# Storage and treatment of fluorescent lamps

**Quick guide 214_12** **Issued** 30/04/2012

**What's this document about?**

This document covers appropriate storage and treatment requirements for fluorescent lamps using Best Available Treatment Recovery and Recycling Techniques (BATRRT). This is required by the WEEE Directive, and is also an extension of the principles of Best Available Techniques (BAT) required under the Integrated Pollution Prevention and Control Directive.

**Who does this apply to?**

This guidance has been produced to help Environment Agency compliance officers with enforcing BATRRT at fluorescent lamp storage and treatment sites. The main focus of the guide is on minimising uncontrolled mercury vapour and dust releases during storage and crushing of lamps prior to treatment at recovery facilities. Whilst this is an internal guide it may be shared externally where appropriate to help deliver a consistent regulatory approach.

**Main issues covered by this guide**

Fluorescent lamp types, composition and hazardous waste coding

Permitting requirements

Storage and handling standards

Treatment requirements

Use of lamp glass / End of waste

Health and safety considerations during site visits

Document details

Related documents

Feedback

**Contact for queries**

Paul Fernee

7 21 2624

Paul Barker

7 24 6154

**Fluorescent lamp types, composition and hazardous waste coding**

This guidance focuses primarily on straight and compact fluorescent lamps. Other types of lamp may also contain mercury and will also need to be handled in accordance with this guidance to prevent uncontrolled breakage and mercury emissions. Examples include: high pressure sodium, mercury vapour, metal halide, neon and UV lamps.

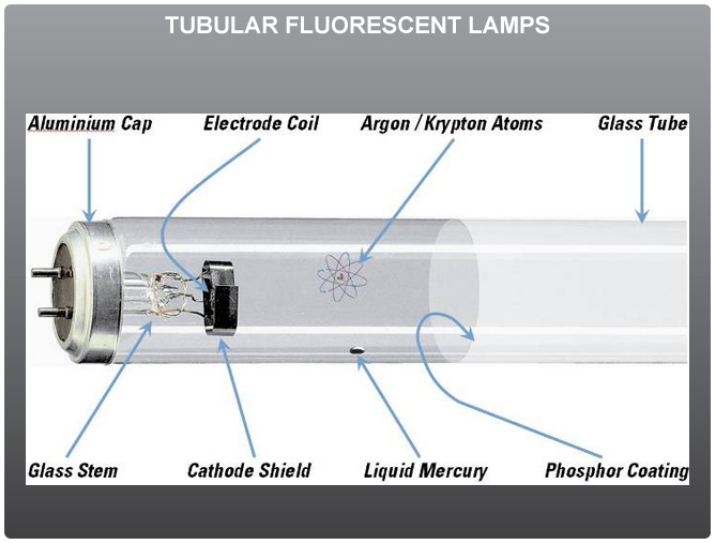


Fig 1: typical fluorescent tubular lamp (source: Lighting Industry Federation website)

Fluorescent lamps come in various sizes. Standard straight lamps typically contain <10mg mercury, with newer tri-phosphor lamps containing <5mg. The mercury is typically in an amalgam today, rather than a visible droplet as indicated above, which is found in historic lamps. Historic tubes and other types of lamp may contain higher levels of mercury (e.g. High intensity discharge lamps contain around 30mg). The mercury is slowly absorbed into the glass, phosphor powder and electrodes throughout the lamp's life. Mercury will therefore be unevenly distributed throughout the lamp. For older style lamps up to 90% of the mercury is latched onto the halo-phosphor powders, but research has shown less (around 60%) latched to newer tri-phosphor lamps.

The principal environmental and health risk in fluorescent lamp recycling relates to mercury release. Any breakage or damage to lamps will result in potential exposure to mercury vapour and dust. Mercury vapour is invisible and odourless and can readily vaporise at room temperature. Heat and air movement will increase mobility of the mercury vapour and dust, therefore any storage containers for crushed or whole lamps must be appropriately sealed to minimise the risk of uncontrolled mercury emissions.

Other metals may be also be present in fluorescent lamps including aluminium, barium compounds, and copper. Cadmium compounds may be found in historic lamps (> 20 years old). Antimony and arsenic may also be present in the plastics of compact fluorescent lamps (CFLs).

A wide range of lamps are in common use. Where content is unknown producers should contact the lamp manufacturer to help classify the specific components and likely hazards present in spent lamps to ensure appropriate handling. Where this information is unavailable or there is uncertainty the presumption must be that they contain mercury.

