PRODUCT SAFETY DATA SHEET

prepared in accordance with Annex II of the REACH Regulation EC 1907/2006, Regulation (EC) 1272/2008 and Regulation (EC) 453/2010

1 IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

1.1 Product identifier

Substance name:	Mercury
EC name:	Mercury
IUPAC name:	Mercury
Chemical formula:	Hg
CAS:	7439-97-6
EC No.:	231-106-7
Molecular Weight:	200.59 g/mol
REACH Registration number:	01-2119548380-42-0000

1.2 Relevant identified uses of the substance or mixture and uses advised against

1.2.1 Relevant identified uses

Relevant identified industrial uses of mercury:
- IU 1 Waste recovery

- IU 2 Production of phenyl mercury carboxylates- IU 3 Chlor-alkali electrolysis
- IU 4 Production of mercury dispensers for discharge lamps
- IU 5 Production of gas discharge lamps
- IU 6 Production of dental amalgam

Please refer to section 16 for an overview table of identified uses for which an exposure scenario is provided as an annex.

1.2.2 Uses advises against

IU 9: Production of thermometers and measuring devices intended for sale to the general public

1.3 Details of the supplier of the safety data sheet

Name:	**NQR Nordische Quecksilber Rückgewinnung GmbH**
Address:	**Bei der Gasanstalt 9, D-23560 Lübeck**
Phone N°:	**+49 (0) 451-583000**
Fax N°:	**+49 (0) 451-581913**
E-mail of competent person responsible for SDS in the MS or in the EU:	**nqr@remondis.de**

1.4 Emergency telephone number

European Emergency N°:	112	
National centre for Prevention and Treatment of Intoxications N°:	**Gift-Informationszentrum Nord, Göttingen** **Poison Information Center, Göttingen** **Tel.: +49 (0)551-19240** **(only in german and english)**	
Available outside office hours:	☒ Yes	☐ No
Office hours:	**7:00 – 17:00 hours**	

2 HAZARDS IDENTIFICATION

2.1 Classification of the substance

The classification information given below is the harmonised classification and labelling as listed in Annex I and Annex IV of Commission Regulation (EC) No 790/2009 (amending Regulation (EC) No 1272/2008) and in accordance with the classification information given in the REACH registration dossier (version 2010) for mercury.

2.1.1 Classification according to Regulation (EC) No 1272/2008 [CLP/GHS]

Acute toxicity – inhalation:

Acute Tox. 2 - H330: Fatal if inhaled.

Reproductive toxicity:

Repr. 1B – H360: May damage fertility or the unborn child. Specific effect – H360D – May damage the unborn child.

Specific target organ toxicity – repeated:

STOT Rep. Exp. 1 - H372: Causes damage to organs through prolonged or repeated exposure (affected organs unknown).

Hazard to the aquatic environment:

Aquatic Acute 1 - H400: Very toxic to aquatic life.
Aquatic Chronic 1 - H410: Very toxic to aquatic life with long lasting effects.

2.1.2 Classification according to Directive 67/548/EEC

T+; R26 - Very toxic; very toxic by inhalation.

T; R48/23 - Toxic; Toxic: danger of serious damage to health by prolonged exposure through inhalation.

Repr. Cat. 2; R61 - May cause harm to the unborn child.

N; R50/53 - Dangerous to the environment; very toxic to aquatic organisms, may cause long-term effects in the aquatic environment.

2.2 Label elements

The label elements given below are based on the classification according to the criteria of Regulation (EC) No 1272/2008, as listed above.

2.2.1 Labelling according to Regulation (EC) 1272/2008

Signal word: Danger

Hazard pictogram:


GHS06


GHS08


GHS09

Hazard statements:

H330:	Fatal if inhaled.
H360D	May damage fertility or the unborn child.
H372:	Causes damage to organs through prolonged or repeated exposure.
H410:	Very toxic to aquatic life with long lasting effects.

Precautionary statements:

P201:	Obtain special instructions before use.
P273:	Avoid release to the environment.
P304 + 340:	IF INHALED: Remove victim to fresh air and keep at rest position comfortable for breathing.

The number of precautionary statements has been reduced to three to appear on the labels.

