

Leaflet 17

Radioactive Electronic Valves

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Scope

1 A large number of radioactive electronic valves are used across a wide range of MOD activities particularly in radar and telecommunications equipment. Items such as electronic switches, spark gaps, protection cells, TR cells, surge protectors and high energy ignition switches may all contain radioactive material either in gaseous or solid form.

2 This Leaflet describes the radiological requirements for keeping, using and disposing of such equipment. Summaries of the radiation risk and regulatory requirements for examples of electronic valves are provided at the annexes to this Leaflet. Summary risk assessments for a comprehensive range of electronic valves are available from the RPA who may also be consulted for further advice regarding the hazards and requirements for these items.

Statutory Requirements

3 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 (EPR10) (as amended) (parallel arrangements);
- Radioactive Substances Act (Scotland and Northern Ireland) 1993 (RSA93) (as amended) (parallel arrangements);
- Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2009 (apply directly).

Duties

Commanding Officer (CO) and Head of Establishment (HoE)

4 The Commanding Officer/Head of Establishment (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)

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

- They are familiar with the specific radiation hazards at 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 electronic valves 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)

6 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 rules for radiation safety (see Leaflet 16) which addresses the requirements of this Leaflet.

Workplace Supervisor (WPS) (Radioactive Materials)

7 In units holding radioactive electronic valves 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

8 It is the responsibility of all employees to ensure that they are familiar with the relevant parts 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.

Notification/Permitting Requirements for Radioactive Electronic Valves

9 Subject to the activities listed in Table 1 not exceeding the levels shown, radioactive electronic valves are exempt from the requirement under EPR10/RSA93 to obtain a Notification/Permit from the environment agencies. Further advice should be sought from the RPA or the Radioactive Waste Adviser (RWA).

Table 1 Exemption levels for radioactive electronic valves

| Radioactive material or accumulated radioactive waste type | Maximum quantity of radionuclides for each individual item of material or waste | Maximum quantity of radionuclides: -on any premises in items of the material or waste which satisfy the limit in column 2; -in mobile radioactive apparatus held by a person |
|--|---|--|
| Tritium (H3) | 20 GBq | 5 TBq |
| Any other radionuclide | 4 MBq | 200 MBq |

10 Exemption from Notification/Permitting does not preclude the requirement of notification the HSE and the requirements of Leaflet 3, paragraphs 23-28, Annex C and Annex D are to be actioned by the unit or establishment.

Hazards

Table 2 Hazards associated with radioactive electronic valves

| Radiation type | Emitted | Comments |
|----------------|---------|---|
| Alpha | ✓ | Alpha radiation is emitted within valves containing nuclides of radium, thorium and uranium. The alpha radiation does not penetrate beyond the casing of the valve. Alpha radiation poses a potential internal hazard only in the event of breakage of the valve. |

| Radiation type | | Emitted | Comments |
|----------------|----------------|---------|---|
| Beta | Direct | ✓ | Low energy beta radiation is emitted within valves containing H-3, C-14, Ni-63, Pm-147 but the energy of the beta is insufficient to penetrate beyond the valve casing. Higher energy beta radiation, which may penetrate for a short distance beyond the valve casing, is emitted from valves containing Cl-36, Co-60, Kr-85, Tl-204, Ra-226, Thorium and Uranium. Beta radiation poses a potential hazard in the event of breakage of a valve due to the possibility of inhalation of gas (H-3 or Kr-85), inhalation of dusts or via contamination of the skin. |
| | Bremsstrahlung | ✓ | Low levels of Bremsstrahlung radiation (X-rays) are emitted from valves containing beta emitters. |
| Gamma | | ✓ | Gamma radiation is emitted by valves containing Co-60, Ra-226, Thorium and Uranium. Valves containing Kr-85, Pm-147 also emit low levels of gamma radiation. External radiation dose rates depend on the activity of the gamma emitter contained within the valve but the levels are likely to be measurable only within about 30 cm of the valve (see examples of summary risk assessments at annexes to this Leaflet). |
| X-rays | | ✓ | Parasitic X-rays are a by-product arising from many types of high voltage equipment (>5 kV) (see Leaflet 23). They may be emitted from electronic valves within high voltage equipment and/or other parts of the equipment when it is operating. |
| Neutrons | | ✗ | |

Risk Assessments for Radioactive Electronic Valves

11 The number of radioactive electronic valves in service within MOD is too large to list in this publication. Similarly, it is not possible to include risk data for all valves. However, examples of summary risk assessments are reproduced at Annexes A to C of this Leaflet. These summary risk assessments may be used to scope the hazard and control requirements for a wider range of valves and may be used, where appropriate, 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 radioactive electronic valves may be sought from the RPA or more information can be located on the Dstl ESD Radiation Protection webpage: <http://collab.dstl.r.mil.uk/DRPA/Pages/default.aspx>

Handling of Radioactive Electronic Valves

12 No protective clothing is required for the routine handling of radioactive electronic valves. However, the valves are not to be carried on the person.

