

§2. Towards Establishment of Technology Bases for Fusion Demonstration Reactor

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The establishment of technology bases required for the development of DEMO has been discussed by a joint effort throughout the Japanese fusion community. Basic concept of DEMO premised for investigation has been identified and the structure of technological issues to ensure the feasibility of this DEMO concept has been examined. The necessary technological activities have been sorted out and arranged in the chart with the time line to prospect the Japanese fusion roadmap.

The Working Group on Fusion Research under the council in the MEXT has discussed the future prospect of fusion R&D and has pointed out the need of the Japanese roadmap and a framework of implementation throughout Japan. Then Working Group requested NIFS and JAEA to form a team in cooperation with universities and industry to examine the way to establishment of technology bases required for the development of a fusion DEMO reactor in July 2013. The mission of this Joint-Core Team is to investigate

- 1) Concept of DEMO premised for investigation
- 2) Activities requiring commitment and their goals
- 3) Scientific and technological review works for the above mentioned activities

The Joint-Core Team, which consists of experts from the Japanese fusion community including industry, organized thorough investigation into the reports [1,2] to clarify technology which should be secured, maintained, and developed in Japan, to share the common target among industry, government, and academia, and to activate actions under a framework for implementation throughout Japan.

Japanese fusion research and development is now in so called the 3rd phase, to show the scientific and technological feasibility of fusion energy with the core project of ITER. The next 4th phase is defined as the program with the core project of DEMO targeting technological demonstration and economic feasibility of fusion energy. DEMO is on only one-step from ITER to commercialization which is prospected in the middle of the 21st century.

The Joint-Core Team has pointed out that DEMO should be aimed at steady power generation beyond several hundred thousand kilowatts, availability which must be extended to commercialization, and overall tritium breeding to fulfill self-sufficiency of fuels. Projecting the goal of DEMO, it is necessary to define the technological issues to fulfil the transition conditions towards the 4th-phase program first by a tokamak, which exhibits the most

advanced development. At the same time, in order to promote acceleration and resolution by innovation and to incorporate a comprehensive state of progress of fusion R&D, complementary and alternative concepts, for example, a helical system to a tokamak should be managed in good balance and in a strategically linked manner.

Based upon examination of the structure of technological issues in the following 11 elements of DEMO; 1) superconducting coils, 2) blanket, 3) divertor, 4) heating and current drive systems, 5) theory and numerical simulation research, 6) reactor plasma research, 7) fuel systems, 8) material development and standards / criteria, 9) safety of DEMO reactor and safety research, 10) availability and maintainability, 11) diagnostics and control systems, all related research and development programs are organized in the Chart of Establishment of Technological Bases for DEMO around the development of the design of DEMO as the primary axis with attention paid to required evidence to support the maturity of the design of DEMO and consistency in the timeline. It is relevant to elaborate the timeline of technological development with the presumption of the Intermediate Check & Review around 2020 and the Assessment of Transition Conditions around 2027 along with the progress of the ITER project. It should be noted that the important decisions are made based upon comprehensive assessment of overall progress of fusion research and development.

Principal and urgent matters of weight which have been recognized in formulating the Chart are summarized into the following 4 points.

- (1) The ITER project is the definite critical.
- (2) Besides the ITER project, they are “reinforcement of DEMO design activity” and “strategic acceleration of research and development of divertor” that are the present critical paths and should be grappled with most urgently with more investment of resources than at present.
- (3) From the prospect around the Assessment of Transition Conditions, “Test Blanket Module (TBM)” and “fusion neutron source” are cited for critical paths to determine the complete timeline.
- (4) A framework for implementation throughout industrial, governmental and academic sectors in Japan is necessary for establishment of technological bases for DEMO and actions to make this framework effective, in particular, making the best use of human resources, should be taken.

It is expected that the fusion-related community of industry, education and research, and government will closely examine this chart and consequently define the roadmap of the development of DEMO.

- 1) Yamada, H., et al., NIFS-MEMO-71, Feb.02,2015, Japanese-language version: NIFS-MEMO-69, Sep.09, 2014.
- 2) Yamada, H., et al., NIFS-MEMO-73, Mar.03,2015, Japanese-language version: NIFS-MEMO-72, Feb.02, 2015.

Both reports are available at the web;
<http://www.naka.jaea.go.jp/english/reports.html>.