

Research and Development of High-performance Instruments for Safety Measures in LWRs

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In June 2011, the Japanese government referred to “Enhancement of instrumentation to identify the status of the reactors and PCVs” as a lesson of the accident at the Fukushima Dai-ichi (1F) Nuclear Power Station, in the report of Japanese government to the IAEA ministerial conference. In accordance with such situation, we started from 2012 a research and development which corresponds to the provisions so as to monitor the situations of nuclear power plants during a severe accident. The R&D is carried out in the following three fields and the latest progresses will be introduced in this symposium.

(i) Radiation-resistant monitoring camera

The objective is development of a radiation-resistant high-definition and high-sensitivity three-CMOS monitoring camera which can obtain high-resolution images even under a severe environment. The design and fabrication of trial products for image sensor in camera and the gamma radiation tests had been carried out in FY 2013. The result from irradiation tests showed the some effective circuits on image sensor under the irradiation condition. The trial image sensor, which has highest radiation-resistance, works after over 100 kGy irradiation. Based on these results, we will carry out trial fabrication of the monitoring camera.

(ii) In-water wireless transmission system

A transmission method using visible light was adopted because of its relatively lower attenuation rate and higher transmission rate in water. Light-emitting diodes and photo diodes were adopted for emission and receiving devices. Radiation tests for these devices and transmission test in water had been carried out in FY 2013. From the result of radiation test, the devices were able to work with efficient performance although they degraded under the radiation on the lens and window made of glass or resin. The result of transmission test in water showed the possibilities to use commercially available optical devices in the developing transmission system.

(iii) Heat-resistant signal cable

As a major candidate for data transmission, mineral insulator (MI) cable was adopted on the basis of the research of conventional signal cables performance. The materials and the fabrications of the sheath, insulator, and core wire have been carefully selected so as to inhibit radiation-induced conductivity and insulation degradation even under high-radiation and high-temperature environment. The results of the insulation resistance test at high temperature showed that the enough value of the insulation resistance was confirmed at 1000°C. Moreover, gamma-ray irradiation and in-core irradiation tests are also planned in the future.