

## Concept Study of Compact Fusion DEMO Plant at JAERI

K. Tobita, S. Nishio, M. Sato, M. Enoeda, T. Isono, S. Suzuki, S. Sakurai, H. Nakamura,

S. Ishiyama, Y. Nakamura, the DEMO Plant Design Team

*Japan Atomic Energy Research Institute*

E-mail: tobitak@fusion.naka.jaeri.go.jp

Three options of fusion DEMO plant are proposed in accordance with the functions of the center solenoid (CS). The prime option "Slim CS" uses a downsized CS which does not provide sufficient Volt-sec for plasma current rampup ( $\sim 10$  Wb) but supplies the coil current enough for plasma shaping. This option produces the fusion output of 3 GW with the major radius of 5.5 m, the aspect ratio of 2.6, the normalized beta of 4.3 and the maximum field of 16.4 T, as listed in Table I. The estimated reactor weight is lighter (about 17,500 tons) than other conventional tokamak reactors ( $\sim 25,000$  tons), suggesting an economic advantage. In spite of its compactness, physical and technological requirements for the "Slim CS" option are rather conservative, being on a par with SSTR. The plant uses foreseeable technologies in 2020's such as Nb<sub>3</sub>Al superconductor, water-cooled solid breeder blanket, low activation ferritic steel as the structural material and tungsten monoblock divertor plate. In order to avoid the Be-water reaction in the blanket on an accident, supercritical CO<sub>2</sub> is considered to be an alternative coolant. When it is used at the outlet temperature of about 500°C, the thermal efficiency by supercritical CO<sub>2</sub> cooling is almost same as that by water cooling. However, the turbine size for super critical CO<sub>2</sub> can be dramatically downsized, offering a cost benefit. The design philosophy and key issues related to the constituent technologies of the plant are described.

**Table I** Preliminary parameters of the prime DEMO option "Slim CS"

$R_p$	5.5 m	$q_{95}$	5.4
$a$	2.1 m	$\beta_N$	4.3
$A$	2.6	HHy2	1.3
$\kappa$	2.0	$n/n_{GW}$	0.98
$\delta$	$\sim 0.4$	$f_{BS}$	0.77
$V_p$	941 m <sup>3</sup>	$P_{fus}$	3.0 GW
$S_p$	700 m <sup>2</sup>	$P_{cd}$	60-80 MW
$B_T$	6.0 T	$P_n$	3.5 MW/m <sup>2</sup>
$B_{max}$	16.4 T	$Q$	$\sim 50$
$I_p$	16.7 MA	Reactor weight	17,500 tons