

## Induced Radioactivity in VMS Accelerators

High energy linear accelerator radiation beams are capable of inducing radioactivity in matter. The process where non-radioactive substances become radioactive due to interactions with high-energy radiation is called activation. Metal parts in direct contact with linear accelerator radiation beams with energy greater than 10MV (10MeV) are most likely to become activated. Table 1 (below) lists the most commonly activated VMS accelerator components with their associated, estimated\* activity values. The isotopes present in the greatest quantities are:  $^{181}\text{W}$ ,  $^{57}\text{Co}$ ,  $^{58}\text{Co}$ ,  $^{60}\text{Co}$ , and  $^{54}\text{Mn}$ .

**Table 1: Activated VMS accelerator components, expected radioactive isotopes, activity estimates\***

<u>Accelerator Component</u>	<u>Expected Isotopes</u>	<u>Estimated Activity*</u> <u>(<math>\mu\text{Ci}</math>)</u>
Target	$^{181}\text{W}$ , $^{57}\text{Co}$ , $^{58}\text{Co}$ , $^{60}\text{Co}$ , $^{54}\text{Mn}$	10, 1, 0.1, 0.05, 0.05
Filters (15x), (18x), (20x)	$^{181}\text{W}$ , $^{57}\text{Co}$ , $^{54}\text{Mn}$	10, 5, 4
Multi-Leaf Collimator	$^{181}\text{W}$ , $^{57}\text{Co}$ , $^{54}\text{Mn}$	5, 3, 1
Beryllium Window	$^{181}\text{W}$ , $^{57}\text{Co}$ , $^{58}\text{Co}$ , $^{60}\text{Co}$ , $^{54}\text{Mn}$ , $^{51}\text{Cr}$	15, 2.0, 1.5, 0.4, 1, 0.5
B-Mag Wedge/Bracket	$^{57}\text{Co}$ , $^{54}\text{Mn}$	0.4, 0.8
Upper/Lower Jaws	$^{181}\text{W}$ , $^{57}\text{Co}$ , $^{58}\text{Co}$ , $^{60}\text{Co}$ , $^{54}\text{Mn}$	5, 0.1, 0.5, 0.2, 0.05
Ion Chamber	$^{62}\text{Cu}$ , $^{64}\text{Cu}$ , $^{196}\text{Au}$ , $^{198}\text{Au}$	< 0.01 (all isotopes)

\* These activity estimates were obtained from measurements of one specific machine: Clinac 2100; s/n 0097; measured 10/15-16/2007. The estimated activity is based on normal machine use and a two week decay period since the last Beam-On. Actual values may vary significantly depending on actual machine use, beam energy, beam intensity and the time since last beam-on.

Accelerators should not be dismantled within three days of last Beam-On except by expertly trained personnel. Three days is the amount of time for the vast majority of radioactivity to decay within VMS accelerators. However, a two week decay period is recommended. Nonetheless, significant quantities of radioactivity may remain; therefore, it is recommended that only trained personnel equipped with calibrated radiation detectors perform "radiation work". Sound radiation protection principles must be employed.

The recycling of radioactive metals/materials is highly regulated. The regulations often vary from country to country. However, the International Atomic Energy Agency (IAEA) has published guidelines for the recycling of radioactive materials (see the reference below). It is the responsibility of the recycler to ensure all applicable regulations are satisfied.

[1] IAEA Safety Standards Series RS-G-1.7, Application of the Concepts of Exclusion, Exemption and Clearance; 2004.