

Leaflet 18

Ionisation Type Smoke Detectors

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Scope

1 The majority of ionisation type smoke detectors across the MOD contain Americium-241 (Am-241) and this Leaflet details the specific requirements for this radionuclide. Consult the RPA in respect to smoke detectors containing other radioactive material. The following information describes the requirements for keeping, using and disposing of such equipment. 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 Leaflet.

2 Summary risk assessments for a comprehensive range of smoke detectors are available from the RPA.

3 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

4 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:

- Ionising Radiations Regulations 1999 (IRR99) (apply directly);
- Environmental Permitting (England and Wales) Regulations 2010 (as amended) (EPR10) (parallel arrangements);
- Radioactive Substances Act 1993 (Scotland & Northern Ireland) (as amended) (RSA93) (parallel arrangements);
- Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2009 (apply directly).

Duties

Commanding Officer and Head of Establishment (CO/HoE)

5 The CO/HoE has a duty to the Secretary of State, and a personal responsibility, to protect the environment and secure the health, safety and welfare of their staff at work. The CO/HoE is also required to protect persons not in MOD employment (e.g. members of the public) against risks to their health and safety arising from the MOD work activities. This includes radiation safety. The CO/HoE's authority (but not responsibility) for radiation safety management arrangements may be delegated to appropriate personnel, such as a Radiation Safety Officer (RSO).

Radiation Safety Officer (RSO)

6 The Radiation Safety Officer (RSO) is to ensure that:

- They are familiar with the specific radiation hazards of their unit or establishment and that an appropriate risk assessment has been carried out;
- Local orders include the requirements for keeping, using and disposing of smoke detectors containing radioactive material as detailed in this Leaflet;
- Staff are appointed, instructed and trained in their duties relating to this Leaflet;
- The requirements stemming from this Leaflet are subject to audit.

Radiation Protection Supervisor (RPS)

7 A Radiation Protection Supervisor must be appointed where it is necessary to designate areas as controlled or supervised (see Leaflet 4). Where an RPS is so appointed they are to ensure that the work is carried out in accordance with local orders for radiation safety (see Leaflet 16) which addresses the requirements of this Leaflet.

Workplace Supervisor (WPS) (Radioactive Materials)

8 In areas where there is no requirement for an RPS, a WPS should be appointed to carry out duties that ensure work is carried out in accordance with local orders for radiation safety which are to include the requirements of this Leaflet.

Employees

9 It is the responsibility of all employees to ensure that they are familiar with the requirements of the relevant local orders to ensure that these items are handled safely and correctly. Any incidents are to be reported to the appropriate supervisor or line manager.

Hazards

Table 1 Hazard associated with Am-241 smoke detectors

Radiation type		Emitted	Comments
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.
Beta	Direct	✗	
	Bremsstrahlung	✗	
Gamma & 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 heads (see summary risk assessments at annexes to this Leaflet).
Neutrons		✗	

Risk Assessments for Smoke Detectors

10 Table 2 gives brief details of a number of smoke detectors in service in MOD. The list is not intended to be exhaustive. Summary risk assessments are provided at Annexes A and B respectively. These summary risk assessments may be used to scope the hazard and control requirements for all the detectors listed in Table 2 and may be used as input to the risk assessments and local orders required in accordance with Leaflets 2 and 16 respectively. Advice on further detail and assessments for detectors not listed should be sought from the RPA.

Table 2 List of common smoke detectors used in MOD

Supplier	Name	NSN	Am-241 Activity	Summary risk assessment
AICO	Auto	182-6137	33.3 kBq	Annex A
Apollo	Series 60	301-4061	33.0 kBq	Annex A
Tyco (Thorn)(Minerva)	MF 301	313-3953	33.3 kBq	Annex A
Tyco (Thorn)(Minerva)	MF 301EX	051-6941	33.3 kBq	Annex A
Tyco (Thorn)(Minerva)	MF301H	301-7679	33.3 kBq	Annex A
Tyco (Thorn)(Minerva)	MF 501	930-5280	33.3 kBq	Annex A
Tyco (Thorn)(Minerva)	MF 501 EX	125-4400	33.3 kBq	Annex A
Tyco (Thorn)(Minerva)	F712 M	768-1561	29.6 kBq	Annex A
Tyco (Thorn)(Minerva)	F712 EX	736-4962	29.6 kBq	Annex A

Supplier	Name	NSN	Am-241 Activity	Summary risk assessment
Tyco (Thorn)(Minerva)	MF 901 EX	151-1011	33.3 kBq	Annex A
Ginge-Kerr	Sensor 1551	465-2258	37 kBq	Annex A
Hochiki	GLYNX F Sim	301-0881	33.3 kBq	Annex A
Minerva	F31	519-3461	3 sources total 2.2 MBq	Annex B
Minerva	F35	542-2133	3 sources total 2.2 MBq	Annex B
Minerva	F36	519-3462	3 sources total 2.2 MBq	Annex B

Handling of Smoke Detector Heads

11 Latex or surgical-type gloves are to be worn by personnel routinely handling higher activity smoke detector heads or large quantities of low activity smoke detector heads.

