LEAFLET 22

LUMINISED EQUIPMENT

CONTENTS

SCOPE

1 Luminous articles to which this chapter applies are those in which the luminous paint contains radioactive material. Commonly used equipments of this type include watches, compasses, sound-powered telephones, telephone control boards and dials of instruments found in establishments or in vehicles, ships and aircraft. Modern equipment (post 1970s) uses tritium (H-3) as the radioactive material. However, in the past other radioactive materials have been used, including promethium-147 (1950s and 1960s) and radium-226 (pre-war to the 1950s). Further information regarding historical luminised items is provided in paragraph 16.

2 This Leaflet describes the radiological requirements for keeping, using and disposing of equipment luminised using radioactive materials. Summaries of the radiation risk and regulatory requirements for some specific luminised equipments are provided at the Annexes to this leaflet. Summary risk assessments for a range of other in-service luminised equipments not listed in the Annexes are also available from the Dstl RPA Body. Additionally, the RPA is to be consulted where further information regarding the radiological hazards and safety requirements for luminised equipment is required.

3 It should be noted that not all luminous articles are radioactive. Some are luminised using non-radioactive materials.

4 This leaflet does not describe the requirements for the de-luminsing and re-luminising of radioactive luminous components. These are specialist activities and must only be undertaken under controlled arrangements determined through consultation with the RPA.

STATUTORY REQUIREMENTS AND PARALLEL ARRANGEMENTS

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:

- Ionising Radiations Regulations 1999 (IRR99) (apply directly);
- Radioactive Substances Act 1993 (RSA93) (parallel arrangements);
- Radioactive Substances (Luminous Articles) Exemption Order 1985 (parallel arrangements);
- Carriage of Dangerous Goods and Transportable Pressure Equipment Regulations 2007 (apply directly).

DUTIES

Commanding Officer and Head of Establishment (CO/HoE)

6 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 is to be delegated to appropriate personnel, such as a Radiation Safety Officer (RSO).

Radiation Safety Officer (RSO)

7 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 luminised equipment 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)

8 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. Further information on the requirements for appointment of an RPS is given in Table 3.

Workplace Supervisor (Radioactive Materials) (WPS) (RAM)

9 In units holding luminised equipment but where it is unnecessary to appoint an RPS, a WPS (RAM) 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

10 It is the responsibility of all employees to ensure that they are familiar with the relevant parts of local orders to ensure that luminous articles are handled safely and correctly. Any incidents are to be reported to the appropriate supervisor or line manager.

CLASSIFICATION OF LUMINISED ARTICLES

11 Radioactive Substances (Luminous Articles) Exemption Order 1985 states that luminised articles containing tritium or promethium-147 are classified as Class A or Class B articles. The classification dictates the conditions under which holdings of such articles, and the arrangements for accumulation and disposal of such articles as waste are exempt from specific requirements of RSA93. The classification criteria are outlined in paragraphs 12 and 13.

12 Class A articles are instruments, illuminants or indicators which contain either tritium or promethium-147 paint, which is insoluble in water, and have a maximum activity as detailed in Table 1.

13 Class B articles are components of a clock, watch, instrument, illuminant or indicator that contain either tritium or promethium-147 paint, which is insoluble in water, and have a maximum activity as detailed in Table 1.

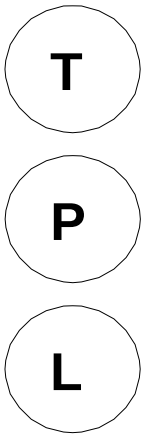
Table 1 Maximum radionuclide content

Radionuclide	**Maximum activity incorporated in an individual luminised article**
Promethium-147 (Pm-147)	80 MBq
Tritium* (H-3)	4 GBq

14 Further advice is to be sought from the RPA.

MARKINGS

15 The following markings are sometimes found on luminised equipment.



Radioactive containing tritium

Radioactive containing promethium-147

NOT radioactive

Figure 1 Markings for luminised articles

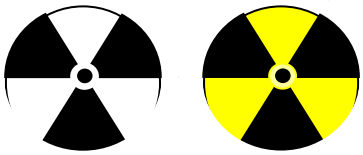


Figure 2 Standard radiation trefoil. Colour of symbol: black on yellow or white background.

