

Luminosity issues associated with 'AWS Alarm & Indicator Units' and 'AWS Indicator Units'

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Reviewed by members of the Train Control Technical Sub Group (TCTSG), a sub group of the Vehicle/Train Control and Communications Systems Interface Committee (V/TC&C SIC)

Appendix A to the TCTSG Report to the V/TC&C SIC

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1 Luminosity issues associated with 'AWS Alarm & Indicator Units' and 'AWS Indicator Units'

1.1 Introduction

- 1.1.1 This briefing paper has been prepared on behalf of the RSSB Train Control Technical Sub Group (TCTSG) reporting to the RSSB V/TC&C SIC (Vehicle/Train Control and Command System Interface Committee), by Nick Wright (TCTSG Chair) and Paul Harris (TCTSG Suppliers Representative) with a view to informing the rail industry of an emerging issue arising with the luminosity of a number of different AWS Alarm & Indicator Units (and AWS Indicator Units). The investigations into luminosity issues also exposed the earlier use of radioactive luminous paint in these units, but it has been confirmed that proper use of the units does not introduce a significant radiological risk. The presence of radioactive material within these units requires operators to be in compliance with certain legislation.

1.2 Background

- 1.2.1 In December 2010, a representative of the TOCs (Train Operating Companies) raised a query at a meeting of the TCTSG regarding a perceived reduction in luminosity on the AWS Alarm and Indicator (A&I) Units used in their fleet, asking if the brightness of the AWS Sunflower had a quoted life.
- 1.2.2 The unit concerned was manufactured by STS Rail (now Mors Smitt, although subsequently acquired by Wabtec Corporation), part number TY191, PADS number 98/7628, some of which were distributed via Thales under their part number 100151. An investigation commenced and the manufacturers were asked to supply details of the type of luminous paint used and whether any change to the paint type had occurred. After some research, it was established that there had indeed been a change to the type of luminous paint used on the sunflower 'flags' – see Appendix 2 for clarification of the affected portion.
- 1.2.3 It further transpired that the luminous paint previously used was tritium-based and had since been changed to a non-radioactive substitute. Tritium is a low energy beta particle emitting radioactive element which can be mixed with paint to produce a substance which provides illumination. Although the last order of sunflower flags with tritium-based paint was in November 2006, it took until January 2008 for the last remaining stock of these flags to be fitted to completed A&I Units.
- 1.2.4 That last batch of 481 sunflower flags with the tritium-based paint (fitted up until January 2008) were slightly less bright than previous ones (nominally 35% less bright with a 37% lower radioactive activity level). The brighter paint was no longer available from the supplier. This reduction in brightness is equivalent to three years of aging, so it is not of major significance for a product that has been in production and service for 30 years.
- 1.2.5 It is not possible to differentiate between the different paint types used on the flags by the A&I Units either visually, by part number or modification state. However, the Unit serial number can be used for this purpose: TY191 (98/7628) A&I Units with serial numbers above 7904 were manufactured with non-radioactive luminous paint (see the caveats in sections 1.8.2 and 1.8.3). Regardless of serial number, TY191 units repaired via Thales from June 2011 onwards have been marked as 'Mod 5' on the label on the end of the units, i.e. the digits 1 to 4 inclusive are blacked

out). As part of the repair and modification process, sunflower flags with tritium-based paint are replaced with flags with the new non-radioactive luminous paint.

1.2.6 As consequence, these findings gave rise to two issues:

1. The effect of the change on the luminous performance;
2. Certain legal obligations associated with handling radioactive materials.

1.2.7 Furthermore, a third and unrelated issue came to light with this same A&I Unit, although to date this has been limited to just a few newer fleets of rolling stock. There have been a number of instances recorded of the sunflower flag sticking in the 'black and yellow' (warning) state. The horn still sounds and the driver is able to silence this by pressing the AWS acknowledgement pushbutton as normal. This is a right-side failure. The failure has tended to be of an intermittent nature and is seldom reproducible. Investigations are ongoing to determine the root cause within the A&I Unit. Operators are being requested to provide detailed fault reports (and ideally OTMR data recorder log files) in such instances.

1.2.8 Luminosity degradation is not new: historically, issues have arisen from time to time over the long term luminosity of non electrically back-lit cab desk indicators, which included devices such Class 43 (HST) speedometers etc.

1.3 Effect on Luminosity

1.3.1 The original tritium-based paint used has an effective half life, as far as the luminous intensity is concerned, of around five years. This is different from the intrinsic half life of tritium itself, which is 12.3 years. As the design of this A&I Unit dates back to March 1982, the luminous intensity of any original units will have dropped to nominally 2% of their original value (after six half-lives). Ten-year-old models will be 25% of their original intensity, for example. Note that, however, the human eye does not respond linearly, so these reductions will not seem as dramatic to users as perhaps the numbers suggest.

1.3.2 The new non-radioactive paint has the brand name 'Super-LumiNova' (by RC Tritec in Switzerland, who also supplied the tritium-based paint). The luminous performance of this new material does not suffer any aging.

1.3.3 It has been established that there is a difference in performance between the two paint technologies during night-time operation. Experiments concluded that if the ambient cab background light level is below three lux, then after 14 hours the new Super-LumiNova paint is no longer visible, whereas the original tritium-based version was still faintly visible. A background light level of three lux is enough to sustain the Super-LumiNova version for around 5.5 hours provided that it was exposed to a bright enough 'excitation' level of light before the period of near darkness. 220 lux excitation was sufficient, whereas 95 lux was insufficient – the Super-LumiNova flag was not visible after 5.5 hours, whereas the tritium flag was still faintly visible. It should be noted that freight and sleeper trains may operate for long periods with very low background ambient light levels and without brighter lights in stations to recharge the indicator. Furthermore, the AWS indicator flag will not recharge significantly in the all-black state.

