THE EUROPEAN FUSION REACTOR ACTIVITIES

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The European Power Plant Conceptual Study (PPCS) has been a study of conceptual designs for commercial fusion power plants. It focussed on five power plant models, named PPCS A, B, AB, C and D, which are illustrative of a wider spectrum of possibilities. They are all based on the tokamak concept and they have approximately the same net electrical power output, 1500 MWe. These span a range from relatively near-term, based on limited technology and plasma physics extrapolations, to an advanced conception. All five PPCS plant models differ substantially from the models that formed the basis of earlier European studies. They also differ from one another, which lead to differences in economic performance and in the details of safety and environmental impacts.

The main emphasis of the PPCS was on system integration. Systems analyses were used to produce self-consistent plant parameter sets with approximately optimal economic characteristics for all models. In the PPCS models, the favourable, inherent, features of fusion have been exploited to provide substantial safety and environmental advantages. The broad features of the safety and environmental conclusions of previous studies have been confirmed and demonstrated with increased confidence.

Two key innovative developments made within the PPCS study are worthy of a special note. One is the development of a scheme for the scheduled replacement of the internal components which shows the potential for an overall plant availability in excess of 75%. The other is a conceptual design for a helium-cooled divertor, which permits the toleration of heat loads of at least 10 MW/m^2.

The PPCS study has highlighted the need for specific design and R&D activities, in addition to those already underway within the European long term R&D programme, as well as the need to clarify the concept of DEMO, the device that will bridge the gap between ITER and the first-of-a-kind fusion power plant. A detailed assessment of the PPCS models with limited extrapolations highlighted a number of physics issues that must be addressed to establish the DEMO physics basis. In parallel, a number of technological issues are being addressed to establish the basic features of DEMO. They are primarily related to the divertor and blanket concepts, to the maintenance scheme of the internal components and to the magnet technology.

PPCS Plant Parameter	A	B	AB	C	D
Unit Size (GW_e)	1.55	1.33	1.46	1.45	1.53
Fusion Power (GW)	5.00	3.60	4.29	3.41	2.53
Major Radius (m)	9.55	8.6	9.56	7.5	6.1
Net efficiency (fusion power/net electrical output)	0.31/0.33	0.36	0.34	0.42	0.60
Plasma Current (MA)	30.5	28.0	30.0	20.1	14.1
Bootstrap Fraction	0.45	0.43	0.43	0.63	0.76
P_{add} for H&CD (MW)	246	270	257	112	71
Divertor Peak load (MWm^{-2})	15	10	10	10	5
Average neutron wall load (MWm^{-2})	2.2	2.0	1.8	2.2	2.4

Key parameters of the PPCS models