HISTORICAL ITEMS

16 Promethium-147, which has a radioactive half-life of only 2.6 years, was used until the 1970's as a luminising agent. A few items containing promethium-147 remain in service but the limited activities of promethium-147 that generally remain on any such equipment are such that the radiation emitted is difficult to detect, Furthermore, such items are unlikely to remain luminous. The hazards associated with promethium-147 luminised articles are summarised in table 2.

17 Radium luminised compounds, unlike other luminised materials, can be identified by the easily measurable gamma radiation emitted. The age of the equipment can also be an indicator of the potential presence of radium. Many items dating from pre-war to the 1950s were luminised with radium based paint, and the luminous material is now likely to be dirty brown in appearance. As is the case for articles luminised using promethium-147, radium luminised articles are unlikely to remain luminous today. However, much of the original radioactivity will remain as the half life of radium-226 is approximately 1600 years.

18 Where radium luminised equipment is held by museums and in historical collections, such articles are not to be stored, used, handled or placed on display, unless a risk assessment has been completed in consultation with an RPA as there can be external dose rates from the luminised surface. The RPA is to be contacted for further guidance on the use and handling of radium luminised equipment. Radium items other than those held by museums or historical collections are to be removed from service and arrangements put in place to dispose of the items through authorised disposal routes.

19 Equipments containing radium must not be passed for any sale involving members of the public.

HAZARDS

Table 2 Hazards associated with luminised equipment

Radiation type		Emitted	Comments
Alpha		✓*	***For radium-226 luminised articles only** Radium-226 emits alpha radiation. This radiation will be fully attenuated by the instrument casing but will present an internal hazard if the casing is damaged and the luminising material is inhaled, ingested or contaminates the skin.
Beta	Direct	✓	Low energy beta radiation is emitted by tritium and promethium-147 luminised articles, but the energy of the beta is insufficient to penetrate beyond the instrument casing. Radium-226 luminised articles emit higher energy beta radiation which may not be fully attenuated by the instrument casing. Tritium and promethium-147 can present a hazard internal to the body if taken in by ingestion, inhalation, and absorption through the skin or through cuts in the skin. The beta radiation emitted by radium-226 can give rise to a radiation dose to the skin in the event of skin contamination and will present an internal hazard if the material is ingested, inhaled, or absorbed through cuts in the skin.
	Bremsstrahlung	✓	Low levels of Bremsstrahlung radiation (X-rays) can be emitted from luminised equipment.
Gamma		✓*	***For radium-226 luminised articles only** Radium luminised equipment can present an external hazard during use or storage as dose rates of 10-100's μSv h^{-1} could be measured. A leaking source will cause contamination that could lead to an internal hazard if the radioactive material enters the human body.
X-rays		✘	
Neutrons		✘	

TRITIUM MONITORING AND DETECTION

20 Monitoring the radiation dose rate from a tritium luminised article is difficult due to the very low energy beta radiation emitted and will therefore record a level less than 1 μSv h^{-1}. Similarly, it is very difficult to detect tritium contamination without the use of specialised monitoring instrumentation. Tritium surveys are therefore generally carried out by indirect means involving the taking and analysis of smears of the surfaces to be monitored.

RISK ASSESSMENTS FOR LUMINISED EQUIPMENT

21 The range of luminised articles in service within MOD is too large to describe in this publication. Similarly, it is not possible to include risk data for all items. However, summary risk assessments for a selection of luminised articles are provided at Annexes A to C of this leaflet. These summary risk assessments can be used to scope the hazard and control requirements for a wider range of luminised equipment and can 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 can be sought from the RPA.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

22 PPE is not required for the routine handling of intact luminised equipment.

BREAKAGE OF LUMINISED EQUIPMENT

23 Luminised equipments are not to be damaged deliberately or have protective covers removed by unauthorised persons.

24 Broken luminised articles are potentially hazardous because loose radioactive material can enter the body by a variety of means including inhalation of radioactive dust and absorption through cut or damaged skin. Detailed guidance on the procedure for dealing with broken luminised equipment is in Leaflet 40.

