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The Secretary,
House of Representatives Inquiry into Australia's International Research Collaboration
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Submission to the Inquiry into Australia's International Research Collaboration

The Australian ITER Forum includes over 150 Australian scientists and engineers from universities, Government research laboratories and industry, who support an Australian involvement in the international development of fusion energy via participation in the world's largest science project, the International Thermonuclear Experimental Reactor ITER. This is one of the "Gold Standard" international projects of this century and the Forum believes it is in Australia's interests, both scientifically and in terms of our long term energy security, to have some involvement in the ITER undertaking.

ITER is designed to demonstrate the technical and scientific feasibility of fusion power, which promises virtually limitless energy for the future. Fusion, a reaction first discovered by the Australian Sir Mark Oliphant in 1934, is the fundamental process that powers the Sun and the stars. In ITER and successor power plants, isotopes of hydrogen – the most abundant of the elements, will fuse to produce helium, an inert gas, and releasing an energetic neutron, whose energy will be harnessed to generate electricity.

Successfully taming nuclear fusion offers clean, base-load sustainable power generation, virtually free of greenhouse emissions. The fusion process itself generates zero greenhouse gas emissions, acid rain or particulates. Almost all emissions are derived from the construction and processing of materials and fuel used in the reactor. Unlike fission, the direct products of fusion are not radioactive. Rather, radioactivity is generated indirectly, by neutron activation of the first wall and vessel structure. Employing present-day technology, the materials used in a fusion power plant which become radioactive could be completely recycled within 100 years of shutdown. Fusion is also intrinsically safe. There can be no chain reaction, explosions or meltdown. At worst, a loss of magnetic confinement will damage the first wall of the system. Magnetic confinement fusion cannot be used as a weapon, or in weapons development.

The attractive features of fusion have inspired governments representing half the planet's population to invest over US$18bn to build and operate the ITER experiment. Everything about the ITER project is a grand challenge: the science questions it will answer, the technology and engineering needed to construct it, and the international negotiation, policy and global management issues it creates. . It will define not only fusion energy development over the next 30 to 40 years, but become the textbook for large scale international science.

Under the "ITER Broader Approach", two of the seven ITER partners (the EU and Japan) have also drawn up plans for the post-ITER development of fusion power with a demonstration reactor, DEMO. The ITER Broader approach also includes the International Fusion Materials Irradiation Facility (IFMIF), a high current linear accelerator in which materials that will be developed for the ITER device will be tested. The research outcomes of ITER and the ITER Broader approach will guide design of a prototype power plant, and design roadmaps envisage that fusion will become a commercial technology in the second half of this century.

At this stage, Australia is not part of the ITER partnership. The benefits to Australia for engagement are multi-fold and include: participation in global efforts to find a technological solution to mitigate climate change; scientific kudos and leadership; capability development and retention of skills; potential contract opportunities for Australian industry; and maximisation of the value of Australia's mineral resources of strategic importance to fusion. Perhaps the most significant is that without an Australian engagement in ITER the long term viability of the research activity in Australia is in jeopardy, and so the nation may lose the ability to harness opportunities during the commercial exploitation of fusion power.

In this submission we make several points about international engagement:

- The International Science Linkages program was of great benefit to the Australian fusion science community in terms of fostering valuable exchanges of people and knowhow.
- There is no engagement agency between the Australian government, domestic research community, and international consortia for large scale international science.
- There is no Australian research provider for projects on the scale of ITER.

We believe that these issues can be addressed by evolving the International Science Linkages program to cater for both short time frame projects and larger scale endeavours such as the ITER project. The new program might coordinate policy response from the Australian government on large scale international science engagement, act as the single point of government contact, assess applications, and have an advisory function to government. For successful projects the entity should also be the legal authority for international projects, and fund the totality of Australian research needs.

In the remainder of this submission we limit our attention to the fusion science and engineering and address the terms of the inquiry. Representatives of the Australian ITER Forum would be willing to speak to the Inquiry if requested. We thank the Lower House Parliamentary Committee for this opportunity to comment.

