LEAFLET 18

SMOKE DETECTORS CONTAINING AMERICIUM-241

CONTENTS

SCOPE

1 This Leaflet applies only to smoke detector heads incorporating radioactive sources containing Americium-241 (Am-241). 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. The examples chosen are representative of a lower activity and a higher activity Am-241 smoke detector.

2 Summary risk assessments for a comprehensive range of smoke detectors are available from the RPA who is also to be consulted regarding the hazards and requirements for detectors not covered by the scope of this Leaflet.

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 AND PARALLEL ARRANGEMENTS

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);
- Radioactive Substances Act 1993 (RSA93) (parallel arrangements);
- Radioactive Substances (Smoke Detectors) Exemption Order 1980 as amended by the Radioactive Substances (Smoke Detectors) Exemption (Amendment) Order 1991 (parallel arrangements);
- Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2007 (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 Where an RPS is appointed, they are to ensure that work is carried out in accordance with the local orders for radiation safety which are to include the requirements of this leaflet. The requirements for appointment of an RPS are covered in Table 3.

Workplace Supervisor (WPS) (Radioactive Materials)

8 In units holding smoke detectors but where it is unnecessary to appoint an RPS, a WPS (Radioactive Materials) is to be appointed with duties to ensure that work is carried out in accordance with the 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 relevant requirements of 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		✓	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).
X-rays		×	
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 for a lower activity smoke detector (up to 40 kBq Am-241) and a higher activity (2.2 MBq Am-241) 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 may 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
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 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 containing Am-241. Two categories are considered - where a smoke detector does not fall into either of the two categories or where it contains radionuclides other than Am-241, the RPA is to be consulted for advice. The two separate categories of smoke detector considered in Table 2 are:

- Those containing up to 40 kBq of Am-241 (i.e. ≤ 40 kBq);
- Those containing more than 40 kBq of Am-241 but up to 2.2 MBq (i.e. > 40 kBq ≤ 2.2 MBq);

Table 3 Legal and MOD mandatory requirements for smoke detectors containing Am-241

Requirement	Applicable	Comments	Related Leaflet*
HSE authorisation (both categories)	×		
HSE notification (≤ 40 kBq)	× (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
HSE notification (>40 kBq ≤ 2.2 MBq)	× (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
EA notification** (≤ 40 kBq)	× (but see comment)	Only if more than 500 uninstalled smoke detectors are stored in any building must EA be notified in accordance with Leaflet 3.	3
EA notification** (> 40 kBq ≤ 2.2 MBq)	× (but see comment)	Notification not necessary where these smoke detectors are installed but notification is required where 1 or more of these detectors are 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)	×		
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 containing Am-241 (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 to be leak tested.	
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 (≤ 40 kBq)	✓	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 as refuse – RPA to be consulted for advice – Leaflet 12 also refers. Keep records of disposal for 2 years.	12
Disposal of redundant items (> 40 kBq ≤ 2.2 MBq)	✓	Preferred route is return to manufacturer via stores as above. **Disposal as refuse is not permitted**. Advice on other options for disposal is to be sought from the RPA – Leaflet 12 also refers.	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	
Example shown is the Tyco (Thorn) MF 501 Example shown contains 33.3 kBq of Am-241	 External view  Internal view 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.
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.
Classification	Smoke detectors containing up to 40 kBq of Americium-241 fall under the Radioactive Substances (Smoke Detectors) Exemption Order 1980 and are also the subject of an HSE Type Approval. This confers exemptions on notification of environment agencies and HSE for up to 500 of these items. Exemptions may only apply if specified conditions for use, storage and disposal are met (see below) – the RPA is to be contacted if further information is required.
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 μSv h^{-1} 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 μSv. (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.
Radioactive Substances Act 1993	Although exempt from formal RSA 93 notification to the environment agencies, 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 equipment is to have the recognised radioactive trefoil on it. The storage/installed area is also to have a sign showing radioactive material within i.e. a trefoil including the contact name and telephone number of the RPS or WPS and stating the nature of the radiological hazard in appropriate languages: ***Smoke detectors contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item damaged.***
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 this item, unbroken to the Stores Organisation.

LEAFLET 18 ANNEX B

SUMMARY RADIATION RISK ASSESSMENT FOR HIGHER ACTIVITY SMOKE DETECTOR

Example – Smoke Detector Containing 2.2 MBq Americium-241	
Example shown is the Minerva F36 **Example shown contains 2.2 MBq of Am-241**	  Marking 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.
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.
Classification	Smoke detectors of this type (containing more than 40 kBq but less than 4 MBq of Am-241) fall under the Radioactive Substances (Smoke Detectors) Exemption Order 1980 and are also the subject of an HSE Type Approval **but only when the detectors are installed**. This confers exemptions on notification of environment agencies and HSE for these items when installed. Exemptions may only apply if specified conditions for use and disposal are met (see below). Units or establishments **storing** these items **are not exempt from the notification procedures** detailed in Leaflet 3. Your RPA should be contacted if further information is required.
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 μSv h^{-1} 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 μSv. (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.
Radioactive Substances Act 1993	Although installed items of this type are exempt from notification to the environment agencies, 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 in accordance with Leaflet 9. The equipment is to have the recognised radioactive trefoil on it. The storage/installed area is also to have a sign showing radioactive material within. i.e. a trefoil including the contact name and telephone number of the RPS or WPS and stating the nature of the radiological hazard in appropriate languages: ***Smoke detectors contain radioactive material. Low external radiation hazard from intact item. Radioactive contamination hazard if item damaged***. 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 μSv h^{-1}.
Disposal	Units and establishments are to return this item, unbroken to the Stores Organisation.