1.3.4 As points of reference:

1. The 'Locomotives and passenger rolling stock' TSI (LOC & PAS TSI, Commission Regulation (EU) No 1302/2014 of 18 November 2014) in section 4.2.9.1.8 headed "Internal lighting", reads "Cab general lighting shall be provided on driver's command in all normal operational modes of the rolling stock (included 'switched off'). Its luminosity on desk level shall be higher than 75 lux at the level of the driver's desk, except for OTMs [On Track Machines] for which it shall be higher than 60 lux."

2. GM/RT2130 “Vehicle Fire, Safety & Evacuation” issue 4 section 6.4.4 reads “Where photo-luminescent signage is used a minimum illumination of 50 lux shall be provided by the normal lighting in the area to ensure the signs are charged to cater for emergency conditions that may arise.”, so that is a similar example where a minimum excitation level is required.

1.3.5 The new Super-LumiNova paint relies solely on being charged up by background light (at a level equivalent to a very dark day) – this is photoluminescence. In addition to an element of photoluminescence, the tritium-based paint effectively has an internal energy source feeding the visible light emission or ‘afterglow’ – this is radio luminescence.

1.4 Implications of radioactivity

1.4.1 Following investigation and having discovered the issue of the low-level radioactive content of the tritium based paint used in the 98/7628 A&I Unit, the distributors of these units had a legal obligation to advise their customers accordingly. Thales produced a ‘Compliance Information Pack’ and covering letter (dated 9th July 2012) which was posted to all their customers (train builders, TOCs, FOCs, ROSCOs etc) to whom they had supplied this product over the years. The Compliance Information Pack contained explanatory information about the relevant legal regulations plus a number of templates to help their customers to comply.

1.4.2 Thales addressed their letter and pack to the HSE contact within each customer’s organisation, for them to disseminate appropriately. Where an HSE contact could not be determined, a senior Engineering contact was selected.

1.4.3 Copies of the above two documents are included as Appendices 4 and 5 of this briefing paper.

1.4.4 To summarise, the actions required by users, maintainers and disposers of these types of devices are as follows in order to comply with the requirements of the Ionising Radiations Regulations etc. (for which templates were supplied by Thales):

1. Inform the Health & Safety Executive – this was done to inform the regulator that work with ionising radiation is being carried out. The Environment Agency (or relevant Authority within Scotland and Northern Ireland) need not be notified under the Environmental Permitting (England & Wales) Regulations 2010 as the units are ‘exempt’ sources and therefore no permit is required.
2. Undertake a risk assessment (the template has all the technical information filled in, just needing end user company-specific references inserting and then final review and adoption);
3. A procedure for working with the units which contains suggested control measures and contingency plans;
4. Record keeping sheets to verify presence of the units;
5. When transporting A&I Units below serial number 7905 by road, they need to be sent as “Excepted Packages” in order to comply with the requirements of the transport regulations (see the caveats in sections 1.8.2 and 1.8.3).

1.4.5 “Excepted packages” are packages in which the allowed radioactive content is restricted to such low levels that the potential hazards are insignificant. To qualify as an excepted package, the radiation level at any point on the external surface of the package must not exceed 5 µSv/h.

1.4.6 Additional tests undertaken by Thales have measured the external radiation level on 23 individually packed A&I Units and found that the level was well below this threshold.

1.4.7 Thales also identified that their normal courier (Quickshift UK Ltd) will take Excepted Packages at no extra charge, so this process need not be onerous. Users should check with their own preferred carriers (or contact Quickshift).

- 1.4.8 It should be noted that although Thales only addressed the letter and pack to customers they had supplied this particular A&I Unit to, ATOC subsequently circulated the two documents to a much wider audience (their members) on 31st July 2012. Furthermore, the Thales letter and pack only concentrated on 98/7628, but there are other types of AWS A&I Units, and Indicator-only units, which may also have radioactive luminous paint. See Appendix 1 for further details, although it should be noted this is still work in progress and further updates to this table will occur. Where there is a “Yes” in the box in the “Radioactive?” column, this is based on measurements with a radiation meter. Where there is a “Suspected”, this is merely read across by virtue of similarity and requires confirmation before assuming there is no radioactive issue associated with the particular device.

1.5 Options for End Users, e.g. Train/Freight Operators & RoSCos

- 1.5.1 Where the aging effect of the tritium-based paint (regardless of manufacturer) or the reduced performance of the Super-LumiNova paint for extended periods of operation in near complete darkness is an issue for operators, there are a couple of options available:
1. Whilst Mors Smitt have experimented with increasing the thickness of Super-LumiNova paint and extending luminous paint to also cover the non-luminous yellow paint area (see Appendix 2), the electromechanical A&I Unit is considered to be nearing the end of its design life and is therefore not being recommended for new applications. Note also that Mors Smitt have determined that they can no longer support the electromechanical versions (TY191 & TY268) beyond 01/03/2016. Technically, the proposed improvements would have enabled the Super-LumiNova paint to equal or exceed the performance of the traditional tritium-based paint for use in extended periods of darkness.
 2. Solid state LED (Light Emitting Diode) A&I Units are available as drop-in replacements from Mors Smitt and Unipart Rail have a new redesigned one in development. When considering this change, operators should consider the following as a minimum, conducting trials on a per-fleet basis if required:
 - a. Ensure the yellow segments are still visible in bright sunlight and glare (may be dependent on the angle and location in which it is mounted);
 - b. Ensure the yellow segments are not too bright for night time operation;
 - c. The electromechanical indicator intrinsically retains its indication state when power is removed, which can be of benefit after an accident, whereas an LED-based solution may not offer this (the Mors Smitt model certainly includes this memory feature).
- Mors Smitt have indicated that the cost to replace the existing electromechanical indicator in 98/7628 (TY191) with an LED display would also be nominally £550, which was the same cost as for option 1 above. To replace the flag on the electromechanical indicator involved quite bit of work which is why the costs are the same.