Breakage of Radioactive Electronic Valves

13 Radioactive valves are not to be broken deliberately.

14 A broken radioactive valve is potentially hazardous because loose radioactive material can enter the body by a variety of means including inhalation of gaseous material (if present), inhalation of radioactive dust and absorption through cuts or scratches in the skin.

15 Because a large number of radioactive valves contain gaseous tritium (H-3), it is important that the room or compartment where the breakage has occurred is vacated and ventilated for 1 hour before dealing with the broken fragments wearing gloves and safety goggles. If it is certain that the valve does not contain tritium or krypton-85 (Kr-85), a delay before dealing with the fragments is not necessary. Detailed guidance on the procedure for dealing with and disposing of a broken valve is in Leaflet 40.

Legal and MoD Mandatory Requirements

16 Table 5 below summarises the legal and MOD mandatory requirements for radioactive electronic valves. In cases of doubt, the RPA/RWA is to be consulted for advice.

Table 1 Legal and MOD mandatory requirements for radioactive electronic valves

| Requirement | Applicable | Comments | Related leaflet* |
|---|------------------------|---|------------------|
| HSE authorisation | ✗ | - | - |
| HSE notification | ✓ | In general, work carried out involving radioactive valves is to be notified to HSE in accordance with Leaflet 3. Where only small numbers of valves are held, notification may not be necessary (see Leaflet 3). | 3 |
| EPR10/RSA93 Permitting | ✓ | There are exemptions in place. See Table 1 above and Leaflet 3. | 3 |
| Risk assessment | ✓ | See examples at Annexes to this Leaflet. Further specific risk assessments or prior risk assessments may be required (see Leaflet 2). | 2 |
| Restriction of exposure | ✓ | Observe manufacturer's instruction and guidance. Also, see Leaflet 4. | 4 |
| PPE | ✗ | Not required except when dealing with a breakage | - |
| Maintenance of radiation engineering controls | ✗ | - | - |
| Contingency plans | ✓ | See Leaflet 40 – breakage/fire | 40 |
| Designated areas | ✗ (but see comment) | The presence of radioactive electronic valves in equipment does not usually, on its own, lead to a requirement for area designation – designation may, however, be necessary for other reasons (e.g. parasitic X-rays). Stores holding quantities of electronic valves 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 appropriately marked. | 4 |
| Monitoring | ✗ (but see comment) | Monitoring of installed electronic valves 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 | ✓ | Information and Instruction only. | 15 |
| Local orders | ✓ | See Leaflet 16 for guidance. | 16 |

| | | | |
|----------------------|------------------------|--|---------------------------------|
| Appointed person | ✓ | RPS not required except for storage areas required to be designated as controlled or supervised. Where an RPS is not required, a WPS (Radioactive Materials) needs to be appointed in accordance with Leaflet 39. | 39 |
| Storage | ✓ | In a segregated secure store/container/cupboard marked with radiation trefoil warning sign and stored in accordance with Leaflet 9. Valves are not to be removed from their cartons until required. | 9 |
| Accounting | ✓ | Recorded on a source list (retained for 2 years) and mustered in accordance with Leaflet 9. Recorded on Dstl Annual Holdings Return, copy retained for 1 year. | 9 |
| Leak testing | ✓ | Leak testing is not normally appropriate for valves containing gaseous radioactive material. For valves containing solid or liquid radioactive material, the risk assessment is to identify whether or not leak testing is appropriate; the RPA should be consulted. | - |
| Personal dosimetry | ✖ (but see comment) | Personal dosimetry will only need to be worn if there is a requirement for a designated area. | 6 |
| Reporting procedures | ✓ | All losses and certain other incidents require to be reported to MOD authorities. Reporting to external regulatory authorities may also be required. See Leaflet 14 for details. | 14 |
| Transport | ✓ | Items and bulk quantities may generally be transported as excepted packages subject to the item and package limits for 'other form' (rather than 'special form' items) as detailed in JSP 800 Vol. 4b (road, rail, sea) or JSP 800 Vol. 4a (air). | JSP 800 Vol. 4a & Vol. 4b |
| Marking | ✓ | All storage areas and containers holding radioactive valves are to be marked with appropriate signage. There is no longer a requirement to classify these valves but equipment can still be found with the markings detailed in Annex D. | - |
| Sale/transfer | ✓ | See Leaflet 11 | 11 |




*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).

