FusionCanada

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NATIONAL FUSION PROGRAM

Canadian Fusion Funding

Canada's Minister for Natural Resources, the Hon. Anne McLellan, has announced that after March 31 next year (1997), the Government of Canada will cease making funding contributions to Canadian fusion R&D. Natural Resources Canada is the Ministry which provides federal fusion funding, through its program on energy R&D.

Funds from Natural Resources Canada provide 50% of total funding for Centre canadien de fusion magnétique (CCFM) located in the Province of Québec, and the Canadian Fusion Fuels Technology Project (CFFTP) located in the Province of Ontario. The other 50% of the funding for each of these fusion sites is provided by matching funding at the Provincial level.

Numerous representations to Minister McLellan have been made, requesting that the Government of Canada reconsider its decision to curtail federal fusion funding. The representations are being made by parties including Ontario Hydro (which co-funds CFFTP), Hydro-Québec (which co-funds CCFM), and the Government of Québec. A debate on fusion funding was held June 5th in the House of Commons, Canada's federal parliament.

Federal fusion funding is administered by the National Fusion Program (NFP), which is mamaged by AECL on behalf of the Government of Canada. The NFP is also responsible for establishing and maintaining international fusion cooperation agreements, and for arranging participation in international fusion programs such as those of the International Energy Agency and the International Atomic Energy Agency.

Until at least March 31,1997, complete funding for all of Canada's fusion programs is assured.

The federal decision to cease its contributions to fusion R&D funding next year was part of a broad range of cuts in federal spending announced in the March federal budget, designed to reduce the federal deficit. The decision of the Government of Canada does not necessarily exclude continuation of work at CCFM or CFFTP, funded by other means.

In the House of Commons, Minister McLellan stated on June 5th that the National Fusion Program is a good program, but also said that Canada's federal priorities in energy research will in future concentrate on short- and medium-term priorities. She cited energy efficiency research as an example. Minister McLellan stated that her office will assist, as far as possible, parties involved in CFFTP and CCFM to seek alternative funds for these projects.

ITER REMOTE HANDLING

CFFTP Increases its Remote Handling Effort for ITER

Three-year Program has started: ITER L-7 Divertor Maintenance Task

Spar Aerospace to develop equipment

The Canadian Fusion Fuels Technology Project (CFFTP) has increased its remote handling effort for the International Thermonuclear Engineering Reactor (ITER). As a result of requests from Europe's fusion program, CFFTP has agreed to supply design effort and remote handling equipment - over a period of three years - worth about $4 million, for ITER's divertor maintenance program. Canada contributes to ITER through the European Community's fusion program.

A further request from Europe for ITER asks CFFTP and Spar Aerospace to develop a system concept for removal of the 16 large vacuum cryopumps placed in the divertor ducts. These pumps maintain the high vacuum in the large volume of the fusion plasma chamber.

Divertors are large components inside the fusion reactor chamber, designed to remove impurities from the fusion plasma, including the helium "ash" from the fusion reaction itself. As presently designed, the ITER Divertor consists of 60 individual 'cassettes', each weighing several tonnes, arranged in a ring at the bottom of the ITER plasma chamber.

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The new work is for an ITER divertor maintenance program known as ***ITER Task L-7.*** Divertor maintenance trials will be done at the ENEA Brasimone site (Italy) on the new Divertor Test Platform, which is a full scale mock-up of a portion of the ITER reactor. Divertor maintenance procedures and equipment will be developed, and the divertor design tested for maintainability.

The expertise of CFFTP and Spar Aerospace Ltd. will be the core of this expanded effort in divertor maintenance. The agreement with Europe's fusion program to expand CFFTP's remote handling contribution was completed in detail earlier this year. Discussions began last autumn, following a request from Europe's ITER Home Team for CFFTP and Spar to assist with ITER Task L-7. CFFTP and Spar were already supplying remote handling expertise and equipment to ITER, but the new contributions to the ITER L-7 maintenance task represent a substantial increase in effort. The new work began in 1995, while the details of the new remote handling contributions were being finalized. Funding considerations notwithstanding, the work will be completed in 1998, when the last of the equipment is delivered to Italy from Canada, and tested. First hardware deliveries are scheduled for 1997.

Fusion reactors will need sophisticated remote handling equipment and software to do maintenance tasks around and inside the reactor, because of high radiation levels and tritium-bearing atmosphere that will be created by operating the fusion reactor. Divertors are expected to suffer erosion from high fluxes of heat, radiation and plasma particles. They must therefore be designed at the outset with remote maintenance in mind.

