FusionCanada

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Tritium

Canadian Tritium Availability

Canadian tritium is now available for export for approved end uses including government-sponsored fusion energy research.

The Government of the Province of Ontario has authorized Ontario Hydro to sell tritium produced by its Darlington Tritium Removal Facility (TRF). On August 30, Provincial Energy Minister Lyn Mcleod announced the Ontario Government's approval of tritium sales by Ontario Hydro, adding that any tritium sold ".. will be used for peaceful purposes only".

Minister Mcleod said that three end uses for the tritium were acceptable:

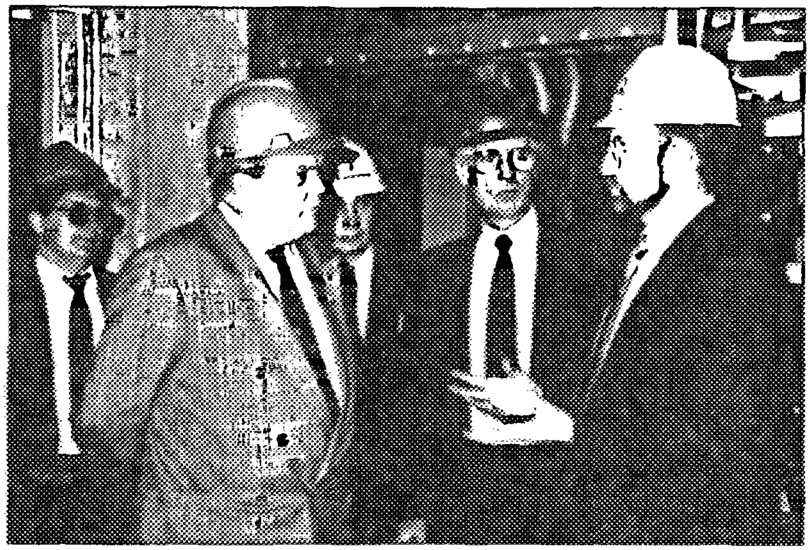
- Government-sponsored fusion energy research.
- Medical research.
- The manufacture in Canada of self-powered tritium lights.

Ontario Hydro produces tritium at its Tritium Removal Facility (TRF), located at Darlington Nuclear Generating Station. The plant removes tritium from tritiated heavy water in the moderators of its CANDU nuclear power reactors. The TRF has a rated capacity of about 2,500 grams of tritium per year, with tritium concentration in the feed of 10 Curies per kilogram of heavy water. Annual output may be greater, depending on the actual feed tritium concentration. The TRF produced its first tritium in mid-1988. Ontario hydro has 16 operating CANDU power reactors, with four more being built at Darlington.

Atomic Energy of Canada Limited (AECL) owns Canada's second plant, the Chalk River Tritium Extraction Plant (TEP) located at AECL's Chalk River Nuclear Laboratories. The TEP was built to extract tritium from tritiated heavy water in its own heavy water moderated research reactors. Construction of the TEP is complete; it is being commissioned now and is scheduled to be in service by late 1990. The plant's rated capacity is about 150 grams per year, with a feed concentra-

Continues inside

Velikhov visits CCFM



During his November 9 visit to CCFM, Soviet fusion physicist Evgeny Velikhov (front, left) listens as Réal Décoste of CCFM (front, right) explains power supply operation on Tokamak de Varennes in the Tokamak's power equipment room.Mr Velikhov was accompanied by colleague Yury Schyan (left, rear). Richard Bolton and Brian Gregory (at back) of CCFM escorted the party. Mr. Velikhov is Deputy Chairman of the Soviet Academy of Sciences and Director of the I.V. Kurchatov Institute of Atomic Energy, Moscow. He and Mr. Schyan took the opportunity for an unscheduled visit to CCFM while in Canada on a tour of universities. Mr. Schyan is Director of International Relations (North America) for the Soviet Academy of Sciences.

Continued from front page

tion of 10 Curies per kilogram. Like the Darlington TRF, the TEP could produce more with a higher tritium concentration in the feed.

The two tritium plants were built to enhance general occupational radiation safety at Canada's heavy water reactor sites. Operating heavy water reactors routinely build up tritium as deuterium-tritium-oxide (DTO) in their heavy water coolant and moderator through neutron capture by deuterium atoms in the heavy water. The moderator water, which can accumulate tritium to levels of tens of Curies per kilogram during several years of normal reactor operation, is used as the feed to the tritium extraction plants. Tritium is extracted with high efficiency, and stored as a metal tritide, from which tritium gas (T_2) can be recovered.