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Leaflet 17 Annex A

Summary Radiation Risk Assessment

| Tuned 'T' 1007 Radar (Waveguide Fit) | |
|---|---|
| Description | <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>Valve BS810</p> </div> <div style="text-align: center;">  <p>Tuned Junction Box</p> </div> <div style="text-align: center;">  <p>Valve marking</p> </div> </div> <p>Tuned 'T'. The radioactive valve BS810 is found within a junction box (NSN 5840-99-543-3741/5985-99-531-8473) of the Kelvin Hughes 1007 Radar waveguide See BR 8549 for maintenance and fitting.</p> |
| Use | Navigational and Helicopter operation frequency adjustment. |
| Supplier | E2V Technologies, 106 Waterhouse Lane, Chelmsford, Essex CM1 2QU |
| NSN / Part No | 5960-99-000-1923/BS810 |
| IPT | FWS. |
| Radionuclide | Tritium (H-3). |
| Ionising radiation | Beta (low energy (19 keV)). |
| Half life | 12.3 years. |
| Original activity | 5.43 MBq. |
| External radiation hazard | H-3 does not present an external radiation hazard since the beta radiation is of low energy and will not penetrate even a thin layer of material. |
| Internal radiation hazard | <p>Very small amounts of tritium leak from these valves over a prolonged period of time but this does not present a significant health risk. The escape of tritium from a broken valve could result in a minor health risk if breakage occurs in a confined space.</p> <p>Tritium may be present both as an elemental gas (behaving, chemically, in the same way as hydrogen gas) and also in the form of tritiated water vapour. The latter (behaving, chemically, in the same way as water vapour) presents the greater hazard due to its ability to enter the body both by inhalation and by rapid absorption through the skin.</p> <p>In the case of breakage, evacuation affords the best protection against internal hazards since the filters in respiratory protection will not absorb tritium nor prevent absorption through the skin.</p> <p>Total dose to an individual, following breakage of a single valve of this type in a confined space is likely to be less than 0.2 µSv.</p> |

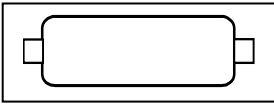

Tuned 'T' 1007 Radar (Waveguide Fit) (continued)

| | |
|---|---|
| Local orders | Details of the control measures taken from this leaflet are to be included in the local orders for radiation safety (Leaflet 16 refers). |
| Control measures during use | No protective clothing or special precautions required. Item not to be carried on the person. |
| Inspection | Annually as well as during routine maintenance. Check to be made for signs of damage. |
| Leak testing | Leak testing is not required for this component. |
| Accounting | This item is to be accounted for on a Radioactive Source List. Leaflet 9 refers. All radioactive material is to be mustered monthly. Any change of location is to be entered in the Source Movement Log together with any change in custodian. |
| EPR10/RSA93 | Although exempt from formal EPR10/RSA 93 notification to the environment agencies, this item is to be included in the Annual Holdings Return to Dstl – Leaflet 3 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 display the recognised radioactive valve warning label on it. The storage/installed area is 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. Items contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item is damaged should also be included. |
| Contingency plans breakage/loss/incident | If a breakage occurs the area is to be evacuated and ventilated. Tritium gas will disperse relatively quickly however some may remain bonded to the component. Once appropriate ventilation time (one hour) has passed, the broken item can be cleaned up using a breakage kit, see Leaflet 40. RPA advice is to be sought regarding disposal of the fragments. Reporting of loss and certain other incidents is to be carried out in accordance with procedures described in Leaflet 14. |
| Transport | This item may be transported within an excepted package provided the total package activity does not exceed 8000GBq. |
| Disposal | Units and Establishments are to return this item, unbroken, through the Stores Organisation. Broken items are to be disposed of in accordance with Leaflet 40 but RPA advice is to be sought in the first instance. |