LEGAL AND MOD MANDATORY REQUIREMENTS

25 Table 3 below summarises the legal and MOD mandatory requirements for luminised equipment. In cases of doubt, the RPA is to be consulted for advice.

Table 3 Legal and MOD mandatory requirements for luminised equipment

Requirement	Applicable	Comments	Related leaflet*
HSE authorisation	✗		
HSE notification	✓	The HSE is to be notified in accordance with leaflet 3.	3
EA notification**	✓	Holdings of tritium luminised equipment up to an individual activity of 4 GBq and of promethium-147 luminised equipment up to an individual activity of 80 MBq are exempt from notification to the relevant environment agency under the Radioactive Substances (Luminous Articles) Exemption Order 1985, provided the total activity of Class B equipment kept on a premises is less than 200 GBq for tritium and 4 GBq or promethium-147 luminised equipment.	3
Risk assessment	✓	See examples at annexes to this leaflet. Further specific risk assessments or prior risk assessments can 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	✗	Not required	
Contingency plans	✓	See leaflet 40 for contingency plans for incidents involving breakage of radioactive items or radioactive items involved in a fire.	40
Designated areas	✗ (but see comment)	The presence of luminised equipment does not usually, lead to a requirement for area designation. See leaflet 4 for guidance.	4
Monitoring	✗ (but see comment)	Not normally required except when dealing with a breakage	
Training for users	✓	Information and instruction only.	15
Local orders	✓	See leaflet 16 for guidance.	16
Appointed person	✓	RPS not required except for when storage areas require to be designated as controlled or supervised. Where an RPS is not required, a WPS (RAM) needs to be appointed in accordance with Leaflets 15 and 39.	15, 39

Table 3 Legal and MOD mandatory requirements for luminised equipment (continued)

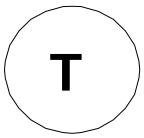
Requirement	Applicable	Comments	Related leaflet*
Storage	✓	In a segregated secure store/container/cupboard marked with radiation trefoil warning sign and stored in accordance with Leaflet 9.	9
Accounting	✓	Recorded on a source list (retained for 2 years) and mustered in accordance with Leaflet 9. Recorded on Dstl Annual Holdings Return, copy retained for 1 year.	9
Leak testing	✗	Leak testing is not appropriate for luminised equipment.	
Personal dosimetry	✗ (but see comment)	Personal dosimetry will only need to be worn if there is a requirement for a designated area.	
Reporting procedures	✓	All losses and certain other incidents require to be reported to MOD authorities. Reporting to external regulatory authorities can also be required. See leaflet 14 for details.	14
Transport	✓	Items and bulk quantities can generally be transported as excepted packages as detailed in JSP 800 Volume 4b (road, rail, sea) or JSP 800 Volume 4a (air) provided that; • For tritium, the total activity per package does not exceed 40,000 GBq • For promethium-147 the activity per luminised item does not exceeded 20 GBq and the total activity per package does not exceed 2000 GBq. Radium is to not be transported without prior consultation with the RPA.	JSP 800 Vol. 4a & Vol. 4b
Marking	✓	All luminised equipment stores and containers are to be marked appropriately in accordance with this Leaflet.	9
Sale/Transfer	✓	See Leaflet 11	11

Disposal of redundant items	✓	Unbroken modern luminised are to be returned via Stores. Historic items, particularly those containing radium-226 cannot be returned through stores. The RPA is to be contacted for specific advice. Broken luminised (except Radium luminised) equipment is to be placed in a suitable container (e.g. a paint tin) following the approved cleanup procedure. In the UK the disposal of the tin, luminous component fragments, cloths, gloves etc, may be via the normal refuse route, provided not more than 10 luminised items (or the fragments of 10 luminised items) are disposed per week from the premises. The disposal container is to not have any markings to indicate the presence of radioactive material. Disposal must not be to a tip on the establishment site. Where surplus MOD stocks are sold at auction, it is particularly important that sales items are checked for the presence of radioactive materials. See Leaflet 12 for further guidance. Further advice can be sought from the RPA as necessary. Keep records of disposal for 2 years.	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 22 ANNEX A