**Fluorescent lamp types, composition and hazardous waste coding, continued**

Compact fluorescent lamps (e.g. a typical energy saving bulb) may have integrated ballasts (shown below). These contain a small circuit board which will also need to be removed as a separate fraction where over 3.5cm diameter (circuit boards over 10 square centimetres require removal under BATRRT).

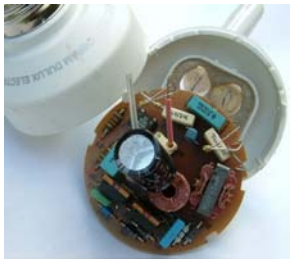

Fig 2 integrated ballast (source: http://commons.wikimedia.org/wiki/File:Elektronstarterp.jpg)

Luminares (light fittings) for fluorescent lamps may also contain batteries where used for emergency lighting which will require removal for recovery under BATRRT as a separate fraction. Historic luminaries may also contain capacitors with polychlorinated biphenyls (PCBs) which require separate removal. All unmarked capacitors could contain PCBs, unless they were manufactured after 1986, are labelled as PCB free or are marked with “+” and “-“ indicating they are electrolytic capacitors. Modern capacitors are unlikely to contain hazardous substances.

Note - Sodium lamps may also contain mercury and lead. These lamps must be stored and handled appropriately to prevent breakage and uncontrolled exposure to water sources or humidity. The main risk is potential fire/explosion from contact with large quantities of water as sodium produces hydrogen. Sodium hydroxide is also produced from contact with smaller quantities of water, which is corrosive and will cause skin burns. Sodium metal has the risk phrases R14, R15 and R34. R14 & 15 relate to its reactivity with water and evolution of flammable gasses and R34 to its corrosive nature.

**Hazardous waste coding**

All fluorescent tubes and bulbs containing mercury should be coded 20 01 21* fluorescent tubes and other mercury-containing waste, regardless of source. This is an absolute hazardous waste, which means that the tube is considered hazardous without assessment.

If the tube is part of an electrical item it will be coded 20 01 35* discarded electrical and electronic equipment containing hazardous components. The presence of a fluorescent tube, or other hazardous components, in electrical equipment means the waste is hazardous.

When a lamp is crushed the mixed residues will be coded 19 02 04* pre-mixed wastes composed of at least one hazardous waste. This is an absolute hazardous entry. This waste must then go for separation so that the constituents of the lamp can be recovered.

Some crushing processes include an integral separation step. Wastes separated from treating tubes can be coded according to their type – see Figure 3.

**Permitting requirements**

Temporary storage pending collection of waste lamps at the original producer's premises does not require an EPR permit or exemption (see Schedule 25 part 3 (2) of the Environmental Permitting Regulations in related documents for more information).

Storage of waste lamps at a collection point can be exempt from permitting under the terms of an S2 exemption. Up to 400 cubic metres of WEEE in total can be stored for up to 6 months under this exemption. See schedule 3 Para S2 of the Environmental Permitting Regulations for more information.

Crushing can take place under the terms of a T17 exemption at the original site of production. There is also a new regulatory position which extends the use of T17 to allow crushing at a collection point (see link in related documents). The T17 exemption authorizes the crushing of up to 3 tonnes of waste tubes (approx 15,000 tubes, assuming an average weight 0.2 kg per tube) per day. Any mercury emissions must not exceed 25 microgrammes per cubic metre, and the waste must be collected in a secure container under weatherproof covering. See schedule 3 Para T17 of the Environmental Permitting Regulations for more information.

From a health and safety perspective, the EU has also agreed a Workplace Exposure Limit (WEL) for mercury of 20 microgrammes/$m^3$ 8 hour time-weighted average. This was implemented in the UK on 18$^{th}$ December 2011 (more information in related documents).

On site crushing cannot be viewed as an ancillary treatment under the non waste framework position due to change in the characteristics of the waste, therefore an exemption or permit is required for this activity

Any sites producing 500kg or more of hazardous waste per year (around 2,500 tubes) are required to register as a hazardous waste producer. If other hazardous wastes are produced or held they will also count toward this limit. A hazardous waste consignment note must accompany the movement of the waste, however there is a derogation relating to reduced consignment charges for sites that receive fluorescent tubes (see link in related documents).

Any other treatment activities will require a site permit.

