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## **Experimental Study of Exposure Situations at Shielded and Unshielded Medical Cyclotron Facilities in Pakistan**

This experimental study presents an evaluation of the exposure situation on shielded (PET Trace 800) and unshielded (IBA 18/9) cyclotrons installed in Pakistan. The cyclotrons are used for the production of  $^{18}\text{F}$  through  $^{18}\text{O}(\text{p},\text{n})$  reaction with the energetic protons ( $\sim 18$  MeV). The production process results the emission of energetic neutrons with an average energy in the range of 2-4 MeV. Different experimental studies were conducted to assess the neutron field inside and outside medical cyclotron vault, identify radioactive byproducts in the components of medical cyclotrons, evaluate the design of the PET cyclotron facilities.

Activation in the components of cyclotrons was assessed with the help of portable HPGe detector. Micro-trans-SPEC HPGe Detector was installed around the cyclotrons and spectra were acquired, at different distances and times, to identify the radioactive by-product in the components [1].

Design of the PET Cyclotron facilities was assessed on the basis of IAEA guidelines [2] that workers should not be exposed to radiation level of greater than  $2.5 \mu\text{Sv/h}$  and dose rate in the controlled area should not be greater than  $25 \mu\text{Sv/h}$ . It was observed that the facilities are well designed and radiation exposures in these areas are well below the acceptable limits [3].

On the basis of these observations, recommendations to ensure radiation safety practices in shielding, operation, QC, repair & maintenance and management of radioactive waste at medical cyclotron facilities were proposed. The appropriate actions on the recommendations will result optimization in radiation exposures and personnel doses.

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