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FusionCanada

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INTERNATIONAL THERMONUCLEAR EXPERIMENTAL REACTOR

ITER EDA Agreement signed July 21 in Washington, D.C.

Six-year Engineering Design Activities Begin

Representatives of the European Community, Russia, Japan, and the USA signed an agreement July 21, 1992 to jointly undertake the engineering design of the International Thermonuclear Experimental Reactor (ITER).

Together, the four parties expect to spend an estimated $1.2 billion on the design activities over the six-year term of the effort, known as the ITER Engineering Design Activities (EDA).

The objective of the EDA work is to complete an engineering design for the ITER machine, a large fusion test reactor, so that construction could begin when and if the Parties agree to build it. The machine would be intended to demonstrate the scientific and technological feasibility of fusion energy. The ITER collaboration is being conducted under the auspices of the International Atomic Energy Agency.

"Today's agreement is truly a milestone in the development of a safe, environmentally sound energy source for the next century", said Admiral James D. Watkins, US Secretary of Energy, who signed the ITER EDA agreement on behalf of the United States. Dr. Hans Blix, Director-General of the International Atomic Energy Agency, conducted the signing ceremony.

Canada plans to participate in the EDA by means of an arrangement with the European Community. Canada contributed through the European Community to ITER's first phase, the Conceptual Design Activities (CDA), conducted during 1988-90. The Canadian Fusion Fuels Technology Project (CFFTP) and Centre canadien de fusion magnétique (CCFM), Canada's key fusion R&D centres, both participated in the CDA, and are discussing plans for effective contributions to the EDA. CFFTP expects that it may contribute in the areas of fuel cycle, remote handling, blanket and first wall, and safety, as well as other areas such as site and systems integration. CCFM anticipates continuing its contributions to the ITER long term physics program in several areas, including power and particle exhaust physics, plasma disruptions research, radiofrequency plasma current drive and long pulse tokamak operation.

During the CDA, the construction cost of ITER was estimated to be in the region of $5 billion. A more detailed cost estimated will be developed during the EDA.

ITER design and R&D work will be done by a Joint Team of workers from the four Parties, supported by the individual

Federal Minister of Labour the Hon. Marcel Danis visited Centre canadien de fusion magnétique on June 25. Here, in TdeV's Diagnostics Bay No. 3, Mr. Danis (centre) receives an explanation of plasma biasing from Réal Décoste, CCFM Operations Director (right) and Richard Bolton, CCFM Director-General (left). As reported in the last issue of FusionCanada, Mr. Danis and his colleague the Hon. Jake Epp, federal Minister of Energy, Mines and Resources, were instrumental in assuring five-year federal funding for CCFM through the National Fusion Program.