- 1.5.2 As can be seen in Appendix 1, the historical use of tritium-based paint may not have been confined to Mors Smitt (formerly STS Rail). Unipart Rail (formerly NRS) and Howells Railway Products have supplied functionally similar devices, although the types of luminous paint are presently unknown.

1.6 Disposal

- 1.6.1 There are no significant concerns regarding the disposal of A&I Units from a radioactive point of view. Under the Environmental Permitting (England & Wales) (Amendment) Regulations 2011

they may be disposed of through normal refuse. One A&I Unit can be disposed of per 0.1 m³ of normal refuse (EWC Code 20.03.01), not as WEEE (Waste Electrical and Electronic Equipment). Up to 10 TBq of activity can be disposed of via this method in a year, this is approximately 5,000 A&I Units per year. No permit is needed from the Environment Agency for disposal. The disposer may still have to consider hazards from the non-radioactive elements of the units before disposal.

1.7 Storage

1.7.1 This is covered in various parts of Appendix 5 which should be consulted for full details. However, in summary, the requirements include:

- Record keeping (quantity and their location).
- Marking any storage containers as radioactive.
- Storing units in a secure and safe manner so as to prevent accidental removal, loss or theft from the premises where they are held.
- When in storage, restricting access to trained and authorised workers.
- Creating a main lockable radioactive source store at the depot.
- Notifying the relevant Agency as soon as practicable in the event that a unit has been lost or stolen (or suspected lost or stolen).

1.7.2 The storage requirements do not apply when the A&I Unit is fitted to a vehicle cab.

1.8 Clarifications regarding the radioactivity

1.8.1 The A&I Units are classed as 'individual sealed sources containing only tritium as a radioactive component', not as Gaseous Tritium Light Devices (GTLD). The classification affects permitted limits for various things such as waste disposal. They are classified as 'sealed' rather than 'unsealed' as the units are pretty robust and in the normal course of use there is unlikely to be a reasonably foreseeable release of radioactive material into the environment. GTLDs are an entirely different device (e.g. beta lights where tritium gas is sealed inside a glass capsule).

1.8.2 Some 98/7628 A&I Units have seemingly unusual serial numbers that do not fit the normal four-digit format, for example "S-IU02-16814". See Appendix 3 for an example. It is normal practice to provide a new serial number when the one fitted cannot reliably be read. In that way the work done can be traced back to the last service. In such instances, operators are advised to treat the unit as being radioactive, erring on the side of caution.

1.8.3 It has come to light since Issue 1 of this paper that, in common with all items of AWS equipment since the 1970s, some TY191 (98/7628) A&I Units have been repaired by Unipart Rail (formerly British Rail then NRS) rather than the OEM (Mors Smitt / Wabtec, formerly STS Rail and Field & Grant, or Howells). In the process the AWS indicator modules moved from one TY191 unit to another, so that the external serial number of the complete AWS A&I Unit is not necessarily a reliable indication of the type of luminous yellow paint used. NRS/Unipart Rail would fit a new or refurbished AWS indicator module as part of the repair process, to minimise the repair time, returning the faulty AWS indicator module to Mors Smitt (or Howells) for repair. The repaired AWS Indicator Module would subsequently be fitted to a different A&I Unit. Each AWS Indicator Module (TY189 in the case of TY191) has its own unique serial number (and modification number). AWS Indicator Modules (TY189) with a serial number above 6566J are not radioactive, but these are indistinguishable from the outside of the units. Operators/maintainers using the NRS/Unipart Rail repair channel for TY191 (98/7628) A&I Units may wish to consider all repaired units as potentially containing a tritium-painted flag (in a refurbished indicator module), regardless of the external serial number.

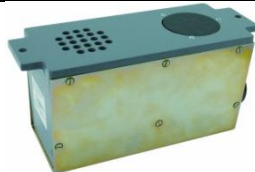
- 1.8.4 The information supplied by Thales is cautious in that it makes no reduction in activity level as the radioactive paint ages (and does not try to distinguish units with the last batch of flags with a slightly lower activity level when new). Technically it would be possible to allow for radioactive decay based on the half life of tritium and calculate an estimated current activity level for each unit, and the older ones would have fewer legal requirements for certain activities, such as road transportation. Adding this level of complexity is likely to lead to errors and confusion. The Swiss supplier of the tritium-based paint (RC Tritec) has advised of a five year practical half life for the radioactivity, instead of the normal 12.3 years for tritium. However, Thales' independent external RPA (Radiation Protection Adviser) has advised not to rely upon this without concrete evidence to support the theory.
- 1.8.5 For information only, beta particles from tritium can penetrate only about 6 mm of air, and they are incapable of passing through the dead outermost layer of human skin. Since tritium is a low energy beta emitter, it is not dangerous external to the human body. Tritium is potentially dangerous if inhaled or ingested (or if it enters the body via a puncture wound or skin/eye contamination absorption). Ref: North Carolina chapter of the Health Physics Society, www.nchps.org, however it requires large amounts of tritium to pose a serious risk.
- 1.8.6 It needs to be appreciated that these units are not a significant radiological risk to users, but the issue is more one of legal compliance and ensuring appropriate procedures are put in place and followed. The risks are higher for those experts dismantling the units for repair.
- 1.9 Further recommendation (configuration control)**
- 1.9.1 In the light of section 1.8.3 above, it is recommended that all repairers of AWS/TPWS equipment maintain sufficiently detailed records of service/repairs. Records should include:
- 1.9.1.1 At LRU (Line Replaceable Unit) level:
- the manufacturer's name
 - the part number
 - the revision or issue, if any
 - the external serial number
 - the modification number.
- 1.9.1.2 For any internal part, sub-assembly or module that is replaced and that bears a serial number:
- the manufacturer's name
 - the part number
 - the revision or issue, if any
 - the serial number
 - the modification number.