12 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.

Legal and MOD Mandatory Requirements

13 Table 3 below summarises the legal and MOD mandatory requirements for smoke detectors.

Table 3 Legal and MOD mandatory requirements for smoke detectors

Requirement	Applies	Comments	Related Leaflet*
Notification to HSE (≤ 40 kBq) (Am^{241})	✗ (but see comment)	Only if more than 500 uninstalled smoke detectors are stored in any building must HSE must be notified in accordance with Leaflet 3.	3
Notification to HSE (>40 kBq ≤ 2.2 MBq) (Am^{241})	✗ (but see comment)	Notification not necessary where these smoke detectors are installed but HSE must be notified where 1 or more of these detectors are stored.	3
EPR10/RSA93 Notification/ Permitting	✗ (but see comment)	Exempt on the following conditions: That each smoke detector contains a sealed source with an activity of less than 4MBq; there is no upper limit on numbers for exemption if the smoke detector is installed. If uninstalled, up to 50 smoke detectors can be stored. Where the activity is less than 40kBq, up to 5000 can be stored.	3
Risk assessment (both categories)	✓	See Annexes, further specific risk assessments or prior risk assessments may be required.	2
Restriction of exposure (both categories)	✓	See Leaflet 4.	4
PPE (both categories)	✓	Latex or surgical gloves are to be worn if handling large quantities of these detectors.	4
Maintenance of radiation engineering controls (both categories)	✗		

Requirement	Applies	Comments	Related Leaflet*
Contingency plans (both categories)	✓	See Leaflet 40.	40
Designated areas (both categories)	✗ (but see comment)	Areas housing solely installed smoke detectors do not require designation but stores holding quantities of smoke detectors may require designation if they meet the criteria detailed in Leaflet 4. Note: small stores which people cannot enter (e.g. drawers or cupboards) do not require designation but must be marked.	4
Monitoring (both categories)	✗ (but see comment)	Monitoring of installed detectors is not required but where stores are designated areas, then monitoring will be required in accordance with Leaflets 4 and 8.	4, 8
Training for users (both categories)	✓	Information and Instruction only.	15
Local orders (both categories)	✓	See Leaflet 16 for guidance.	16
Appointed person (both categories)	✓	RPS not required except for storage areas required to be designated as controlled or supervised areas. Where an RPS is not required, a WPS needs to be appointed in accordance with Leaflet 39.	39
Storage (both categories)	✓	In a segregated secure store/container/cupboard marked with radiation trefoil warning sign and stored in accordance with Leaflet 9.	9

Table 3 Legal and MOD mandatory requirements for smoke detectors (continued)



Requirement	Applicable	Comments	Related Leaflet*
Accounting (both categories)	✓	Mustered annually, recorded on a source list and retained for 2 years. Where detectors require leak testing (see below), test certificates are to be retained in accordance with Leaflet 9. Recorded on Dstl Annual Holdings Return, copy retained for 1 year.	9
Leak testing (≤ 40 kBq)	✗	Smoke detectors containing up to 40 kBq of Am-241 do not require leak testing.	
Leak testing (> 40 kBq ≤ 2.2 MBq)	✗ (but see comment)	Where experience shows that a particular type of detector is prone to leakage, appropriate testing will be recommended by the RPA. Leak testing is currently required for F31, F35 and F36.	
Leak testing (Type F31, F35 and F36 only)	✓	Smoke detectors F31, F35 and F36 require to be leak tested at intervals no greater than 24 months. Contact the RPA for details of leak testing, if unsure. Details of the leak test undertaken and the results obtained are to be retained for 2 years.	-
Personal dosimetry (both categories)	✗ (but see comment)	Personal dosimetry will only need to be worn if there is a requirement for a designated area.	6
Reporting procedures (both categories)	✓	All losses to be reported in accordance with Leaflet 14.	14
Transport (≤ 40 kBq)	✓	Items transported as Exempt Packages in accordance with JSP 800 Vol. 4b (road, rail, sea) or JSP 800 Vol. 4a (air) – maximum number in a package is 500.	JSP 800 Vol. 4a & 4b
Transport (> 40 kBq ≤ 2.2 MBq)	✓	Items transported as Excepted Packages in accordance with JSP 800 Vol. 4b. Overall package limit is an activity of 1 GBq.	JSP 800 Vol. 4b
Marking (both categories)	✓	All smoke detectors are to be marked externally with a radiation trefoil or the word radioactive and details of the radionuclide and activity they contain.	4
Sale/transfer	✓	See Leaflet 11	11
Disposal of redundant items	✓	Preferred route is to return to the manufacturer via stores as appropriate. In some cases it may be permissible to dispose of small numbers of detectors local but RPA to be consulted for advice – Leaflet 12 also refers. Keep records of disposal indefinitely.	12

*JSP 392, unless otherwise stated

**Environment Agency (EA) for England and Wales, Scottish Environment Protection Agency (SEPA) for Scotland and Environment and Heritage Service for Northern Ireland (EHSNI).