2.3 Other hazards

The substance does not meet the criteria for PBT or vPvB substance.
No other hazards identified.

3 COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Main constituent

Name: Mercury

CAS: 7439-97-6

EC No.: 231-106-7

REACH Registration No: 01-2119548380-42-0000

Concentration: >99.99%

Impurities

No impurities > 0.1 % (w/w) relevant for the classification and labelling of the substance.

4 FIRST AID MEASURES

4.1 Description of first aid measures

General advice

- In all cases, immediately call a poison centre or doctor/physician.
- Get medical advice/attention if you feel unwell.
- Instantly remove any clothing soiled by the product.

Following inhalation

- Get medical aid immediately.
- Remove from exposure and move to fresh air immediately. Keep at rest in a position comfortable for breathing.
- If breathing is difficult, give oxygen.
- Do NOT use mouth-to-mouth resuscitation.
- If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.

Following skin contact

- Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes.
- Get medical attention immediately.
- Wash clothing before reuse.
- Thoroughly clean shoes before reuse.

Following eye contact

- Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally.
- Get medical attention immediately

Following ingestion

- Do NOT induce vomiting.
- Never give anything by mouth to an unconscious person.
- Get medical attention immediately.

Notes to the physician

- The concentration of mercury in whole blood is a reasonable measure of the body-burden of mercury and thus is used for monitoring purposes. Treat symptomatically and supportively. Persons with kidney disease, chronic respiratory disease, liver disease, or skin disease may be at increased risk from exposure to this substance.
- Antidote: The use of d-Penicillamine as a chelating agent should be determined by qualified medical personnel. The use of Dimercaprol or BAL (British Anti-Lewisite) as a chelating agent should be determined by qualified medical personnel.

4.2 Most important symptoms and effects, both acute and delayed

- Mercury is highly toxic (fatal via the inhalation route)
- Mercury accumulates in body tissues and organs
- Mercury may damage the unborn child and it causes damage to organs through prolonged exposure.

4.3 Indication of any immediate medical attention and special treatment needed

Follow the advises given in section 4.1

5 FIRE FIGHTING MEASURES

5.1 Extinguishing media

5.1.1 Suitable extinguishing media

- Use any means suitable for extinguishing surrounding fire.

5.1.2 Unsuitable extinguishing media

- Not applicable.

5.2 Special hazards arising from the substance or mixture

- Undergoes hazardous reactions in the presence of heat and sparks or ignition.
- Smoke may contain toxic mercury or mercuric oxide.

5.3 Advice for fire fighters

- In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full face piece operated in the pressure demand or other positive pressure mode.

5.4 Additional information

- Mercury vapours and mercury oxides generated during fires involving this product are toxic.
- Do not allow water runoff to enter sewers or waterways.
- Not considered to be an explosion hazard.
- NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 0

6 ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

6.1.1 For non-emergency personnel

- Do not breathe vapour.
- Provide ventilation.
- Clean-up personnel require protective clothing and respiratory protection from vapour.
- Use personal protective equipment as required.
- Refer to protective measures listed in section “Handling and storage” (section 7) and “Exposure controls / personal protection” (section 8).

6.1.2 For emergency responders

- See section 6.1.1.

6.2 Environmental precautions

- Avoid runoff into storm sewers and ditches which lead to waterways.
- Avoid release to the environment.
- If the product contaminates rivers and lakes or drains inform respective authorities.

6.3 Methods and material for containment and cleaning up

- Provide ventilation.
- Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container.
- Avoid runoff into storm sewers and ditches which lead to waterways.
- Clean up spills immediately, observing precautions described in section 7.

6.4 Reference to other sections

Refer to protection measures listed in section 7 and 8. For more information disposal considerations, please check section 13 of this safety data sheet and the attached annex.

7 HANDLING AND STORAGE

7.1 Precautions for safe handling

7.1.1 Protective measures

- Obtain special instructions before use.
- Do not handle until all safety precautions have been read and understood.
- Wash thoroughly after handling.
- Remove contaminated clothing and wash before reuse.
- Minimize dust generation and accumulation.
- Keep container tightly closed.
- Do not get on skin or in eyes.
- Do not ingest or inhale.
- Use only in a chemical fume hood.
- Discard contaminated shoes.
- Do not breathe vapour.
- Use personal protective equipment as required.