- 1.9.1.3 This recommendation (1.9.1) is considered to be in line with Recommendation 31 of “The Southall Rail Accident Inquiry Report” by Professor John Uff QC FREng. For ease of reference, this recommendation stated “Efforts should be concentrated on ensuring that AWS and other trainborne safety equipment does not fail in service through preventable causes. This should include regular replacements of equipment, maintenance of full service records and provision for full traceability of repairable parts and components”.
- 1.9.1.4 Repair records should be kept for a period of time consistent with a ‘useful life’ of 20 years, unless a longer period is required contractually, in line with EN 50155.
- 1.9.1.5 This recommendation (1.9.1) will be put to the RSSB V/TC&C SIC for consideration and endorsement.
- 1.9.1.6 Unipart Rail have stated that they are willing to log configurations by serial number etc, going forward, if this is recommended.
- 1.9.1.7 Note that in this instance train safety has not been compromised in any way through lack of traceability to sub-assembly level. It would just have eased compliance with general Health & Safety legislation.

2 Appendix 1 – Identification of ‘AWS Indicator Units’ and ‘AWS Alarm and Indicator Units’

- 2.1.1 This list is not exhaustive and some of the content is provisional, based on best information available. It draws information from the PADS database and from GM/GN2169 Issue 1 (April 2007). With assistance from the rail industry, it is intended to update this table.
- 2.1.2 Where there is a “Yes” in the “Radioactive?” column, this is based on measurements with a radiation meter (often based on only one sample). Where there is a “Suspected”, this is merely read across by virtue of similarity and requires confirmation before assuming there is no radioactive issue associated with the particular device.

PADS No.	Description	Radio-active?	Photo	Comments
098/006925	Howells Alarm & Indicator Unit	Yes		Also wrongly listed in GM/GN2169 Issue 1 as an STS (now Mors Smitt) product. Howells part number HRM 2172. May be labelled as NRS Ltd.
062/500028	Howells AWS Indicator, bulkhead mounting	Suspected		PADS describes this version as “flush mounting”. GM/GN2169 also implies the flush mounting and bulkhead mounting versions are swapped.
062/500029	Howells AWS Indicator, flush mounting	Suspected		PADS describes this version as “bulkhead mounting”.
062/500042	Howells Alarm and indicator Unit	Suspected		Howells
062/500043	Howells Alarm and indicator Unit	Suspected	No picture yet	Listed in GM/GN2169. PADS states “This part has been replaced by

PADS No.	Description	Radio-active?	Photo	Comments
				062/500042 Unit AWS Alarm and Indicating".
062/014454	Unipart Rail AWS Alarm & Indicator Unit, LED variant	No		This is the Mk1 version LED Alarm and Indicator. Unipart Rail have a new redesigned version (Mk2) in development (see 062/015807, 062/015808 & 062/015809 below).
098/007628	Mors Smitt AWS Alarm & Indicator Unit, former Field & Grant design	Yes (below serial number 7905 [†]) No (serial number 7905 and above [†]) [†] Subject to the caveats in sections 1.8.2 & 1.8.3		Mors Smitt part number TY191. Also supplied via Thales: Thales part number 100151.
Unknown	Mors Smitt AWS Alarm & Indicator Unit	Suspected		Mors Smitt part number TY292. Consists of a TY191/GRP06 with a flying lead in a light blue box. Used as a retrofit solution.
093/060445	Mors Smitt AWS Alarm & LED Indicator Unit	No		Mors Smitt part number TY346/GRP01.
334/030100	Mors Smitt AWS Alarm & Indicator Unit <i>(The PADS number is not recognised by Mors Smitt, so the photo is an assumption.)</i>	Suspected		Listed in GM/GN2169. PADS states "Company: Alstom Partslink, Part No. DTR0009009632. Company: Thales Part No. 100151", i.e. the same as 098/007628, Mors Smitt TY191.