Leaflet 18 Annex A

Summary Radiation Risk Assessment for Lower Activity Smoke Detector



Example - Smoke Detector Containing up to 40 kBq Americium-241	
<p>Example shown is the Tyco (Thorn) MF 501</p> <p>Example shown contains 33.3 kBq of Am-241</p>	<div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center;">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>
Use	Early detection of smoke.
Radionuclide	Americium –241 (Am-241)
Ionising radiation	Alpha/Gamma (α 5.44 MeV, 5.46 MeV – γ 59.5 keV, 26.3 keV, 13.9 keV)
Half life	433 years.
Regulatory body notifications	Up to 5000 uninstalled items can be held on one site without the requirement for notification to the regulatory bodies if storage and disposal conditions are met (see below) – contact the RPA for further advice.
External radiation hazard	Am-241 emits low energy gamma radiation. The hourly dose rate from external radiation from this type of detector is extremely low (<0.01 μ Sv/hr at 30 cm) and is not considered significant.
Internal radiation hazard	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 this case, a body intake by ingestion and inhalation could give rise to an internal dose of no more than about 10 μ Sv. (DRPS Report 167/2004 dated 02/07/04).
Local orders	Details of the control measures taken from this leaflet are to be included in the local orders for radiation safety. Leaflet 16 gives guidance on the content of local orders.
Control measures during use	Latex or surgical gloves are to be worn for personnel routinely handling large quantities of smoke detector heads (SDH). It is recommended that hands be washed after handling SDHs.
Inspection	Annually as well as during routine maintenance. Check is to be made for signs of damage.
Leak test	No routine leak test is required.

Example - Smoke Detector Containing up to 40 kBq Americium-241	
Accounting	This item is to be accounted for on a Radioactive Source List. Leaflet 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.
Annual Holdings Return	This item is to be included in the Annual Holdings Return to Dstl – Leaflet 9 refers.
Storage and labelling	If uninstalled, this item is to be stored in a dedicated area for radioactive materials – see Leaflet 9. 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. <i>“Smoke detectors contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item damaged”</i> should be included.
Contingency plans breakage/loss	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 – Leaflet 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 Leaflet 14.
Transport	These items can be transported as an exempt package, provided the total package does not exceed 500 of these items.
Disposal	Units and establishments are to return unbroken items through the Stores Organisation. Consult the RPA in respect to broken or damaged items.

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Leaflet 18 Annex B

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>	<div style="display: flex; align-items: center; justify-content: center;">  <div style="margin-left: 20px;">  <p style="text-align: center;">Marking</p> </div> </div> <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. These detectors are mostly found in high voltage cabinets or weapon magazines.</p>
Use	Early detection of smoke.
Radionuclide	Americium –241 (Am-241).
Ionising radiation	Alpha/Gamma (α 5.44 MeV, 5.46 MeV – γ 59.5 keV, 26.3 keV, 13.9 keV).
Half life	433 years.
Notification to regulatory bodies	Notification to the regulatory bodies is not required. Up to 90 uninstalled individual units can be stored without notification (subject to compliance with storage and disposal arrangements (see below). Contact the RPA for further information.
External radiation hazard	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 μ Sv/hr at 30 cm).
Internal radiation hazard	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 this case, a bodily intake by ingestion and inhalation could give rise to an internal dose of about 400 μ Sv. (DRPS Report 6/2004 dated 02/03/04).
Local orders	Details of the control measures taken from this Leaflet are to be included in the local orders for radiation safety. Leaflet 16 gives guidance on the content of local orders.
Control measures during use	Latex or surgical gloves are to be worn for personnel routinely handling this type of smoke detector heads (SDH). It is recommended that hands be washed after handling SDHs.
Inspection	Annually as well as during routine maintenance. Check is to be made for signs of damage.

Example – Smoke Detector Containing 2.2 MBq Americium-241	
Leak tests	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 F31, F35 and F36 require a leak test to be carried out every 24 months once they are unpacked and put into service.
Accounting	These items are to be accounted for on a Radioactive Source List - Leaflet 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.
Annual Holdings Return	This item is to be included in the Annual Holdings Return to Dstl – Leaflet 9 refers.
Storage and labelling	Up to 90 uninstalled, this item is to be stored in a dedicated area for radioactive materials in accordance with Leaflet 9. 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. " Smoke detectors contain radioactive material. Low external radiation hazard from intact item. Radioactive contamination hazard if item damaged. " should be included. Note: storage areas may require to be designated as controlled or supervised areas in accordance with RPA advice (see Leaflet 4).
Contingency plans breakage/loss	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 – Leaflet 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 in Leaflet 14.
Transport	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 μ Sv/hr.
Disposal	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.