DGUV
Deutsche Gesetzliche Unfallversicherung
Spitzenverband

Description of exposure

Exposure to mercury during the recycling of lamps

This description of exposure was produced by the German Social Accident Insurance Institutions for the trade and distribution industry (BGHW), the administrative sector (VBG) and the energy textile electrical and media products sectors (BG ETEM).

General

Section 6 (1) 3 of the German Ordinance on hazardous substances (GefStoffV) [1] requires companies to determine the nature and scale of exposure of their employees. This can be achieved by workplace measurements or other, equivalent assessment methods.

Descriptions of exposure constitute a suitable method of assessing the exposure to mercury arising during the recycling of lamps containing mercury, and are based upon measurements of airborne hazardous substances at recycling workplaces. No exposure to mercury or its inorganic compounds arises during activities involving intact lamps.

This description of exposure can be used in accordance with Sections 6 and 7 of the German Ordinance on hazardous substances (GefStoffV) during the performance of risk assessments. It provides support during assessment of inhalative exposure to mercury and the resulting measures. Other hazards, such as those arising from skin contact or physical and chemical effects, must be considered separately. The obligations to use substances and/or methods presenting a lower risk in accordance with the TRGS 600 technical rules [2] concerning observance of the ranking of protective measures and the provision of instruction to employees etc. continue to be mandatory.

1 Scope

Lamps containing mercury constitute electronic scrap in the sense of the German Electrical and electronic equipment act (ElektroG) [3]. The ElektroG governs the collection of lamps and end-of-life electronic devices containing mercury for the purposes of disposal. Private and commercial users are obliged to dispose of these products separately from household waste. In accordance with Section 13 of the ElektroG, municipal and district authorities have a duty to set up collection points for this waste. The trade sector may also accept used lamps from private consumers.

The Stiftung EAR national register for waste electric equipment estimates that approximately 10,000 tons of lamps containing mercury enter the recycling stream each year. This collected volume is sourced throughout Germany from a total of approximately 5,000 collection points for small quantities, approximately 400 collection points for large quantities, and large companies.

To these are added lamps that are rejected during manufacturing for quality assurance reasons.

This description of exposure applies to the recycling of lamps containing mercury by means of the shredder and end-cut-and-separate methods [4]. It describes exposure to mercury and its inorganic compounds during use of these recycling methods, together with procedures and protective measures.

This description of exposure does not apply to the recycling of other devices containing mercury, such as thermometers, or electronic components, such as switches. Such items generally contain much greater quantities of metallic mercury, and must be recycled separately.

The manufacture of lamps containing mercury is addressed by a separate description of exposure. Recommendations for risk assessment (EGUs) by the German Social Accident Insurance Institutions have been issued for the collection of lamps containing mercury and for the dismantling of flat-screen TVs/monitors backlit by lamps containing mercury.

2 Definitions

The terms below used in this description of exposure are defined as follows:

Mercury vapour lamps are gas-discharge lamps that use the excitation of mercury atoms to generate light. They include compact fluorescent lamps (CFLs; also referred to as energy-saving lamps), fluorescent tubes, special types of fluorescent tube, high-pressure mercury vapour lamps, and cold cathode fluorescent lamps (CCFLs) used for the backlighting of flat-screen TVs/monitors.

Recycling of lamps
Lamps that have been rejected during the manufacturing process or collected by the municipal authorities are generally supplied to recycling plants subsequently. A range of processes are used for recycling in which the lamps are dismantled into their constituent parts in order to be returned to the raw materials cycle.

3 Work processes/activities

The lamps and the broken lamp debris supplied to the recycling plant are first stored separately before the recycling process proper begins. Where required, the lamps are sorted manually according to lamp type at a sorting point. Broken lamp debris is separated out and placed in sealable containers.

The various lamp types and the broken lamp debris are then supplied by the workers to the recycling plant on conveyor belts. The belts are normally enclosed and are accessed only for troubleshooting or for cleaning. In the recycling plants, the intact lamps and debris are broken down into their individual fractions (phosphor, glass, metal, electronic waste). The fractions must be stored in closed containers outside the working areas until they are transported away.

4 Exposure to hazardous substances

In accordance with EU Regulation 1272/2008 on classification, labelling and packaging of substances and mixtures (CLP Regulation) [5], mercury is classified as a hazardous substance.

Table 1: Classification and marking of mercury under the CLP Regulation

Hazard class	Hazard category	Pictogram	H phrase
Acute toxicity, inhalation	Cat. 2		H330, Fatal if inhaled

Hazard class	Hazard category	Pictogram	H phrase
Reproductive toxicity	Cat. 1B		H360D, May cause harm to the unborn child
Specific target organ toxicity (repeated exposure)	Cat. 1		H372, Causes damage to organs through prolonged or repeated exposure
Acute and chronic aquatic toxicity	Cat. 1		H400, Very toxic to aquatic life H410, Very toxic to aquatic life with long lasting effects

Mercury must also be marked with the signal word "Danger".

