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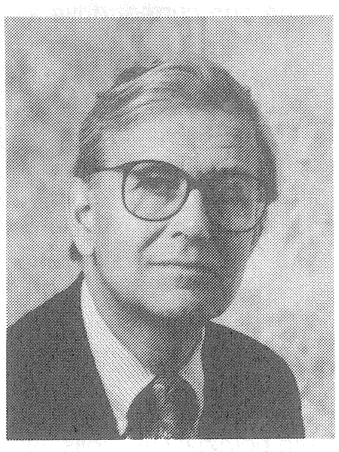
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA

SECOND MEETING OF THE ITER TECHNICAL ADVISORY COMMITTEE

by Prof. P.H. Rutherford, TAC Chair



Dr. Rutherford received a BA (1959) and a PhD (1963) in theoretical physics from Cambridge University. He joined the staff of the Princeton Plasma Physics Laboratory in 1965, serving as Head of the Theoretical Division from 1974 to 1980. In his current position as Associate Director for Research, he is responsible for the scientific direction of the laboratory's experimental and theoretical research programme. In 1983, Dr. Rutherford was the recipient of the E.O. Lawrence Memorial Award in physics for his contributions to the basic theory of plasma confinement and to the toroidal reactor concept. He was a member of ISTAC during the ITER CDA and, since September 1992, has been the Chair of the ITER Technical Advisory Committee.

At the second meeting of the ITER Council (IC-2), held in Moscow on 15-16 December 1992, the Council formulated the following charge to the TAC:

"The ITER Council requests TAC to conduct an assessment of the preliminary design being developed by the Director in response to the IC-1 request. This assessment should address the overall concept, machine parameters, the underlying physics basis, the magnet concept, the primary structural materials including first-wall material, and the cost, safety and environmental implications in the context of the technical objectives provided by SWG-1. A comprehensive TAC design review will be conducted at a later date when systems designs and costs have been produced by the JCT."

The second meeting of TAC was called to address this charge. The following TAC members attended the meeting, which was held at the ITER Co-Centre, Garching, 15-17 March 1993: R. Andreani, R. Aymar, D.C. Robinson and F. Troyon (EC); N. Inoue, S. Itoh, K. Miya and M. Seki (Japan); E.O. Adamov, B.B. Kadomtsev and M.I. Solonin (RF); P.H. Rutherford and J. Sheffield (US). Also, C.A. Flanagan (US) attended and was appointed TAC Secretary. In addition, ten experts attended upon nomination by the Parties and invitation of the Chair: F.Engelmann, K. Lackner and W. Daenner (EC); M. Nagami, E. Tada and K. Tomabechi (Japan); O. Filatov (RF); S.J. Piet, D.L. Smith and J.C. Wesley (US).

The Director and the Joint Central Team (JCT) had prepared the "ITER Preliminary Design Report" in eight sections:

A. ITER Overall Design and Physics Basis (ITER TAC-2-02)
B. Machine Parameters (ITER TAC-2-03)
C. Operation Parameters and Comparison with the CDA (ITER TAC-2-04)
D. Poloidal Field System (ITER TAC-2-05)

E. In-Vessel Components (ITER TAC-2-06)
F. Magnet System Design Description (ITER TAC-2-07)
G. Basic Safety and Environmental Considerations (ITER TAC-2-08)
H. Cost Estimates for the ITER EDA (ITER TAC-2-09)

This Preliminary Design Report was intended to allow an interim assessment by the TAC of the EDA design being developed by the Director and the JCT, with assistance from the Parties' Home Teams. The Director and JCT emphasized that the ITER EDA design is still at a preliminary stage and must accordingly still accommodate some variations in the configuration, as well as a range of options in regard to certain design choices. As the design concept becomes better defined, increasing convergence in the design may be expected.

The TAC commended the Director and the JCT on the quality of the ITER Preliminary Design Report. The overall design concept was clearly described, and the considerations that have led to the choice of machine parameters, as well as the design approaches that have been adopted for individual systems, were cogently presented. Nonetheless, the TAC noted that there are substantial differences in the level to which the designs of individual systems have been developed at this stage. The TAC noted also that the auxiliary heating and current drive systems have not been specified at this time.

