# 11. Safety and Environmental Research Center

The Safety and Environmental Research Center (SERC) has been studied to promote and to implement radiation safety issues in NIFS. The major mission of SERC is radiation safety management of X-ray emission devices which are LHD, CHS, and their plasma heating devices like NBI and ECH, and a Tandem type accelerator for plasma diagnostic device which is called as Heavy Ion Beam Probe (HIBP). For safety operation of LHD and relative devices, radiation management system and access-control system were well integrated. Radiation monitoring by the Radiation Monitoring System Applicable to Fusion Experiments (RMSAFE) has continued successfully. The other radiation safety issues are planning the safety management system and development of radiation safety equipments considering the deuterium (D) plasma experiments in LHD, especially protection of neutron and tritium. The SERC is responsible to the research and development regarding fusion safety, so that variety of issues should be surveyed not only in the field of radiation safety management and radiation protection but also in the field of general safety science, health and environment. It would be pointed out that some of these scientific investigations have been successfully carried out as collaboration with researchers of many universities, research institutes and companies. Topics of the activities of the SERC during FY 2006 are summarized as follows:

(i) Radiation management and monitoring

For the occupational workers in radiation control area, educational training and registration system have been established. The radiation management had been performed by radiation safety management office in the health and safety promoting division in NIFS and management issues have been discussed and proposed by the SERC.

It is required that the annual exposure dose caused by operation of some radiation emission devices should not exceed 50 $\mu$Sv on the site boundary. To ensure the limit, a monitoring system RMSAFE works to detect burst X-ray and to discriminate the radiation caused by plasma experiment from the natural radiation and to accumulate the exposure dose. The annual radiation dose level caused by experiments of LHD and CHS at the site boundary was less than 1 $\mu$Sv in FY 2006. Also the environmental radiation has been measured every three months using thermo-luminescence dosimeter TLD and radiophoto-luminescence dosimeter RPLD. Also to apply to highly precise measurement, sensitivity of the TLD and RPLD to cosmic ray was measured in Ogoya tunnel. As the integrating dosimeter an electronic integrating dosimeter has been applied to environmental radiation monitoring. In the present study measurement error has been clarified. The detail annual report will be published elsewhere.

To know the natural background in the office of concrete building, neutron and ionizing components of cosmic rays were measured. Good correlation between them and the shield of concrete wall and ceiling were clearly seen.

(ii) Tritium measurements

It is important to grasp tendency of the environmental tritium concentration level in water and atmosphere before start DD experiment in LHD. Simple and accurate tritium measurement method in the environmental water with liquid scintillation counting system has been developed Some water samples of extremely low level of tritium in the environmental have been measured. Also the atmospheric tritium gases have been measured with separating chemical forms of water, hydrogen and methane respectively. High sensitive tritium monitor has been developed using an improved proportional counter. These studies were performed as collaboration with Nagoya University, Niigata University.

(iii) Studies of tritium treatment system and safety

The tritium and neutron are key issues from view point of radiation safety for the DD experiment of LHD and for a future nuclear fusion facility. The specific technologies are extremely low level tritium monitoring and removing or separation of tritium from the vacuum pumping gas or exhausting air from the large plasma vacuum vessel. The main topics of research and developments are (a) measurement of tritium concentration in air by using gas chromatography, (b) direct immersion method to detect tritium in concrete, (c) development of tritium recovery based on proton conducting oxide such as $SrZrO_3$, $CaZr_{0.9}In_{0.1}O_3$, (d) safety tritium treatment system of exhaust gas and effluent liquid, (e) advanced honeycombs intend to high volumetric gas treatment under small flow resistance, (f) experimental analysis of activated dust behavior under the loss of vacuum event. These studies were performed as collaboration with Kyushu University, Shizuoka University and the other research organizations.

(iv) Non-ionizing radiation monitoring and management

Leakage of static magnetic field and variable frequencies of electromagnetic fields are concerned in a magnetic fusion plasma experimental facility. The static magnetic leakage has been measured continuously outside of the LHD hall, and its strength monitored was less than 1 mT. There are electromagnetic fields around the LHD because LHD has strong radio frequency and micro wave generators for plasma heating. We have install probes for monitoring, and the observed values were less than 0.07A/m which is less than the occupational regulation level proposed as guideline by ICNIRP. It has been performed as collaboration with Utsunomiya University and Nagoya Institute of Technology.

(iv) Education

Some materials contain natural weak radio-active

components, such as sinter (hot sprig deposit) and dried seaweed. The method is proposed to make a disk-shaped radiation source by compressing and shaping the original material. This will be a weak radiation source easy to be handled for educational use.

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List of Reports

1. "Correlation of cosmic ray dose in concrete buildings between neutron component and ionizing component," Yamanishi H. (NIFS)
2. "Tritium Measurement," Sakuma Y. (NIFS)
3. "Trial production of monitor for tritium in vapor of atmospheric air," Ogata Y. (Nagoya Univ.)
4. "Improvement of Infinitesimal Concentration Hydrogen Analyzer," Kawano T. (NIFS)
5. "Water-extraction Method for Measuring Tritium Concentration of Concrete," Kawano T. (NIFS)
6. "Study on proton transfer under electrochemical hydrogen pump using $SrZrO_3$-base oxide," Tanaka M. (NIFS)
7. "Performance of electrochemical hydrogen pump by a proton-conducting oxide for a tritium monitor," Tanaka M. (NIFS)
8. "Development of Exhaust Gas Treatment System for LHD," Asakura Y. (NIFS)
9. "Evaluation of pressure drop and hydrogen oxidation performance of a honeycomb catalyst impregnated with the noble metal," Uda T. (NIFS)
10. "Entrainment behavior of activated dust in accidental event," Ebara S. Kyushu Univ.)
11. "Monitoring of static and varying electromagnetic fields intended for a large plasma experimental facility," Uda T. (NIFS)
12. "Study of EM Coupling between EM Fields and Electronic Circuits in Plasma Experimental Environment," Wang J. (Nagoya Inst. Of Tech.)
13. "Method of Fabricating Neutral Radiation Source," Kawano T. (NIFS)