7.1.2 Advice on general occupational hygiene

Avoid inhalation or ingestion. General occupational hygiene measures are required to ensure a safe handling of the substance. These measures involve good personal and housekeeping practices (i.e. regular cleaning with suitable cleaning devices), no drinking, eating and smoking at the workplace, unless otherwise stated below the wearing of standard working clothes and shoes. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

7.2 Conditions for safe storage, including any incompatibilities

- Keep container closed when not in use.
- Store in a tightly closed container.
- Store in a cool, dry, well-ventilated area away from incompatible substances.
- Keep away from metals.
- Store protected from azides.

7.3 Specific end use(s)

Please check the identified uses in Section 16. For more information please see relevant exposure scenario (Annex to this SDS) or contact supplier.

8 EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

PNEC aqua (freshwater): 0.0574 µg Hg/L
PNEC aqua (marine water): 0.0672 µg Hg /L
PNEC aqua (intermittent releases): 0.776 µg Hg/L
PNEC sediment (freshwater): 9.3 mg Hg/kg sediment dw
PNEC sediment (marine water): 9.3 mg Hg/kg sediment dw
PNEC STP: 2.25 µg Hg/L
PNEC soil: 22 µg Hg/kg soil dw

DNEL urinary Hg level: 30 µg Hg/g creatine in urine

Refer to section 11 and 12 of the SDS for information on PNEC and DNEL derivation. Guidance on how to comply with these DNELs and PNECs is given in the attached Exposure Scenarios, in the annex.

8.2 Exposure controls

8.2.1 Appropriate engineering controls

- Apply technical measures to comply with the occupational exposure limits.
- Refer to protective measures listed in section “Handling and storage” and “Exposure controls / personal protection”.
- Detailed information on exposure controls, e.g. engineering controls and individual protection measures is given in the attached Exposure Scenarios (Annex of this SDS).

8.2.2 Individual protection measures, such as personal protective equipment

Please refer to the annex - exposure scenarios of this SDS for detailed information.

8.2.3 Environmental exposure controls

Please refer to the annex - exposure scenarios of this SDS for detailed information.

9 PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Property		Value/ Result	Remark
a	Appearance	silver-white liquid	at room temperature; (handbook data / database)
b	Odour	odourless	(handbook data / database)
c	Odour threshold	not applicable	-
d	pH	not available	-
e	Melting point	-38.67 °C	at 1013 hPa; the mean of 2 values was taken; (handbook data / database)
f	Boiling point	356.66 °C	at 1013 hPa; the mean of 2 values was taken; (handbook data / database)
g	Flash point	not applicable	inorganic substance
h	Evaporation rate	not available	-
i	Flammability	non flammable	(handbook data / database)
		no pyrophoric properties	based on chemical structure
j	Explosive limits	non-explosive substance	void of any chemical structures commonly associated with explosive properties
k	Vapour pressure	0.00163 hPa	at 20 °C (handbook data / database)
l	Vapour density	6.93	rel. vapour density (handbook data / database)
m	Relative density	13.54	at 20 °C; the mean of 2 values was taken (handbook data / database)
n	Solubility in water	0.0567 mg/L	at 25 °C (handbook data / data base)
o	Partition coefficient	not applicable	inorganic substance; not soluble in water
p	Auto ignition temperature	not applicable	non-combustible liquid
q	Decomposition temperature	not applicable	-
r	Viscosity	1.55 mPa * s (dynamic)	at 20 °C (handbook data / data base)
s	Explosive properties	non explosive	void of any chemical structures commonly associated with explosive properties
t	Oxidising properties	no oxidising properties	based on the chemical structure, the substance does not contain a surplus of oxygen or any structural groups known to be correlated with a tendency to react exothermally with combustible material

9.2 Other information

No further information.

10 STABILITY AND REACTIVITY

10.1 Reactivity

See section 10.5.

10.2 Chemical stability

- Stable under recommended storage

10.3 Possibility of hazardous reactions

See section 10.5.