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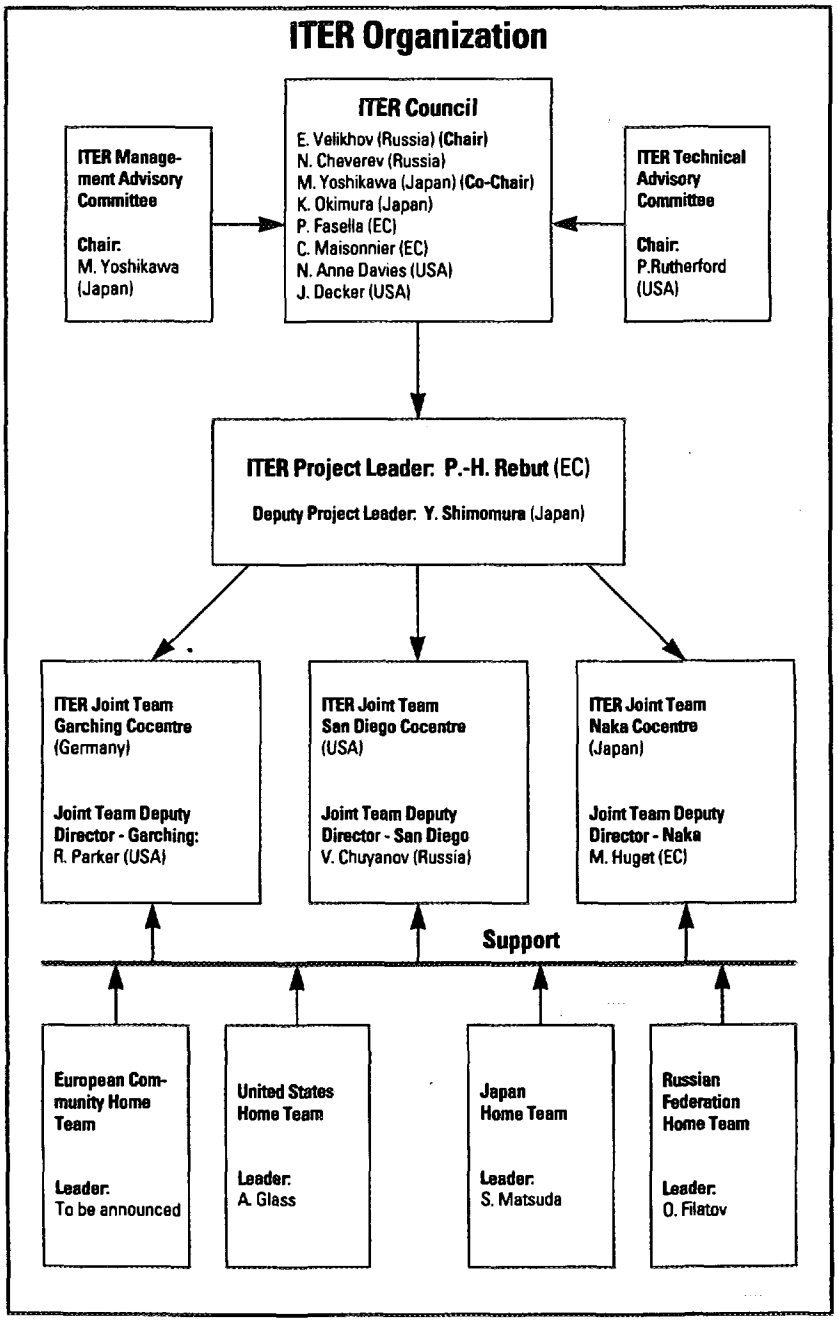
Home Teams of each Party. The Joint Team will be located at three co-centres; Garching (Germany), Naka (Japan), and San Diego (USA). The Director of the Joint Team is expected to be Dr. Paul-Henri Rebut of the European Community.

The project will be overseen by the ITER Council, composed of two members from each of the four Parties. ITER Council meetings will be held in Moscow, with the first meeting expected to take place in the autumn. Persons already nominated by the Parties for key positions in the EDA structure are expected to be confirmed in their positions at that meeting.

The accompanying chart indicates some of the main elements in the EDA organizational structure, and the some of the persons nominated to key EDA positions as of mid-August, when FusionCanada went to press.



CCFM - CENTRE CANADIEN DE FUSION MAGNÉTIQUE

CCFM Directions

Advisory Committee Review

CCFM's international Advisory Committee has reviewed the last year of work at CCFM, and has warmly endorsed CCFM's present strategy and scientific programs, especially the research emphasis on tokamak plasma biasing combined with closed divertor operation.

The Advisory Committee met in May this year to examine CCFM's research plans and evaluate CCFM's research and operations since the last Committee meeting at the end of 1990. Members of CCFM's Advisory Committee are recognized fusion experts, mostly from other countries' fusion programs.

Following its review, the Committee's primary recommendation was that CCFM should maintain its present focus on plasma biasing, especially the emphasis on the use and understanding of biasing to enhance divertor operation. In endorsing this priority, the Committee noted that, "..CCFM staff had already achieved well deserved recognition as experts in this field." After its 1990 review of CCFM work, the Committee had recommended that CCFM should narrow its broader priorities of that time, to concentrate on biasing and divertors.

The Committee had also previously recommended attention to reducing plasma impurity levels. CCFM was able to report this year, to the Committee's satisfaction, that successful tokamak boronization work and divertor operation had dramatically reduced plasma impurities in TdeV. Pumped divertors promise further reductions in Z_{eff}.

The Committee also commented on the good progress in 1991 and 1992 with the radiofrequency Lower Hybrid Current Drive (LHCD) system now being installed on TdeV. The LHCD team at CCFM, responsible for the system's design and construction, were commended on their work.

It was recommended at this review that greater priority should be placed on merging the theoretical and experimental programs at CCFM. It would be beneficial, for example to upgrade between-shot data reduction and analysis for TdeV, so as to expedite evaluation of experiments.

The forthcoming trials of Compact Toroid fuelling on TdeV found approval, despite the relatively high scientific risk. It is viewed as an opportunity to contribute to a very new branch of fusion research.

The Advisory Committee endorsed CCFM's participation in the international fusion community where, they noted, "..CCFM has earned wide respect as a needed and highly relevant participant at the forefront, in areas of research where its special capabilities are greatly appreciated." The continued pursuit of international collaborations in specific research topics was strongly encouraged

In summarizing its 1992 review of CCFM, the Committee recorded that "...it is again impressed with the soundness of the CCFM program ...and the effectiveness of its staff."

