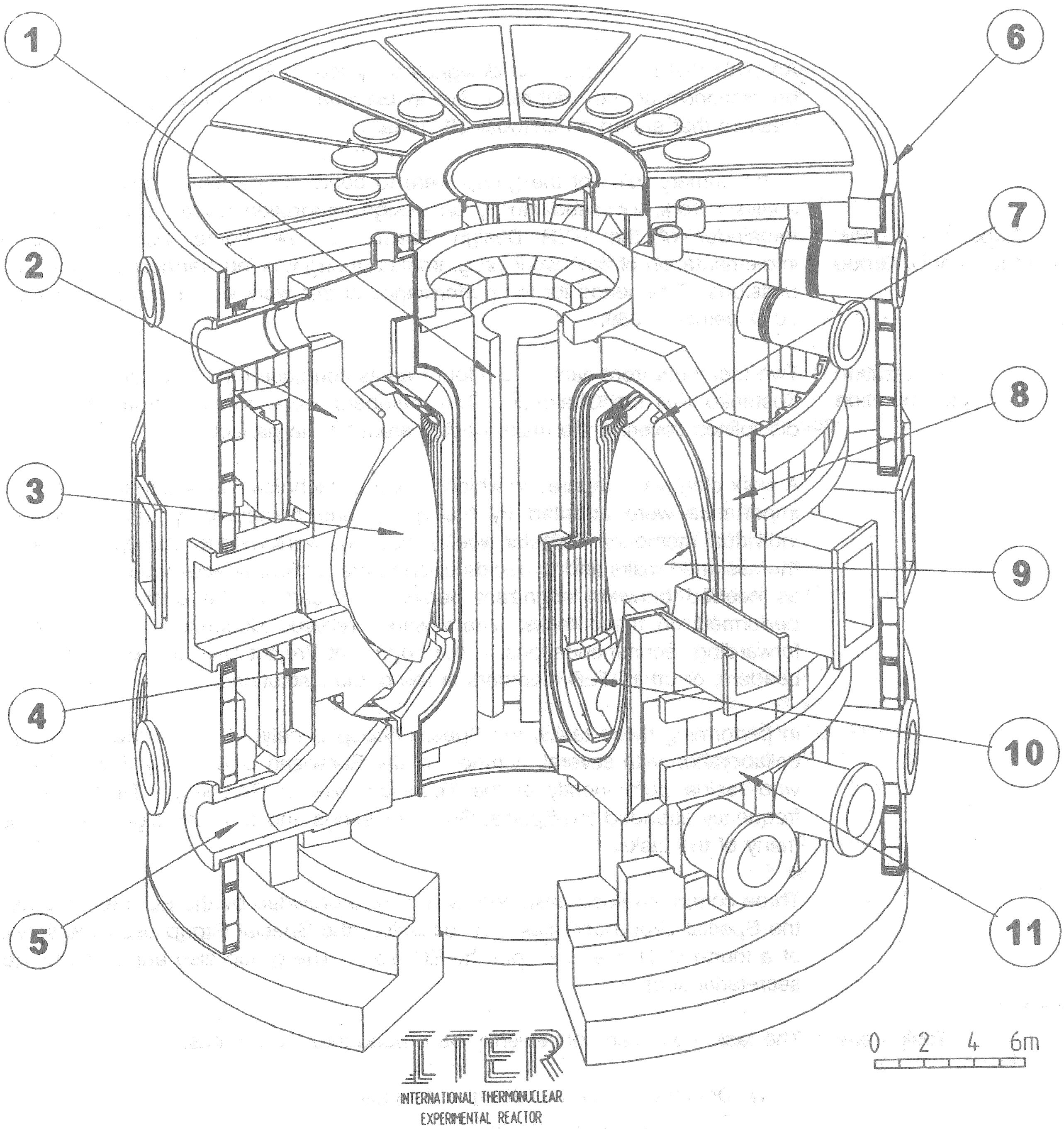
1) Documentation and design information,
2) Design and analysis, and
3) Maintenance and interface considerations.

Documentation and design information

In the documentation and design information areas, a number of tasks were completed.

The Interim Report was prepared by the Special Group for publication by the IAEA. The report describes the status of the ITER Conceptual Design Activities after the first year of the Design Phase. In mid-December 1989, the report was delivered to the IAEA in camera-ready format for publication.

Members of the Special Group reviewed the summary reports prepared by the ITER Design Units during the 1989 Summer Joint Work Session. Based on the latest design information in these summary reports, changes were made to selected sections of the Design Information Document, which is the working document used by the project members.