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Leaflet 17 Annex B

Summary Radiation Risk Assessment

| Goalkeeper Spark Gap TG-375-20 5/24KV | |
|--|--|
| Description | <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Spark Gap diagram</p> </div> <div style="text-align: center;"> <p>CLASS 2</p>  <p>Valve marking</p> </div> <div style="text-align: left;"> <p>One Spark Gap found in High Voltage Circuit.</p> <p>BR 8423(7) Vol 2 Fig 04-033 Items BV1</p> </div> </div> |
| Use | Spark gap. |
| Supplier | Clare High Energy Devices, Maryland Heights, MO 63043, USA. |
| NSN / Part number | 5920-01-223-0747 / 3522 500 41574 (TG-375 -20 5/24KV). |
| IPT | Goalkeeper. |
| Radionuclide | Caesium-137 (β 1.17 MeV, β 510 keV, γ 662 keV). |
| Ionising radiation | Beta and Gamma. |
| Half life | 30 years. |
| Original activity | 37 kBq. |
| External radiation hazard | Caesium-137 sealed sources emit gamma radiation. The dose rate arising from 37 kBq of Cs-137 is $<0.5 \mu\text{Svh}^{-1}$ at 10 cm and $<0.1 \mu\text{Svh}^{-1}$ at 30 cm. |
| Internal radiation hazard | An internal hazard can only occur if the valve is broken. The likelihood of damage to this component when installed to such a degree that caesium escapes is low. A more severe accident, for example, crushing, could possibly result in a small fractional release. Should this happen then a committed effective dose of $<0.01 \mu\text{Sv}$ could be received, which is not significant. |
| Local orders | Details of the control measures taken from this leaflet are to be included in the local orders for radiation safety (Leaflet 16 refers). |
| Control measures during Use | No protective clothing required. This item is not to be carried on the person and handling of the item is to be kept to a minimum. |
| Inspection | Annually as well as during routine maintenance. Check is to be made for signs of damage. |
| Leak testing | Leak testing is not required for this component. |


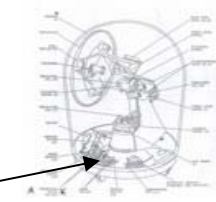

Goalkeeper Spark Gap TG-375-20 5/24KV (continued)

| | |
|---|---|
| Accounting | <p>This item is to be accounted for on a Radioactive Source List (Leaflet 9 refers) under the supervision of an RPS or WPS (Radioactive Materials).</p> <p>All radioactive material is to be mustered at least monthly. Any change of location is to be entered in the Source Movement Log together with any change in custodian.</p> |
| EPR10/RSA93 | <p>This item is exempt from notification to the environment agencies under EPR10/RSA 93. The item is, however, to be included in the Annual Holdings Return to Dstl ESD (Leaflet 3 refers).</p> |
| Storage and labelling | <p>If uninstalled, this item is to be stored in a dedicated area for radioactive materials (see Leaflet 9).</p> <p>The equipment is to have the recognised radioactive trefoil and marking on it.</p> <p>The storage/installed area is 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. Items contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item is damaged should also be included.</p> |
| Contingency plans breakage/loss/incident | <p>If a breakage occurs the area is to be cordoned off. The broken item can be cleaned up using a breakage kit (Leaflet 40 refers).</p> <p>Reporting of loss and certain other incidents are to be carried out in accordance with the procedures described in Leaflet 14.</p> |
| Transport | <p>These items may be transported as excepted packages providing the total package activity does not exceed 600 GBq.</p> |
| Disposal | <p>Units and Establishments are to return this item, unbroken, through the Stores Organisation. Broken items are to be disposed of in accordance with Leaflet 40 but RPA advice is to be sought in the first instance.</p> |

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Leaflet 17 Annex C

Hazard Grade Radioactive Electronic Valve – Example of a Summary Radiation Risk Assessment