Gilbert Bartholomew and Michael Saltmarsh are now retiring from the Advisory Committee, having served on it since the Tokamak de Varennes project began in 1982. The staff of CCFM and the National Fusion Program wish to thank them for their stalwart support and invaluable counsel over the last decade, and their experienced guidance during the early years of the project.

CCFM Advisory Committee

Chairman:
Gilbert Bartholomew *(Consultant)*

Secretary:
Charles Daughney *(AECL Research)*

Members:
Don Dautovich *(CFFTP)*
Akira Hirose *(University of Saskatchewan)*
Jan Hugill *(AEA Culham Laboratory, UK)*
William Rowan *(University of Texas, USA)*
Michael Saltmarsh *(Oak Ridge, USA)*
Franz Söldner *(IPP Garching, Germany)*
Jörg Winter *(KFA Jülich, Germany)*

CFFTP

CFFTP Fusion Pilot Plant Study

A CFFTP-led consortium of five Canadian companies is preparing a design study and cost estimate for a fusion pilot plant of 20 MW fusion power. This project, the CFFTP Pilot study, will produce an overall design for the plant. Design work will be at the scoping level. The major plant systems will be sized with respect to their key operating parameters, such as (for example) sizes, flow rates, power requirements, tritium inventories and neutron fluxes. One objective of the study is to enhance Canadian industry familiarity with fusion plant design, through joint work on an integrated study.

The study will be based on a steady-state-burn, high aspect ratio tokamak reactor with copper magnets, fuelled with deuterium-tritium, and having ion cyclotron auxiliary plasma heating and current drive. No electric power turbines are included, since these are considered standard technology. The power output interface will be a hot helium duct from the breeder blanket assembly, although the study may at some point encompass steam generators. Compact toroid fuelling is being considered. Design life of the fusion reactor is set at one full-power year.

The tokamak design reference point was selected with the assistance of John Galambos of ORNL. The US TETRA tokamak design code was used to survey a limited range of key parameters and to specify the main characteristics of the plasma and magnet systems.

Each of the five companies participating is responsible for one aspect of design or maintenance of the plant.

Fuel Cycle: Wardrop Engineering (Mississauga, Ontario) will design an integrated reactor fuel cycle including deuterium-tritium storage, vacuum pumping, fuel cleanup, isotope separation, blanket tritium extraction, and coolant detritiation.

Breeder Blanket: Spectrum Engineering (Peterborough, Ontario) will design and analyze performance of the helium-

cooled first wall and breeder blanket.

Maintenance: SPAR Aerospace (Brampton, Ontario) will examine the plant's maintenance aspects, including tokamak assembly, and in-vessel and ex-vessel maintenance.

Heat Transport System: Canatom Inc. (Montréal, Québec) will design primary and secondary cooling systems for the breeder blanket and neutron shield, the divertors and the magnets.

Balance of Plant: Canadian International Power Services Inc. (Mississauga, Ontario) will provide scoping designs for all building structures, electrical plant, plant utilities and waste management.

