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J-PARC Center

The cause of the malfunction of the EQ magnets for the slow extraction system of the 50-GeV synchrotron in J-PARC

The accident of the radioactive material leakage at the Hadron Experimental Facility (HD facility) was triggered by a malfunction of Extraction Quadrupole (EQ) magnets for the slow extraction system of the 50-GeV synchrotron. As a result of the malfunction, 2×10^{13} protons were extracted in a very short period of five milliseconds, whereas 3×10^{13} protons should have been slowly extracted over two seconds in a normal operation. The gold target of the HD facility was heated to extremely high temperature by the instantaneous injection of high intensity pulsed beam. Then it is considered that the gold target partially melted and radioactive material in the target diffused into the surrounding atmosphere.

After the accident, the J-PARC Center has investigated the cause of the malfunction of the EQ magnets in cooperation with the manufacture of the EQ power supply. As a result of the investigation, it was identified that a transient failure occurred in part of the transmission system of the power supply, not correctly transferring current command input as follows. The failure was resulted from voltage drop in a circuit board of constant voltage power supply that supplies a voltage of 5V to the interface circuit board that converts an external input signal. The EQ power supply had operated without a failure since 2009. However, a circuit board of the relevant power supply was suffering aging degradation due to insufficient preventive measures against overheat in a three-terminal positive output regulator and it let to the malfunction this time. To avoid having recurrence of aging degradation, we will change the configuration of the circuit board of the power supply.

On the other hand, if J-PARC had taken measures for any abnormal beam injection, the damage of the gold target would have been mitigated. Furthermore, we deeply regret not having sufficient measures against preventing radioactive material leak even when the target was damaged. In order to adequately enforce the safety and credibility of the system, the J-PARC Center promises to take certainly the measures for preventing a recurrence of a similar accident as shown in the third statutory report on the radioactive material leak at the HD facility.