Government of Canada Regulations

Tritium is subject to export control under Canada's Export and Import Permits Act and the Atomic Energy Control Act, both of which provide the basis for the implementation of Canada's nuclear non-proliferation policy. In anticipation of Canada's tritium being put to research or commercial use, the Government of Canada, through the Atomic Energy Control Board, published in 1986 Notice number 86-5 governing the export of tritium and tritium-related technology. Sales of Canadian tritium outside Canada require an export permit to be issued in accordance with the Guidelines contained in that notice. In part, Notice 86-5 indicates that government-sponsored fusion energy research outside Canada is an eligible end use for Canadian tritium. The Atomic Energy Control Board is Canada's national nuclear regulatory agency.

Fusion Use

It is the policy of The National Fusion Program and its key project centres to assist and participate in international fusion energy research. The use of Canadian tritium in government-sponsored fusion energy research is consistent with that policy.

The Canadian Fusion Fuels Technology Project (CFFTP) may be contacted regarding fusion-related exports of Canadian tritium. As well as direct sales for fusion-related applications, CFFTP would consider supplying tritium as part of exporting Canadian fusion-related tritium systems.

Further information [illegible] Donald Da[illegible]

ITER Update

The 1989 ITER Summer Work Session ended October 23. This year, it was decided to increase the major radius of the ITER torus to 6 metres, from 5.5 metres. Analyses conducted over the winter with last year's reference design, which had a 5.5 metre major radius, indicated some uncertainty whether the central solenoid was large enough to provide, with a high degree of assurance, the 325 volt-seconds now considered necessary to achieve ohmic ignition of the ITER plasma. To house a larger central solenoid without unduly weakening the reactor structure, the major radius was redefined at 6 metres. This has required some changes in magnet and reactor vessel configuration.

The ITER team has estimated the construction cost for ITER as US$3,750 million (October 1989 estimate), not including engineering or equipment installation costs.

The present reference reactor design includes neutral beam (NB) plasma heating, and radiofrequency (RF) plasma heating/current drive at electron cyclotron (EC) and lower hybrid (LH) frequencies. Maximum foreseen values of some ITER reactor parameters (as of October 23) are:

- Max. Toroidal field = 13.5 Tesla.
- Poloidal Beta = 0.6.
- Max. injected RF power (EC) = 20 MW at 140 GHz.
- Max. injected RF power (LH) = 45 MW at 5-6 GHz.
- Max. injected NB power = 75 MW at 1.3 MeV beam energy.
- Peak electric power required (reactor systems and magnets) = 290 MW.

Canada has continued its ITER contributions, and will continue to do so. Here are some examples of contributions this year:

- Canada's ETMOD environmental tritium dispersion code is one of two benchmark codes to used to evaluate off-site tritium releases. The other code is from KfK Karlsruhe.

- The hydrogen isotope separation system designed by Sood et al. (see FusionCanada issue 7, May 1989) has been adopted as the ITER reference design, as part of ITER's Fuel Storage and Preparation system.

- Al Dombra of AECL Chalk River has prepared on behalf of the EC ITER Team a complete preliminary design for an atmospheric detritiation system. The design is based on using catalytic converters for HT-to-HTO conversion, and sorption of HTO in regenerable molecular sieve desiccant beds.

Other areas of Canadian ITER contributions this year have included safety philosophy and analysis, plant and reactor system integration, plant layout and design, blanket and remote handling.

Canada contributes to ITER through the European Community. Canada is represented on the European ITER team by Robert Stasko of CFFTP; he will continue to represent Canada in the ITER Winter and Summer 1990 work sessions at Garching, FRG.

Further information from Robert Stasko, CFFTP (See Contact Data)

Centre canadien de fusion magnétique

CCFM Update:

▪ Tokamak Upgrade News
▪ New Team Organization

In September, CCFM announced a re-organized staff structure. We introduce the key team members in this issue.

Richard Bolton continues as head of CCFM, with the new title of Director-General. Georges Wilson is formally appointed as Manager–Administration.

Réal Décoste is newly appointed as Director of Operations. He and his section heads are responsible for ensuring that the tokamak is available and operating, in the appropriate technical configuration, to meet experimental program needs. The group's other chief responsibilities are execution of generic and specific tokamak research programs, and the planning and execution of tokamak upgrade programs.

