

For Practical Use of Fusion Energy

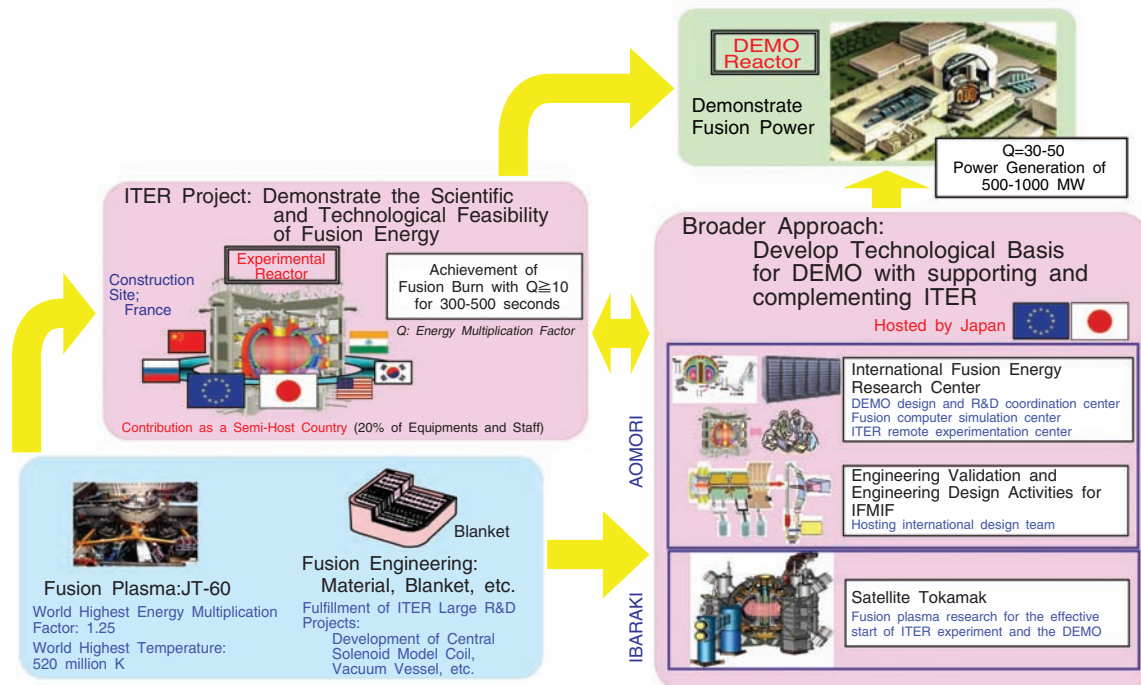


Fig.3-1 Development Steps Toward the Fusion DEMO Reactor

At the Fusion Research and Development Directorate, crucial R&D for practical use of fusion energy (fusion plasma and fusion engineering R&D) is being carried out in wide scale international cooperative projects such as ITER project and Broader Approach, aiming at realization of the fusion DEMO reactor (Fig.3-1).

ITER (International Thermonuclear Experimental Reactor) Project

The ITER project is an international cooperative project to demonstrate the scientific and technical feasibility of fusion energy through construction and operation of an experimental reactor. The participants are Japan, EU, US, Russia, China, Korea, and India. The participants account for more than half of the world population. The experimental reactor, ITER, is being constructed in Cadarache in France. The ITER agreement entered into force in October 2007, and JAEA was designated as the domestic agency of ITER project in Japan. Topic 3-5 and Topic 3-7, “World Record Achievement in Plasma Heating Device” and “Demonstration of Final Installation to within 0.5mm of a 4-ton Blanket by Remote Handling” are research results achieved in the course of preparation for ITER equipment procurement.

Broader Approach (BA) Activity

The BA activity is a joint project by Japan and EU executing research supporting ITER and the research and development for the DEMO reactor, the next step of ITER, aiming at the early realization of fusion energy. It is being implemented in Japan during the period of ITER construction (about 10 years). It consists of three projects; the activities of the International Fusion Energy Research Center, the engineering validation and engineering design activities of the international fusion material irradiation facility (IFMIF), and the research activities of Satellite Tokamak (upgrade of JT-60 to a superconducting machine). The former two is being conducted at Rokkasho village in Aomori Prefecture, and the satellite tokamak project at Naka city in Ibaraki Prefecture. The agreement launching

BA entered into force in June 2007, and JAEA was designated as the implementing agency of BA activity in Japan. The BA activity includes a remote experiment of ITER, and Topic 3-3, “Development of the Plasma Movie Database System for JT-60”, is a result which contributes to realize it.

Fusion Plasma Research

The critical requirement for the future fusion reactor is to attain a high level of economical efficiency, namely, to sustain a high fusion power in a reactor core of compact size. It is necessary to improve the plasma pressure (temperature \times density) to accomplish that. Topic 3-1, “Establishment of Long-Pulse Operation for “ITER” Burning Plasmas”, experimentally demonstrated that a high plasma pressure can be maintained stably using JT-60. Furthermore, Topic 3-2, “Finding the Intrinsic Rotation by Plasma Pressure”, clarified the guiding principle to achieve high plasma pressure.

Fusion Engineering Research

The fuel of fusion energy is deuterium and tritium. A large quantity of deuterium exists in seawater. The tritium hardly exists naturally at all, but it can be produced from lithium, which is also contained plentifully in seawater. Topic 3-8 and Topic 3-9, “Materials Necessary for Stably Supplying Fuel Tritium to Fusion Reactors” and “Tritium Extraction Using a Fuel Cell” yielded results which contribute to the steady production of tritium.

It is necessary to heat plasma to cause the fusion reaction. Topic 3-4 and Topic 3-6, “Achieving High Power in the JT-60U RF System” and “Development of a Large Negative Ion Source” are results which enable the plasma to be heated more efficiently.

It is necessary to streamline the maintenance of the fusion reactor in order to raise its operation rate and thus improve its economic efficiency. Topic 3-10, “Torus Configuration and Maintenance Concept of Compact Fusion DEMO Reactor” is a result which raises the operation rate of the plant by executing regular maintenance in a short time.