§4. Radiation Shielding Analysis of Large Helical Device (LHD)

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It is necessary to provide information on radiation shielding of LHD and its effect for the equipment designs and operation planning.

The building concrete wall gives major radiation shield against neutrons and X(γ)-rays generating from LHD. Therefore it is important to examine the nuclear data of concrete to be used in radiation shielding analysis.

Benchmark experiment has been performed at the Fusion Neutronics Source (FNS) Facility of the Japan Atomic Energy Research Institute. Figure 1 shows the geometry of FNS concrete benchmark experiment. The cylindrical concrete assembly was 600 mm in diameter and 600 mm thick, which was suitable configuration for checking two-dimensional calculation. Deuterium-tritium neutrons were produced by bombarding a water-cooled titanium target containing 7 Ci tritium with a 330 keV deuteron beam. Seven kinds of foils, the sensitive energy regions of which varied from thermal to 14MeV, were selected for the measurement of reaction rates. The set of foils were placed along the central axis of the assembly, as shown in Fig.1.

Calculations have been carried out by using several data libraries and transport codes and compared with the experimental results. The reliability of JENDL-3, a newly released general data library, has been shown in the calculations combined with a Monte Carlo code, MCNP, giving good agreements with the FNS experiments. Furthermore, comparison of three groupwise cross section sets, FUSION-J3, FUSION-40 and GICX-40, has been made with applications of the DOT-3.5 transport code. Both of FUSION-J3 (detailed set) and FUSION-40 (practical set) are derived from JENDL-3, while GICX-40 is from ENDF/B-III database. Generally speaking, in high energy region (>MeV) all the libraries give quite good results, but for the lower neutron energies GICX-40, which was mainly used in the previous design work, gives smaller penetrating neutron fluxes than those given by experiments as well as other calculations.

Since FUSION-40 results look like more reliable than GICX-40 on the same practical level, the revision of shielding analyses of LHD and its surroundings with FUSION-40 are under way, where a detailed modelling of machine structures is also taken into account.

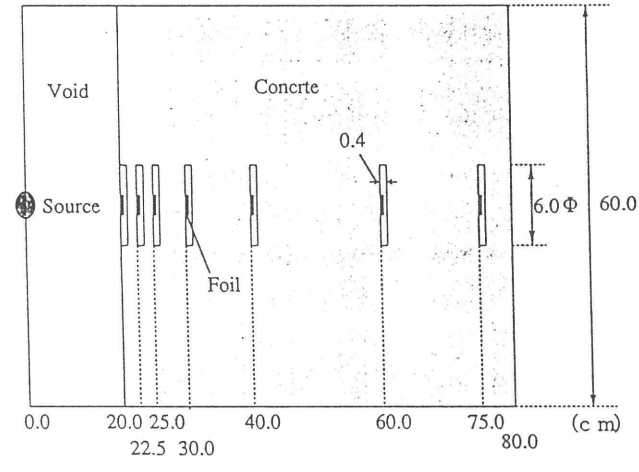

Fig. 1. Geometry of FNS concrete benchmark experiment.