1- CENTRAL SOLENOID
2- SHIELD/BLANKET
3- PLASMA
4- VACUUM VESSEL-SHIELD
5- PLASMA EXHAUST
6- CRYOSTAT
7- ACTIVE CONTROL COILS
8- TOROIDAL FIELD COILS
9- FIRST WALL
10- DIVERTOR PLATES
11- POLOIDAL FIELD COILS

Fig. 1. ITER Device

Necessary corrections were made to all reference drawings to incorporate the decisions made by the Design Units at the last Joint Work Session.

During initial assembly of ITER, all components will be at room temperature. Therefore, new drawings were prepared for the vacuum vessel and magnet components in which all dimensions are for room temperature (20°C) conditions. These drawings were prepared starting from the reference drawings, which reflect dimensions at operating temperatures.

Recognizing that there will be many operations to be performed prior to, during, and after assembly of individual components, several related tasks were performed to aid in the process of device assembly. As a result of these considerations a standard form was developed, and distributed to the Project and Design Unit Leaders for their action. The form solicits information for each major component and system which will be useful for a more detailed study of the device assembly. The requested information includes dimensions, wieghts, required pre-assembly testing, required pre-assembly fit-ups, special tools needed, and identification of where pre-assembly and test operations are to be performed (at shop or at site).

Design and analysis

A variety of design and analysis tasks were performed during this period. A few are briefly described to indicate the breadth and nature of the work. A perspective view of the present ITER design is given in Fig. 1.

A significant design issue receiving focussed attention within the project is the divertor. Accommodating all of the design conditions and constraints while recognizing the large uncertainty in the operating conditions represents a difficult challenge. Several design tasks were performed in this area. An alternative shape for the divertor plate was developed in an attempt to provide an improvement in the pumping performance while minimizing the adverse impacts on other areas of the design. The alternative shape makes a modification to a portion of the plate at the outboard side by changing the angle of inclination but requires a reduction in the local shielding and a reduction in the outboard null strike-point distance. The modified shape, along with required dimensional changes, will be investigated by the cognizant design personnel to determine the overall benefits and adverse impacts, if any.

Two other divertor design tasks were completed. A concept was developed to provide a method for minimizing misalignment between adjacent divertor plates. The concept uses a common base for support of the two adjacent plates. Finally, a divertor locking system concept was proposed and confirmatory analysis of the concept must be performed.

An overall approach for the initial assembly of the major components of the device was developed. Drawings were prepared illustrating the major steps of the assembly. Based on the initial assembly procedure and associated analysis, recommendations and requirements for the reactor building layout were generated. The process has been documented and distrbuted within the project for review and comment.

An important operations issue is control of the position of the plasma within the plasma chamber. The major magnet coils for this purpose are located external to the toroidal field coils. However, small copper coils are used for plasma active control purposes and these are to be located within the vacuum vessel and blanket modules. How to integrate such coils into these components was examined and candidate options identified. This work is now under review by the cognizant design personnel.

Operations and safety considerations make it highly desirable to preclude the introduction of air into the torus during operations and during maintenance. The use of an inert cover gas in ITER was assessed. It has been concluded that an inert gas is needed in some areas. The volume of these areas should be minimized by designing close-fitting secondary boundaries around the affected components or systems. The choice of what inert gas is most favoured need not be made immediately. Several candidate gases exist; there are advantages and disadvantages with each candidate gas. The results of this assessment and the associated recommendations are now under review by the project members.

Additional design and analysis tasks were performed including development of designs of all equatorial ports and their connections to the major components coupling into the ports, examining concepts for insulation and support schemes for in-magnet components, and examination of the biological shielding needs for the present design.

Maintenance and interface considerations

Preliminary maintenance schemes were developed for a variety of major systems and their associated interfaces. These systems include the heating and current drive systems (neutral beam injection, electron cyclotron waves, and lower hybrid waves), the torus vacuum pumping system, the blanket and shield system, the divertor system, and the test modules and test specimens.

For each of these areas, the system maintenance data was defined, the maintenance requirements identified, a maintenance scheme developed, and equipment functions and requirements identified. In most instances, the assessment resulted in the identification of more information required from the cognizant design unit so that the maintenance aspects can be better quantified and specified, and more information needed regarding the building layout, particularly with respect to the maintenance needs. These observations and recommendations are being addressed by the cognizant project members.

Summary

In general, the Special Group was successful in addressing its goals and tasks. The functions of the group were performed smoothly and the group benefitted from its small size and ability to focus on a broad range of issues and tasks. All of the work has been thoroughly documented. The results of the group efforts are now under review and study by the project members at their home institutions. Most of these issues will be re-visited at the next Joint Work Session beginning on 22 January 1990. Project decisions will be confirmed during this Joint Work Session.