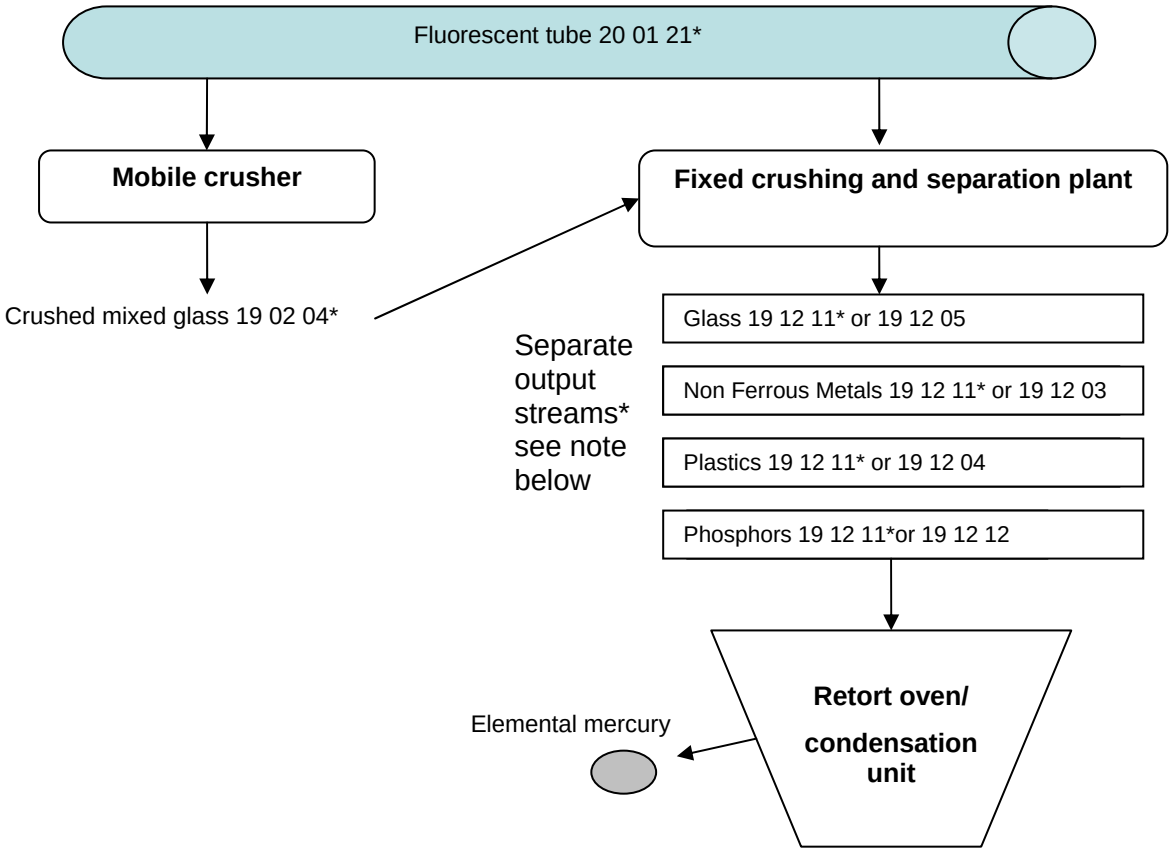


Figure 3: Typical process steps for fluorescent tube treatment *(*note- material specific codes for the crushed outputs can only be used after the initial hazardous waste assessment is completed and if the treatment results in an effectively separated non-hazardous material stream).*

**Storage and handling standards**

**Key Requirements:**

1) Waste fluorescent lamps must be stored in securely enclosed and robust weatherproof containers to prevent rainwater entry and minimise escape of mercury vapour.

2) Lamps must be neatly packed into containers to minimise movement and risk of breakage during transportation.

3) Containers must be handled carefully during loading and unloading to minimise breakage e.g. damage from dropping the container or over stacking of lamps or containers leading to crushing of the contents. Smashing or breaking of lamps into containers is unacceptable.

4) Lamp containers must be stored on an impermeable surface with sealed drainage at reception sites. Sealed drainage is also recommended for production sites to minimise pollution risk.

5) It is best practice for irregular shaped lamps to be stored separately to straight tubes to reduce potential for breakage, either segregated within or in a separate container, where storage space allows.

6) To minimise breakage containers should be appropriately sized for lamp type. For ease of handling a number of smaller containers are recommended over one large bulk container. Where pipe style containers are used, they must be stored appropriately to prevent falling or rolling.