10.4 Conditions to avoid

Avoid exposure or contact to extreme temperatures and incompatible chemicals.

10.5 Incompatible materials

Mercury is incompatible with acetylene and acetylene derivatives, amines, ammonia, 3-bromopropyne, boron diiodophosphide, methyl azide, sodium carbide, heated sulfuric acid, methylsilane /oxygen mixtu res; nitric acid /alcohol mixtures, tetracarbonylnickel/oxygen mixtures, alkyne/silver perchlorate mixtures, halogens (i.e. chlorine, bromine) and strong oxidizers (i.e. c hlorine dioxide, pe rchlorates). Mercury can attack copper and copper alloys. Additionally, mercury can react with many metals (i.e. calcium, lithium, potassium, sodium, rubidium, aluminium) to form amalgams .

10.6 Hazardous decomposition products

If this product is exposed to extremely high temperatures in the presence of oxygen or air, toxic vapours of mercury and mercury oxides will be generated.

11 TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

The information provided in this section is consistent with the information provided in the REACH chemical safety report (CSR) for mercury. For more detailed information please refer to the CSR.

Toxicity endpoints	Outcome of the effects assessment
(a) Acute toxicity	Mercury is fatal via inhalation route of exposure. Oral route: (i) LD_{50} = >9.2 mg Hg/kg bw (recalculated from >12.5 mg $HgCl_2$/kg); findings: mild to moderate morphological changes in kidneys, decrease of lactate dehydrogenase activity, increase in serum cholesterol and phosphorus levels. Method: test material: $HgCl_2$, species: female rats; gavage (ii) LD_{50} = 26 mg Hg/kg bw (recalculated from 35 mg $HgCl_2$/kg) for 2 week old pups; Method: test material: $HgCl_2$; species: rat (most sensitive group: 2 week old pups); gavage Both studies for acute oral toxicity testing were considered for the value used in risk assessment: 35 mg/kg bw Acute inhalation toxicity: LD_{50} = < 27 mg Hg/m_3 (for 2 h exposure time) Method: test material: Hg vapour, species: male rats; inhalation vapour, whole body Classification: acute tox 2 (fatal if inhaled) Acute dermal toxicity: Only little information available. Effect level= 0.5 – 1 g/kg (all animals died within 3 to 6 days after the last treatment; morphological changes in kidneys) Method: test material: mercury ointment (50 % Hg; 50 % $HgCl_2$ ointment), species: rabbits; dermal, not covered

Toxicity endpoints	Outcome of the effects assessment
(b) Skin corrosion / irritation	For skin irritation, no data from animal and in vitro studies with inorganic mercury are available. However, human data and one animal study were used for risk assessment: Result: not irritating Method: OECD 404, test substance: Ti-Hg, Cu-Sn Zr-Al alloy (containing 24.8 % mercury); species rabbit; occlusive, clipped Information from accidental exposure in humans indicates a potential to cause acrodynia, dermatitis and conjunctivitis in exposed subjects. Classification: skin corr 1B for $HgCl_2$; but metallic mercury is not classified as irritant or corrosive for the skin
(c) Serious eye damage / irritation	No data from animal and in vitro studies are available. Human data were used for risk assessment (Bluhm; et al.;1992) (Sexton; et al.; 1978) Classification: metallic mercury is not classified as irritant or corrosive for the eye
(d) Respiratory or skin sensitisation	<u>Skin sensitisation:</u> For skin sensitisation, no data from animal studies with inorganic mercury are available. However, human data and one animal study were used for risk assessment: Result: not sensitising Method: OECD 406, test substance: Ti-Hg, Cu-Sn Zr-Al alloy (containing 24.8 % mercury); species guinea pigs; occlusive Allergic contact dermatitis in humans to mercury was shown to be uncommon. Classification: not warranted <u>Respiratory sensitisation:</u> No data are available and no testing is required. Classification: not warranted
(e) Germ cell mutation	Read-across from $HgCl_2$ key studies: (i) Method: forward mutation assay at the thymidine kinase locus (TK+/-) in L5178Y mouse lymphoma cells with $HgCl_2$ Results: Positive with metabolic activation (weekly mutagenic). (ii) Method: Mammalian in vivo cytogenetic assays. Analysis of chromosome aberrations in bone marrow cells.; test substance: $HgCl_2$; in vivo; mouse Results: Positive. The supportive studies are not listed here (refer to CSR) In-vitro and in-vivo genotoxicity studies for $HgCl_2$ showed equivocal results. Classification: mercury is not classified for genotoxicity
(f) Carcinogenicity	Read-across from $HgCl_2$ Human and animal data were used for risk assessment: (i) NTP (1993): species rat; test substance: $HgCl_2$; oral, gavage Result: some evidence of a carcinogenic activity in male rats and equivocal evidence of a carcinogenic activity in female rats. (ii) NTP (1993): species mice; test substance: $HgCl_2$; oral, gavage Result: equivocal evidence of a carcinogenic activity in male mice and no evidence of a carcinogenic activity in female mice (iii) Human data (Barregård;1990 and Cragle; 1984): occupational inhalation exposure Result: equivocal. The evidence for a mutagenic or carcinogenic potential of Hg in both animal and epidemiological studies is equivocal, and it is so far lacking in humans at low exposure concentrations < 50 µg/g creatinine in urine. The mutagenic or carcinogenic potential of Hg seems to be related to metal induced oxidative stress and thus, if a potential is present in humans, a threshold effects is hypothetically possible. Classification: no classification for carcinogenicity

