EFDA

EUROPEAN FUSION DEVELOPMENT AGREEMENT

Cadarache
as a
European Site for ITER

Report on the Technical and Socio-economic Aspects

27 September 2001

Executive Summary

1. Background

The objective of the ITER machine is to demonstrate the scientific feasibility of fusion, with extended burn and marginally controlled ignition for a duration sufficient to achieve stationary conditions on all time-scales characteristics of plasma processes and plasma-wall interactions. To do so the installation will produce 500 MW of fusion power during pulses of at least 400 seconds. The facility will also demonstrate key fusion technologies.

The ITER Engineering Design Activities (EDA) were carried out between July 1992 and July 2001 under the framework of the ITER Agreement and Protocol signed by representatives of the four Parties, the European Atomic Energy Community, Japan, the Russian Federation and the United States of America (the USA withdrew in 1999). During the EDA, the ITER Joint Central Team (JCT) elaborated a reference design, called hereafter "generic design", including in particular a minimum set of requirements to be satisfied by any proposed site and additional assumptions.

Canada, the European Atomic Energy Community, Japan and the Russian Federation are about to start negotiations in order to select a site for the construction of ITER and to establish an ITER Legal Entity. In Europe, on 16 November 2000, the Research Council of Ministers asked the European Commission "to conduct negotiations on the establishment of an international framework allowing the ITER EDA Parties and qualified third countries to prepare jointly for the future establishment of an ITER Legal Entity for ITER construction and operation, if and when so decided."

At the European Consultative Committee on Fusion (CCE-FU) meeting on 11 July 2000, the French Delegation announced that "CEA was proposing the site of Cadarache as a possible site for ITER construction", calling on active contributions from the Euratom-Fusion Associations and on a strong involvement of European industry in the preparation of the proposal. The CCE-FU invited the EFDA Steering Committee to carry out swiftly – in close interaction with CEA and in consultation with the ITER JCT – an in-depth examination of the CEA proposal.

A European ITER Site Technical Study group (EISS group) has been established to examine ITER sites in Europe. For the Cadarache site, the EISS group was asked to:

- establish the compliance of the site with the ITER technical site requirements;
- identify key elements for the licensing procedure;
- examine site specific aspects of the ITER construction and operation costs;
- evaluate the social and infrastructure impacts of the project.

This document summarises the main conclusions of the work undertaken by the EISS group on the Cadarache site.

The two options (local reinforcement of the building and the use of paraseismic bearings) are feasible. No major modification with respect to the generic design is foreseen.

2.4 Heat sink and water supply

A consumption of 1.5 million m^3 per year has been estimated for the cooling water circuits. This is equivalent to the present total consumption of the Cadarache centre. It will therefore be necessary to install a new system. The preferred solution is to supply water by means of gravity from the EDF canal of Vinon-sur-Verdon. The investment cost for this solution is slightly higher than for other alternatives, but this is offset by the reduced cost of operation since no pumping station is required. Other new installations are foreseen at Cadarache and will also require modifications of the water supply; synergies might be obtained between the different projects.

The climate in Cadarache, warm but very dry in the summer, allows the overall dimensions of the cooling towers to be reduced, the wet bulb temperature in Cadarache being 24°C instead of 29°C as assumed by ITER. However, the relocation of the cooling towers leads to an increase in the length of pipe work by 300 m (2 pipes of 2 m diameter).

About two thirds of the water evaporates in the cooling towers. The rest will be discharged into the Durance River or the canal, after the necessary controls, making use of the current discharge outlet of the Cadarache site.

2.5 Electrical Power Supply

The electrical network around Cadarache is well equipped with many lines and two powerful nodes, Boutre (5 km east of the ITER site, with an interconnection at the 400 kV/225 kV level through an autotransformer) and Sainte-Tulle (8 km north of the ITER site, with an interconnection at the 225 kV/63 kV level). Moreover, Tore Supra is already supplied by a 400 kV dedicated line and the Cadarache centre by two 63 kV lines.

The generic ITER design is based on a single 400 kV line and a double 225 kV line. Several alternatives have been considered and compared by the public company RTE. In particular, the environmental impact has been considered very carefully taking into account the visual impact of 225 kV and 400 kV pylons. The reference scheme is shown in Figure 1.4. All modifications necessary take place on CEA property.

The design assumptions for the reactive power compensation are not satisfied. The ITER static VAR compensator will have to be increased from 540 Mvar to 660 Mvar and driven as voltage regulator to reduce the voltage drop on the network within acceptable limits. This design modification will have a modest impact because there are margins in the present design. On the other hand, the design assumptions with respect to the active power are widely exceeded and 1000 MW could be delivered for 30 s instead of the assumed 500 MW. Should this point be confirmed, a scheme with only a double 400 kV line could be proposed, leading to cost savings on both site adaptation and generic design. This scheme is fully compatible with the ITER site requirements and design assumptions.