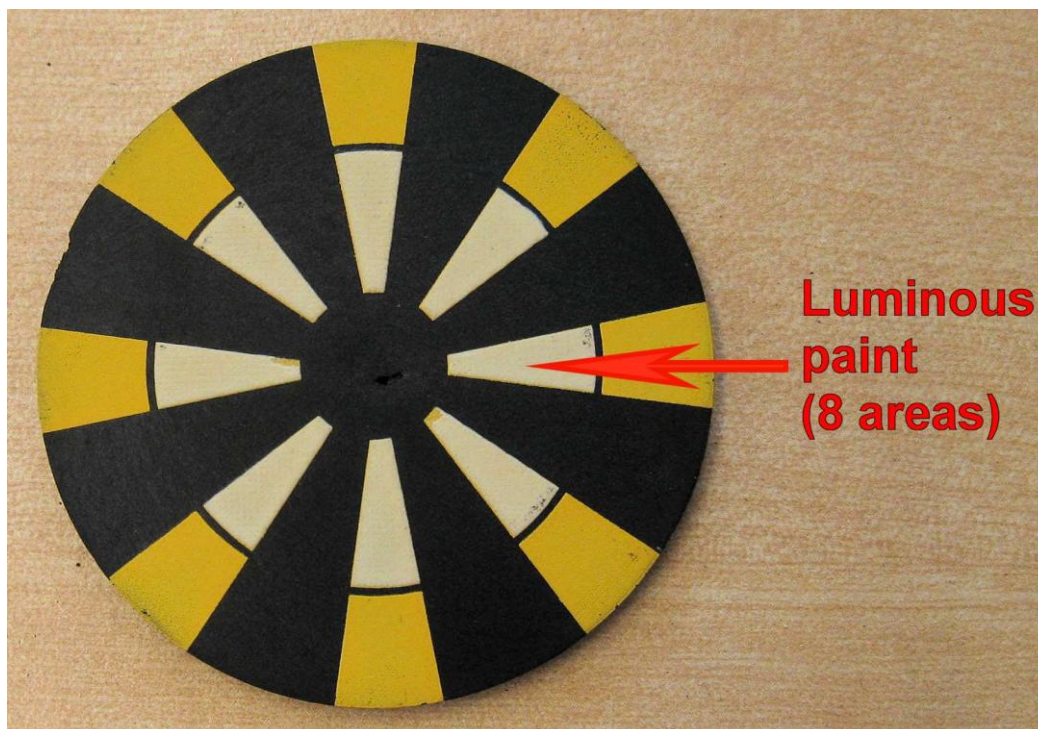
PADS No.	Description	Radio-active?	Photo	Comments
062/006580	Unipart Rail AWS Indicator, bulkhead mounting	Yes		Listed as "Indicator, FL. (Repair only)" on Unipart website. This product may originate from Ferranti (not verified). 80mm diameter sunflower. PADS describes this version as "flush mounting".
062/006610	Unipart Rail AWS Indicator, flush mounting	Suspected		PADS describes this version as "bulkhead mounting". GM/GN2169 also implies the flush mounting and bulkhead mounting versions are swapped.
062/00100	Unipart Rail AWS Alarm & Indicator Unit <i>(The PADS number is not recognised by Mors Smitt, so the photo is an assumption.)</i>	Suspected		Listed in GM/GN2169. PADS states "Part No.: 100151", which is the Thales part number for 098/007628, Mors Smitt TY191.
062/006601	Unipart Rail AWS Alarm & Indicator Unit	Suspected	No picture yet	Described on Unipart's website as "R062/006601 Modified Alarm & Indicator Serviced" PADS states "Modified to include harness. Company: Atkins Rail".
Unknown	Mors Smitt AWS Indicator Unit	Yes		Mors Smitt part number TY268. Same 45mm diameter sunflower flag as in TY191 (98/7628).

PADS No.	Description	Radio-active?	Photo	Comments
093/055054	Alarm and Indicator with flying lead	Suspected	It is like TY191/GRP01 and GRP05 but with a flying lead, as shown from the back: 	Mors Smitt part number TY191/GRP06. Derivative of 098/007628.
062/015825	AWS LED Alarm and Indicator Unit, Rear Mounted, Connector Variant	No	No picture yet	Unipart. For Use On Class 165 &166 Vehicles
062/015807	Unipart Rail Mk2 LED AWS Alarm & Indicator Unit, set to an audible sound level at 1m of 85dBA.	No		New design (Mk2).
062/015808	Unipart Rail Mk2 LED AWS Alarm & Indicator Unit, set to an audible sound level at 1m of 90dBA.	No		New design (Mk2).
062/015809	Unipart Rail Mk2 LED AWS Alarm & Indicator Unit, set to an audible sound level at 1m of 85dBA.	No		New design (Mk2). Rear mounted with nut inserts in the face panel, for use as an alternative to the rear fixing panel.
062/006602	AWS Alarm and Indicator Unit with flying lead, set to 85dBA.	Suspected	No picture yet	Unipart
062/015960	AWS Visual Warning Indicator	Unknown	No picture yet	Unipart

2.1.3 Acknowledgment is given for photos from the PADS database website, Thales, Mors Smitt and Unipart Rail, all used with permission.

3 Appendix 2 – Luminous painted region

- 3.1 The 'sunflower' disc, known as the 'flag', has luminous paint just on the inner sectors, as shown below.



4 Appendix 3 – Non-Standard Serial Number Format

- 4.1 An example of a Mors Smitt A&I Unit allocated a new serial number by Unipart Rail during repair, where the original number could not be read reliably. The 'Mod Level' on this ('Mod 3') implies that it was made in 1993 or earlier, so would have used the tritium-based paint.



5 Appendices 4 & 5 – Documentation supplied by Thales to their Customers

5.1 The following 15 (3+12) pages comprise the following:

5.0.1 Appendix 4 – Letter issued by Thales to their Customers

The letter is reproduced on the following three pages of this briefing paper.

5.0.2 Appendix 5 – ‘Compliance Information Pack’ issued by Thales to their Customers

The Compliance Information Pack is reproduced on the subsequent 12 pages of this briefing paper. Note that one page of the pack is itself entitled “Appendix”.

Client

Client address Line 1

Client address Line 2

Client address line 3

City

Postcode

For the attention of:

«Contact name»

9th July 2012

Dear Customer,

Supply of STS Rail Automatic Warning System (AWS) Alarm & Indicator Units to Thales customers

As you may be aware Thales has supplied your organisation, either directly or indirectly, with TPWS & AWS equipment which is currently installed within rail vehicle cabs.

Thales has become aware that a third-party product that forms a part of its AWS supplied system contains radioactive material in the form of Tritium (mixed with paint). The radioactive material is mixed with the paint in order to utilise its luminescent qualities, thereby allowing the component to be visible in low light conditions without the need for electrical charge.