Figs 4 & 5: Good lamp storage practice - lamps neatly stored to minimise breakage

Figs 6, 7 & 8: Examples of poor lamp storage. Fig 6. corrugated container not assembled correctly (collar missing) therefore lamps not appropriately enclosed. Fig 7. lamps poorly stacked in oversized storage container leading to breakage. Fig 9. lamps not stored in appropriately sized enclosed container – risk of breakage.

7) At reception sites appropriate health and safety procedures should also be in place. This includes recording mercury levels with a mercury monitor to ensure levels remain below the workplace exposure limit (see permitting requirements). Where levels exceed typical background or permitted limits the cause should be investigated and the problem resolved immediately to minimise worker exposure to mercury. Good hygiene procedures should also be followed to minimise exposure such as hand washing and footwear protection in potentially contaminated areas.

8) Storage sites should have appropriate procedures & equipment to deal with any lamp breakages/spillages. For larger reception sites spillages should be cleaned up immediately using an appropriate industrial vacuum cleaner with mercury filters. Sweeping is not appropriate due to increased mercury dispersion/ contamination.

9) Ambient temperature is also a factor with higher temperatures giving greater potential for mercury vapour being generated from damaged stored lamps.

**Treatment requirements**

The relevant treatment requirements of the WEEE Directive are contained in Defra's BATRRT guidance (reproduced in Table 1). Waste fluorescent tubes and lamps must only be treated at sites that meet these requirements.

**Key requirements:**

The focus of these requirements is on minimising uncontrolled mercury vapour and dust releases during crushing of lamps using a portable or fixed crusher. Crushers are used to reduce bulk and prevent accidental breakage during transportation of whole lamps. There are several types of lamp crusher available for this purpose.

1) Any equipment used must ensure that any mercury vapours and phosphor/glass dusts are effectively contained.

2) The crushed material must be stored in a secure container under weatherproof covering. A secure container for crushed lamps is either an airtight sealed drum or airtight sealed heavy duty impermeable plastic bag. Where bags are used they must be sufficiently durable and handled appropriately to minimise the risk of punctures or tears during use. Dustbin bags or other non heavy duty or non sealable bags are not acceptable.

3) To prevent escape of mercury vapour or powders from bag punctures/tears, any damaged bags must be placed in a secondary sealed container or double bagged as appropriate.

4) All bags/ drums must be labelled to show their contents, including the presence of mercury.

5) The crushing unit must be effectively sealed and operate under suction to capture all dusts and vapour. This also includes a seal where required to ensure any containers containing crushed lamps which remain attached to the unit when not in use do not result in mercury vapour escaping. All seals must be regularly checked and replaced as required to maintain their operational effectiveness. Care must also be taken during crusher assembly or drum/filter replacement that the seals remain effective.

6) Any filters including HEPA for dust and carbon / charcoal filters which absorb the mercury vapour should be regularly maintained to ensure they remain fit for purpose. Maintenance regimes will vary with equipment and use, but filters are typically replaced every 6 months or sooner if mercury leakage is detected. Compliance officers should check dates / maintenance records accordingly. Any used filters contaminated with mercury will also need to disposed of appropriately.

**Treatment requirements continued**

Figure 8 – example of mercury filters on small mobile crusher

7) Regular representative mercury emission monitoring checks are required to ensure the crusher complies with the relevant emission limits specified under the exemption/permit and/or workplace exposure limit (see permitting requirements). These will vary depending on size and use of the equipment, but should be undertaken typically at weekly or monthly intervals using a portable mercury monitor and the results recorded for inspection.

8) The highest routine occupational exposure to mercury occurs during drum/bag changes. Tube breakages and jamming during feeding into the crusher can also lead to increased risk of exposure, as well as flying glass. Appropriate PPE must be worn by operators at all times during crushing operations.

9) Crushed lamps should be stored in appropriate containers to prevent double handling of the contents and increased exposure/ dispersion of mercury prior to loading into the processing/separation plant.

10) Any crushing activities must be carried out on an impermeable surface with sealed drainage, with appropriate equipment and procedures to deal with any spillages.

At processing/separation plants which separate out the lamps into a phosphor powder stream, a glass stream and a metal stream, similar potential risks for mercury to be released are present.

In order to minimise any releases these plants must operate under negative pressure and have appropriate abatement systems to capture any dusts and mercury vapour prior to venting to a suitable monitored emission point. The equipment must also be regularly maintained to ensure any door seals and filters are replaced accordingly. The filters typically comprise of a HEPA filter and carbon filter (to capture dusts and mercury vapour respectively). Some carbon filters are also impregnated with sulphur or iodine to enhance mercury capture and help control emissions to air (sulphur reacts with mercury to form mercuric sulphide, a solid powder at room temperature).

