

RADIATION PROTECTION SERVICE

DEPARTMENT OF WELLBEING, SAFETY & HEALTH



UNIVERSITY OF LEEDS

RPA GENERIC RISK ASSESSMENT NO 6: HAZARD IDENTIFICATION & RISK ASSESSMENT FOR THE AMERICIUM-241 DIAL TYPE X-RAY CALIBRATION SOURCE

SOURCE DESCRIPTION

- 1) The 370 MBq americium-241 source is a highly polished stainless steel cylinder, ~40 mm diameter by ~25 mm tall. On the bottom of the cylinder is a small aperture through which the radiation beam escapes. A black plastic thumb wheel on the side rotates and changes the targets, and hence the x-ray spectrum, which ranges from ~10 keV to 60 keV.
- 2) During radioactive decay americium-241 emits both alpha particles (5.48 MeV / 85.2%) and photons (gamma radiations; 0.66 keV). When the alpha particles hit a metallic target (in the dial), the energy absorbed is re-emitted as characteristic x-rays; the weak photons are shielded by the cylinder / target material.
- 3) When not in use, the source is stored in an outer container, a wooden box, to which is affixed a label bearing the details required by Schedule 1, Section 4 of the University's closed source registration (Environment Agency ref BB1139 dated 2 July 1998), namely a trefoil, the radionuclide, activity, serial number and activity date.

<u>Version</u>	<u>Author</u>	<u>Date of issue</u>	<u>Revised</u>	
1.1	Ian Haslam	16 th July 2004	5 th October 2011	

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- 4) The source is used for the purposes of calibrating x-ray detectors such as are found in x-ray diffractometers, where they produce an x-ray spectrum that reproduces the typical operational range of the detectors, i.e. ~10 to 60 keV.
- 5) If kept at a location away from the Radiation Protection Source Store overnight (or longer), then when not in use it must be kept in a locked cupboard in a secured room, and the cupboard marked with a radiation hazard warning sign (issued by the Service). The responsible person must keep a movement log (also issued by the Service). Under normal circumstances the source may only be kept in a Department for a maximum of 5 days at a time (issue Monday returned by 16:00 on a Friday).

HAZARD & RISK ASSESSMENT

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
Source in outer container	External irradiation			
	(1) holding the source with the hand over the position of the aperture during carriage.	Penetrating x-rays; dose rate ~20 $\mu\text{Sv h}^{-1}$.	<p>Health – Low</p> <p>Time to reach dose constraint from continual exposure = 50 hrs.</p> <p>Collateral – Low</p> <p>Dose rate exceeds internal guidelines and national guidelines for ‘giving consideration to the establishment of designated areas’; potential for legislative infraction.</p>	<p>Carry the source inside the wooden outer container (box), ensure the source is stored with the aperture down, and handle for a minimum period; no unnecessary handling.</p> <p>Nb Do not wrap the source / outer container in lead as this will obscure the hazard warning trefoil.</p>
Unshielded source	External irradiation			
	(2) holding the source with the hand over the aperture during use.	Penetrating x-rays; dose rate ~75 $\mu\text{Sv h}^{-1}$.	<p>Health – Low</p> <p>Time taken to reach dose constraint from continuous exposure = ~13 hrs.</p> <p>Collateral – Low</p> <p>Dose rate exceeds internal guideline and is close to the national dose rate limit for the designation of Controlled Areas; potential for</p>	<p>Hold the source by the sides, with the aperture facing away from the body.</p> <p>Only use the un-boxed source in an XRD cabinet or similar enclosure.</p>

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
			legislative infraction.	
	(3) Setting up the source in such a position that the radiation beam would inadvertently be directed towards the operator or other person.	Penetrating x-rays; dose rate $\sim 50 \mu\text{Sv h}^{-1}$.	<p>Health – Low</p> <p>Time taken to reach dose constraint from continuous exposure = 20 hrs.</p> <p>Collateral – Low</p> <p>Dose rate exceeds internal guideline and national guidelines for 'giving consideration to the establishment of designated areas'; potential for legislative infraction.</p>	Use the source in an XRD cabinet or similar enclosure; with the aperture facing away from the viewing position; towards a wall or other shielding material.
Leaking source	External irradiation			
	(4) The source becomes damaged and the contents leak, giving rise to alpha and gamma contamination of the skin.	<p>Alpha radiations do not penetrate the 'dead layer' of skin, so there would be no external radiation exposure.</p> <p>Weak photons penetrate the skin to the depth of a few cms, localised external exposure.</p> <p>radiation dose = $2.4 \cdot 10^2 \times 0.3 \mu\text{Sv h}^{-1}$</p>	<p>Health – Low</p> <p>The contamination of the skin with alpha particles is an extreme hazard. Risk of intake and transfer to other persons.</p> <p>The risk of external irradiation by photons is low, time taken to reach dose constraint = ~ 13 hrs.</p> <p>Collateral – High / Extreme</p>	<p>Handle the source with latex (or similar) gloves.</p> <p>Check, by visual inspection, that the source is in good condition, and that there are no liquids or stains, also check that the box is dry / clean.</p> <p>The source should be leakage tested by the Radiation Protection Service</p>

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
		= 72 $\mu\text{Sv h}^{-1}$	Spread of alpha contamination poses an extreme risk, immediate closure of large areas of the School until decontamination has been affected; possible legislative infraction; adverse publicity.	on an annual basis or if it is dropped or damage is suspected.
Leaking source	Internal irradiation			
	(5) The source becomes damaged and leaking contents are transferred, via hand and mouth into the body.	Alpha particles are ingested into the body, and / or transferred as cross contamination to third party. Taken internally, alpha radiation would irradiate healthy, radiosensitive skin such as the alveoli (lungs) and gut lining. The particles would also be taken up into the bloodstream and distributed about the body.	Health – High / Extreme The ingestion of the maximum activity (370 MBq Am^{241}) would give rise to a fatal internal dose of 74 Sv: ingestion of 1% of the source activity would give an internal dose of 0.74 Sv, which could be fatal to susceptible persons. Collateral – High / Extreme Spread of alpha contamination poses an extreme risk, immediate closure of large areas of the School until decontamination has been affected; possible legislative infraction; adverse publicity.	Handle the source with latex (or similar) gloves. Check, by visual inspection, that the source is in good condition, there are no liquids or stains, that the box is dry / clean. If the source is dropped or otherwise becomes damaged, notify the Radiation Protection Service immediately. The source should be leakage tested by the Radiation Protection Service on an annual basis or if it is dropped or damage is suspected.

Condition	Exposure pathway	Radiation exposure	Level of risk	Risk reduction measures
Loss or theft	<i>n/r</i>			
	(6) The source becomes lost because of negligent keeping.	n/r	Collateral – High Infraction – Likely enforcement action by the Environment Agency.	When not in use, store the source in a locked 'closed source store' (e.g. a lockable metal container that is bolted to a wall / floor, a lockable filing cabinet drawer). The room in which the source is stored must also be lockable. Only remove the source for the duration of its use, no longer. Do not leave unattended.
	(7) The source is stolen because of improper use / keeping or through poor security.	n/r	Collateral – High / Extreme Infraction – Likely prohibition action by the Environment Agency.	When not in use, store the source in a locked 'closed source store' (e.g. a lockable metal container that is bolted to a wall / floor, a lockable filing cabinet drawer). The room in which the source is stored must also be lockable. Only remove the source for the duration of its use, no longer. Do not leave unattended.