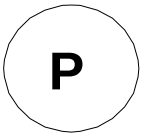
WRIST WATCH DIVERS 300M– EXAMPLE OF A SUMMARY RADIATION RISK ASSESSMENT

Wrist Watch Divers 300M	
Description	  Watch marking The Divers Watch contains 2.4 MBq of tritium paint, which is used to luminise the hands and numbers, in dark/ dimly lit conditions.
Use	Luminous watch for use underwater
Supplier	Cabot Co Ltd
NSN	0555-99-757-3314
IPT Details	Combat Support
Radionuclide	Tritium (H-3)
Ionising Radiation	Beta
Half Life	12.3 years
Original Activity	2.4 MBq
Classification	Class B article under the Luminous Articles Exemption Order 1985.
Hazard	Tritium is the radioactive form of hydrogen and is present within the luminising material on the watch dial. The glass face of the watch is sufficient to attenuate the beta radiation emitted by the tritium. If the watch is destroyed in a fire the tritium is rapidly converted to tritiated water – a more hazardous form of tritium. Tritium and tritiated water emitted during such an event may present a hazard due through inhalation and absorption through the skin.
Risk Assessment	The likelihood of accidental damage to this watch is low, because it would require a strong and directional force to break the glass face of the watch. If broken, and on the basis of an assumption that 10% of the tritium is removed of which 1% is ingested, a committed effective dose of 0.1μSv could be received. This dose is negligible. (Ref DRPS Report 289/2004 dated 10/12/04).
Local orders	Details of the required control measures as detailed in 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.
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.
Radioactive Substances Act 1993	Exempt from formal RSA93 notification to the relevant environment agencies provided the total activity of Class B luminised equipment kept on the premises is less than 200 GBq. This item is to be included in the Annual Holdings Return to Dstl – Leaflet 3 refers.

Storage and Labelling	This item is to be stored in a dedicated area for radioactive materials. Leaflet 9 refers. The storage area is to have a sign indicating the presence of radioactive material within i.e. a trefoil including the contact name and telephone number of the RPS and stating the nature of the radiological hazard e.g. Items contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item damaged
Contingency Plans	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). Reporting of loss and certain other incidents are to be carried out in accordance with the procedures described in Leaflet 14.
Transport	This item may be transported in an excepted package provided the total package activity does not exceed 40,000GBq and the surface dose rate of the package is less than 5 $\mu Sv\ h^{-1}$. JSP 800 Volume 4a & 4b refer.
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.

LEAFLET 22 ANNEX B

CHRONOGRAPH WRIST WATCH LUMINOUS– EXAMPLE OF A SUMMARY RADIATION RISK ASSESSMENT

Chronograph Wrist Watch Luminous	
Description	  Watch marking The Chronometer watch contains a total of activity of 2.4 MBq of Promethium-147 in the form of luminised paint. This paint is used to luminise the hands and the numbers of the watch.
Use	Luminous watch
Supplier	Seiko
NSN	6645-99-814-9181
IPT Details	Combat Support
Radionuclide	Promethium-147
Ionising Radiation	Beta
Half Life	2.6 years
Original Activity	2.4 MBq
Classification	Class B article under the Luminous Articles Exemption Order 1985.
Hazard	Promethium is present within the luminising material on the watch dial. The glass face of the chronometer watch is sufficient to attenuate the beta radiation.
Risk Assessment	The likelihood of accidental damage to this watch is such a degree that the risk of Pm-147 release is low. A more severe accident, for example, smashing or crushing the watch face, could result in a small dose (0.6 μSv) through ingestion or inhalation of promethium 147. Reference DRPS Report 289/2004 - Combat Support Luminised Items.
Local orders	Details of the required control measures as detailed in 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.
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.
Radioactive Substances Act 1993	Exempt from formal RSA93 notification to the relevant environment agencies provided the total activity of Class B luminised equipment kept on the premises is less than 4 GBq. This item is to be included in the Annual Holdings Return to Dstl – Leaflet 3 refers.

