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A TOKAMAK FUSION TEST REACTOR EXPERIMENT*

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The Tokamak Fusion Test Reactor (TFTR) is the first U.S. fusion research device planned to generate reactor-like fusion power densities from a magnetically confined deuterium-tritium plasma. The TFTR project has been authorized by the Energy Research and Development Administration for construction at the Princeton Plasma Physics Laboratory, at a cost of $228 million. Following a five-year construction period, the TFTR experimental program will be initiated in early 1981.

The tokamak is a doughnut-shaped "magnetic bottle" for confining hot plasma, of a type originally discovered at the I. V. Kurchatov Institute in Moscow, U.S.S.R. In the U.S., further developments of the tokamak approach have been achieved in experiments conducted at Princeton, at the Oak Ridge National Laboratory, at the Massachusetts Institute of Technology, and at General Atomic. Significant advances were made in plasma temperature, density, and confinement time, and in the understanding of the physics of tokamak confinement. New methods for plasma heating by intense neutral atom beams and by plasma compression were demonstrated successfully.

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These developments of the period 1970-75 have provided the basis for the design of the TFTR. It is a tokamak device twice the physical size of the largest currently operating tokamaks, the T-10 at the Kurchatov Institute and the PLT at Princeton. The plasma will be heated to temperatures of 50-100 million degrees Centigrade by deuterium atom beams of 120,000 electron volts particle energy and 20 million watts total power. At the top end of this temperature range, the TFTR plasma will be typical of the plasmas planned for future tokamak fusion power reactors.

The neutral-beam heating method has the incidental advantage of increasing the fusion-power-production capability of the TFTR severalfold, since the injected energetic deuterons react with the tokamak plasma, in addition to heating it. When a tritium plasma is used in the TFTR, the total fusion power output will be roughly equal to the heating power input of 20 MW; thus the TFTR can be said to approximate "break-even" conditions from the plasma-physics point of view, during reaction intervals lasting about a tenth of a second. In a practical engineering sense, the TFTR is not yet near break-even conditions. For this purpose, superconducting magnet coils will have to be used in future devices, to minimize extraneous power losses. The objective of the TFTR is to verify the physics concepts that will be needed in the design of a tokamak power reactor, and to serve as an initial test bed for reactor technology.

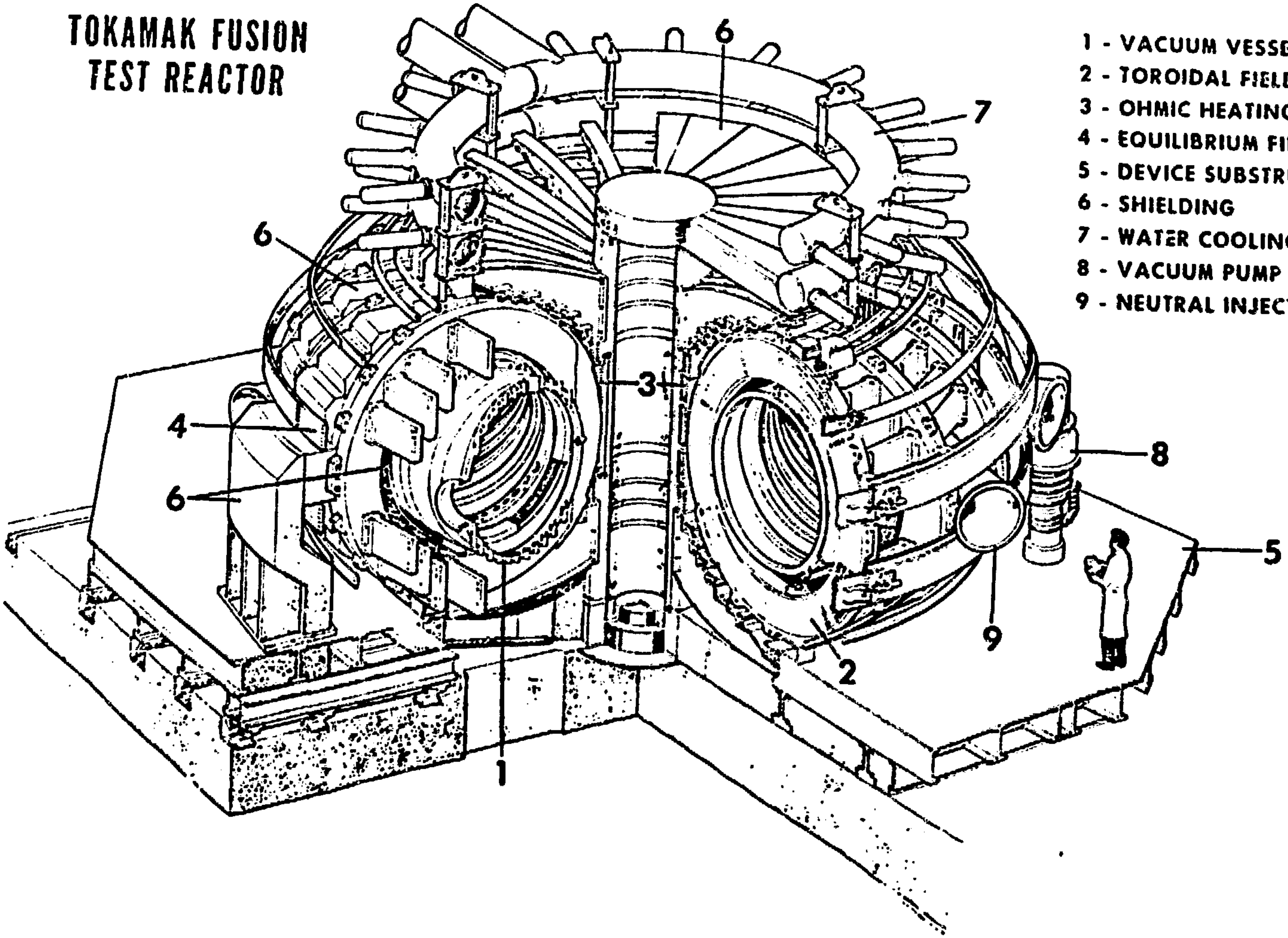
The TFTR Conceptual Design Study was undertaken in early 1974 by the Princeton Plasma Physics Laboratory and the Westinghouse

Electric Corporation. The TFTR construction project is headed by Paul J. Reardon. Design and construction will be carried out by a joint effort of the Princeton Plasma Physics Laboratory and an industrial subcontractor, to be selected. The high-powered neutral-atom-beam injection system of the TFTR is being designed and developed in collaboration with the Oak Ridge National Laboratory and the Lawrence Berkeley/Livermore Laboratories.

Several other large tokamak projects are currently under consideration, in Europe, Japan, and the U.S.S.R. The Joint European Torus (JET) is comparable to the TFTR in size and construction time scale, but differs substantially in technical design. Its location has not as yet been designated. The Japanese JT-60 will be somewhat larger, and the Soviet T-20 will be about twice as large.

A tokamak reactor installation similar to the TFTR, but using massive neutron shielding and superconducting magnet coils, could prove economically attractive as a high-powered neutron source — for improving fission-reactor fuels, or burning out radioactive wastes. A tokamak reactor suitable for electric power production is expected to be several times larger. The realization of the first experimental fusion power reactor is expected to follow the completion of the TFTR by five to ten years.

TOKAMAK FUSION TEST REACTOR



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