Report of ITER Special Working Group 1

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ITER Special Working Group 1 (SWG-1) was established by the terms of the ITER-EDA Agreement. According to that agreement "SWG-1 shall, based on the (ITER) Conceptual Design Report, review the detailed technical objectives along with the technical approaches to determine the best practicable way to achieve the programmatic objective of ITER, as described in Article 1(2) of the Agreement... SWG-1 shall submit, not later than three months after entry into force of the Agreement, its findings in a Review Report to the Council for its approval."

The ITER Council subsequently provided to SWG-1, as "a general guideline," that detailed technical objectives and technical approaches, including appropriate safety margins, should be compatible with the aim of maintaining the cost of the device within the limits comparable to those indicated in the final report of the ITER CDA (Conceptual Design Activities), as well as keeping its impact in the long-range fusion program. The Council asked the Director to present an outline of the design within about 10 months, at the time when a draft agreement of Protocol 2 should have been prepared by SWG-2. The members of SWG-1 are listed in Table I. The rest of this paper is the verbatim report of SWG-1.

PREAMBLE

- In accordance with Article 10 of the ITER EDA Agreement,
- with reference to Sections 1 and 2 of Protocol 1,
- in the light of the Guidelines for SWG-1 imposed by the 1st ITER Council Meeting (Attachment 1),

1 Work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract No. W-705-Eng-48.
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Table I. Members of ITER Special Working Group 1 (SWG-1)

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<td>Dr. R. Aymar</td>
<td>O.G. Filatov</td>
<td>Acad. B.B. Kadamtev</td>
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<td>Dr. E. Canobbio</td>
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<td>Dr. K. Lackner</td>
<td>Prof. R. Toschi</td>
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<td>Prof. R. Toschi</td>
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- on the basis of the ITER Conceptual Design Activities Final Report, ITER Documentation Series No. 16, and the documents referred to therein,

The Special Working Group has agreed as follows.

1. GENERAL CONSTRAINTS

The ITER detailed technical objectives and technical approaches, including appropriate margins, should be compatible with the aim of maintaining the cost of the device within the limits comparable to those indicated in the final report of the ITER CDA as well as keeping its impact in the long-range fusion programme. ITER should be designed to operate safely and to demonstrate the safety and environmental potential of fusion power.

2. PERFORMANCE AND TESTING

Plasma Performance

ITER should have a confinement capability to reach controlled ignition. The estimates of confinement capa-
bility of ITER should be based, as in the CDA procedure, on established favourable modes of operation. ITER should:

- demonstrate controlled ignition and extended burn for a duration sufficient to achieve stationary conditions on all time scales characteristic of plasma processes and plasma wall interactions, and sufficient for achieving stationary conditions for nuclear testing of blanket components. This can be fulfilled by pulses with flat top duration in the range of 1000s. For testing particular blanket designs, pulses of approximately 2000s are desirable.
- aim at demonstrating steady state operation using non-inductive current drive in reactor-relevant plasmas.

**Engineering Performance and Testing**

ITER should:

- demonstrate the availability of technologies essential for a fusion reactor (such as superconducting magnets and remote maintenance);
- test components for a reactor (such as systems to exhaust power and particles from the plasma);
- test design concepts of tritium breeding blankets relevant to a reactor. The tests foreseen on modules include the demonstration of a breeding capability that would lead to tritium self-sufficiency in a reactor, the extraction of high-grade heat, and electricity generations.

**3. DESIGN REQUIREMENTS**

The choice of parameters of the basic device should be consistent with margins that give confidence in achieving the required plasma and engineering performance. The design should be sufficiently flexible to provide access for the introduction of advanced features and new capabilities, and to allow for optimizing plasma performance during operation. The design should be confirmed by the scientific and technological database available at the end of the EDA.

An inductive pulse flat-top capability, under ignited conditions, of approximately 1000s should be provided. In view of the ultimate goal of steady-state operation, ITER should be designed to be compatible with non-inductive current drive, and the heating system required for ignition in the first phase of operation should have current drive capability.

To carry out nuclear and high-heat flux component testing at conditions relevant to a fusion power reactor:

- the average neutron wall loading should be about 1 MW/m²,
- the machine should be designed to be capable of at least 1 MWe/m² to carry out longer-time integral and materials tests.

It is desirable to operate at higher flux and fluence levels. Within the engineering margins the ITER designers should examine the implications and possibilities of exploiting a wider range of operational regimes. The design of the permanent components of the machine should not preclude achieving fluence levels up to 3 MWe/m². For the second phase of operation, the design should include the capability of replacing the shield with a breeding blanket.

**4. OPERATION REQUIREMENTS**

The ITER operation should be divided into two phases:

- The first phase, the Basic Performance Phase, is expected to last a decade including a few thousand hours of full DT operation. This phase should address the issues of controlled ignition, extended burn, steady-state operation, and the testing of blanket modules. It is assumed that for this phase there will be an adequate supply of tritium from external sources.

Controlled ignition experiments in ITER will address confinement, stability and impurity control in alpha particle heated plasmas. Extended burn experiments will address, in addition, the control of fusion power production and plasma profiles, and the exhaust of helium ash.

The aim of current drive experiments in this phase should be the demonstration of steady-state operation in plasmas having alpha particle heating power at least comparable to the externally applied power. Using the heating systems in their current drive mode, non-inductive current drive should be implemented for profile and burn control, for achieving modes of improved confinement, and for assessing the conditions and power requirements for the above type of steady-state operation. Depending on the out-