

# 18 Ionisation Type Smoke Detectors

## Scope

1. The majority of ionisation type smoke detectors across the MOD contain Americium-241 (Am-241) and this Chapter details the specific requirements for this radionuclide. Consult the RPA in respect to smoke detectors containing other radioactive material.
2. Summaries of the radiation risks and regulatory requirements for two examples of smoke detector heads containing Am-241 are included in the Annexes to this Chapter.
3. Summary risk assessments for a comprehensive range of smoke detectors are available from the RPA.
4. It should be noted that where reasonably practicable and where suitable alternatives exist, non-radioactive detectors should be used in preference to those containing radioactive material. Smoke detectors containing Ra-226 are not to be used.

## Statutory Requirements

5. In addition to the general requirements of the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, the following specific legislation applies directly or is applied indirectly through parallel arrangements designed to achieve equivalent standards:
  - a. Ionising Radiations Regulations 2017 (IRR17) (apply directly);
  - b. Environmental Permitting (England and Wales) Regulations 2016 (as amended) (EPR16) (parallel arrangements);
  - c. Environmental Authorisations (Scotland) Regulations 2018 (EASR18) (parallel arrangements);
  - d. Radioactive Substances Act 1993 (Northern Ireland) (as amended) (RSA93) and associated Exemption Orders; and
  - e. Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2009 (apply directly).

## Duties

6. Duties as detailed in Chapter 39 apply.

## Radioactive Substances Legislation Notification/Permitting Requirements

7. In England, Wales and Northern Ireland the keeping and use smoke detectors is exempt from the requirement to obtain a Notification / Permit from the environment agencies, provided the activity per smoke detector is less than 4 MBq. There is no limit to the number of these smoke detectors affixed to the premises. The number of uninstalled smoke detectors with an activity less than 4 MBq count toward the maximum quantity of small sealed sources (i.e. other sealed source with an activity less than 4 MBq) kept on the premises which cannot exceed 200 MBq.

8. In Scotland there is no requirement for an authorisation for the keeping and use of smoke detectors with an activity less than 40 kBq subject to the condition that no more than 500 smoke detectors not affixed to the premises are being kept. For smoke detectors with an activity up to 200 kBq these are subject to the general binding rules for the keeping and use of category 5 sealed sources (i.e. small sealed sources). On premises where smoke detectors with an activity greater than 200 kBq are being kept SEPA should be notified of 'the management (other than the disposal) of a category 5 sealed source that contains an activity exceeding 200 kBq).

## **Hazards**

9. Alpha - Alpha radiation emitted from the foil source will not penetrate beyond the casing of the smoke detector head. Alpha radiation poses a potential internal hazard only in the event of breakage of the detector head and the sealed Am-241 source.

10. Gamma and X-rays - Gamma radiation and low energy X-rays are emitted by the source and will penetrate through the smoke detector head. External radiation dose rates depend on the activity of Am-241 but will only be significant within about 30 cm of the detector head.

## **Risk Assessments**

11. Examples of summary risk assessments are reproduced at Annexes A and B of this Chapter. These summary risk assessments may be used to scope the hazard and control requirements for a wider range of smoke detectors and may be used, where appropriate, as input to the risk assessments and local orders required in accordance with Chapters 2 and 16 respectively. Advice on further detail and assessments for smoke detectors may be sought from the RPA

## **Handling of Smoke Detector Heads**

12. Latex or nitrile gloves are to be worn by personnel routinely handling higher activity smoke detector heads or large quantities of low activity smoke detector heads.

13. Smoke detector heads are not to be dismantled, repaired or tampered with in any way except by authorised persons working to approved procedures and with the advice of the RPA.

## Summary Radiation Risk Assessment for Lower Activity Smoke Detector

<b>Example - Smoke Detector Containing up to 40 kBq Americium-241</b>	
<p><b>Example shown is the Tyco (Thorn) MF 501</b></p> <p>Example shown contains 33.3 kBq of Am-241</p>	<div style="display: flex; align-items: center;">   <div style="margin-left: 20px;"> <p>External view      Internal view</p> <p>Within the smoke detector there is a chamber. Across this chamber a low-level electrical voltage is applied to collect ions produced as a result of the alpha particles emitted from the Am-241. When smoke enters the space between the electrodes of the chamber, the current drops in the smoke detector, setting off an audible alarm.</p> </div> </div>
<b>Use</b>	Early detection of smoke.
<b>Radionuclide</b>	Americium –241 (Am-241)
<b>Ionising radiation</b>	Alpha/Gamma ( $\alpha$ 5.44 MeV, 5.46 MeV – $\gamma$ 59.5 keV, 26.3 keV, 13.9 keV)
<b>Half life</b>	433 years.
<b>External radiation hazard</b>	Am-241 emits low energy gamma radiation. The hourly dose rate from external radiation from this type of detector is extremely low (<0.01 $\mu$ Sv/hr at 30 cm) and is not considered significant.
<b>Internal radiation hazard</b>	Am-241 emits alpha particles which are completely absorbed before they escape the smoke detector head. Hence for an intact unit, there is no internal hazard. The likelihood of accidental damage to this component to such a degree that Am-241 escapes is low. A more severe accident, for example, crushing or fire, could possibly result in the release of some particulate Am-241. In some highly unlikely circumstances, there is a potential for an internal dose to be received. For further advice contact the RPA.
<b>Local orders</b>	Details of the control measures taken from this Chapter are to be included in the local orders for radiation safety. Chapter 16 gives guidance on the content of local orders.
<b>Control measures during use</b>	Latex or nitrile gloves are to be worn by personnel routinely handling large quantities of smoke detector heads (SDH). It is recommended that hands be washed after handling SDHs.
<b>Inspection</b>	Annually as well as during routine maintenance. Check is to be made for signs of damage.
<b>Leak test</b>	No routine leak test is required.
<b>Accounting</b>	This item is to be accounted for on a Radioactive Source List. Chapter 9 refers. Uninstalled SDHs must be mustered monthly. Any change of location is to be entered in the Source Movement Log together with any change in custodian.

