The European Power Plant Conceptual Study

Overview

JA-US Workshop on Power Plant Studies

with EU participation

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Overview

Power Plant Conceptual Study models

PPCS main conclusions

Issues and future studies

The EU Power Plant Conceptual Study

The European Power Plant Conceptual Study has been completed in May 2004. Final editing and formal approval of the final report is (nearly) completed.

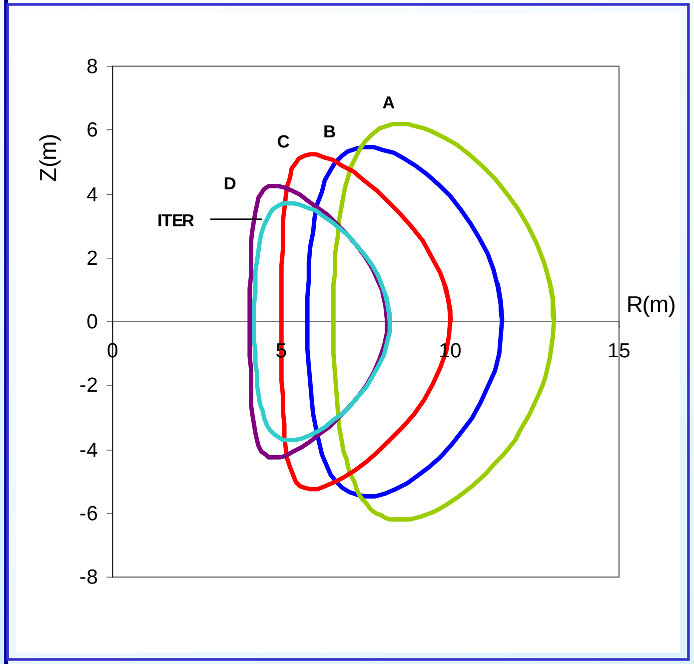
Overall objectives of PPCS (July 1999)

- to assess the fusion energy status
- to establish coherence and priorities in the EU fusion programme

Detailed objectives (July 2001), demonstrate:

- the credibility of fusion power plant design
- the claims for the safety and environmental advantages and for the economic viability of fusion power
- the robustness of the analyses and conclusions

PPCS Models



4 plant models developed, ranging from "limited" to "very advanced" extrapolations in physics and technology, as examples of a spectrum of possibilities (e.g. 3 different coolants considered: water, helium and lithium-lead).

Development of a 5th model undertaken in 2004.

Models selected considering EU blanket concepts development program (DEMO and long term).

Systems code (PROCESS), subject to assigned plasma physics and technology rules and limits, determined the economic optimum for each model.

Fusion Reactors PPCS Parameters

Parameter	Model A	Model B	Model C	Model D
Coolant	water	He	He/LiPb	LiPb
Unit Size (GW_e)	1.55	1.33	1.45	1.53
Fusion Power (GW)	5.00	3.60	3.41	2.53
Major Radius (m)	9.55	8.6	7.5	6.1
Net efficiency	0.31/0.33	0.36	0.42	0.60
Plasma Current (MA)	30.5	28.0	20.1	14.1
Bootstrap Fraction	0.45	0.43	0.63	0.76
P_{add} (MW)	246	270	112	71
Divertor Peak load (MW/m^{-2})	15	10	10	5
Av. neutron wall load (MW/m^{-2})	2.2	2.0	2.2	2.4

PPCS Main Conclusions (1/2)

- Plasma performance only marginally better than the design basis of ITER is sufficient for economic viability of fusion reactors*
- A first generation of commercial fusion power plant will be economically acceptable, with major safety and environmental advantages
- Conceptual design of a helium-cooled divertor capable of tolerating a peak heat load of 10 MW/m²
- Definition of a maintenance concept capable of delivering high availability* (75%)

* Assuming a 10th of a kind reactor

PPCS Main Conclusions (2/2)

PPCS conclusions confirm that the main thrusts of the European fusion development programme are on the right lines:

- ITER;
- the optimisation low activation martensitic steels, the development of tungsten alloys, and their testing;
- the development of blanket models, to be tested in ITER.

More work should be undertaken on:

- development of divertor systems
- development of maintenance procedures
- performance of a DEMO conceptual study

Issues

Towards the end of the PPCS, significant efforts were devoted to design integration.

A number of issues were recognised as "critical" even though not all were discussed during the study. They include:

- Impact of physics assumptions on engineering (I_P, I_{CD}, CD efficiency)
- Impact of technological choices & limitations on physics (e.g. W first wall)
- Min. & max. operating temperatures of materials and coolants (e.g. min. He T_{out} for He-cooled reactors)
- Availability, in particular impact of debugging time for new technologies (e.g. secondary circuit with He)

Towards a Fusion Reactor (1/2)

Next Step -- DEMO -- FOAK Reactor -- Reactors

scientific and technological feasibility of fusion energy

ITER FDR

Qualification of components and processes

DEMO Conceptual Studies

- High availability
- Safe and environmental-friendly
- Economically acceptable

Power Plant Conceptual Studies

Towards a Fusion Reactor (2/2)

- The issues identified during the PPCS should be resolved prior to the final reactor concept selection.
- They should be addressed in the DEMO program and, therefore, in any DEMO conceptual study.