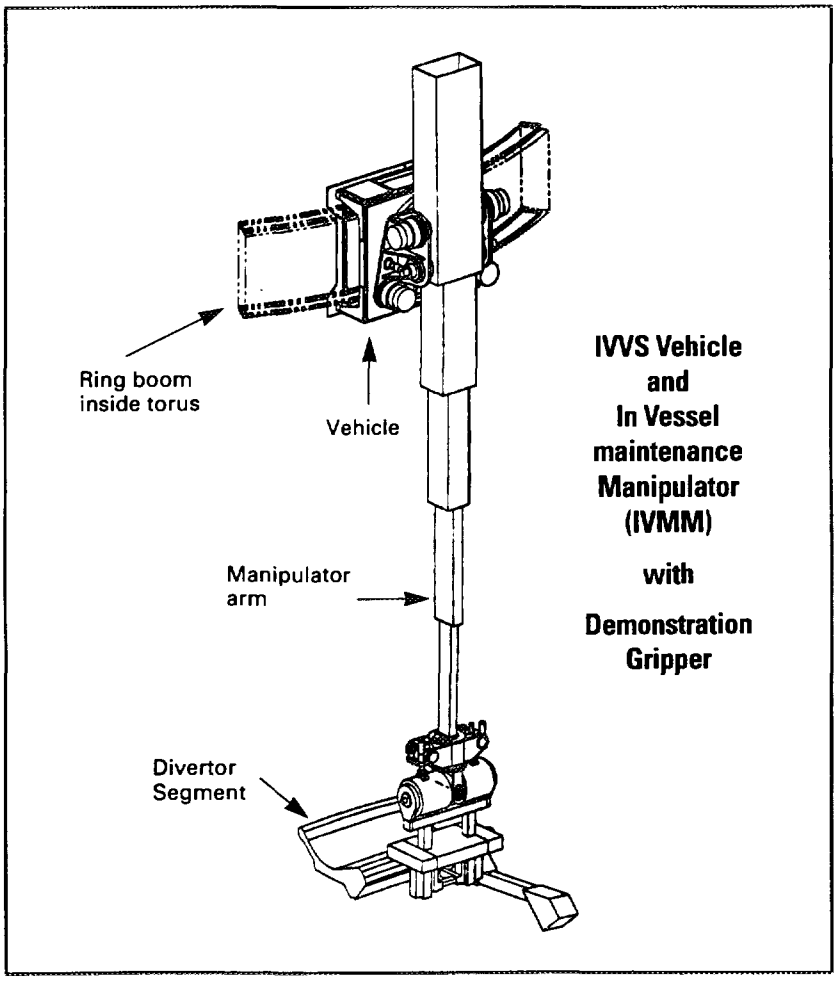
The study is being funded by CFFTP. It will be completed by October this year.

More information from Paul Gierszewski, CFFTP (416) 855-4717.

NET-SPAR-CFFTP

Robotic Maintenance for NET

A robotics design concept for remote maintenance of large fusion test reactors was presented in July to the Next European Torus (NET) by SPAR Aerospace (Brampton, Ontario). SPAR designed the remote maintenance system for NET in collaboration with the Commissariat à l'Énergie Atomique (CEA) of France. NET is Europe's fusion test reactor design project, headquartered at Garching, near Munich, in Germany. The system was designed to remotely maintain the inside of the torus vessel, including replacement of divertor plates. It consists of two ring booms, which are deployed inside the reactor torus when in-vessel maintenance is initiated, with several automated in-vessel vehicles which travel around the ring booms. The vehicles carry the maintenance arms, remote manipulators and tooling. SPAR designed the in-vessel vehicles and high precision maintenance arms under a CFFTP contract. The vehicles and manipulators are designed to handle loads exceeding 1200 kg and place them with a worst-case accuracy of 30 mm fully loaded (5 mm unloaded) with a repeatability of 3 mm. Absolute placement resolution is 0.5 mm. The entire system is designed to operate in radiation levels up to 3 megarads per hour. The diagram shows a vehicle and maintenance arm, riding a section of the ring boom, carrying a divertor plate in the manipulator.



More information from Julian Millard, SPAR Aerospace (416) 790-4486 or John Blevins at CFFTP (416) 855-4721.

INTERNATIONAL

New International Effort:

Environment, Safety and Economic (ESE) Aspects of Fusion Power

Four parties - Canada, Europe, Japan and the USA - have jointly launched a five-year international R&D collaboration to study the environmental, safety and economic (ESE) aspects of fusion power. The collaboration, being conducted under the auspices of the International Energy Agency (IEA), began officially on July 6

with the signing of an IEA Implementing Agreement in Paris. The IEA is an agency of the Organization for Economic Cooperation and Development.

Joint international fusion R&D programs operating under the IEA's auspices are coordinated by its Fusion Power Coordinating Committee (FPCC) through Implementing Agreements, including this new one on ESE matters. Implementing Agreements provide the framework for doing joint R&D work under agreed terms covering matters such as costs, responsibilities and sharing of results.

Canada is a member of two other IEA Implementing Agreements, which cover plasma-wall interactions studies on the TEXTOR tokamak (Germany), and fusion materials R&D. David Jackson, Director - National Fusion Program, represents Canada on the FPCC. Bill Holtslander, NFP Manager-International Programs, represents Canada on the Executive Committee which oversees present and future work under the Implementing Agreement on ESE matters.

The new collaboration was launched to address the generally recognized need for developing methodologies, models and computer codes for assessing the ESE aspects of fusion power. The goal is to generally advance the analytic capabilities needed to perform ESE assessments, such as public risk assessments, of fusion power plant designs as well as the designs of burning-plasma fusion test reactors.

Work Programs.

Specific cooperative work programs, or Tasks, are set out in Annexes to the Implementing Agreement. The first two Tasks have already been initiated. These concern (a) ESE models and computers codes (Annex I), and (b) ESE analysis methodologies and assessments (Annex II). As additional joint Tasks are identified, other Annexes may be put in place to organize them.

