

European Concepts of First Generation Fusion Power Plants

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ABSTRACT

A Power Plant Conceptual Study (PPCS) has been carried out in Europe between 2001 and 2004, which aimed at the demonstration of the credibility, the safety and environmental advantages and the economic viability of fusion power. A set of requirements was issued by industry and utilities concerning safety, operational and economic aspects. In this framework, three “near term” reactors models have been studied, which were based on limited extrapolation on both physics and technology. The net electric power was set at about 1500 MWe. The fusion power was then determined by efficiency, energy multiplication and current drive power. Given the fusion power, the plasma size was mainly driven by considerations on the divertor and a system code (PROCESS) was used to finalize the plant parameters in order to produce an economic optimum.

All models meet the overall objectives of the PPCS mentioned above (design, safety, economics) and it can be concluded that a first generation fusion power plant will be economically acceptable, with major safety and environmental advantages. Two key innovative concepts have been developed within the study. One is a scheme for the scheduled replacement of the blanket and divertor, which shows the potential for good overall plant availability (at least 75%). The other is a conceptual design for a helium-cooled divertor, which permits heat loads (10 W/m^2) twice as high as those previously foreseen for helium-cooled concepts.

The study has allowed to point out important R & D topics: the validation of suitable structural materials is one of the main concerns. The operating temperature windows and the behaviors under irradiation are among the most important points to be clarified. The compatibility of physics scenarios with a full tungsten first wall is also to be investigated.