Toxicity endpoints	Outcome of the effects assessment
(g) Toxicity for reproduction	Effects on fertility: Read-across from $HgCl_2$ One supportive animal study and human data were used for risk assessment: (i) Animal data: species rat; test substance: $HgCl_2$; oral, drinking water; effects on male fertility (ii) Human data: Limited epidemiological studies in humans show that there is a transfer from mother to fetus during Hg vapour exposure. Only a few epidemiological studies have been performed and these were mostly in the field of dentistry. As a whole, the limited data presently available provide no conclusive evidence for occupational exposure to mercury vapour being harmful to reproduction. There is no link to an increase in teratogenic or other adverse pregnancy outcomes. Developmental toxicity: No reliable data available. Classification for elemental mercury: repr cat 2 (may cause harm to the unborn child)
(h) STOT-single exposure	The classification criteria according to regulation (EC) 1272/2008 as specific target organ toxicant (STOT) – single exposure, are not met.
(i) STOT-repeated exposure	Read-across from $HgCl_2$ Repeated dose toxicity, oral (i) NTP (1993): species rat; test substance: $HgCl_2$; oral, gavage; 26 weeks Result: LOAEL = 0.23 mg Hg/kg bw/d (recalculated from 0.312 mg $HgCl_2$/kg bw/d) based on kidney weights of male rats (ii) NTP (1993): species rat; test substance: $HgCl_2$; oral, gavage; 2 years Result: LOAEL = 1.9 mg Hg/kg bw/d (recalculated from 2.5 mg $HgCl_2$/kg bw/d) based on effects on survival, increased kidney weights and severity of nephropathy as well as renal hyperplasia and forestomach epithelium hyperplasia in male rats Repeated dose toxicity, dermal No adequate animal data are available for repeated dermal toxicity. Human data were used for risk assessment. Evaluation of human literature revealed some information about clinical findings in subjects using skin lightening creams containing mercuric ammonium chloride. It could be concluded that an urinary mercury concentration of 29 µg/l (range 0 -90 µg/l) must be regarded as a LOAEL based on established mercury induced nephrotic syndrome. However, absorption through the skin is very limited and thus systemic toxicity following repeated dermal exposure appears to be not of major concern. Repeated dose toxicity, inhalation No adequate animal data are available for repeated inhalation toxicity. Human data were used for risk assessment. The biological effects of long-time low to moderate exposures to metallic mercury vapours under occupational settings were evaluated in depth by EuroChlor (2009): It was concluded that with the exception of urinary excretion of N-acetyl-beta-D-glucosamidase (NAG) from the proximal tubular kidney cells it seems from the review of scientific literature that effects on the central nervous system are the most sensitive indicator of Hg toxicity. The conclusion of the author of this review, putting a particular emphasis on the latest Ellingsen; et al. studies encompassing the magnitude of reversibility after cessation or reduction of exposure, there are reasons to support a NOAEL (no adverse effect level) of 30 µg Hg/g creatinine. Key value for CSA: LOAEL: 0.312 mg/kg bw/day (subchronic; rat) Target organs: urogenital: kidneys Classification: STOT rep exp 1 (causes damage to organs through prolonged exposure)
(j) Aspiration hazard	No hazard expected.
Further remarks	