Yours Sincerely,

M.J. Hole

Dr Matthew Hole

Chair, Australian ITER Forum

Detailed Submission: Inquiry into Australia's International Research Collaboration

With regard to fusion science, the terms of reference of the inquiry are largely addressed by the Australian ITER Forum's August 2007 strategic plan "A strategy for Australian fusion science and engineering: Through ITER and into the future," which we have attached, together with letters of support. The strategic plan was developed over a 12 month period, drawing input from the international and domestic research community, as well as government departments and industry. The plan articulates the opportunities and benefits presented to Australia by joining other nations in the development of fusion power, and proposes a new, multi-faceted Australian Fusion Initiative ("the Initiative") that spans the innovation system as it pertains to strategic research, innovation and industry involvement. This Initiative, if supported, secures Australian scientific expertise with a targeted fellowships scheme, provides appropriate support for Australian fusion science infrastructure, and advances Australian industry capabilities through a formal engagement with, and a contribution to, ITER.

We have addressed the terms of reference of the committee as follows:

1. The nature and extent of existing international research collaborations.

Australia has a strong presence in theory and modeling, plasma diagnostics and basic experimental plasma physics, and an emerging footprint in materials science relating to the high heat and neutron flux environment produced by fusion plasmas. Scientists in these fields have extensive international research collaborations across Japan, the European Union, the USA and Korea. The nature of these collaborations is vast, and spans:

- project collaboration,
- database studies,
- participation in international agreements of nation member organizations
- representation on international councils and committees
- memorandum of understanding between Australian and international research institutions
- hosting workshops and conferences
- collaborative exchange

In funding extent and scope, these projects range from individual representation and travel up to multi-million dollar projects. Research collaborations are supported by institutional investment, direct government support, and competitive grants.

- Institutional investment includes ongoing support from the Australian National University, the Australian Nuclear Science and Technology Organisation, the University of Sydney, the University of Newcastle, and the Australian Institute for Nuclear Science and Engineering.
- Direct government support comprises research infrastructure investment in the Australian Plasma Fusion Research Facility hosted by the ANU. In May 2009 the Australian Government invested $7m into this facility for an infrastructure upgrade.
- Competitive grants form the bulk of the research project support. While some funding related to fusion science has arisen from the Australian Research Council, the majority of Australian support has been delivered by the International Science Linkages program.

The projects and output that this investment supports affords Australian participation and presence on several important international organizations, including:

- Participation in the IEA Implementing Agreement on the Stellarator Concept, and board membership of the corresponding International Advisory Committee
- Membership of the International Fusion Research Council of the IAEA, as well as the Fusion Power Coordinating Council of the IEA. The members of the IFRC represent the 12 IAEA nation members and alliances with have a significant fusion research activity. The function of the IFRC is to promote the development of fusion power and act as a bridge between ITER and non-ITER community. The FPCC, which has a similar remit, is populated by government representatives.
- Membership of the IUPAP International Union on Pure and Applied Physics C16: Commission Son Plasma Physics.

In detail Australia's international partners and research collaborators in the field of fusion science and engineering are as listed below.

International Partner / Body
Japan Atomic Energy Agency
National Institute for Fusion Science, Japan
Hiroshima University, Japan
Kyoto University, Japan
Yokohama University, Japan
Nagoya University, Japan
Culham Centre for Fusion Energy (formerly UKAEA Fusion), UK
Cambridge University, UK
Max Planck IPP (Garching and Greifswald), Germany
Institute of Metals and Technology, Slovenia
RTWH-Aachen University of Technology, Germany, and Linköping University, Sweden
Istituto Gas Ionizzati del CNR, Italy
Consorzio RFX - Associazione EURATOM/ENEA sulla Fusione, in Padua, Italy
Chalmers University and Institute of Technology, Sweden
Politecnico di Torino, Italy; IPP; Laboratorio Nacional de Fusion, Madrid, Spain
École Polytechnique Paris
CNRS-Université de Provence, Marseille, France
University of Naples, Italy
Rutherford Appleton Laboratory, UK
University of Orleans, France
Princeton University Plasma Physics Laboratory, US
Oak Ridge National Laboratory, US
General Atomics in La Jolla, California, US

University of California, Berkeley, US
University of California, San Diego, US
Naval Research Laboratory, US
University of Iowa, US
West Virginia University, US
University of Wisconsin, Madison, US
Massachusetts Institute of Technology, US
Motorola, US
Lawrence Berkeley National Laboratory, US
Drexel University, US
National Fusion Research Centre, Republic of Korea
Korea Basic Science Institute, Republic of Korea
Pohang University of Science and Technology, Pohang, Republic of Korea

Further details about the current research activities of Australia, take-up of Australian research, and international engagement can be found in Appendices 3, 4 and 5 of the Australian ITER Forum Strategic Plan.