The overall design concept outlined in the Preliminary Design Report is for an ITER EDA device that is somewhat larger, overall, than the CDA device. The increase in size arises partly from the need for increased voltseconds to provide a 1,000 second inductive pulse, as specified in the SWG-1 report, partly from increasing the plasma current (from 22 MA to 25 MA), and partly from maintaining confinement capability while adopting a lower, more conservative value for plasma elongation and increased allowance for impurities and helium accumulation. A partially compensating factor is an increase in the strength of the toroidal field, both at the coils and at the plasma, relative to their values in the CDA design. On the basis of empirical confinement scalings developed during the CDA, the present EDA design would have slightly more confinement capability than the CDA device.

A new design concept is presented for the toroidal field and poloidal field coils, using layer-wound cable-in-conduit conductors to allow all connections to be external to the core of the tokamak. Structurally, the toroidal-field coils and central solenoid are mutually supported against a bucking cylinder. This approach is intended to provide greater compactness, possibly at the cost of more difficult manufacturability and added complexity.

Emphasis is placed on the divertor design and the mode of divertor operation. A single-null divertor is adopted, both for simplicity and to provide the maximum space for the divertor assembly. Although the details of the mode of divertor operation are not yet provided, the concept is for a "gaseous" divertor employing recycled gas reinjected perpendicular to the divertor channels which, in high-density operation, can "extinguish" the plasma in front of the divertor-plate, thereby distributing the power flow by radiation and charge-exchange over the entire surface area of the divertor channels. The present design concept includes the use of beryllium as the high-heat-flux plasma-facing material for divertor components.

A number of options are being considered by the JCT for first-wall materials and coolants, although the evaluation of these options is not yet complete. The requirement for high-temperature bakeout and moderately-high-temperature operation of the first wall, as well as safety concerns relating to lithium compatibility, high coolant pressures and tritium permeation, have led to de-emphasis of water as the coolant, in favour of other options including liquid-metal coolants. In the presently preferred concept, lithium is used as the breeder in the blanket modules, which are cooled by tubes containing either another liquid-metal coolant or high-pressure helium gas. The first-wall, like the divertor-plate, would be beryllium-coated. The present design concept thus excludes all graphite first-wall materials, thereby eliminating a potential safety concern, reducing in-vessel tritium inventory, and improving neutron fluence capability in view of the degradation in thermal conductivity of graphites under intense neutron irradiation. Safety and environmental factors are given prominence in the design approach. In addition to the materials choices described above, the exhaust and refuelling scheme, without hydrogenic isotope separation, seeks to minimize the tritium inventory.

The TAC's review of the Preliminary Design Report focused on five issues perceived to be critical at this time: (i) the overall design concept and major machine parameters (i.e., field strength, plasma current, plasma major and minor radii, and elongation) and the underlying physics data base; (ii) the magnet design concept, including the magnet structures; (iii) the choice of first-wall and high-heat-flux materials and coolants and the operational requirements dictating these choices; (iv) the overall approach to safety and environmental issues of the design; and (v) cost estimates. In regard to the major machine parameters, the TAC believes it necessary to finalize these by the IC-3 meeting in April in order to provide a secure basis for further development of the EDA design.