CFFTP's remote handling program is dedicated to developing robotic hardware for this purpose, including mechanical equipment, electronics and sophisticated imaging systems. Other CFFTP/Spar remote handling work includes developing a 3-D laser camera imaging system, and radiation hardened electronics.

Technical Description

The main objective of the ITER L-7 divertor remote handling work at Brasimone is to demonstrate that the ITER divertor segments can be maintained and replaced remotely, and that the individual divertor cassettes can be taken to and remotely refurbished in a 'Hot Cell'. Each of ITER's 60 individual divertor cassettes is a self contained operating divertor segment, with its own vacuum and coolant lines, and other pipework, diagnostic and electrical connections.

CFFTP and Spar will design and supply to the Brasimone site:

- A remotely-controlled, self-powered vehicle, called a 'skid', which will enter the vault containing the ITER reactor, and perform a mix of complex tasks involving precise manipulation of parts weighing several tonnes. The skid will use automatic tooling carried on board. Among the tasks to be accomplished are the breaking of a vacuum seal weld on the port covers, the stowing of the cover, installation of a radial rail system, the cutting and handling and re-rewelding of cooling pipes and the removal of the 20-tonne divertor cassettes.
- The software which will define and control the exact work functions of the tooling, the skid, and an on-board manipulator.

To understand the functions of the vehicle, it is necessary to understand the divertor configuration and change-out procedure:

There will be four divertor maintenance ports in the ITER structure and cryostat. Up to 30 of the 60 divertor cassettes can be withdrawn through one port when maintenance is needed. The main actions involved in changing a cassette are:

- Cutting and removal of seal plates and shielding sections in ITER's cryostat and vacuum vessel, at the nearest divertor maintenance port to the cassette requiring attention.
- Cutting and removal of divertor cooling pipes of complex shape on each divertor cassette, using both internal bore cutters and external pipe cutters.
- Radial removal of the first divertor cassette exposed (the central cassette) at one of the four maintenance ports, and its removal to a Hot Cell for refurbishment with other remote equipment.
- Toroidal displacement of each remaining divertor cassette to its adjacent maintenance port, so that all - in turn - can be taken out radially and sent for refurbishing.

Divertor segments will be replaced by the same vehicle, carrying out the operations in reverse order.

Further information from John Blevins at CFFTP, or Julian Millard at Spar Aerospace Ltd.

Blevins: Tel: (905) 855-4721,
Fax (905) 823-8020,
e-mail =
John.Blevins@oht.hydro.on.ca

Millard: Tel: (905) 790-4486,
Fax (905) 790-4506.

NATIONAL FUSION PROGRAM

Gil Phillips Retires from National Fusion Program

Dr. Gilbert Phillips, Manager - International Program for the Canada's National Fusion Program (NFP), retired from AECL (which runs the NFP for the Government of Canada) on May 21 this year.

We extend our profound best wishes to Dr. Phillips in his retirement.

Among his decade-long contributions to Canada's fusion work, Gil Phillips represented Canada for several years, as Canada's executive committee member on the International Energy Agency's *Implementing Agreement on Fusion Materials*. He was Committee Chairman in 1991. Prior to taking responsibility for NFP's International Program, Dr. Phillips was NFP's Manager - Fusion Fuels, responsible for the coordination of NFP with the Canadian Fusion Fuels Technology Project. He came to the NFP in 1986 after an assignment at AECL's Head Office in Ottawa where he worked in the Business Development Office.

Dr. Phillips joined AECL as a reactor physicist in 1957 after obtaining his Ph.D. in nuclear physics at the University of British Columbia. In the early portion of his career Gil worked on the design and optimization of fission reactors, and contributed materially to development of reactor-related computer codes. Among his many happy memories of a long career, he fondly remembers his attachment, in 1969-1970, at Britain's UKAEA Winfrith site in Dorset, where he was responsible for transferring the WIMS system of reactor codes to AECL.

CFFTP - Canadian Fusion Fuels Technology Project

Paul Gierszewski of CFFTP Wins FPA Award for 'Excellence in Fusion Engineering'

Paul Gierszewski, coordinator of the Fuel Cycle R&D program at the Canadian Fusion Fuels Technology Project (CFFTP) has won the 'Excellence in Fusion Engineering' Award, given out each year by the USA's *Fusion Power Associates* (FPA) organization.

