17 Radioactive Electronic Valves

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 Chapter 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 Chapter. 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:

a. Ionising Radiations Regulations 2017 (IRR17) (apply directly).

b. Environmental Permitting (England and Wales) Regulations 2016 (EPR16) (as amended) (parallel arrangements);

c. Environmental Authorisations (Scotland) Regulations 2018 (EASR18) (parallel arrangements)

d. Radioactive Substances Act (Northern Ireland) 1993 (RSA93) (as amended) and associated Exemption Orders (parallel arrangements);

e. Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2009 (apply directly).

Duties

4. Duties as detailed in Chapter 39 apply.

Notification / Permitting Requirements for Radioactive Electronic Valves

5. In England, Wales and Northern Ireland radioactive electronic valves with activities below those listed in Table 1 are exempt from the requirement under EPR16/RSA93 to obtain a Notification / Permit from the environment agencies. In Scotland, EASR18 requires that SEPA be notified of the keeping and use of certain electronic valves with an activity in excess of 200 kBq unless the valve contains tritium for which the limit is 20 GBq. 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

Hazards

Alpha

6. 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.

7. Alpha radiation poses a potential internal hazard only in the event of breakage of the valve.

Beta

8. 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.

9. 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.

10. Low levels of Bremsstrahlung radiation (X-rays) are emitted from valves containing beta emitters.

Gamma

11. 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 Chapter).

X-rays

12. Parasitic X-rays are a by-product arising from many types of high voltage equipment (>5 kV) (see Chapter 23). They may be emitted from electronic valves within high voltage equipment and / or other parts of the equipment when it is operating.

Risk Assessments for Radioactive Electronic Valves

13. Examples of summary risk assessments are reproduced at Annexes A to C of this Chapter. 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 Chapters 2 and 16 respectively. Advice on further detail and assessments for radioactive electronic valves may be sought from the RPA.

Handling of Radioactive Electronic Valves

14. 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

15. Radioactive valves are not to be broken deliberately.

16. 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.

17. 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 Chapter 40.

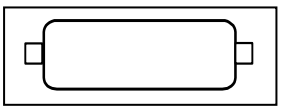
Summary Radiation Risk Assessment

Tuned 'T' 1007 Radar (Waveguide Fit)	
Description	 Valve BS810  Tuned Junction Box θ Valve marking 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.
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	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. 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. 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. 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.

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

Local orders	Details of the control measures taken from this chapter are to be included in the local orders for radiation safety (Chapter 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. Chapter 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.
EPR16/EASR18/RSA93	Although exempt from formal EPR16/EASR18/RSA 93 notification to the environment agencies, this item is to be included in the Annual Holdings Return to Dstl – Chapter 3 refers.
Storage and labelling	If uninstalled, this item is to be stored in a dedicated area for radioactive materials – see Chapter 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 Chapter 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 Chapter 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 Chapter 40 but RPA advice is to be sought in the first instance.

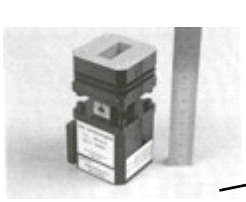
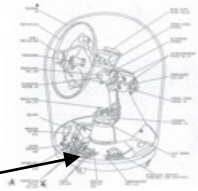
Summary Radiation Risk Assessment

Goalkeeper Spark Gap TG-375-20 5/24KV	
Description	 Spark Gap diagram **CLASS 2**  Valve marking One Spark Gap found in High Voltage Circuit. BR 8423(7) Vol 2 Fig 04-033 Items BV1
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 $\mu Sv h^{-1}$ at 10 cm and <0.1 $\mu Sv h^{-1}$ 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 µSv could be received, which is not significant.
Local orders	Details of the control measures taken from this chapter are to be included in the local orders for radiation safety (Chapter 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	This item is to be accounted for on a Radioactive Source List (Chapter 9 refers) under the supervision of an 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.
EPR16/EASR18/RSA93	This item is exempt from notification to the environment agencies under EPR16/EASR18/RSA 93. The item is, however, to be included in the Annual Holdings Return to Dstl ESD (Chapter 3 refers).
Storage and labelling	If uninstalled, this item is to be stored in a dedicated area for radioactive materials (see Chapter 9). The equipment is to have the recognised radioactive trefoil and marking 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 cordoned off. The broken item can be cleaned up using a breakage kit (Chapter 40 refers). Reporting of loss and certain other incidents are to be carried out in accordance with the procedures described in Chapter 14.
Transport	These items may be transported as excepted packages providing the total package activity does not exceed 600 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 Chapter 40 but RPA advice is to be sought in the first instance.

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

SCOT 1A/1D/2D TR Cell	
Description	  **CAUTION**  BS4415 Antenna 55 MBq H-3 Valve Markings 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).
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	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. 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. 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. 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.

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

Local orders	Details of the control measures taken from this chapter are to be included in the local orders for radiation safety (Chapter 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 Chapter 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.
EPR16/EASR18/RSA93	This item is exempt from notification to the appropriate environment agency under EPR16/EASR18/RSA93 (Chapter 3 refers). However, it is to be included in the Annual Holdings Return to Dstl ESD (Chapter 3 refers).
Storage and labelling	If uninstalled this item is to be stored in a dedicated area for radioactive materials (see Chapter 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 Chapter 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 Chapter 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 Chapter 40 but RPA advice is to be sought in the first instance.

Annex D

Markings on Radioactive Electronic Valves and on Containers and 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.

θ

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 equipment 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*