

THE INTERNATIONAL ASPECTS OF FUSION

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December, 1979

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Paper presented at the IEEE 6th Region Conference
"The 1980's - A Forest of Energy Decision Trees"
in February, 1980.

San Diego

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ABSTRACT

International collaborative efforts in magnetic confinement fusion in which the USA is involved are reviewed. These efforts are carried under the auspices of international agencies and through bilateral agreements.

The USA cooperates with other countries in the development of fusion energy through the International Atomic Energy Agency (IAEA), through the International Energy Agency (IEA), and through bilateral agreements. This cooperation provides for a valuable exchange of ideas and information, reduces the risk, and shares the expense in the development of fusion energy.

1. INTERNATIONAL ATOMIC ENERGY AGENCY

The fusion programs of the IAEA are guided by its International Fusion Research Council (IFRC). This Council is made up of prominent fusion authorities from 13 nations. The IAEA sponsors conferences and specialists meetings and the International Tokamak Reactor Activity.

1.1. Conferences and Specialists Meetings

The IAEA sponsors conferences and specialists meetings on a variety of subjects in fusion research. Biennial conferences on Plasma Physics and Controlled Nuclear Fusion Research attract many hundreds of participants and are a major forum for the exchange of information on a broad range of subjects in plasma physics. An annual meeting is held to discuss the next generation of large tokamaks which are under design and construction throughout the world. Two Workshops on Fusion Reactor Design (1974 and 1978) have been instrumental in disseminating fusion reactor design concepts world-wide. Numerous specialists meetings on nuclear data, materials, chemistry, etc. of fusion have helped to establish world-wide agreement on research priorities. A workshop on the environmental effects of fusion is scheduled for this year. The IAEA also publishes the journal Nuclear Fusion which provides for a world-wide dissemination of research results in plasma physics.

1.2. International Tokamak Reactor (INTOR) Activity

In 1978, the Soviet Union proposed to the IAEA that the next major experiment beyond the next generation of large tokamaks (TFTR-USA, JT60-Japan, T15-USSR, JET-EC) should be built as a cooperative international enterprise. The INTOR Workshop was organized by the IAEA to identify the programmatic and technical objectives and the characteristics of such a device and to determine if the scientific and technical basis for this experiment will be available in the near future consistent with a 1990 initial operation. The INTOR Workshop was conducted during 1979 to determine whether the project could be taken into the definition, or conceptual design, phase in 1980. This determination was positive. Subsequent phases of the project would be design and construction/operation. At the end of each phase, the involved parties will decide whether to continue to the next phase.

The parties to the INTOR Workshop were the European Community, Japan, the USA and the USSR. Each party was represented by four participants who met together from time to time in Vienna to define the effort of the Workshop, to review and discuss the contributions of the four parties, and to prepare the report of the Workshop. The bulk of the work of the INTOR Workshop was performed by experts working in their home institutions. This home effort involved over 100 senior scientists and engineers and 10-20 man years of effort in each of the participating countries.

Detailed assessments of the physics and technology bases for INTOR were compiled in each country, and special studies were carried out on various critical topics. The content of these reports was then discussed and compared at the Workshop sessions in Vienna and served as the basis for the preparation of the joint report of the INTOR Workshop. The material prepared in each country for the INTOR Workshop was published as a national report.

The INTOR Workshop report, which represents the technical judgement of the world fusion community, concludes that the operation of a major D-T burning tokamak engineering test facility in the early 1990s is scientifically and technically feasible, provided that the supporting R&D effort is expanded in certain critical areas, and is the appropriate next step for fusion power development. This broad international consensus on the readiness of fusion to take such an important step is clearly a major milestone.

2. INTERNATIONAL ENERGY AGENCY

The fusion programs of the IEA are guided by its Fusion Power Coordinating Committee. Programs being carried out under IEA agreements are the Large Coil Program, cooperation on neutron sources for materials testing, and plasma-wall interaction research on TEXTOR. A possibility for future cooperation is the design of an ignition test reactor, ZEPHYR.

