Report Of The ERDA Fusion Review Committee

The Fusion Power Reactor Senior Review Committee of the Energy Research and Development Administration issued the following draft report on the status and prospects of fusion development. A final report will be issued soon.

The Committee, made up of scientists and administrators from major U.S. industries, advocated an all-out effort to pursue every promising avenue of fusion research. The title of the report is "Perspectives on the Development of Fusion Power by Magnetic Confinement."

The Committee met to hear presentations by the fusion community and to assess the status and prospects for fusion development.

The Committee found that over the past few years the magnetic fusion energy program has demonstrated enormous progress, both in terms of experimental demonstrations and theoretical understanding. The program is carefully planned, logical, organized to utilize the qualified personnel available, and actively seeking new organizational participants as the program evolves in character from a research to an engineering development program.

The Committee agrees that the present relative emphasis among subprograms is reasonable, that is, the tokamak is the principal approach, the magnetic mirror concept is the principal alternate, and a vigorous search for new alternatives is maintained.

In tokamaks, ion temperatures (T_i) of 20 million degrees have been achieved; this is to be compared with the 45 million degrees theoretical minimum required for ignition and the 60-100 million degrees estimated as required for an operating fusion reactor. The product of density times confinement time ($n\tau$), which is the other key parameter for successful (net energy) fusion, has been raised to 2×10^{13} cm^{-3} sec; this is to be compared with the theoretical minimum value of 6×10^{13} cm^{-3} sec for energy breakeven, and the value $3\text{-}10 \times 10^{14}$ cm^{-3} sec estimated as that required for an operating fusion reactor. Experiments are now being fabricated which within the next two to seven years should permit the achievement of T_i greater than or equal to 45 million degrees and $n\tau$ greater than or equal

IAEA's Fusion Research Council:

'Aggressive Fusion Effort Urgent'

The International Fusion Research Council of the International Atomic Energy Agency recently released the following recommendations to the IAEA on fusion development. The council, which met in May, is composed of leading scientists and directors of the fusion research efforts internationally. This is their public review of the status of fusion since 1970.

In view of the great progress achieved in fusion since 1970, the Council is convinced that the time is ripe to urgently make a large and aggressive effort towards the practical demonstration of fusion power at the earliest possible date. Such an effort is needed now and could be maximized by efficient worldwide cooperation and planning in this field.

It therefore suggests that the Agency (IAEA) make an important contribution to this goal by taking the following steps:

— inviting interested member states and regional institutions to submit to the Agency their estimates of attainable fusion research and development schedules with the objective of helping to coordinate the necessary efforts for a rapid and most economic way of achieving this goal;

— realizing that fusion is now the remaining major goal in nuclear energy research, the Agency should make its fusion activity better known to governments and to the scientific community as a whole;

— organizing a scientific session at the next general conference of the Agency to provide an opportunity to discuss this IFRC report and its implications;

— appointing a scientist to coordinate and stimulate work on the environmental impact of fusion and coordinate studies on future fusion reactor material requirements with special reference to the conservation of helium;

— identifying problems where no large apparatuses are needed and which can be tackled by scientists in developing countries, and giving guidance to developing countries wishing to work in this area;

— stimulating international cooperation by organizing and facilitating circulation of fusion scientists, establishing a "mobility fund" for that purpose;

— expanding the Agency's efforts to find the best means to establish and coordinate computer programmes and systems for fusion research;

— continuing to have the International Committee in Theoretical Physics involved in theoretical plasma physics and broadening its work in other scientific areas related to fusion. Participation of scientists from developing countries and their training in major fusion centers should be facilitated.

to 6×10^{13} cm^{-3} , sec both separately and combined in a single device.

There is a high degree of confidence in the scientific community that these achievements will be accomplished and hence many scientists believe that the "scientific feasibility" of fusion is assured. The Committee recommends that the *primary near-term objective of the fusion program should be to demonstrate these reactor level values of* T_i *and* n_t *experimentally as expeditiously as possible.*

Programs aimed at this objective should not be funding-limited.

The Committee notes that the first generation of significant amounts of fusion energy from a deuterium-tritium plasma is scheduled for the early 1980s in the Tokamak Fusion Test Reactor. This device should be pursued with a high priority, aimed at achieving conditions approximating breakeven, that is, fusion energy release approximately equal to the input energy to the plasma. Such a demonstration would logically be followed by maintenance of the fusion burn for longer periods of time and eventually the reaching of ignition. These latter steps may require substantial funds for upgrading TFTR or possibly the building of a new device, for example, an Ignition Test Reactor. Planning for these eventualities should begin now.

Magnetic Mirrors

In magnetic mirrors, the density-confinement time product has been recently increased by an order of magnitude, scaling of confinement with temperature has been demonstrated and sustenance of the plasma by neutral beams has been proven. Two new ideas, the Tandem Mirror and the Field-Reversed Mirror, have emerged as attractive concepts for evaluation towards practical systems. The Committee recommends that the magnetic mirror program continue to be strengthened as the primary alternative to the tokamak.

The Committee also recommends a continued strengthening of the research and development activities related to alternate fusion concepts, including increased emphasis on those concepts with attractive physics properties and desirable size, cost, and environmental features for eventual commercialization. The new ideas that result from the increased involvement of talented physicists and engineers in this area will also impact and enhance the prospects for success of the mainline approaches.

A continued strengthening of the technology and engineering effort will be required. The Committee believes that this effort should be properly phased with the evolving near-term experimental program and that the engineering technologies required for the design of devices that will demonstrate useful power output should be vigorously pursued.

Broad Base of Research

Recent successes warrant increased attention to considering the range of possible end-uses to which fusion energy may be applied; this includes a considerable effort on conceptual design studies of compact fusion power reactors, on studies relating to advanced fuels, and on other potential applications such as fissile fuel and synthetic fuel production. Nevertheless, it should be recognized that the fusion program at this time is primarily an R and D program, albeit a rapidly evolving and successful one. The present fusion program should include the necessary broad base of research, technology, and engineering so that the most promising applications and technologies can be pursued....

Activities to strengthen the dialogue with the electric utilities and to further involve industry in fusion program activities are evident and very good. This trend should be continued....

The Committee believes that the benefits of fusion energy production are so great and that the recent accomplishments and progress are so striking that it is reasonable to assume that fusion energy development will be successful. In these circumstances, it seems prudent for the country to make the necessary investment to permit progress to proceed at a pace limited only by the technology and the availability of highly qualified people.