1990 WINTER JOINT WORK SESSION

Two intensive sessions of joint work in Garching are scheduled in 1990 to accomplish the conceptual design of ITER by the end of this year. These efforts, of course, will be strongly supported by the design and research activities at home laboratories. Winter joint work begins on January 22 and will continue for 2 months. The international design team comprises about 50 full-time professionals, all four Parties being rather evenly represented. The later session will start early in July.

Focus on design integration

An important task for the winter session is to advance the design integration. Starting from the review of the first iteration of Basic Machine (BM) systems and components design, the work should then proceed toward the accomplishment of engineering analyses of the BM as an integrated system. Self-consistent parameters and interfaces should be defined, and respective drawings completed.

Also, a directive is planned to be issued for preparation of an integrated design of the Balance of Plant. Detailed tasks will be generated for further homework, focusing on resolution of the remaining integrated design problems.

Following the definition of major tasks for the Design Phase, outlined in the Terms of Reference, the ITER Management Committee plans to work out directives for preparation of final cost estimate and final construction and operating schedule of ITER.

Six specialists' meetings (see ITER Events Calendar) and a number of workshops with possible participation of short-term experts will be held in Garching during the winter session. Based on preliminary information, the total number of visiting scientists and engineers taking part in these supporting activities will be close to 100 or more. At the end of the session, the ITER Scientific and Technical Advisory Committee (ISTAC) will meet in Garching to review progress in joint work and to assess ongoing R&D activities and long-term R&D plans for ITER.

NEW ITER PUBLICATIONS

Recent ITER information expeditiously published

Results achieved in the joint work by ITER Parties in 1989 are documented in three reports published by the IAEA in January 1990. The conceptual design at the conclusion of the 1989 session of joint work is described in a report by the ITER Management Committee accepted by the ITER Council (IC) on 1 December. Concurrently a special working party, chartered by the IC to explore ways and means for achievement of ITER objectives, presented their initial report to the Council. In summary, the Council prepared a concise report of the status of ITER activities as of December 1989. These three reports were expeditiously published by the IAEA in January 1990, as part of the Agency's ITER Documentation Series.

Document No. 7 of the series, "Conceptual Design: Interim Report", 132-page, summarizes the results of the first year of the Design Phase, following the selection of the ITER concept in the fall of 1988, which was described in Doc. No. 3, "ITER Concept Definition", Vol. 1 and 2.

Document No. 8, 23-page "Initial Report of the ITER Council's Ways and Means Working Party" contains preliminary outcome of common exploration by the ITER Parties of the support elements needed for possible conduct of the Engineering Design Activities, including both definition of this co-operative effort and some relevant practical topics.

Document No. 9, 19-page "ITER Activities Status Report: December 1990" presents a brief summary of the Conceptual Design Activities by the ITER Council. It includes status of design activities, estimation of cost and schedule for the realization of ITER and consideration of possible engineering design activities. This report is distributed to all ITER Newsletter recipients.

Coming publications

Also, two more ITER documents are planned to be published in the first quarter of 1990:

- Document No. 6, "ITER Council Proceedings: April 1988 - August 1989", and
- Document No. 10, "ITER Physics Guidelines 1989".

ITER EVENTS CALENDAR - 1990

Joint Work Session	Garching	22 Jan - 23 March
Meetings of Working Party on Ways and Means	Vienna Vienna	29 - 31 Jan 13 - 16 March
ISTAC Meeting	Garching	21 - 23 March
ITER Council Meeting	Vienna	26 - 27 Apr
Joint Work Session	Garching	2 July - 16 Nov
ITER Council Meeting	Washington	8 - 9 Oct
ISTAC Meeting	Vienna	28 - 30 Nov
ITER Council Meeting	Vienna	13 - 14 Dec

Specialists' Meetings at Garching in support of joint design work:

Transient Electrogmagnetics and Plasma Control	5 - 9 Feb
Reference Materials Data Base	7 - 9 Feb
Shielding Experiments and Analysis	12 - 14 Feb
Magnet Materials	26 - 28 Feb
Current Ramp-up by LH	26 Feb - 2 March
ITER Profiles and Beta Limits	5 - 7 March
Plasma Operation Control in ITER	23 - 27 July
Advanced Divertor	20 - 24 Aug
Design Criteria	10 - 14 Sep

Related Events:

16th Symposium on Fusion Technology	London	3 - 7 Sep
13th IAEA Conference on Plasma Physics and Controlled Nuclear Fusion Research	Washington	1 - 6 Oct

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