Storage and Labelling	This item is to be stored in a dedicated area for radioactive materials. Leaflet 9 refers. The storage area is to have a sign indicating the presence of radioactive material within i.e. a trefoil including the contact name and telephone number of the RPS and stating the nature of the radiological hazard e.g. Items contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item damaged.
Contingency Plans	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). Reporting of loss and certain other incidents are to be carried out in accordance with the procedures described in Leaflet 14.
Transport	This item may be transported in an excepted package provided the total package does not exceed 2,000GBq and the surface dose rate of the package is less than 5 $\mu Sv\ h^{-1}$. JSP 800 Volume 4a & 4b refer.
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.

LEAFLET 22 ANNEX C

SILVA COMPASS NATO 4B – EXAMPLE OF A SUMMARY RADIATION RISK ASSESSMENT

Silva Compass NATO 4B	
Description	 Equipment marked with a trefoil **GTLD** = 0.74 GBq (end of direction arrow). **Paint** = 0.33 GBq (Inside capsule – 2 dots, 1 each side of red arrow) **Light Film** =0.22GBq (needle and scale).
Use	Luminous dial for compass
Supplier	Silva Sweden AB, BOX 998, 191 29 Sollentuna, SWEDEN
NSN	1430-99-529-3731
IPT details	Combat support IPT
Radionuclide	H-3
Ionising radiation	Beta
Half life	12.3 years
Original activity	1.29 GBq
Classification	Class A under the GTLD Exemption Order 1985 SI 1047 Activity not exceeding 20GBq. Class B article under the Luminous Articles Exemption Order 1985.
Hazard	Tritium is the radioactive form of hydrogen and is a highly flammable gas. Tritium within the compass is in the form of gas (GTLS) and solid (luminous paint). If destroyed in a fire, the tritium is rapidly converted to tritiated water. Tritiated water presents the greater hazard due to its ability to enter the body both by inhalation and rapid absorption through the skin. In an enclosed space this constitutes an extra risk to personnel in the immediate vicinity.
Risk assessment	The likelihood of accidental damage to this compass is low, because it would require a strong and directional force to break the face. There is a low probability of release of tritium. If broken and 10% was removed and 1% of that were ingested a committed effective dose of 10µSv, could be received, which is less than two days natural daily background radiation in the UK. (Ref DRPS Report 289/2004 dated 10/12/04).
Local orders	Details of the required control measures as detailed in this leaflet are to be included in the local orders for radiation safety (Leaflet 16 refers).
Control measures during use	No special precautions are required.
Inspection	Annually as well as during routine maintenance. Check should 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 should be entered in the Source Movement Log together with any change in custodian.
Radioactive Substances Act 1993	This item is subject to RSA93 and should be included in the Annual Holdings Return to Dstl.

Storage and labelling	This item is to be stored in a dedicated area for radioactive materials. The equipment is to have the recognised radioactive trefoil on it. The storage area is also to have a sign indicating the presence of radioactive material within. i.e. a trefoil including the contact name and telephone number of the RPS and stating the nature of the radiological hazard - Items contain radioactive material. No radiation hazard from intact item. Radioactive contamination hazard if item damaged.
Contingency plans	If a breakage occurs the area is to be evacuated and ventilated. Tritium gas will disperse relatively quickly. However some will remain bonded to the component. Once a suitable amount of ventilation time has passed (one hour) the broken item can be cleaned up using a breakage kit, see Leaflet 40. 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 as an excepted package provided the total package does not exceed 8000GBq and the surface dose rate of the package is less than 5 $\mu Sv\ h^{-1}$. JSP 800 Volume 4a & 4b refer.
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.