2. The benefits to Australia from engaging in international research collaborations.

Several compelling reasons can be formed for an Australian involvement in ITER and broader fusion science program. These include:

- Climate change mitigation: participation in development of a global long-term energy solution
- Kudos and leadership: (Direct) engagement with world's largest science project.
- R&D now driven by ITER program and ITER partners. Australia can only fully participate in fusion research through international engagement.
- Capability development: equip nation with skills to assess and/or adopt fusion power during DEMO
- Skills and training: supporting other power technologies (e.g. high-temperature coal, fission, solar)
- Australian involvement would increase our standing in international science and engineering and give us access to a wide range of technologies.
- There are potential short and long term contract opportunities for Australian engineering and component manufacturing industries in this project.
- Our nation possesses large reserves of materials which are strategically important to the development of fusion power. ITER involvement will allow these reserves to be exploited.
- As mankind tackles the problem of energy supply, our involvement in the ITER project will inspire a new generation of Australian students to choose a career in the sciences or engineering

- Increased cross-fertilization of plasma physics, materials science, complex systems, and engineering

3. The key drivers of international research collaboration at the government, institutional and researcher levels.

<u>Research level</u>

- Addressing "grand challenge" science goals that require coherent scientific programs to address a goal.
- Access international excellence

<u>Government level (Australian)</u>

- International cooperation
- Developing alternative energy technologies to mitigate climate change and find long term energy solutions for the planet.
- Leverage 97% of the world's research
- Provide international opportunities to Australian industry
- Developing Australia's resources

<u>Institutional Level</u>

- Access international excellence
- Complement skills sets when marketing itself as a research/education provider

We also note that energy security is a large reason why other governments choose to invest in fusion power.

4. The impediments faced by Australian researchers when initiating and participating in international research collaborations and practical measures for addressing these.

There is no Australian analogue to the international research provider. Internationally, fusion is funded by dedicated government portfolios, such as the US Dep. of Energy, or EURATOM. In Australia, fusion research has been historically funded by a combination of institution investment and non-orientated competitive grants programs administered by the Australian Governments science and research portfolio. ITER engagement requires a scale greater than existing non-orientated competitive grant processes. While funding programs of the appropriate scale do exist in the resources and energy portfolio, the focus is on short term fossil-fuel concept realisation (5-10 year), and the funding programs normally require significant co-investment from industry. The lack of a competitive funding program of an appropriate scale and focus is a major impediment to ITER engagement.

A related impediment is that no single Government department has taken responsibility for assessing ITER international engagement. Rather, responsibility is fragmented across the Australian Government: Australia's energy research and policy unit is managed by the Dep. of Resources, Energy and Tourism; Australia's policy unit in response to Climate Change is the Dep. of Climate Change; infrastructure and competitive grants is the responsibility of Dep of Innovation, Industry, Science and Research; and foreign affairs is the responsibility of the Dep. of Foreign Affairs and Trade. Such splintering creates a disconnect between the domestic and international research community and the Australian government.

A third impediment is that existing funding programs are not comprehensive, in that they do not fund the totality of needs required for international research engagement: personnel, travel, collaborative exchange, equipment and facility operating costs.

We believe that these impediments can be addressed by evolving the International Science Linkages program to cater for both short time frame projects and larger scale endeavours such as the ITER project. The new program might coordinate policy response from the Australian government on large scale international science engagement, act as the single point of government contact, assess applications, and have an advisory function to government. For successful projects the entity should also be the legal authority for international projects, and fund the totality of Australian research needs.

5. Principles and strategies for supporting international research engagement.

We suggest the following principles guide support for international research engagement:

- Research priorities should be set by government
- International leverage should form part of the assessment conditions
- No funding caps on individual projects
- Needs a formal advisory conduit to government on lost-opportunities
- Minimise bureaucracy for researchers and international research providers.
- Provide a feedback mechanism to Australian scientists advising how they might support their research.

We suggest that a key strategy for supporting international research engagement be evolving the International Science Linkages program to cater for both short time frame projects and larger scale endeavours such as the ITER project. Such a funding program should focus on value for money, not project funding caps – which should be removed. The assessment panel should evaluate the lost opportunity by not engaging and report to government not only on the areas they have funded, but also identify the lost opportunities in projects that are not funded. The assessment panel might also advise unsuccessful applicants on how they might fund their research.