| SCOT 1A/1D/2D TR Cell | |
|----------------------------------|--|
| Description | <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  <p>BS4415</p> </div> <div style="text-align: center;">  <p>Antenna</p> </div> <div style="text-align: center;"> <p>CAUTION</p>  <p>55 MBq H-3 Valve Markings</p> </div> </div> <p>The BS4415 valve is a sealed volume of 9.1 cc constructed of steel and glass. There is only one radioactive valve in each cell. (NSN 0601-99-805-3998).</p> |
| Use | Protection from high voltage power surges – Two cells are installed in Scot 1A/1D/2D. |
| Supplier | E2v Technologies, 106 Waterhouse Lane, Chelmsford, Essex CM1 2QU. |
| NSN | 5999-99-798-9212. |
| IPT | FWS. |
| Radionuclide | Tritium (H-3). |
| Ionising radiation | Beta (low energy (19 keV)). |
| Half life | 12.3 years. |
| Original activity | 55 MBq. |
| External radiation hazard | H-3 does not present an external radiation hazard since the beta is of low energy and will not penetrate even a thin layer of material. |
| Internal radiation hazard | <p>Very small amounts of tritium leak from these valves over a prolonged period of time but this does not present a health risk. The escape of tritium from a broken valve could result in a minor health risk if breakage occurs in a confined space.</p> <p>Tritium may be present both as an elemental gas (behaving, chemically, in the same way as hydrogen gas) and also in the form of tritiated water vapour. The latter (behaving, chemically, in the same way as water vapour) presents the greater hazard due to its ability to enter the body both by inhalation and by rapid absorption through the skin.</p> <p>In the case of breakage, evacuation affords the best protection against internal hazards since the filters in respiratory protection will not absorb tritium nor prevent absorption through the skin.</p> <p>Total dose to an individual, following breakage of a single valve of this type in a confined space is likely to be less than 2 µSv.</p> |

SCOT 1A/1D/2D TR Cell (continued)

| | |
|---|--|
| Local orders | Details of the control measures taken from this leaflet are to be included in the local orders for radiation safety (Leaflet 16 refers). |
| Control measures during use | No protective clothing or special precautions required. Item not to be carried on the person. |
| Inspection | Annually as well as during routine maintenance. Check to be made for signs of damage. |
| Leak testing | Leak testing is not required for this component. |
| Accounting | This item is to be accounted for on a Radioactive Source List (see Leaflet 9) under the care of an appointed RPS or WPS (Radioactive Materials). All radioactive material is to be mustered at least monthly. Any change of location is to be entered in the Source Movement Log together with any change in custodian. |
| EPR10/RSA93 | This item is exempt from notification to the appropriate environment agency under EPR10/RSA93 (Leaflet 3 refers). However, it is to be included in the Annual Holdings Return to Dstl ESD (Leaflet 3 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 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. Items contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item is damaged should also be included. |
| Contingency plans breakage/loss/incident | If a breakage occurs the area is to be evacuated and ventilated. Tritium gas will disperse relatively quickly, however tritium may remain bonded to the component. Once a suitable amount of ventilation time (1 hour) has passed, the broken item can be cleaned up using a breakage kit (see Leaflet 40). RPA advice is to be sought regarding disposal of the fragments. Reporting of loss and certain other incidents is to be carried out in accordance with procedures described in Leaflet 14. |
| Transport | This item may be transported in an excepted package provided the total package activity does not exceed 8000 GBq. |
| Disposal | Units and Establishments are to return this item, unbroken, through the Stores Organisation. Broken items are to be disposed of in accordance with Leaflet 40 but RPA advice is to be sought in the first instance. |

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Annex D

Markings on Radioactive Electronic Valves and on Containers & Equipment Housing Radioactive Electronic Valves

1 There is no longer a requirement to classify radioactive electronic valves (e.g. Class 1, Class 2 and Hazard Grade). However, equipment with the following markings can still be found across MOD.



Figure 1 Theta marking for Class 1 radioactive valves. Colour of marking – black. (See Note.)

CLASS 2

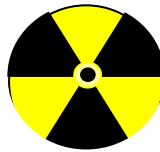
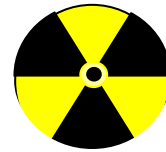


Figure 2 Marking for Class 2 radioactive valves. Colour of symbol: black on yellow background.

CAUTION



55 MBq H-3

Figure 3 Marking for hazard grade radioactive valves. Colour of symbol: black on yellow background.

2 Containers holding radioactive electronic valves may still be found with the markings shown in Table 2.

Table D1 Markings on radioactive valve containers

| | Class 1 | Class 2 | Hazard Grade |
|--------------------------------------|--------------------|---|--|
| Envelope, carton and crate markings. | θ or trefoil | Class 2 and trefoil sign and marked 'radioactive electronic valve'. | Trefoil in black on yellow background and marked 'Radioactive': handle only as instructed. |

3 Equipment containing radioactive electronic valves may still be found with markings containing the information given in Table 3.

Table D2 Markings on equipments containing radioactive valves

| | Class 1 or Class 2 | Hazard Grade |
|---|--|--|
| Equipment containing radioactive valves | The words 'Class 1 or 2' as appropriate Trefoil symbol CV number(s)* | Trefoil symbol. The words 'Hazard Grade'. CV number(s) |

*CV number = Valve Classification Number

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