He was presented with the Award by Dr. Stephen O. Dean, President of FPA, on May 30 at the FPA 1996 Annual Meeting in Pleasanton, California.

In presenting the Award, Dr. Dean announced that "Dr. Gierszewski is recognized for his outstanding technical contributions to numerous projects, including ITER, FINESSE, NET, ARIES, TIBER, TITAN, TPSS and PILOT. The FPA Board also recognized his leadership skills as evidenced by his current responsibilities to oversee CFFTP fusion fuelling technologies and Canadian contributions to ITER".

The Award will also presented this year to Gregory Denisov of Russia's Institute of Applied Physics, for his work in developing millimetre-wave sources and transmission lines for electron cyclotron resonance heating in tokamaks.

Fusion Power Associates, based in Maryland, USA, is an educational and research foundation established to foster the timely development and acceptance of fusion energy. Among its activities, FPA takes part in fusion policy review in the USA, hosts scientific and technical conferences, and has a keen interest in helping educating the public about fusion power.

To contact FPA:
Dr. Stephen O. Dean
or Ruth Watkins
Fusion Power Associates
2 Professional Drive
Suite 248
GAITHERSBURG, MARYLAND
20879 USA

Tel: (301) 258-0545
Fax: (301) 975-9869
e-mail:
72570.707@Compuserve.com.

Paul Gierszewski may be contacted at CFFTP: Tel: (905) 855-4717, Fax (905) 823-8020, e-mail = paul.gierszewski@oht.hydro.on.ca

CCFM - Centre canadien de fusion magnétique

Study Available:

Socio-Economic and Technological Spinoffs of Fusion Research

Study of CCFM/TdeV and Associated Companies

"Considerable and Diversified" Positive Benefits Found

Michel Trépanier of Québec's *Institut National de la Recherche Scientifique* (INRS) has completed a two-year study of the social and economic benefits arising from Canada's tokamak fusion research site, Centre canadien de fusion magnétique (CCFM), where the TdeV tokamak is located. The study is available from CCFM as a 20 page summary report in both English and French. The full study (French only) is available from *INRS-Énergie et Matériaux* or from CCFM. Dr. Trépanier is an economist, and a noted specialist in the social, economic and technological

impacts of science and technology programs. He is with *INRS-Urbanisation*, one of the three INRS research centres affiliated with Université du Québec.

This study, its results, and its innovative methodology, may be of interest to other fusion sites.

Michel Trépanier has also published a book about the conception, building and operation of the CCFM/TdeV project: ***"L'Aventure de la fusion nucléaire: La politique de la 'Big Science' au Canada"***, published by Boréal.

Conclusions of the study

Dr. Trépanier and his colleague studied CCFM itself, as well as 19 commercial companies and three research institutions. The following observations are among the study's numerous conclusions:

- One third of the companies saw their exports increase significantly in the wake of their contracts with CCFM.
- 18 of the 19 companies definitely increased their technological capabilities as a result of supplying goods, services and expertise to CCFM. Without doubt this expanded capability enabled them to obtain other technology-related contracts in the general market place, that would not have been available to them without the benefit of their work for CCFM. When a company representative was stationed at CCFM, the technology transfer to that company was greatest. The simple fact of supplying CCFM, a prestigious science project, with custom equipment enhanced the credibility and reputation of the company, and helped it to secure other business.
- The majority of increased commercial business was outside the fusion sector itself.

Examples of custom goods and services supplied to CCFM by local companies include:

- complex microwave antennas.
- plasma spraying of refractory metals such as tungsten.
- computer control and data acquisition systems using fibre-optic data paths and special VLSI multiplexer chips.
- high-power tokamak power supplies with very fast real-time voltage and current control.

To obtain the summary report, contact:
Dr. Richard Bolton, Director, CCFM.
Tel: (514) 652-8701, Fax (514) 652-8625,
e-mail = bolton@ccfm.ireq.ca

The Summary Report:

English edition: **"Evaluation of the Socio-Economic and Technological Spinoffs of the Centre canadien de fusion magnétique"**, Michel Trépanier and Sophie-Héléne Bataïni. (Quote CCFM report number CCFM RI 457e).

or

French edition: **"Évaluation des retombées socio-économiques et technologiques du CCFM - Rapport synthèse"** (Quote CCFM Report no. CCFM RI 457f).