Brian Gregory is newly appointed as Director of Research. He and his section heads plan and execute experimental and theoretical research programs including plasma-wall interactions, plasma edge work, and impurity and particle transport. (See Fusion-Canada Issue 7, May 1989 for a summary of the 1989-1991 experimental program.)

"The new team structure is the best one for scientifically exploiting Tokamak de Varennes, and systematically meeting the science and technology objectives of our updated Global Plan", said CCFM Director-General Richard Bolton, in October. The CCFM Global Plan is the comprehensive experimental and facilities plan, revised earlier this year, for exploitation of Tokamak de Varennes. The new structure also reflects the establishment of CCFM as an autonomous establishment, after being administered by Hydro-Québec in its formative years.

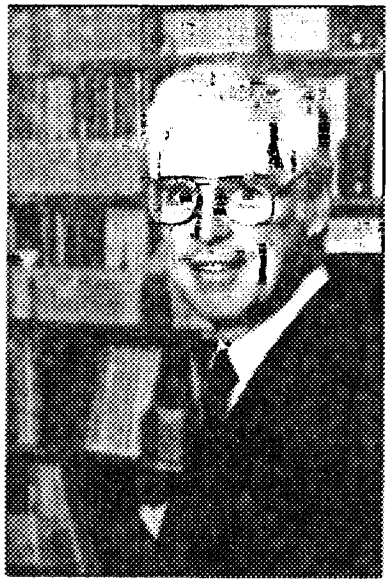
Tokamak Upgrade Progress.

Installation of closed divertors and a fast horizontal plasma position control system on Tokamak de Varennes is progressing steadily. Installation work should be complete in mid-December, to be followed by about two months of commissioning. First plasma with divertors could be achieved in the first quarter of 1990.

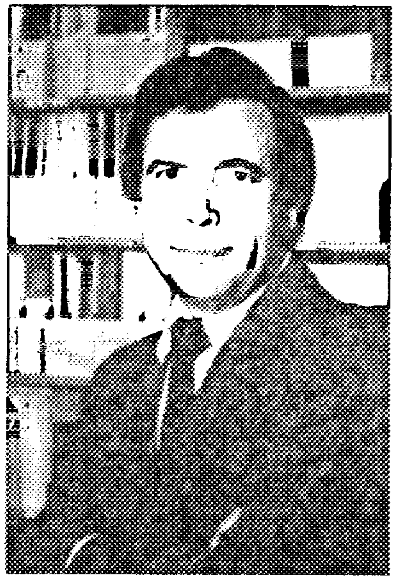
The conceptual design for the proposed lower hybrid plasma current drive (LHCD) undergoes a design review on December 11 by a committee of experts in current drive. Reviewing the design are Stefano Bernabei (PPPL, USA), Gian-Franco Tonon (Tore Supra, Cadarache, France), Claude Gormezano (JET, UK) and Charles Daughney (NFP). Work on prototypes and development of some components are expected to begin following this review.

Further information from Richard Bolton, Brian Gregory or Réal Décoste (See Contact Data)