We would like to emphasise that having engaged a radiological expert, investigated the production process of these units and measured samples, we are able to confirm that proper use of the units does **NOT** present a radiological hazard to individuals working within the vehicle cabs, however, we are obliged to inform you of this discovery and to bring to your attention any precautions you must take as an employer to comply with relevant legislation.

In summary;

- You will need to notify the HSE of ownership or loss
- Where appropriate you need to have procedures, risk assessments and contingency plans in place for usage, storage and transportation
- You need to keep appropriate records of where the units are located

The product supplied by Thales that contains the radioactive material is the STS Rail Limited (now Mors Smitt UK Limited) "AWS Alarm & Indicator Unit" (or "AWS A&I Unit", or "AWS Sunflower"), as shown in the picture over the page.

THALES UK LIMITED

Registered Office: 2 Dashwood Lang Road, The Bourne Business Park
Addlestone, Nr. Weybridge, Surrey KT15 2NX, United Kingdom
Registered in England No 868273



Typical AWS A&I Unit
(Thales part No. 100151 – STS Rail Part No. TY191/all variants – BR Cat./ PADS No. 98/7628)

The radioactive material is protected behind the plastic window and is classed as a sealed source. The plastic significantly absorbs the radiation produced and therefore the devices **do not** present an external radiation exposure hazard during normal use. The construction of the product also means that cab crew and maintainers do not have access to the radioactive material.

The manufacturer of the A&I Units estimates it has supplied approximately 7,900 of these devices into the Industry, of which 3,448 were supplied through Thales when bundled with a full AWS / TPWS system. Please note that other variants of AWS indicators also exist, which may or may not contain radioactive material; however, as these devices have not been supplied via Thales, we suggest you contact the manufacturer direct for information on these devices.

Thales has only relatively recently become aware that this product contains radioactive material, making it non-compliant to our procurement specification, as the supplier had not advised Thales, and had not marked or handled the devices in accordance with legislation.

Although the use of radioactive material to create luminous articles was common within the industry historically, the use of tritium-based luminous paint on this product ceased in February 2008 and was replaced by a non-radioactive photo-luminescent phosphorescent paint. Units with a serial number of 7905 and higher are non-radioactive. Some units that STS Rail have repaired since February 2008 have had their radioactive 'flag' or indicator disc replaced with the later non-radioactive version, but only if the flag or mechanism was faulty. Unfortunately, STS Rail did not identify this change on the product label. All units repaired through Thales from June 2011 will have been returned with non-radioactive flags. For both new and future repaired units, the non-radioactive versions will be identified as Mod 5 (the digits 1 to 4 blacked out) on the product label.

Under the Health & Safety at Work Act 1974 and the Ionising Radiations Regulations 1999 (IRR99), Thales is required to provide you, the Customer, with the relevant information regarding the radioactive content of the units being supplied and information on any precautions that should be taken.

In order to assist your organisation in meeting the requirements of the relevant legislation Thales has produced and enclosed with this letter a 'Compliance Information Pack' which summarises the key radiation protection responsibilities for an employer and includes templates for key safety documentation relating to the keeping and use of the units.

THALES UK LIMITED

Registered Office: 2 Dashwood Lang Road, The Bourne Business Park
Addlestone, Nr. Weybridge, Surrey KT15 2NX, United Kingdom
Registered in England No 868273

Should you have any questions, please do not hesitate to contact any of the individuals below.

Yours sincerely,



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Industrial Director
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Encs.

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Background

Under the Health & Safety etc at Work Act 1974 and the Ionising Radiations Regulations 1999 (IRR99), Thales is required to provide you, the Customer, with the relevant information regarding the radioactive content of the units being supplied and information on any precautions that should be taken.

Thales believes strongly in supporting its customers in all matters relating to health and safety and have provided the accompanying information pack for this purpose.

Please note that whilst the units are being used within your train cabs or stored on site, as the employer, the regulations place duties on your organisation to protect staff and others. For work with radioactive material, relevant legislation is:

- the Ionising Radiations Regulations 1999 (IRR99) – in the UK;
- the Environmental Permitting (England & Wales) (Amendment) Regulations 2011 (EPR11) – in ENGLAND AND WALES ONLY;
- The Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011 and the Radioactive Substances Exemption Order (Scotland) Order 2011 – in SCOTLAND ONLY;
- The Radioactive Substances Act 1993 Amendment (Northern Ireland) Regulations 2011 and the Radioactive Substances Exemption Order (Northern Ireland) Order 2011 – in NORTHERN IRELAND ONLY;
- and the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG09) in the UK.



The Ionising Radiations Regulations 1999 (IRR99)

IRR99 addresses the provision of safe working conditions and practices for staff and others when dealing with radioactive materials. These regulations are enforced by the Health & Safety Executive (HSE). Under IRR99 the employer is required to (amongst other responsibilities):

- Notify the HSE of its intention to work with ionising radiation;
- Carry out a prior risk assessment of any activities involving work with ionising radiation;
- Create and implement, where required, appropriate contingency plans for any reasonably foreseeable incidents involving radioactive materials;
- Draw up working procedures which detail how to effectively work with radioactive material; and
- Keep appropriate records of radioactive material on site.

Templates for you to utilise in meeting the above requirements are provided in the Appendix to this document. It is recommended that a Radiation Protection Supervisor (RPS) be appointed within your organisation who can assist in meeting the requirements of IRR99. The RPS should be provided with appropriate training.