2.1. Large Coil Program (LCP)

The large Coil Program consists of six large superconducting magnets and a magnet test facility. The test facility is under construction at ORNL. Six D-shaped, toroidal field coils of roughly one-half the size and two-thirds the field needed for ETF/INTOR are being built to be tested during 1981-84. One coil each is being provided by Euratom, Japan and Switzerland. Three coils are being provided by the USA.

2.2. Materials Testing

A joint effort between Canada, Japan, Sweden, Switzerland and the USA for materials testing on the FMIT facility being constructed at HEDL is under negotiation. This effort replaces an agreement based on the proposed INS facility at LASL, which was cancelled due to funding limitations.

2.3. Plasma-Wall Interaction

Euratom, Switzerland, Turkey and the USA began participation in plasma-wall research on TEXTOR (tokamak) in 1979. TEXTOR is operated by Euratom and is located in the FRG.

2.4. Ignition Test Reactor

An agreement for USA participation in the design of a tokamak ignition test reactor, ZEPHYR, at the Max-Planck Institute in Garching, FRG is under consideration. USA scientists are presently involved on an informal basis in the feasibility studies for this device.

3. BILATERAL AGREEMENTS

The USA has formal and substantive bilateral agreements in fusion with the USSR and Japan. Smaller, formal and informal agreements are in force or under negotiation with other countries with fusion programs.

3.1. USSR

A formal agreement between the USSR and USA was initiated in 1974 as a consequence of the Nixon-Brezhnev accords. In that year USA scientists spent 68 man weeks working and visiting in the USSR, and Soviet scientists spent 44 man weeks in the USA. This level of exchange grew to 130 and 123, respectively, in 1979. These exchanges involve virtually all areas of magnetic fusion physics and technology. Recent major areas of exchange have been: 1) experimental and theoretical work on confinement and heating of plasmas; 2) design and testing of components of experimental reactors; and 3) engineering problems in fusion reactors. There has also been an exchange of irradiated samples in a joint research project.

3.2. Japan

A formal agreement was signed between Japan and the USA in August, 1979 to enter into a broad range of cooperative activities in magnetic fusion research and development. Cooperation will include a joint research program on the Doublet III tokamak in the USA, a personnel exchange, a joint research institute for plasma physics, and joint planning on the development of alternate confinement concepts. A Coordinating Committee on Fusion Energy has been established to oversee and guide these activities.

Work has already begun on the first of these activities, a five year Doublet III upgrade project, in which Japan is providing funds (about \$11.5 M in 1979) for upgrading the Doublet III facility for operation with increased magnetic field, plasma current, neutral beam power and, possibly, a D-shaped vacuum vessel. A team of Japanese scientists is already in residence at the General Atomic Company at San Diego carrying out experiments of particular interest to Japan. The other three activities were initiated at the Coordinating Committee meeting in November, 1979, and personnel exchange began in December, 1979.

3.3. Europe

From the beginning of the fusion program there has been cooperation between the USA and the European countries. This cooperation, covered under various formal and informal agreements, has reached the stage of exchange of information on ongoing projects, personnel exchanges and coordinated research projects. Negotiations are underway to establish a formal bilateral agreement between the European Community and the USA. Areas of possible collaboration include joint research on alternate concepts, coordinated computational programs and various technology project activities.

4. SUMMARY

The USA is engaged in cooperative international undertakings in magnetic fusion research on a major scale. This cooperation takes place through the IAEA and IEA and through bilateral agreements. The cooperative undertakings involve personnel exchange, joint technology development programs, joint fusion reactor design projects and joint research programs.

ACKNOWLEDGEMENT

The author is grateful to Dr. Michael Roberts, Director of the Division of Planning and Projects in the USDOE Office of Fusion Energy, for assistance in compiling the material in this paper and for reviewing the manuscript.