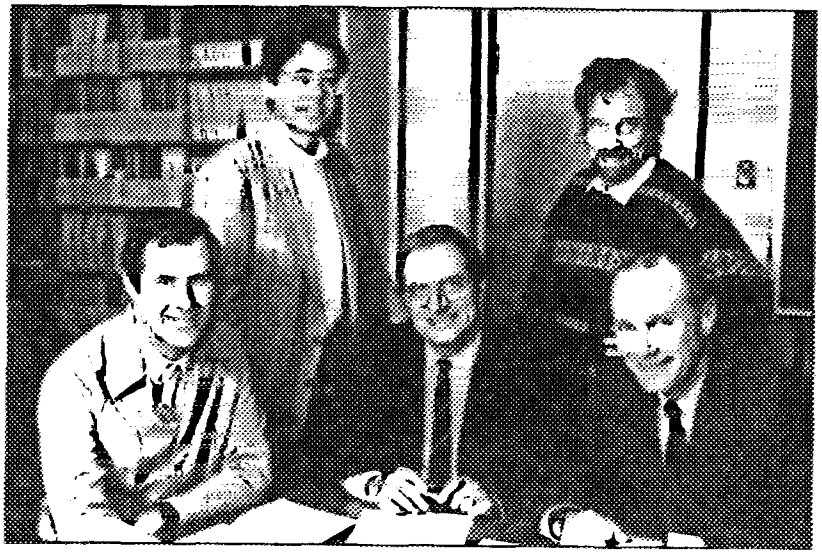
Richard Bolton
CCFM Director-General



Georges Wilson
Manager-Administration



Research Group Section Heads



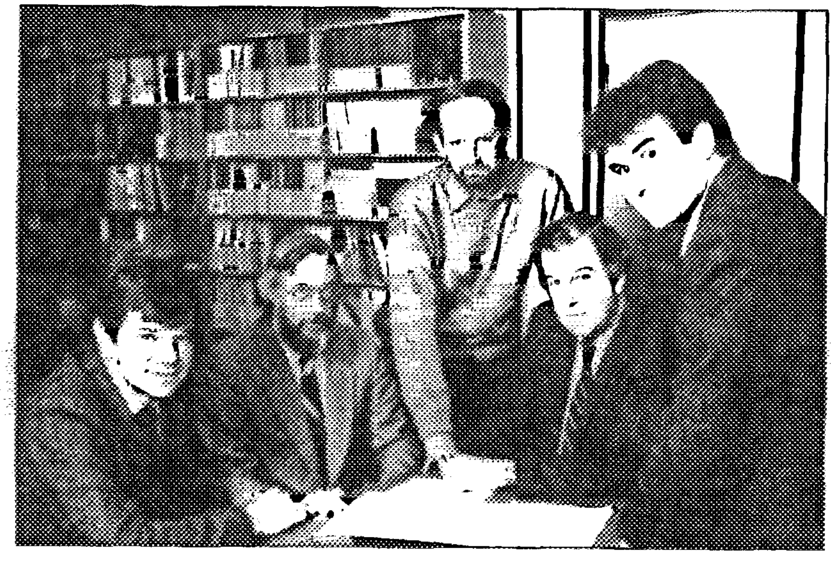
Left to Right, Front:
Barry Stansfield; *Plasma edge.*
Guy Le Clair; *Theory and analysis.*
Brian Gregory.

Left to Right, Back:
Jean-Louis Lachambre; *Impurities and transport.*
Bernard Terreault; *Plasma-wall interactions.*

Brian Gregory
Director of Research

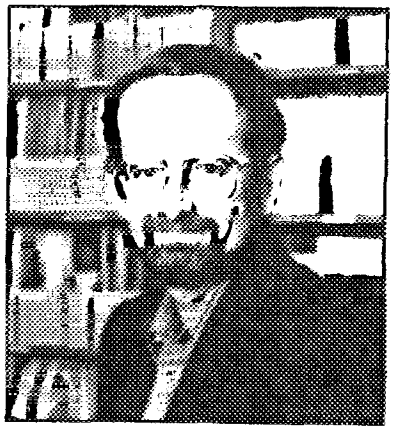
"CCFM's first task with the upgraded tokamak is to explore plasma behaviour with the closed divertors and fast position control system."

Operations Group Section Heads



Left to Right:
C. Richard Neufeld; *Diagnostics I.*
Jean-Marc Larsen; *Data acquisition and control.*
Réal Décoste (also interim Section Leader—Technical Services).
Pierre Couture; *Machine operations.*
Yves Demers; *Radiofrequency systems.*

Réal Décoste
Director-Operations



"The Operations and Research groups work together as one integrated team, with common scientific objectives."

Fusion in China

Bill Holtslander (National Fusion Program) and Kam Wong (CFFTP) visited four fusion Sites in the People's Republic of China during April 28—May 8 this year, at the invitation of Professor Qui Li-Jan, Deputy Director of the Institute of Plasma Physics, Hefei. The following notes and impressions of the Chinese fusion effort may be of interest to our readers.

China has been doing fusion research for several decades, and work today continues on a broad front. There is also an emphasis on applying fusion, strongly linked to China's fission reactor program. A national effort is in progress to design a fusion-fission hybrid machine, using fusion neutrons to breed fission reactor fuel as well as tritium to sustain the fusion machine. Some Chinese scientists offered the opinion that such a hybrid machine, a net power user and not achieving self-sustaining fusion, would have more moderate physics and engineering demands than a self-sustaining fusion device, and so might possibly be built sooner than an igniting fusion power reactor. In producing fission fuel, the hybrid would provide a net energy gain. At present, there are two alternative tritium breeder blanket design programs for the hybrid, one based on a liquid lithium breeding medium and the other on a lithium ceramic breeder. Key experimental programs in support of hybrid reactor work include in-situ tritium recovery from breeder materials, plasma exhaust purification, neutron radiation damage in materials and fusion blanket neutronics.

