Reduction of radioactive waste production of a proton therapy facility

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Introduction

Since 1984, more than 5200 patients have been treated with protons at Paul Scherrer Institute in Villigen, Switzerland. Within the frame of the so-called PROSCAN project, a new superconducting cyclotron with dedicated beam lines was installed in order to serve the existing Gantry 1 and additional new beam lines with protons. First protons were extracted from this cyclotron in 2005; year-round patient treatments have been started after a commissioning phase in 2007.

Since PSI's treatment program now uses its own proton cyclotron and beam lines (compared to the previous parasitic use of the research facilities in the years before 2007), the production of radioactive waste and outgoing air can be directly determined and assigned to the PROSCAN facility.

These figures can be of special interest for the public, since a variety of proton therapy facilities is actually in the planning stage worldwide.

Normal treatment of waste

Regular maintenance works in the type 1-controlled zones of the PROSCAN facility produce on average 1-2 plastic bags containing up to 60 liters of combustible and potentially contaminated radioactive waste per week. Main component of this waste are disposable overalls and oily cleaning rags or papers. These components are normally disposed via special combustion, together with other radioactive materials, e.g. from industry, for about 150 Fr./kg, leading to total costs in the order of several 10 kFr. per year.

Theoretically it is possible to separate the content of the plastic bags into normal and contaminated waste; however, this procedure is also costly, time-consuming, and produces additional waste due to the measurement procedure.

The recent acquisition of an clearance monitor which allows an automatic check for contamination of a complete waste bag (CheckPoint:Waste^{TM}; RADOS RTM 661/440) led to a significant reduction of plastic bags requiring special combustion. After clearance using the new monitor system, actually about 90 % of the waste originating from the type 1-controlled zones of PSI's PROSCAN facility needs no more handling as radioactive waste and can thus be regularly disposed (0.2 Fr./kg), leading to an enormous reduction in disposal costs.

Not combustible waste

Per month, approximately 1 kg of activated and not combustible waste (mainly screws, washers or other small metallic parts) is originating from the PROSCAN facilities. Depending on the nuclei and the amount of activation, these components are either stored at PSI or being prepared for final storage within concrete containers.

Exhaustion of air

Another issue related to proton therapy is the activation of the compartment air in the neighbourhood of the cyclotron and parts of the beam line. The air activation is dominated by ^{11}C and ^{41}Ar and minor contributions of ^{13}N, ^{15}O, and ^{18}F. Since the half lives of all these nuclei are below 2 h and their activities are far below the limits tolerated by the Swiss authorities, the exhaustion of air from the PROSCAN facility is unproblematic.

Conclusions

The waste produced during regular services of a proton therapy unit has to be handled with great care. A defined clearing procedure can lead to a significant reduction of disposal costs.