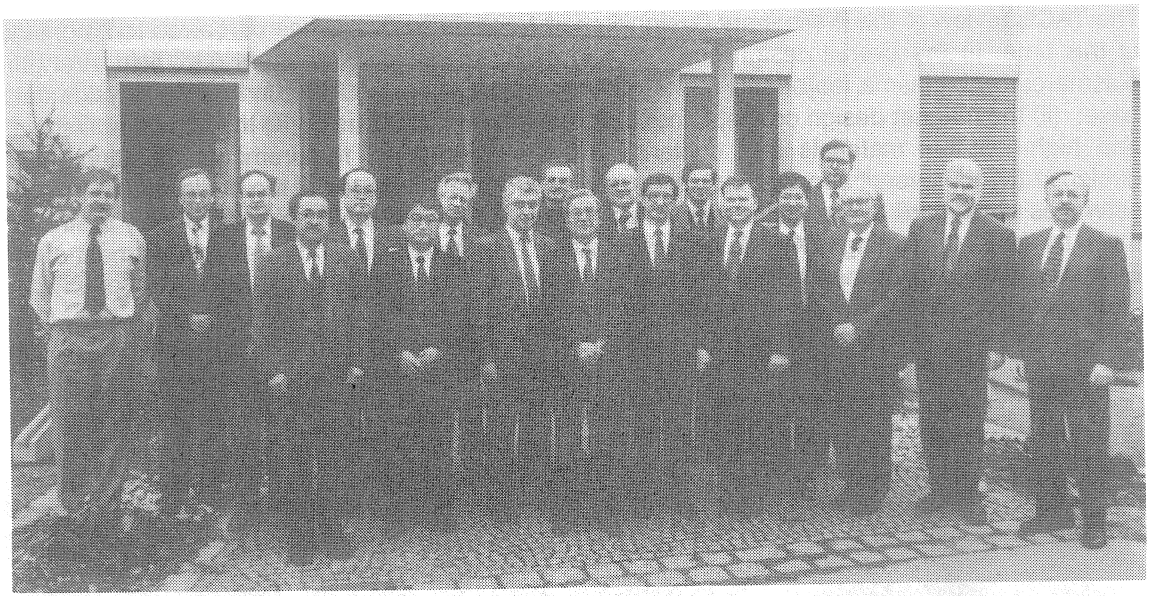
At its three-day meeting at the ITER Co-Centre in Garching, the TAC prepared a draft report summarizing its findings and recommendations on the preliminary design, focussing on the five issues listed above. This report, which is presently being finalized, will be submitted to the ITER council at its meeting on April 21-22, 1993. The TAC views its report as being generally positive regarding the progress of the ITER design to date, although recommending that various alternate or "back-up" approaches be pursued in certain areas. The TAC hopes that its report will provide a basis for further development of the design.

The TAC intends to review again in greater depth the design concept for the divertor system, including the mode of divertor plasma operation and the high-heat-flux divertor materials, devoting a substantial fraction of the planned September TAC meeting to this topic. By this time, improved models of divertor plasma operation should have been developed. The heating and current-drive system will also be addressed at the September meeting.

SECOND MEETING OF THE ITER MANAGEMENT ADVISORY COMMITTEE

by Dr. M. Yoshikawa, MAC Chair

The second meeting of the ITER Management Advisory Committee (MAC), was held at the ITER Co-Centre Garching, Germany, on 24-26 March 1993. Main issues to be reviewed by MAC were the Director's task proposals, conditions for the involvement of other countries, a contract for the ITER Process Management System, and Joint Fund arrangement.



Participants at the MAC-2 Meeting

Concerning the Director's task proposals as urgent R&D tasks, the MAC unanimously endorsed both proposals for task agreements of construction of Model Coil Test Facilities, and Procurement of Strand for Superconducting Magnets. The MAC recommends to the ITER Council to authorize the Director to conclude task agreements with the involved parties on the basis of the proposals presented.

Concerning conditions for the involvement of other countries, the MAC accepted a report of the temporary Working Group and recommended a position to the Council for consideration at its forthcoming meeting.

Discussions on the contract for the ITER Process Management System (IPMS) and the Director's proposal for the Joint Fund arrangement were held. It was agreed that both issues be initiated as rapidly as possible.

MAC decided on dates and locations of its meetings for one year to come as follows:

MAC-3	15-17 June 1993	St. Petersburg
MAC-4	28-30 September 1993	Naka
MAC-5	7-9 December 1993	San Diego
MAC-6	February or March 1994	Garching

LIST OF ATTENDEES

MAC Members

EC: E. Canobbio
R. Toschi (HTL)
J.E. Vetter

RF: Yu.G. Balasanov
O.G. Filatov (HTL)
L.G. Golubchikov

JA: E. Imai
S. Matsuda (HTL)
M. Yoshikawa (Chair)

US: C. Baker (HTL)
A.J. Glass
T.R. James

JCT

P.H. Rebut (Director)
M. Huguet (as Expert from the JCT)
M. Drew (as Expert from the JCT)

Experts
T. Ide (JAERI, JA, Expert for Legal Issues and Interpreter)
R. Parker (JCT, as Expert for MAC as a whole)

Other
V. Vlasenkov (IC Secretary)

Secretary
T. Hirayama (MAC Secretary)

SPECIAL WORKING GROUP 2 (SWG-2) COMPLETES DRAFT FOR PROTOCOL 2

by Dr. M. Roberts, SWG-2 Chair

SWG-2 met in Garching on March 30 - April 1 to complete the work of developing a draft Protocol 2 as required by the Parties in Protocol 1. The JCT provided the hosting at the Joint Work Site in Garching (see photograph).

