Overhead costs of fusion power plants can be reduced by planning reactor maintenance and structure together

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VTT Technical Research Centre of Finland's research results indicate that joint planning of the reactor structure and remote maintenance system can significantly improve the utilisation rates of future fusion power plants. Designing a reactor with the simplest structure possible can reduce maintenance periods, as well as building expenses and overhead costs. Since 1995, VTT Technical Research Centre of Finland has participated in two international projects aimed at building a full-scale fusion reactor and commercialising fusion as an energy source.

ITER and DEMO (DEMOnstration Power Plant) are international programmes targeting the harnessing of fusion energy for energy production. VTT Technical Research Centre of Finland plays an important role in both programmes by developing remote handling systems for critical reactor parts.

ITER is an experimental nuclear fusion reactor currently being built to test various technologies and materials for use in fusion reactors. If ITER proves successful, the next step is DEMO - short for Demonstration Power Plant - which will be the first prototype of a commercial fusion power plant.

Together with the European Fusion Development Agreement, EFDA, VTT Technical Research Centre of Finland has studied how to apply the maintenance and equipment designed during ITER, and avoid the problems encountered during the programme, in a DEMO reactor.

The resulting concept plan provides for the planning of fusion reactor maintenance alongside other structural design work at a sufficiently early stage. Designing remote handling and reactor structure in parallel would prevent major errors that hamper compatibility. This would mean fewer alterations during the building process and minimised downtime in the finished power plant, resulting in lower construction and overhead costs.

Several maintenance issues have been encountered during the ITER experiment.. Installation of service equipment and the required maintenance ports sizes were not considered sufficiently in the original plans, for example, limiting the opportunity for remote maintenance.

Because the objective of DEMO is to build a commercially viable reactor, the maintenance requirements are significantly stricter than for ITER. Problems discovered during ITER would mean extended downtime periods and considerable additional costs if encountered in DEMO. The basic premise of DEMO design has been to minimise maintenance periods through modular design and simple module structure.

Fusion as a source of energy

Although a challenge, harnessing fusion for energy production is an attractive option which would solve mankind's energy problems. A fusion reactor carries no risk of a runaway reaction, and the production of fusion energy creates no radioactive waste.

ITER's objective is to build a full-scale experimental reactor to demonstrate the technical and scientific viability of fusion energy and achieve high efficiency fusion. This project, initiated in the 1980s, is one of the world's most ambitious scientific endeavours. In addition to the EU, there are six other participants - Russia, Japan, China, India, South Korea and the United States.

An ITER reactor is currently under construction in Cadarache, France, due for completion in 2020. VTT Technical Research Centre of Finland and the

Tampere University of Technology TUT, participate by developing the maintenance of the most critical parts of the facility. In 2005, VTT Technical Research Centre of Finland and Tampere University of Technology TUT established ROViR, an international research centre located in Tampere, Finland, that hosts a full-scale model of the fusion reactor base. On a global scale, VTT Technical Research Centre of Finland is unique in its practical experience of the functioning of fusion reactor maintenance equipment in the ITER reactor's divertor area. A divertor is the bottom section of a reactor chamber, or "sink", where the particles leaving the chamber are gathered.

Remote handling and virtual technologies are crucial in fusion reactor maintenance because of radiation and limited space in the interior sections of a reactor. These restrict accessibility and render remote handling the single viable maintenance option. VTT Technical Research Centre of Finland's role in designing and testing is crucial, as a failure in remote handling would lead to extensive downtime.

Provided by VTT Technical Research Centre of Finland