RF SOURCES FOR ITER ION CYCLOTRON H&CD SYSTEM

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The Ion Cyclotron Heating and Current Drive (IC H&CD) system for ITER is one of the major tools for achieving the plasma performances foreseen in the operation scenarios. This system is designed to provide 20 MW into the plasma, at frequencies included in the band 40 MHz to 55 MHz.

The system is made of 2 antenna port plugs, matching systems, transmission lines, Radio Frequency (RF) sources and associated High Voltages Power Supplies. In addition, some test equipments provide the possibility to test the antenna under vacuum outside the tokamak chamber, or to test the RF sources on dummy loads at full power. A control system manages the whole system operation.

ITER India (INDA) is in charge of the procurement of the ICRF sources subsystem and the corresponding arrangement was signed in February 2010. A total of 9 RF sources will be provided: 8 sources used for plasma operation, plus one spare. The typical RF Power Source layout consists of two parallel four-stage amplifier chains, with a combiner circuit on the output side to achieve the required performances. Each amplifier chain is made of a wide band solid state amplifier cascaded to a three tube based tuned amplifier - a pre-driver, followed by a driver stage and an end stage.

The technical specifications of RF sources, under ITER Organization (IO) responsibility, have been defined to ensure the IC H&CD system capability. One source unit has to provide 2.5 MW on Voltage Standing Wave Ratio (VSWR) = 2, all phases of the reflection coefficient. The frequency range, [35 MHZ;65 MHz], is larger than the operational one, to achieve operation reliability. The output power on operation frequency range is extended, under IO responsibility, to 3 MW on VSWR = 1.5.

In this paper, the technical specifications and the resulting constraints on the design of the source are fully described. A risk analysis is done, focused, in particular, on the end stage tube. At present, its specification is not demonstrated in any IC H&CD systems. Indeed, taking into account the losses in the combiner and the reflected power linked to the VSWR, the output power of one amplifier chain shall be not less than 1.7 MW CW, on VSWR = 1.5, all phases. A contract was placed between IO and Large Helical Device team, at the National Institute of Fusion Science in Japan, in order to test the CPI 4CM2500KG tetrode. This tube constitutes one option for the end stage. The results obtained within this collaboration are detailed and analyzed.

An assessment of the use of one high power combiner in existing IC worldwide systems is presented and the specific application to ITER IC sources is detailed (CW operation, power and phase controls, fault conditions, etc.)

As a final point, the test plan for the source development and acceptance is detailed.