UNIVERSITY OF SASKATCHEWAN

Saskatchewan Plasma Group Update

STOR-M Tokamak

In May, Akira Hirose, head of the University of Saskatchewan Plasma Group, reported these events.

Experiments on STOR-M tokamak

Experiments in progress:

- Compact torus (CT) fuelling injection, with variable-injection-angle CT injector.
- AC tokamak operation.
- Segmented limiter plasma biasing.
- Density fluctuation measurements with microwave reflectometry.

Planned experiments:

- Plasma edge electron injection, to attempt to induce ohmic H-mode.
- Microwave cross-polarization scattering for measuring magnetic fluctuations.
- MHD stability of sustained skin current profile.

Collaboration

Akira Hirose recently spent a month at JAERI Naka site, Japan, as Distinguished Foreign Researcher. He collaborated with JAERI staff on kinetic ballooning mode in tokamaks. He was also invited to lecture in May, on magnetic fusion research, at Tokyo Metropolitan Institute of Technology. His collaboration with O. Mitarai (Kyushu Tokai University, Japan) on AC tokamak operation continues.

Tokamak Plasma Theory

Recent investigations include:

- Ion temperature gradient-driven kinetic ballooning mode in negative shear region.
- Drift stability of hot ion modes.
- Drift stability of negative shear tokamak discharge.
- Strong isotope effect of the edge ballooning mode (collisionless electromagnetic mode operative at ß well below $ß_{MHD}$).

Andrei Smolyakov now works with the U. Saskatchewan plasma group as a faculty member; he is an expert on non-linear MHD in tokamaks.

Further information from Prof. Akira Hirose:
Tel: (306) 966-6414,
Fax: (306) 966-6400,
E-mail: hirose@sask.usask.ca

WORLD WIDE WEB

World Wide Web Fusion Sites in Canada

- CFFTP
- CCFM
- INRS
- U. Saskatchewan

Below are brief descriptions of the World Wide Web sites for Canada's two key fusion centres, the Canadian Fusion Fuels Technology Project (CFFTP) and Centre Canadien de fusion Magnétique (CCFM).

CFFTP

Canadian Fusion Fuels Technology Project

http://www.cfftp.com

The four main sections on this web page are:

About the Canadian Fusion Fuels Technology Project. A brief overview of CFFTP and its mission.

What is Fusion Energy? A fusion primer, suitable for high school and undergraduate students. Topics: *What is Fusion Energy?; Status of Fusion Energy Research; Fusion Fuel Supply; Fusion Fuel Cycle; Tritium; ITER.* Links provided to the three ITER Joint Work Sites.

What is CFFTP doing? Provides on-line versions of CFFTP Journal, CFFTP's newsletter, and a listing of all general-release technical reports from CFFTP for the last five years. Select reports and order them by e-mail from CFFTP.

Canadian ITER Siting Group Home Page. A link to this group's web site.

General enquiries about CFFTP: E-mail your enquiries to

cfftp@cfftp.com

CCFM

Centre canadien de fusion magnétique

http://ccfm.ireq.ca

The four main sections on CCFM's Web site are:

CCFM: Information on the Centre and its personnel. This sections includes: *Description of CCFM's scientific program; Descriptions of collaborations with other fusion sites* (with links to many collaborating sites in Canada and abroad); A directory of CCFM personnel with e-mail and other contact data.

TdeV: Overview of the machine and its diagnostics. This comprehensive section includes downloadable MPEG video clips of plasma discharges on the TdeV tokamak. Other information includes: *TdeV characteristics; Pictures of the TdeV and some associated systems; Diagnostics; Upgrade activities (for TdeV-96).*

CCFM/TdeV Research Projects: This section provides: *Descriptions of main research projects; Research highlights and recent interesting results; A list of Publications by CCFM researchers since 1988.*

Fusion Topics: General fusion topics and link to other sites.

Note that CCFM's ***IAEA Fusion Energy Conference*** web page must be accessed directly, and not via this main CCFM site (*see separate article*).

Other Fusion Centre Sites

Two other Canadian fusion-related Web sites are:

- **INRS-Énergie et Materiaux**

http://www.inrs-ener.uquebec.ca/inrs
INRS-Énergie et Materiaux, a research institute of University of Québec, is a joint venture partner in CCFM. INRS provides a number of senior research staff for CCFM, and has it's own independent fusion-related research programs.