ESE Models and Computer Codes (Annex I)

Objectives of this Task are to:

- Jointly establish the data bases required for input to models and computer codes for environmental and safety analyses.
- Cooperate in using test facilities to provide data for codes and validation of codes.
- Perform comparisons of different codes.

Separate work groups will address the following topical sub-tasks: Tritium; Activation products; Plasma-facing materials; Coolants; Plasma disruptions; Magnets; Blankets.

Tritium Sub-Task. Gary Vivian, of the Canadian Fusion Fuels Technology Project (CFFTP), is the Tritium Sub-Task leader. Tritium work programs will include: Tritium Sampling and Measurement; Environmental Models; Environmental Model Validation; Tritiated Organic Compounds; Long-term Databases; Human Dosimetry; Materials Science. Joint work planning has been in progress since 1990.

ESE Analysis Methodologies and Assessments (Annex II)

Technical objectives for this work are to develop environmental and safety design targets and analysis methodologies, and to develop an extensive data base, including failure rate data, on operational experience related to safety.

Further information: Bill Holtslander, NFP, (613) 584-3311 ext. 3241, or Gary Vivian at CFFTP (416) 855-4733.

NEWS NOTES

News Notes *will print update news and late pre-press items. To include an item in this column, contact the editor.*

Compact Toroid (CT) Fueller Operational. By August, the first spheromak plasmas had been made, and accelerated, with the newly-completed CT tokamak fueller built at University of Saskatchewan. Life of the plasmas was 40 μs (design target 33 μs), with good plasma symmetry. The CT fueller will be extensively tested in Saskatchewan through the autumn before shipping to Québec for installation on TdeV to explore the CT fuelling technique.

ETMOD Environmental Tritium Modelling Code Available. The Canadian environmental tritium modelling code ETMOD was recently released for application by interested parties. ETMOD can be used to predict the behaviour and effects of tritium in the environment, including the results of routine or accidental releases of gaseous tritium (HT) and tritiated water vapour (HTO). The code can be used, for example, to predict public doses resulting from a tritium release, as well as to predict tritium holdup in vegetation over a radius of several kilometres around the release point. The code has been developed over the last ten years, and is in use by Ontario Hydro. Data contained in the code include environmental dispersion data obtained from controlled field releases of tritium, as well as laboratory and field data on individual parameters such as deposition velocity and its seasonal variations. More information from Gary Vivian, CFFTP, Telephone (416) 855-4733.

Paul Gierszewski of CFFTP has been elected Secretary-Treasurer of the Fusion Division of the American Nuclear Society. His one year term of office started in June.

Tritium Safe Handling Course (Basic). The Autumn 1992 offering of Basic Tritium Safe Handling Course, to be held October 19-23, has places open. Location is AECL Chalk River Laboratories. Practical work in the laboratory is an aspect of the Course, in addition to lectures. Cost is $3,525 Canadian funds, or US$2,985. Contact Maryann Zito at CFFTP for registration information. Telephone (416) 855-4725, Fax (416) 823-9644.

CFFTP 1991 Annual Report Available. The Canadian Fusion Fuels Technology Project has issued its 1991 Annual Report. The report includes a review of CFFTP's technology development program's and its exports of fusion technology to fusion sites abroad. Copies of the Report are available from Janine Loring, CFFTP Information Coordinator. Telephone (416) 855-4710, or write or Fax (*See Contact Data*).

Available in September - CCFM 1991 Annual Report. Centre canadien de fusion magnétique is currently in the process of printing its 1991 Annual Report. Copies will be available in September. The Report discusses future research plans and experimental programs with TdeV. To receive a copy, contact the CCFM Secretariat (*See Contact Data*).

Physicist **Zhongtian Wang** returns to China in October after a two-year work attachment at CCFM with the Theory Group. "Dr. Wang has contributed much to our investigations of the physics of plasma biasing", said Guy LeClair, CCFM Theory Group leader, adding that he hopes to continue CCFM's informal association in plasma physics theory work with Dr. Wang's home institution in China, the Southwestern Institute of Physics in Leshan, Sichuan Province.

National Fusion Program

Director, *Dr. David P. Jackson*

The National Fusion Program (NFP) coordinates and supports fusion development in Canada. NFP was established to develop Canadian fusion capability, in industry and in research and development centres. NFP develops international collaboration agreements, and assists Canadian fusion centres to participate in foreign and international projects.

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