The Environmental Permitting (England & Wales) (Amendment) Regulations 2011

The Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011 and the Radioactive Substances Exemption Order (Scotland) Order 2011

The Radioactive Substances Act 1993 Amendment (Northern Ireland) Regulations 2011 and the Radioactive Substances Exemption Order (Northern Ireland) Order 2011

These Regulations and Orders relate to the keeping and use of radioactive material and are regulated by the Environment Agency (EA) in England and Wales; the Scottish Environment Protection Agency (SEPA) in Scotland; and the Environment Agency Northern Ireland (EANI) in Northern Ireland. For the use of the units, these pieces of legislation require:

- An adequate record to be kept of the number of units held and their location where they are stored or used.
- That any storage containers containing the units (when they are not installed) are marked or labelled as radioactive.
- That units if stored are done so in a secure and safe manner so as to prevent accidental removal, loss or theft from the premises where they are held.
- The relevant Agency as soon as practicable to be notified in the event that a unit has been lost or stolen (or suspected lost or stolen).

There is no requirement to obtain an environmental permit from any of the above Agencies for keeping and using the units or for disposing of them as waste. This is because of an exemption provided by the Agencies under the above legislation,



subject to requirements. Up to 2500 of the units may be kept and used on site and within cabs without the need for a permit, subject to a set of generic conditions being complied with. Also as part of the exemption the units may be disposed of through normal refuse (not as WEEE). One item can be disposed of per 0.1 m³ of normal refuse. Up to 10 TBq of activity can be disposed of via this method in a year, this is approximately 5000 of the units per year. Units may also be returned to the manufacturer for disposal. For any disposals records should be kept that the units have been disposed of.

The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009

CDG09 relates to the transport of radioactive material and (for Class 7 goods) is regulated by the Office for Nuclear Regulation (ONR). This includes requirements for:

- Ensuring that radioactive material is transported in appropriate packaging which is labelled correctly; and
- Appropriate transport documentation is drawn up for the consignment.

Note whilst fitted to a train CDG09 do not apply to these units.

Under CDG09 when you are transporting the units back to us, they must be transported as 'excepted packages'. There are minimum requirements 'excepted packages' must meet. When transporting the units, the following requirements must be met:

- The package must be able to withstand the normal rigours of transport;
- The appropriate United Nations (UN) number must be displayed on the outside of the package;
- The word 'Radioactive' must clearly be displayed upon opening of the package;
- A transport document which complies with the requirements of CDG09 should accompany the package, this includes a signed declaration from the consignor.

A template for a Transport Document for use when transporting the units by road (not affixed as a part of a vehicle) is provided in the Appendix of this document.



APPENDIX

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Template – Notification to the Health & Safety Executive

Insert address and details

As required by the Ionising Radiations Regulations 1999 (IRR99), the following particulars are being provided in relation to work with ionising radiation carried out by our organisation.

- ***Insert name and address of the employer and a contact telephone or fax number or electronic mail address;***
- Sources of ionising radiation will be used within mainline train cabs;
- ***Insert the nature of the business of the employer;***
- We are using sealed radioactive substances in form of tritium painted components used for indicating to train drivers the status of warning lights.
- Work with ionising radiation has already begun.

Insert signature etc.

Notification to the Health & Safety Executive (HSE) can be made:

By e-mail to: irrnot@hse.gsi.gov.uk

In writing to: HSE, Ionising Radiations Notifications, Phoenix House, 23-25 Cantelupe Road, East Grinstead, West Sussex, RH19 3BE



Template – Risk assessment for carrying out work with the units

1. Description of work with ionising radiation.

1.1 Use of tritium painted components (sealed sources) within train cabs.

2. Details in relation to the above work.

2.1	Sources of ionising radiation present	Tritium (H-3) mixed with paint in order to produce a luminous compound. Estimated activity of the units is 2 GBq.
2.2	Radiation dose-rates	The sources are very low energy beta emitters and there are no measurable external radiation dose-rates present.
2.3	Likelihood of radioactive contamination arising and being spread	Unlikely as the radioactive material is located behind a protective screen and is therefore a sealed source. Contamination may be present if the units are damaged or opened by untrained personnel. Arrangements described for dealing with broken units in procedural document (insert reference) .
2.4	Results of personal dosimetry and area monitoring	See 2.2 above. No personal or area monitoring required.
2.5	Advice from the manufacturer or supplier of equipment about its safe use and maintenance	Information pack provided regarding the use of the units (insert reference) .
2.6	Engineering control measures and design features	Tritium is mixed with paint and is located within units (behind a protective screen). The units are enclosed in a metal case.
2.7	Systems of work	Detailed in procedural document (insert reference) .
2.8	Levels of airborne and surface radioactive contamination	See 2.3 above.
2.9	Personal Protective Equipment (PPE)	Not required as they are enclosed.
2.10	Access to working areas	No access restriction required when units are installed and in use. When in storage access should be restricted to trained and authorised workers.
2.11	Accident situations, likelihood and potential severity	Detailed in procedural document (insert reference) . If it is estimated that if 10% of the 2 GBq of tritium be ingested (i.e. 200 MBq) it would give an internal dose of 0.36 mSv. This instance is highly unlikely but is shown for indicative purposes. See below for working.
2.12	Failure of control measures (electrical interlocks, ventilation systems, and warning devices or systems of work)	Detailed in procedural document (insert reference) .
2.13	Steps to prevent identified accident situations, or limit their consequences	Detailed in procedural document (insert reference) .



