

東芝のITERプロジェクトへの取り組み Contributions of TOSHIBA Corp. to the ITER Project

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1. Toshiba's presence in the ITER project

Toshiba Corp. had participated in the ITER project from the very beginning of the project. During the Conceptual Design Activity (CDA) and the Engineering Design Activity (EDA), more than 50 engineers were dispatched from Toshiba to join the design activities of CDA and EDA.

In EDA, successes of large 7 R&Ds were important achievements of the ITER project. Toshiba participated in 5 among 7 large R&Ds and played major roles in 3 R&Ds, which were trial fabrication of the center solenoid coil, demonstration of the blanket remote handling system and trial of the vacuum vessel sector model. The R&Ds with Toshiba's major contributions are shown in Figure 1 with blue edges.

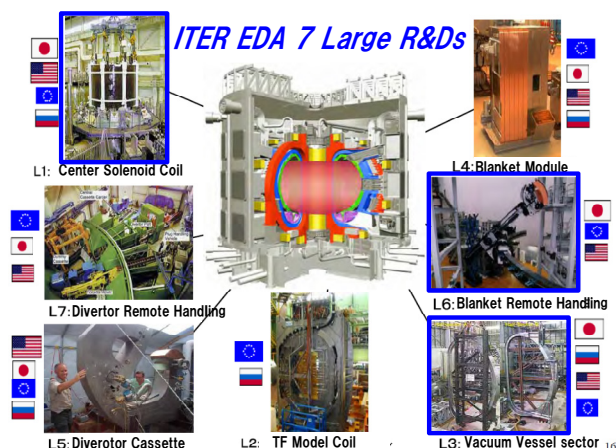


Figure 1 Toshiba's contributions in 7 Large R&Ds.



Figure 2 PF insert coil and TFC SULTAN sample.

In the post-EDA phase, Toshiba maintained its presence in the project both in design and R&D activities. In the development of superconductors for ITER magnets, Toshiba contributed to verify the performance of the superconductors by successful installation of the insert coils for magnet test facilities of JAEA. Toshiba had also fabricated the conductor test sample for SULTAN conductor test facility. Figure 2-A shows overview of PF insert coil installation and Figure 2-B shows the SULTAN sample of the conductor for TF coil.

Another activity in the post-EDA was to demonstrate manufacturing feasibility of TF coil through trials fabrications. Figure 3 shows some of those R&Ds. One of them is the vacuum impregnation (VPI) test for TF coil, in which the behavior of radiation-resistant resin in VPI process was examined and design concept was verified. Another example is the small-scale trial of cover plate welding by hybrid-laser beam welding, which was to measure deformation and to check the manufacturing procedure.

As described in this section, Toshiba has been continuously contributing to the ITER project in both design activities and manufacturing demonstrations from the beginning of CDA up to present manufacturing phase, which is described in next section.

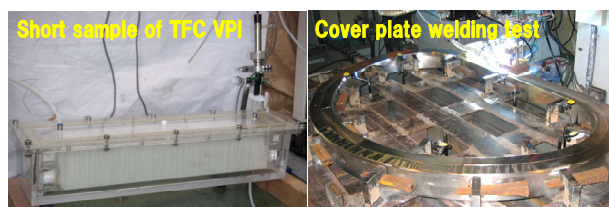


Figure 3 R&Ds in Post-EDA

2. Toshiba's recent activities in the ITER project

In the recent manufacturing phase of ITER project, the area of Toshiba's activities in ITER is wide,

such as TF coil (TFC) manufacturing, the blanket remote handling system and the neutron measurement.

In 2009, Toshiba won two-year contract of full-scale R&Ds, which are parts of TFC Ph2 activities. Many small-scale R&Ds were performed in both winding of coils and manufacturing of coil case. As large-scale R&D, Toshiba carried out,

- 1) Sub-scale double pancake (DP) winding,
- 2) Full-scale regular radial plate (RP) and corresponding cover plates,
- 3) Full scale coil case (CC) manufacturing of A3 and B3 segments.

In sub-scale DP trial, D-shape DP with 3 turns on each side of about 1/3 size of real DP was fabricated. Figure 4 shows the winding of sub-scale DP. This DP was fabricated by using real TF superconductor and it was heat-treated to examine manufacturing procedure and verify deformation of the conductor due to the heat treatment. Then, the sub-scale DP was vacuum-impregnated and cured by using radiation-resistant resin.

Figure 5 shows the trials of RP and CC segments. These R&Ds were finished in 2010. Through achievements of the R&Ds, the manufacturing design was studied as preparation to enter the manufacturing phase of TFC.

In the blanket remote handling system, Toshiba collaborated with JAEA to close PDR (Preliminary Design Review) and is participating in activities to finalize the design. Toshiba is also contributing to design and R&D activities of neutron measurement system.



Figure 4 Winding of sub-scale DP

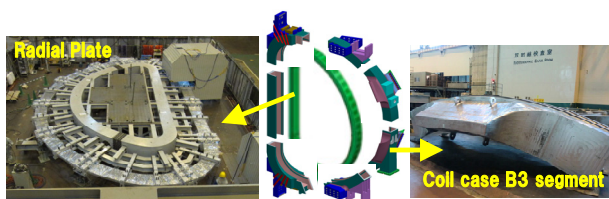


Figure 5 Full-scale R&Ds in TFC Phase 2

3. Prospect of future contributions

The ITER project has entered in construction phase. There are already several contracts for manufacturing equipment for ITER.

By the end of July 2013, Toshiba has been awarded two contracts of JAEA to manufacture two complete sets of TFC and one TFC winding pack. At present, Toshiba is working on remaining R&Ds, which should be finished before serial production. With results of these R&Ds, the manufacturing design will be finalized.

In preparation for TFC production, Toshiba is preparing manufacturing organization. Toshiba plans to use factory space in Keihin Product Operations and Toshiba-IHI Power Systems (TIPS) as shown in Figure 6. In early 2014, factory space for winding TF conductors will be prepared as a first step.

Another important activity of Toshiba toward construction of ITER is the detailed design of the blanket remote handling system. This system itself has design issues, but it also has challenging issues due to its wide interface with other systems, such as the vacuum vessel, the blanket modules, the hot cell, the higher-level plant control system (CODAC) and so on. Toshiba is working on completion this task and preparation for fabricating the remote handling system in collaboration with JAEA and also with ITER organization.

With activities mentioned above and those which will be done in coming years, Toshiba continues to contribute to the ITER project.

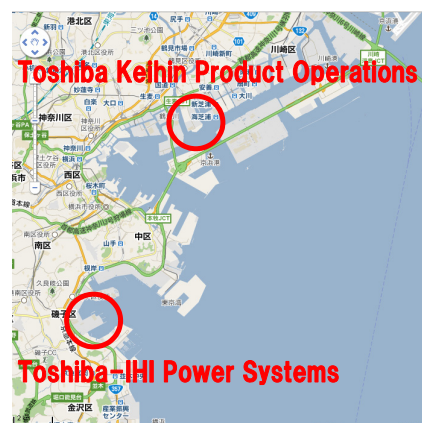


Figure 6 Factor space in Keihin and TIPS will be used for fabrication of ITER TFC.