Participants of SWG-2 Meeting in Garching

The objective of this particular meeting was to complete the working draft of Protocol 2 so that it could be sent to the Council for review at its third meeting, to be held in Tokyo on April 21-22. Comments on the working draft prepared in the previous SWG-2 meeting in Tokyo were provided by each of the Parties and the Director. Following a consideration of these comments on both the Protocol 2 and associated documentation, SWG-2 completed this draft and transmitted it to the Council to meet the objective.

SWG-2 also addressed the additional task assigned at the last Council meeting, namely, the longer-term disposition of facilities and other assets. As a result of this consideration, SWG-2 recommended to the Council that the Guidelines for Implementation of Task Assignments, adopted by the Council at its Moscow meeting, be modified to contain an element dealing with the possible re-use of facilities during the EDA after the original task for which they were intended is completed.

SWG-2 further reported to the Council that additional exploration into this area would be appropriate to address more fully the complicated issue of ownership when components arising from completed Task Assignments are incorporated into other, larger components or facilities constructed under other Task Assignments, possible involving more Parties.

INTEGRATION OF THE SAFETY AND ENVIRONMENTAL FEATURES OF ITER

by Dr. G. Saji, Head, Nuclear Integration Division, ITER Co-Centre San Diego

Fusion energy offers the potential for a safe and environmentally benign energy source for the next century. Present experimental facilities have made great progress in establishing the scientific feasibility of fusion. With ITER we will demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. Since safety and environmental considerations are crucial to the success of ITER, the major objectives of the Nuclear Integration Division (NID) are to integrate safety and environmental features into the design and to prepare for licensing the facility.

ITER must be designed to operate safely in accordance with the applicable safety criteria of the four Parties. Since demonstrating the safety of ITER is the key to the success of the Engineering Design Activities (EDA) the first official workshop was on Safety and the Environment. The workshop was held at the San Diego Joint Work Site on 12-16 October 1992.

The purpose of the workshop was to establish a strategy for conducting the safety programme during the EDA. The safety and environmental features must be integrated into the design and supporting documentation produced for licensing. The four Parties have different licensing requirements, thus, a consensus average must be established on the safety and environmental features as an important step toward satisfying the Parties' basic requirements.

Construction of ITER will require compliance with the nuclear regulations of at least the host country. Thus, regulatory approval will be required before construction of ITER. In order for the Project to proceed into construction without delay, following decisions on construction, preparations for the licensing application should begin during the EDA. Consequently, an early site selection is the key to proceeding with facility licensing on the most rapid schedule.