3. Actions and measures based on the information gathered above.

3.1	What action is needed to ensure radiation exposure is As Low As Reasonably Practicable (ALARP).	Compliance procedural document (insert reference) as listed in 2.7 above.
3.2	What steps are necessary to achieve this control of exposure by use of engineering controls, design features, safety devices, and warning devices and, in addition, by the development of systems of work.	See 3.1 above.
3.3	Whether it is appropriate to provide Personal Protective Equipment (PPE) and if so what type would be adequate and suitable.	See 2.9 above.
3.4	Whether it is appropriate to establish dose constraints for planning or design purposes and if so what values should be used.	Not required as there are no significant dose-rates present. See 2.4 and 2.11 above.
3.5	The need to alter the working conditions of any female employee who declares she is pregnant or is breastfeeding.	Not required as the sources are enclosed low energy beta emitters, the likelihood of exceeding 1 mSv in a calendar year is negligible.
3.6	An appropriate investigation level to check exposures are being restricted as far as reasonably practicable.	Not required as there are no significant dose-rates present. See 2.4 and 2.11 above.
3.7	What maintenance and testing schedules are required for the control measures selected.	See 3.1 above.
3.8	What contingency plans are necessary to address reasonably foreseeable accidents.	Contingency plans for dealing with H-3 incidents are contained within the procedural document.
3.9	The training needs of workers.	Induction training required for health and safety matters when working within the train cabs will include a short section on radiation protection.
3.10	The need to designate specific areas as controlled or supervised areas and to specify local rules.	No requirement.
3.11	The actions needed to ensure restriction of access and other specific measures in controlled or supervised areas.	No requirement.
3.12	The need to designate certain employees as classified persons.	Not necessary to designate employees as classified persons. See 2.4 and 2.11 above.



3.13	The content of a suitable programme of dose assessments for workers.	See 2.4 and 2.11 above.
3.14	The responsibilities of managers for ensuring compliance with 'the regulations'.	See 3.1 above.
3.15	An appropriate programme of monitoring or auditing of arrangements to check the requirements of 'the regulations' are being met.	Insert details on how the company will monitor compliance with its procedural document.

Data

Typical activity of H-3 in unit: 2×10^9 Bq (although activity levels will have decayed to less than 1×10^9 Bq per unit by the end of 2019)

ICRP 68 Ingestion dose coefficient for H-3 water: 1.8×10^{-11} Sv·Bq⁻¹

In the release scenarios, it is assumed that 10% of the H-3 is released (i.e. 2×10^8 Bq) and that 10% of this is ingested (i.e. 2×10^7 Bq).

Therefore the internal doses to a worker would be as follows:

Ingestion:

$$1.8 \times 10^{-11} \text{ Sv} \cdot \text{Bq}^{-1} \times 2 \times 10^7 \text{ Bq} = 3.6 \times 10^{-4} \text{ Sv (or 0.36 mSv)}$$

Reference: ICRP (International Commission on Radiological Protection) Publication 68 "Dose Coefficients for Intakes of Radionuclides by Workers".



Template – Procedural document for working with the units

This document sets out the procedures by which automatic warning system (AWS) alarm and indicator units which contain radioactive material should be kept and used.

Radiation Protection Supervisor (RPS)

The company Radiation Protection Supervisor is [insert name] who can be contacted on [insert details].

Authorised locations

The units can only be stored and used in the following locations:

- Main lockable radioactive source store at the depot
- When fitted within train driver cabs

General working practices

Any persons handling the units shall ensure that they are not modified and shall so far as reasonably practicable ensure that they are not damaged. Any persons handling the units shall so far as is reasonably practicable prevent the loss and access to any unit by any person not authorised.

Any persons handling the units shall so far as is reasonably practicable ensure that each unit is kept either in the dedicated source store or as installed within the cabs. The units shall not be kept in desk drawers, boxes under benches, filing cabinets etc.

Contingency plans

If a unit becomes damaged or broken the following action must be taken:

1. Evacuate the area immediately
2. Inform the RPS immediately
3. Using an appropriate spill kit, the entire unit must be collected using personal protective equipment and bagged within a sealable bag. The area where the breakage occurred should be wiped and the wipes also placed within the bag. Double bagging should also be used.
5. The RPS will arrange for disposal of the damaged source by initially contacting the supplier then using the normal refuse disposal route available.

If a source is stolen or lost, the following actions should be taken:

1. Operator to identify the lost item by Part Number/Serial Number.
2. If not the RPS, the operator should personally inform the Radiation Protection Supervisor (RPS) or his deputy by voice, not by e-mail or other means that might be delayed in transmission
3. The RPS shall duly consider the circumstances of the incident to establish if actions can be taken to minimise the likelihood of a future repetition.
4. If the unit has NOT been located, it is deemed LOST. The RPS shall carry out further actions and notify the relevant authorities.



Template – Transport document

Consignor's Reference No.

TRANSPORT DOCUMENT THE CARRIAGE OF DANGEROUS GOODS AND USE OF TRANSPORTABLE PRESSURE EQUIPMENT REGULATIONS 2009. SI 2009 NO. 1348

HAZARDOUS MATERIAL DESCRIPTION		DETAILS FOR IDENTIFICATION OF PACKAGE
UN Number(s) UN2911		Number of packages One
Proper Shipping Name RADIOACTIVE MATERIAL, EXCEPTED PACKAGE – INSTRUMENTS		
UN CLASS No. Class 7	Radioactive material	Consignee's Name, Address and reference (if any)
NATURE AND QUANTITY OF CONTENTS		
Name(s) or symbol(s) of Radionuclide(s)	Tritium (H-3)	
Chemical and physical state of contents.	Solid article containing luminised radioactive paint	Other Hazardous Properties of Contents N/A
Maximum activity of consignment in becquerels (Bq)	2 GBq	

Declaration

I hereby declare that the contents of this consignment are fully and accurately described by the proper shipping name and are classified, packed, marked and labelled, and in all respects in proper condition for transport by road according to the applicable provisions of all appropriate National and International regulations and codes. All requirements, prohibitions and restrictions imposed by the Competent Authorities concerned in relation to the consignor of the consignment described on this form (and any attached forms) are complied with.

Address of consignor	Name Signature..... .. Date Tel No. Fax No.
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