These plants recover the mercury from the separated phosphor powders which are distilled to separate the mercury.

| | |
|---|---|
| **Use of lamp glass / End of waste** | The WEEE Directive includes a specific lamp recycling target *"for gas discharge lamps, the rate of component, material and substance reuse and recycling shall reach a minimum of 80 % by weight of the lamps."*<br><br>The recovered lamp glass can be used in a variety of new glass melt applications including glass fibre insulation and closed loop recycling into new lamps where the purity is high enough.<br><br>The phosphor powders can also be recovered, with tri-phosphors being reused in new lamps. Other advanced technologies including acid washing to remove the yttrium metals from the phosphors are also in development.<br><br>Lamp glass and other fractions will remain waste until fully recovered. As with other wastes, if an operator would like to submit an application for their material to cease being a waste, further details are available on our website (http://www.environment-agency.gov.uk/business/sectors/124299.aspx) |
| **Health and safety considerations during site visits** | Compliance officers would not normally be expected to enter areas where the mercury concentration and/or the duration of the visit was such that RPE or personal mercury monitors were deemed necessary. However, they should continue to assess their risk of mercury exposure during visits, and ensure they take all reasonable precautions and appropriate actions to maintain their Health & Safety accordingly.<br><br>At treatment sites the operator should be undertaking regular occupational and ambient air monitoring for mercury. If staff have concerns they should ask to see operators risk assessments/ monitoring to satisfy themselves that any mercury releases are being managed effectively on site. Any serious concerns should be reported to the HSE as a Matter of Evident Concern.<br><br>More information from the HSE on controlling mercury exposure risk during lamp recycling is in related documents below. |

**Table 1: Extract from Defra's "Guidance on Best Available Treatment Recovery and Recycling Techniques (BATRRT) and treatment of Waste Electrical and Electronic Equipment (WEEE)" November 2006**

***Gas discharge lamps***

*91. The WEEE Directive requires that:*

***"Gas discharge lamps must be removed, and that Mercury must be removed."***

*92. Gas discharge lamps are defined as lamps in which light is produced by an electrical discharge through a gas. The discharge can either be through gases (such as xenon, neon and carbon dioxide) or through metal vapour (such as mercury or sodium).*

*93. The treatment process for fluorescent lamps involves shredding followed by separation into glass, metal and powder (which contains mercury). The separation process should be designed to prevent fugitive emissions of mercury vapour or dust. The separation process can use either a dry or a wet process; the main advantage of the wet process is that it can separate a wider range of lamps. However, the main disadvantage of this process is the requirement for treatment of the water.*

*94. Recovery of the powder (which contains the bulk of the mercury) and its storage in appropriate labelled containers will be regarded as evidence that the mercury has been removed for the purposes of Annex II to the WEEE Directive.*

## Related documents

**Links**

Waste Electrical and Electronic Equipment Directive

http://ec.europa.eu/environment/waste/weee/legis_en.htm

Guidance on Best Available Treatment Recovery and Recycling Techniques (BATRRT) and treatment of Waste Electrical and Electronic Equipment (WEEE) November 2006

http://archive.defra.gov.uk/environment/waste/producer/electrical/documents/weee-batrrt-guidance.pdf

More information on lamp types is available in lamp guide here

http://www.lif.co.uk/

EEE scope guidance Version 3 March 2010 (see page 10 for lighting equipment)

http://www.environment-agency.gov.uk/static/documents/Business/EEE_Scope_Guidance_V3_0_March_2010_-_Final.pdf

Regulatory position statements link for T17 extension to collection points http://www.environment-agency.gov.uk/business/regulation/99685.aspx

Hazardous waste derogations for fluorescent lamps

http://www.environment-agency.gov.uk/business/topics/waste/35142.aspx

Environmental Permitting Regulations 2010

http://www.legislation.gov.uk/uksi/2010/675/pdfs/uksi_20100675_en.pdf

Health & Safety inspection commentary: fluorescent tamp/tube recycling

http://www.hse.gov.uk/foi/internalops/sectors/manuf/03-11-01/appendix-3.htm

Workplace exposure limits – HSE guidance EH40 (updated 2011)

http://www.hse.gov.uk/pubns/priced/eh40.pdf