The hybrid reactor effort falls under the Energy Section of China's National High Technology Program. An Expert Committee in the Energy Section controls energy technology R&D which includes work on fast breeder and HTGR fission reactors and advanced coal energy, as well as the fusion work.

In general, Chinese fusion workers are interested in integrating their work into world fusion work, and accordingly are attending to areas such as high power ICRF plasma heating, where other countries do not have big programs. China is planning to build during the next decade a tokamak with exceptionally high heating power density, in the MW/m^3 range, using radiofrequency heating.

Sites Visited

Institute of Plasma Physics Academia Sinica – Hefei. The conceptual design group at this institute (IPP) plays a major role in designing IPP's approach to the hybrid reactor, called FFFF (Fusion-Fission Fuel Factory). The IPP approach includes a solid lithium ceramic breeder blanket. Other special interests include ICRF plasma heating, neutral beam technology and superconducting magnets, with experimental work on fields up to 20 Tesla and the manufacture of high temperature superconductors.

IPP has two well-equipped small tokamaks, HT6 and HT6M, and is planning a new mid-sized tokamak called HT-U, to be designed and built almost completely on site. The Institute has excellent fabrication facilities, and exports fusion hardware. IPP is building a new vacuum vessel for the TEXT tokamak at the University of Texas, under a commercial contract.

Southwest Institute of Nuclear Physics and Chemistry – Mian Yang. Fusion work at the Institute (SWINPC) has two main themes; tritium breeding research with lithium ceramics and plasma exhaust processing. The tritium breeding work includes irradiation of lithium aluminate in their 3.5 megawatt pool-type reactor, using both sealed sample capsules and recirculating sweep-gas capsules.

SWINPC is building an experimental plasma exhaust tritium recovery system, with both palladium diffuser and cryosorption trains for separating mixed hydrogen isotopes (H,D,T) from other gases and impurities. Hydrogen isotopes are separated by gas chromatography. Glass microspheres are charged with DT gas for inertial confinement fusion experiments at another institute. SWINPC also makes titanium tritide targets for accelerators, which they can sell to other countries.

Southwest Institute of Physics – Leshan. This Institute (SWIP) is devoted entirely to fusion work. It has three fusion research themes; tokamak research, mirror machine research, and fusion technology. Conceptual design of fusion-fission hybrids with liquid lithium breeders dominates fusion technology work, coupled with a supporting experimental program. Conceptual designs are finished for an experimental hybrid machine and a production fuel-producing device. A liquid lithium loop is planned for 1990 to study materials compatibility and MHD effects. SWIP's HL-1 tokamak has similar scientific objectives to the Canadian Tokamak de Varennes at CCFM, Québec.

Institute of Atomic Energy – Beijing. The main programs are in nuclear physics, fusion, isotope research and nuclear reactor engineering. In fusion-related work, the Institute is interested in tritium breeder research and hydrogen isotope separation, and has an inertial confinement program.

Inertial Confinement Fusion

Laser Fusion Project

A proposal for a national laser fusion laboratory is being prepared by a project group in the province of Alberta, under the technical direction of Dr. A. Offenberger. The proposal is centred around using the Krypton Fluoride (KrF) laser equipment loaned to the University of Alberta by Lawrence Livermore National Laboratory in the United States. The R&D program of the proposed laboratory would focus on development of laser equipment including electron-beam excited amplifiers, ultraviolet laser optics and laser beam smoothing techniques. The accompanying research program would include experimental and theoretical studies of laser/target interaction to determine the feasibility of direct drive inertial confinement fusion using high power KrF amplifiers.

Financial support for the preparation of the project proposal has been provided by the National Fusion Program, Alberta Research Council, and three Alberta Government departments: Energy; Environment and Technology; Research and Telecommunications. The project will be managed by a Foundation which includes University of Alberta, the Northern Alberta Institute of Technology and several associations representing the private sector. Dr. Clem Bowman, President of the Alberta research Council, is serving as interim chairman of the Foundation.

Further information from Alan Offenberger (403) 451 9500.

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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Contact Data Update:

The following changes have already been made. Please change your records.

New National Fusion Program Office FAX number is (514) 584-4243

New Postal Code for CCFM-Tokamak de Varennes is J3X 1S1