AN OPTIMIZED PERIODIC MAINTENANCE PLANNER FOR A COMMERCIAL MEDICAL CYCLOTRON FACILITY

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Implementation of scheduled preventive maintenance at regular intervals is mandatory in order to ensure the reliable supply of radiopharmaceuticals from medical cyclotron center to hospitals. The unplanned downtime of the cyclotron interrupts radiopharmaceutical supply which has a compounding impact on the hospital staff, patients, and bystanders. Unplanned production failure of a single day in our facility could affect more than five hundred people which includes about 200 patients expecting imaging. This is a huge economic loss to the cyclotron centre but a much higher revenue loss to the hospitals and mental agony/indirect cost to the patients. The purpose of this study was to develop an effective maintenance protocol to reduce unexpected failures of cyclotron operation in a commercial radiopharmaceuticals production facility.

Siemens Eclipse HP self-shielded medical cyclotron with 11 MeV proton beam installed in our facility at Kochi, India was used for this study. It has four tantalum F-18 targets with dual irradiation capability of up to 120 μA total beam current. As the best practice, we followed manufacturer's operating guidelines from the time of cyclotron's commissioning itself. The operational parameters are kept at optimum reference value to produce maximum isotope yield which also helps in improvement of lifespan of the cyclotron parts. Based on our operation experience, we felt that the pre-default guidelines from the manufacturer are not sufficient to reduce the downtime of the cyclotron. Initially, we experienced three to four weeks of downtimes annually.

Major maintenance issues observed in the last six years were failure of RF and ion source, vacuum leakage, target foil rupture, extraction foil rupture, failure of valves in the activity transfer line, and cyclotron network communication error. Sometimes they were not standalone issues, instead were observed as sequential. Though, the manufacturer's guidelines provide the detailed troubleshoot actions, it did not give information to prevent or minimize such issues. In this scenario, we developed a periodic maintenance protocol to minimize the major and minor troubles in the cyclotron based on our past experience. This protocol includes a daily check list of different parameters in addition to monthly, quarterly, semiannual, and annual maintenance.

We followed the policy that prevention is always better than cure. In such a way, we periodically assessed the performance of each cyclotron parts and replaced whenever found it has underperformed. The parts such as targets, ion source and extraction foils are rebuilt when it reached 80% of its recommended consumption. Keeping detailed record of all the parameter readings of cyclotron is a good practice to find out any sudden change in those values. The gradual increase of the ion source current each day predicts its performance and time to rebuild. More attention is required for the service of the radioactive parts as sufficient time must be allowed for decay of radioactivity to workable limits. Having four water targets allowed us to cool the target for an extended period thereby reducing radiation

exposure. Availability of most of the parts at the facility or somewhere near to the facility was also ensured for faster replacement of the parts.

Application of the developed protocol in the two years resulted in smooth operation of the cyclotron with very little downtimes. Talking in figures, the annual downtime reduced to 1 – 2% from previous 5 – 8% which resulted in significant socioeconomic benefit not only to the cyclotron center but also to the hospitals and patients.

REFERENCES

[1] Siemens Eclipse HP/Eclipse RD Cyclotron Operator's Manual, Knoxville, USA 10531634, Rev.01

[2] IAEA-Technical Reports Series No. 468, Cyclotron Produced Radionuclides: Physical Characteristics and Production Methods.