<b>Annual Holdings Return</b>	This item is to be included in the Annual Holdings Return to Dstl – Chapter 9 refers.
<b>Storage and labelling</b>	If uninstalled, this item is to be stored in a dedicated area for radioactive materials – see Chapter 9. The uninstalled equipment is to have the radioactive trefoil on it. The storage area is to display a sign with a radiation warning trefoil and must include the contact name and telephone number of the RPS or WPS (Radioactive Materials). The nature of the radiological hazard e.g. <b>“Smoke detectors contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item damaged”</b> should be included.
<b>Contingency plans breakage / loss</b>	If a breakage occurs the immediate area is to be cordoned off. The broken source fragments item can be cleaned up using a breakage kit – Chapter 40 refers. Broken fragments are disposed of as directed by the RPA. Personnel exposed to leaking Am-241 are to report to the RPS or WPS. The loss of any smoke detectors is to be reported in accordance with procedures described in Chapter 14.
<b>Transport</b>	These items can be transported as an exempt package, provided the total package does not exceed 500 of these items.
<b>Disposal</b>	Units and establishments are to return unbroken items through the Stores Organisation. Consult the RPA in respect to broken or damaged items.

## Summary Radiation Risk Assessment for Higher Activity Smoke Detector

Example – Smoke Detector Containing 2.2 MBq Americium-241	
<p>Example shown is the Minerva F36</p> <p>Example shown contains 2.2 MBq of Am-241</p>	  <p>Marking</p> <p>Within the smoke detector there is a chamber. Across this chamber a low-level electrical voltage is applied to collect ions produced as a result of the alpha particles emitted from the Am-241. When smoke enters the space between the electrodes of the chamber, the current drops in</p>
<b>Use</b>	Early detection of smoke.
<b>Radionuclide</b>	Americium –241 (Am-241).
<b>Ionising radiation</b>	Alpha/Gamma ( $\alpha$ 5.44 MeV, 5.46 MeV – $\gamma$ 59.5 keV, 26.3 keV, 13.9 keV).
<b>Half life</b>	433 years.
<b>External radiation hazard</b>	Am-241 emits low energy gamma radiation. External radiation from a 2.2 MBq smoke detector is measurable in close proximity to the detector head (~0.3 $\mu$ Sv/hr at 30 cm).
<b>Internal radiation hazard</b>	Am-241 emits alpha particles which are completely absorbed before they escape the smoke detector head. Hence for an intact unit, there is no internal hazard. The likelihood of accidental damage to this component to such a degree that Am-241 escapes is low. A more severe accident, for example, crushing or fire, could possibly result in the release of some particulate Am-241. In some highly unlikely circumstances, there is a potential for an internal dose to be received. For further advice contact the RPA.
<b>Local orders</b>	Details of the control measures taken from this Chapter are to be included in the local orders for radiation safety. Chapter 16 gives guidance on the content of local orders.
<b>Control measures during use</b>	Latex or nitrile gloves are to be worn by personnel routinely handling this type of smoke detector head (SDH). It is recommended that hands be washed after handling SDHs.
<b>Inspection</b>	Annually as well as during routine maintenance. Check is to be made for signs of damage.
<b>Leak tests</b>	Only required where advised by RPA. Tests have shown that leakage has been observed in some unit types in which case, leakage tests are advised for units of the same type. Currently, on this basis, the <b>F31, F35 and F36 require a leak test</b> to be carried out every 2 years once they are unpacked and put into service.

<b>Accounting</b>	<p>These items are to be accounted for on a Radioactive Source List - Chapter 9 refers.</p> <p>Uninstalled SDHs must be mustered monthly.</p> <p>Any change of location is to be entered in the Source Movement Log together with any change in custodian.</p>
<b>Annual Holdings Return</b>	<p>This item is to be included in the Annual Holdings Return to Dstl – Chapter 9 refers.</p>
<b>Storage and labelling</b>	<p>This this item is to be stored in a dedicated area for radioactive materials in accordance with Chapter 9.</p> <p>The uninstalled equipment is to have the recognised radioactive trefoil on it. The storage area is to display a sign with a radiation warning trefoil and must include the contact name and telephone number of the RPS or WPS (Radioactive Materials). The nature of the radiological hazard e.g. <b>“Smoke detectors contain radioactive material. Low external radiation hazard from intact item. Radioactive contamination hazard if item damaged.”</b> should be included.</p> <p>Note: storage areas may require to be designated as controlled or supervised areas in accordance with RPA advice (see Chapter 4).</p>
<b>Contingency plans breakage / loss</b>	<p>If a breakage occurs the area is to be cordoned off. Wearing a FFP3 rated mask, the broken source fragments item can be cleaned up using a breakage kit – Chapter 40 refers.</p> <p>Broken fragments are disposed of as directed by the RPA.</p> <p>Personnel exposed to leaking Am-241 are to report to the RPS or WPS.</p> <p>The loss of any smoke detectors is to be reported in accordance with procedures in Chapter 14.</p>
<b>Transport</b>	<p>These items can be transported as an excepted package, provided the total package does not exceed an activity of 1GBq and the surface dose rate does not exceed 5 <math>\mu</math>Sv/hr.</p>
<b>Disposal</b>	<p>Units and establishments are to return unbroken items through the Stores Organisation. Consult the RPA in respect to the disposal of broken or damaged items.</p>