- **University of Saskatchewan Plasma Physics Laboratory.**

http://physics.usask.ca/grad/plasma.html

IAEA FUSION CONFERENCE

Canada Hosts 1996 IAEA Fusion Conference

Montréal, October 7 - 11

16th International IAEA Fusion Energy Conference

Canada is proud to be the host country this year for the ***16th International IAEA Fusion Energy Conference.*** The Conference is being held in the centre of Montréal, at the *Palais de Congrés*, Montréal's foremost conference centre. Arrangements in Montréal are being made by the Centre canadien de fusion magnétique. This notice is to remind participants of the Conference dates, and advise them of the Conference's location.

The IAEA (International Atomic Energy Agency) fusion energy conference is held every two years in a member state of the IAEA.

Canada's fusion projects and the National Fusion Program look forward to welcoming participants in the Conference, and their partners, in Montréal. In the light of the rapid advances in fusion technology and physics since the 1994 IAEA Fusion Conference in Seville, this should be an exciting meeting, with much to report. Early registration and a Welcome Reception will be held on Sunday October 6th.

During the Conference, a visit to CCFM and the TdeV-96 tokamak is offered to participants and their partners on Tuesday October 8th in the evening.

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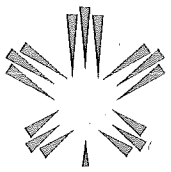

IAEA FUSION CONFERENCE

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Conference World Wide Web Site at CCFM

A World Wide Web Internet site for the conference can be used now. Hotel rooms can be reserved through this Web page via an electronic reservation form, and the information on the scientific and technical program for the Conference is provided. This IAEA Fusion Conference Web site is available at:

http://ccfm.ireq.ca/congres

Within the web site, a comprehensive directory of all Conference arrangements and programs is available. These include social programs, hotel information and information about Montréal, as well as the scientific and technical programs, general Conference arrangements and hotel reservations form. The scientific and technical programs will be given in as much detail as possible, as the information becomes available and can be posted to the web site.

Please note that the Conference web site cannot be reached from CCFM's main world wide web site *http://ccfm.ireq.ca.* Please go directly to the **http://ccfm.ireq.ca/congres** web site URL with your Internet web browser program.

Further information from Raymonde Hubert, Administrative Assistant to CCFM Director Richard Bolton. Tel: (514) 652-8702, Fax: (514) 652-8625, e-mail = hubert@ccfm.ireq.ca

CFFTP Annual Report Available

CFFTP has released its Annual Report for 1995. The Report describes progress in all of CFFTP's technical programs.

For a copy, contact Janine Loring at CFFTP, Tel: (905) 855-4710, Fax: (905) 823-8020, e-mail = Janine.Loring@oht.hydro.on.ca

National Fusion Program

Director, *Dr. David P. Jackson*

The National Fusion Program (NFP) co-ordinates 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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'FusionCanada' Bulletin

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Contact Data

National Fusion Program

National Fusion Program
AECL
Chalk River Laboratories
Station E4A
Chalk River, Ontario
Canada K0J 1J0

Dr. David Jackson
Director – National Fusion Program
(613) 584-8035
Fax: (613) 584-4243

CCFM
Centre canadien de fusion magnétique

CCFM
1804, boul. Lionel-Boulet
Varennes, Québec
Canada J3X 1S1

Dr. Richard Bolton
CCFM Director-General
(514) 652-8701

Dr. Réal Décoste
CCFM Director-Operations
(514) 652-8715

Dr. Brian Gregory
CCFM Director-Research
(514) 652-8729

Secretariat: (514) 652-8702
Fax: (514) 652-8625

CFFTP
Canadian Fusion Fuels Technology Project

CFFTP
2700 Lakeshore Road West
Mississauga, Ontario
Canada L5J 1K3

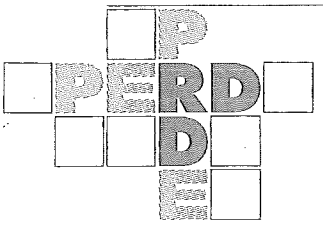
CFFTP Program Manager
Robert Stasko
(905) 855-4700

Enquiries: (905) 855-4701
Fax: (905) 823-8020

FusionCanada Office

Macphee Technical Corp.
80 Richmond Street West
Suite 1901
Toronto, Ontario
Canada M5H 2A4

Telephone: (416) 777-1869
Fax: (416) 777-9804



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