The TRGS 900 technical rules for hazardous substances (occupational exposure limits, OELs) [6] state an OEL of 0.02 mg/m³ for mercury and its inorganic compounds. A level of eight times this value (0.16 mg/m³) must not be exceeded over a brief period (15-minute mean) (peak limit Category II).

The TRGS 903 technical rules for hazardous substances (biological limits) [7] specify a biological limit of 25 µg of mercury per gramme of creatinine.

4.1 Exposure during activities

No exposure to mercury or its inorganic compounds arises during activities involving intact lamps. Exposure may arise when lamps are supplied in broken form or when lamps break on site. Empty collecting containers may also be a source of mercury emissions should they contain residue of broken glass and phosphor coatings.

Lamps supplied for recycling were generally manufactured many years previously and can be assumed to have a mercury content higher than the currently permissible levels. The reduction of mercury and mercury products in electrical and electronic equipment will take several years to feed through to the recycling process. With the EU RoHS Directive [8], substance bans such as that for mercury have come into force for electrical and electronic equipment placed on the market for the first time. Among the permissible exceptions is the use of mercury in lamps. The permitted maximum quantity of mercury in these products is being reduced progressively. Since September 2010, it has been a requirement for the mercury content of lamps placed on the market for the first time to be stated on the products' packaging. For example, the maximum permissible mercury content of a CFL with a rating of < 30 W has been 2.5 mg since January 2013. CFLs with a mercury content clearly below this limit (e.g. 1.5 mg) are already available on the market from a number of manufacturers. Since January 2012, the maximum permissible mercury content of standard straight fluorescent tubes has been between 3.5 and 7 mg, depending upon the type. High-pressure mercury vapour lamps contain up to 30 mg of mercury and have not been placed on the market since April 2015 (RoHS Directive 2011/65/EU, Annex III) [8].

By comparison: barometers and older blood-pressure meters may contain up to several hundred grammes of metallic mercury; clinical thermometers generally up to one gramme [9].

Lamps supplied for recycling, for example legacy lamps manufactured prior to 2013, do not bear a declaration of the mercury content.

The primary uptake route for mercury in the vapour phase is the respiratory tract. The uptake of liquid or gaseous elemental mercury through intact skin is generally negligible. Where elemental mercury enters the digestive tract, it is for the most part not absorbed.

4.2 Results of workplace measurements

The interpretations are based upon mercury exposure measurements obtained during the recycling of lamps. A total of 30 measurements were performed for this purpose in five companies from 2012 to 2014. Work areas inside and outside the recycling plants were examined.

The measurements were performed with reference to the TRGS 402 technical rules [10] according to the method described in the IFA folder [11]. Table 2 shows the number of measurements obtained, the number of companies, the occupational exposure limit (OEL), the maximum measured value and the 50% and 95% values for the hazardous substance of mercury. The measured values relate to a working shift. Stationary personal measurements and measurements obtained by equipment worn on the person were considered.

Table 2: Measurement results for mercury during the period from 2012 to 2014

Hazardous substance	Number of measured values	Number of companies	OEL (mg/m³)	50% value (mg/m³)	95% value (mg/m³)	Maximum measured value (mg/m³)
Mercury	30	5	0.02	0.006	0.015	0.018

All measurements lay below the OEL. Measurements within the recycling plant, e.g. during cleaning work, were not considered in the statistics shown in Table 2. Owing to their level, they were considered separately.

In addition to the exposure measurements conducted at the person, nine stationary measurements and two measurements with equipment worn on the person were conducted in two companies directly on the plant during the performance of cleaning and maintenance work. The measured values lay between 0.010 and 0.22 mg/m³. Seven measurements lay above the OEL of 0.02 mg/m³.

5 Protective measures

General protective measures in accordance with the GefStoffV must be observed at recycling workplaces. The general work hygiene principles described in the TRGS 500 [12] must be observed.

5.1 Delivery/separation/sorting

Undamaged lamps must be stored on pallets or in pallet cages in order for breakage to be largely avoided. Should breakage occur, the debris must be collected immediately and carefully with a brush and shovel, and stored in special, sealable containers. The brush and shovel are to be used for this purpose only, and must be marked accordingly.

Broken lamp debris, such as rejects from manufacturing, is generally supplied in Big Bags. These Big Bags and damaged lamps must be stored in separate storage areas outside of work areas, for example in a covered, outdoor area.

5.2 Feed/shredder plant/crushing

The mercury vapour released during the shredding process must be collected at the point of creation and routed out of the work area. Should it not be possible to collect the mercury vapour completely, a room ventilation system is required.