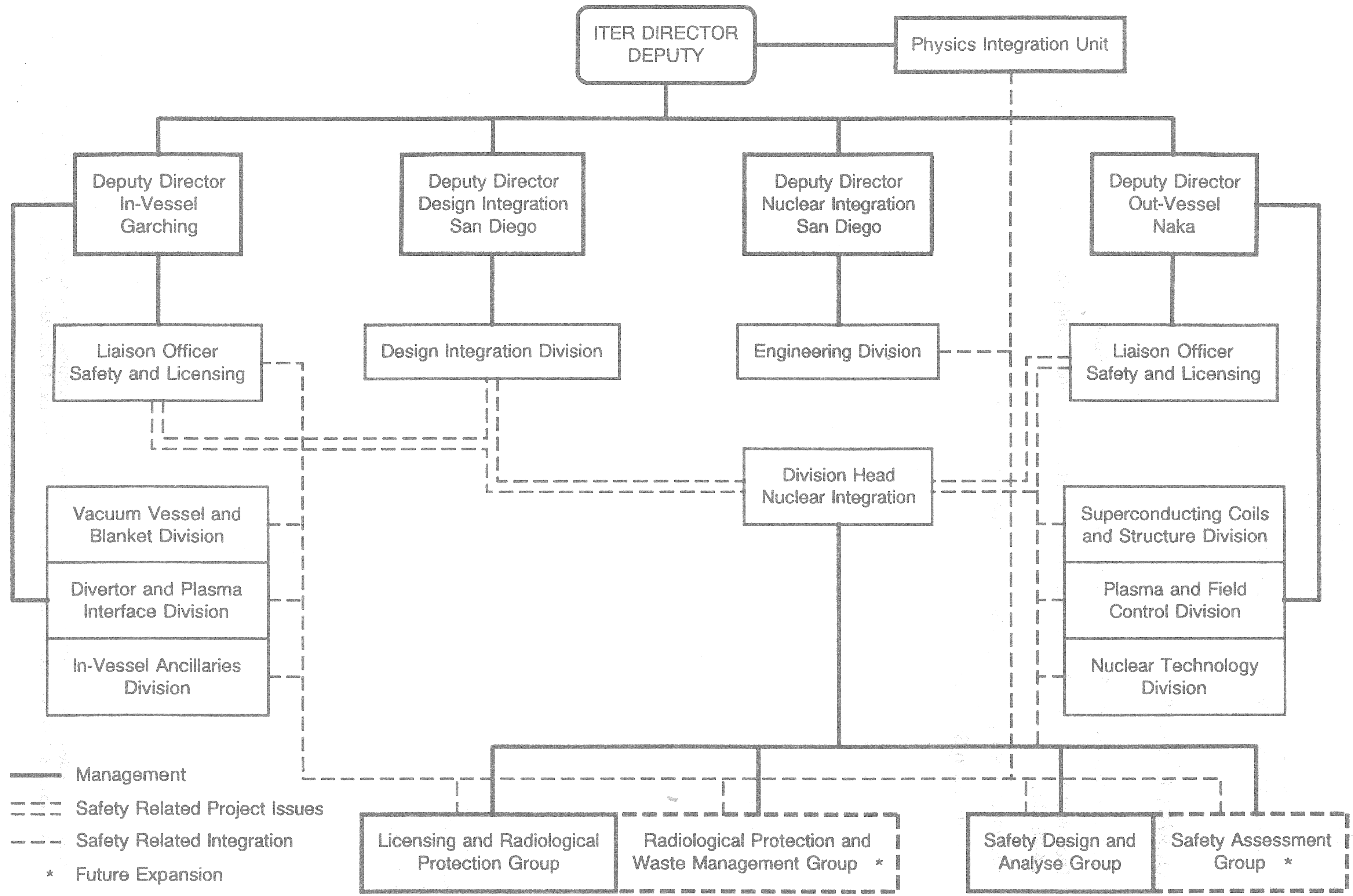
Once the site selection process is completed, it seems likely that the host party will be responsible for licensing the facility according to the host country's requirements. Since all Parties have similar fission reactor licensing processes, the NID will identify their common features as well as their differences. On the basis of this information, we then hope to develop the acceptable criteria that could be compatible with the appropriate fusion-related standards of all the countries proposing to be the host site for ITER.

According to the nuclear regulations of all the parties, an integral part of the licensing of a nuclear project is the safety justification documentation. ITER will be the first fusion facility in which overall "nuclear safety" provisions will be integrated into the facility. Since there are no safety guidelines or regulations specific to fusion projects, guidelines for incorporating the main safety criteria and principles into the design of ITER must be developed.

NID has leading responsibility for defining the basic safety goals of ITER and developing the design safety guidelines. The most efficient scenario would be to have the design safety guidelines approved in advance by at least the host party's regulatory authorities.

Although the NID has the leading role in co-ordinating and integrating safety-related features during the EDA, the actual implementation of design and analysis will rest with the designer of the facility. The safety guidelines developed by NID will be confirmed with specialized assessments by other divisions and/or the Home Teams.

For most of the important safety-related issues, integration and co-ordination with the Design Integration Division (DID) is critical. Similar co-ordination will occur with the Garching and Naka Joint Work Sites through Liaison Officers (LOs) for Safety and Licensing.



Conceptual Drawing of Safety Design Integration and Licensing Activities

The organization chart overleaf illustrates how the safety provisions will be integrated into the overall design process in preparation for the licensing activities. Initially, NID will be organized into two groups: Licensing and Radiological Protection, and Safety Design and Analysis. As the ITER EDA progresses we plan to add two new complementary groups: Radiological Protection and Waste Management, and Safety Assessment.

COMING EVENTS

- Technical Meeting on Plasma Control, Naka, Japan, 26-28 April
- Technical Meeting on Remote Maintenance, Standards and Quality Assurance, San Diego, U.S., 24-28 May
- Technical Meeting on Magnets, Naka, Japan, 1-4 June
- MAC meets in St. Petersburg, RF, 15-17 June

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: 43 222 237762 (phone 23606392).

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