Safety management at Nishina Center since 1990

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The most impressive development since 1990 has been the construction of the radioactive-isotope-beam factory (RIBF). It included the decommissioning of the old 160-cm cyclotron, safety design of the new facility, and its commissioning.

The 160-cm cyclotron was the facility built first when RIKEN moved from central Tokyo, Komagome, to the present campus. The operation started in 1966 and ended in 1990. It accelerated particles ranging from protons to Ne ions with energies of several tens of MeV. A hot laboratory was adjoined, and several points of it were contaminated since it was used for a long period. Decontamination was performed by an external company. Some parts of the accelerator were radioactivated, and the activated parts were removed and stored in the radioactive waste storehouse. The main part of the accelerator is displayed in front of the main research building of the campus, as shown in Fig. 1. However, coils and pole pieces were replaced with mock-ups since these parts were activated.

When the safety design of RIBF started, we did not have any data or computer codes for the shielding calculation. Fortunately, a similar-energy heavy-ion facility, Heavy Ion Medical Accelerator in Chiba (HIMAC), started operation. We could measure the neutron production data at a thick target bombarded by heavy ions in collaboration with Tohoku University.[1] The measured data were not only used as a source term of the high-energy neutron shielding calculation of RIBF, but they also contributed to the development of a computer code, Particle and Heavy Ion Transport Code System[2] (PHITS), which is widely used for estimations of radiation-relating affairs.

Fig. 1. The old 160-cm cyclotron displayed in front of the main research building.

Based on the measured neutron production data, shielding calculation was performed using a discrete ordinates transport code, and the shield thicknesses of the RIBF building were determined. The results were investigated by a radiation safety committee led by Dr. Kamitsubo. The committee firstly discussed the criteria of radiation levels in and around the facility. It also discussed the safety measure for induced radioactivity in accelerator components and in air and water. The committee held 6 meetings over 4 years and approved the design.

The RIBF project and its safety design[3] were explained to the mayor and the municipal government and assembly. After they acknowledged the project, we explained to the residents successfully.

The personal safety interlock system (HIS) was built several years before the installation, and its logic was tested using a simulation device. HIS was a separated system from those of Nishina and Linac buildings, and its logic was comparably simple.

During the construction of RIBF, we applied for the license of uranium acceleration at the old accelerators. On the day when we submitted the application form to the government office, a radioisotope source was illegally found outside of radiation-controlled area. We brought this accident to the notice of the same office immediately. We received a special inspection by the office and sent many documents on the facts of the accident and on measures to prevent a similar accident from occurring again. We luckily could obtain the license within a normal period.

The first beam was extracted from the superconducting cyclotron (SRC) on December 28, 2006. After the tuning of accelerators, a ^{86}Kr beam was transported to the experimental area in the very early morning on March 15, 2007, and we measured the radiation levels in and around the facility before daybreak. The government inspection of the facility was conducted on the same day in reference to our measured radiation data. The pass certificate was issued on March 22, and we could start the experiment. The accelerator staff soon succeeded in the acceleration of ^{238}U by using the fixed-frequency ring cyclotron (fRC), and we passed the government inspection for the whole facility by the end of March 2007.

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