Should activated carbon filters be used in the recycling plant to collect the mercury emissions, they must be serviced regularly. It must be ensured that loaded filters are replaced in good time and disposed of properly

In the area of the manual feed into the recycling plant, protective gloves must be worn at all times in order to prevent cut injuries. Protective goggles and hearing protectors must also be worn.

Persons entering interior parts of the recycling plant, for example in order to change Big Bags or during troubleshooting, mustin addition wear respiratory protection with an Hg P3 filter (see image).

Figure 1: Example of a half-mask with Hg P3 filter

5.3 Cleaning work

Lamp debris arising during activities ahead of the recycling plant itself must be collected immediately and carefully with a brush and shovel, and stored in special, sealable containers. The brush and shovel are to be used for this purpose only, and must be marked accordingly.

The work area must be damp-wiped regularly and at least at the end of each shift. Cleaning cloths contaminated with mercury must be collected in sealable containers and disposed of properly.

6 Information on application

Following changes to the process and otherwise at regular intervals of not more than one year, the user of this description of exposure must review the validity of the assumptions upon which it is based, and document the results of the review. This includes ascertaining that this description of exposure is still valid. The review must be performed in the context of the risk assessment in accordance with Section 6 of the GefStoffV.

The description of exposure provides the company with practical information on how the exposure of employees to mercury can be reduced to a minimum.

Provided the process parameters and protective measures are observed, it can be assumed that the requirement of Section 7 (4) of the GefStoffV for exposure to be minimized is satisfied.

During the complete risk assessment, performance of a hazardous substance measurement is required for documenting of the exposure to mercury at permanent workplaces outside the recycling plants for the purposes of future diagnosis.

Other requirements of the GefStoffV, particularly Sections 6 (covering the gathering of information) and 7 (covering the obligation to observe the ranking of protective measures) continue to apply during application of this description of exposure.

7 Review

This description of exposure was produced in July 2016 by the BGHW, BG ETEM and VBG. It is reviewed at regular intervals. Changes where necessary will be published.

8 Bibliography

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[2] Technische Regel für Gefahrstoffe 600 „Substitution (TRGS 600)“. Ausgabe: August 2008. GMBl. Nr. 46/47 vom 22.09.2008, S. 970-989.

[3] Gesetz über das Inverkehrbringen, die Rücknahme und die umweltverträgliche Entsorgung von Elektro- und Elektronikgeräten (ElektroG) vom 20. Oktober 2015 (BGBl. I S. 1739), das zuletzt durch Artikel 3 der Verordnung vom 20. Oktober 2015 (BGBl. I S. 1739) geändert worden ist http://www.bmub.bund.de/P4112/.

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[5] CLP-Verordnung: Verordnung (EG) Nr. 1272/2008 des Europäischen Parlaments und des Rates über die Einstufung, Kennzeichnung und Verpackung von Stoffen und Gemischen vom 16. Dezember 2008, zur Änderung und Aufhebung der Richtlinien 67/548/EWG und 1999/45/EG und zur Änderung der Verordnung (EG) Nr. 1907/2006..

[6] Technische Regel für Gefahrstoffe 900 „Arbeitsplatzgrenzwerte (TRGS 900)“. Ausgabe: Januar 2006, geändert und ergänzt: GMBl 2016 S. 886-889 [Nr. 45] vom 04.11.2016.

[7] Technische Regel für Gefahrstoffe 903 „Biologische Grenzwerte (BGW) (TRGS 903)“. Ausgabe: Februar 2013, zuletzt geändert und ergänzt: GMBl 2015 S. 1189-1190 [Nr. 60] vom 06.11.2015.

[8] Richtlinie 2002/95/EG (Restriction of the Use of Hazardous Substances, RoHS) ersetzt durch die Richtlinie 2011/65/EU, national umgesetzt durch die Verordnung zur Beschränkung der Verwendung gefährlicher Stoffe in Elektro- und Elektronikgeräten (Elektro- und Elektronikgeräte-Stoff-Verordnung – ElektroStoffV) vom 19. April 2013 (BGBl. I S. 1111), die durch Artikel 1 der Verordnung vom 04. Juli 2016 (BGBl. I S. 1581) geändert worden ist.

[9] NEWMOA, Northeast Waste Management Officials' Association – MERCURY USE IN MEASURING DEVICES – http://www.newmoa.org/prevention/mercury/imerc/factsheets/measuring_devices.cfm, last modified 02/17/2011.

[10] Technische Regel für Gefahrstoffe 402 „Ermitteln und Beurteilen der Gefährdungen bei Tätigkeiten mit Gefahrstoffen: Inhalative Exposition (TRGS 402)“. Ausgabe: Februar 2010, zuletzt geändert und ergänzt: GMBl 2016 S. 843-846 vom 21.10.2016 [Nr. 43].

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[12] Technische Regel für Gefahrstoffe 500 „Schutzmaßnahmen (TRGS 500)“. Ausgabe: Januar 2008, ergänzt: Mai 2008.