Toxicity endpoints	Outcome of the effects assessment
Summary CMR effects	Mercury does not fulfil the criteria for CMR (carcinogen, mutagen, toxic to reproduction) Cat. 1 and Cat. 2 according to Regulation (EC) No 1272/2008.

12 ECOLOGICAL INFORMATION

12.1 Toxicity

For assessing the aquatic toxicity of elemental mercury the use of toxicity tests of mercury salts (e. g. Mercury dichloride CAS: 7487 -94 -7) is appropriate. Mercury will perform its effect eventually as free Hg metal ion, therefore all tests performed with soluble mercury salts are relevant.

Acute aquatic toxicity test results:

Test Organisms	Endpoint	Value	Reference
Freshwater fish: Poecilia reticulata	LC50 (96h)	26 µg/L (element (nominal))	Khangarot, B.S. and P.K. Ray (1987a)
Marine fish: Fundulus heteroclitus	LC50 (96h)	67 µg/L (element (meas.))	Sharp J.R. and J.M. Neff (1980)
Freshwater invertebrates: Daphnia magna	EC50 (48h) mobility	1.5 µg/L (element (nominal))	Guilhermino, L., T.C. Diamantino, R. Ribeiro, F. Goncalves, and A (1997)
Marine invertebrates: Callinectes sapidus	EC50 (48h) hatching	0.3 µg/L (element (nominal))	Lee, R.F., S.A. Steinert, K. Nakayama, and Y. Oshima (1999)
Algae: Selenastrum capricornutum	EC50 (96h) growth rate	9 µg/L (element (nominal)	Chen, C.Y., Lin, K.C., Yang, D.T. (1997)

Reliable chronic toxicity test results:

Overview of most sensitive species-specific NOEC-values for mercury in the freshwater environment

Species	Trophic level	NOEC-value (µg Hg/L)	Reference studies
Pimephales promelas	Fish	0.5	Snarski and Olson, 1982
Hyalella azteca	Crustacean	0.62	Borgmann et al, 1993
Brachydanio rerio	Fish	1	Dave and Xiu, 1992
Daphnia magna	Crustacean	1.7	Biesinger and Christensen, 1972
Villosa iris	Mollusc	4	Valenti et al, 2005
Ceriodaphnia dubia	Crustacean	8.5	Spehar and Fiandt, 1986
Daphnia similis	Crustacean	10	Soundrapandian and Venkataraman, 1990
Cyclops species	Crustacean	18	Borgmann, 1980
Viviparius bengalensis	Mollusc	20	Muley and Mane, 1988
Scenedesmus acutus	Alga	20	Huismans et al, 1980
Chara vulgaris	Aquatic plant	20	Heumann, 1987
Caenorhabditis elegans	Worm	200	Donkin et al, 1995
Anacystis nidulans	Alga	250	Lee et al, 1992
Aedes aegypti	Insect	500	Rayms-Keller et al, 1998

Overview of most sensitive species-specific NOEC-values for mercury in the saltwater environment

Species	Trophic level	NOEC-value (µg Hg/L)	Reference studies
Crepidula fornicata	Mollusc	0.25	Thain, 1984
Mysidopsis bahia	Crustacean	0.8	Gentile et al, 1982
Fucus serratus	Higher plant	0.9	Strömgren, 1980
Skeletonema costatum	Diatom	1	Rice et al, 1973
Laminaria saccharina	Higher plant	1	Thompson and Burrows, 1984
Artemia franciscana	Crustacean	2	Go et al, 1980
Callinectes sapidus	Crustacean	4.9	McKenney and Costlow, 1982
Pelvetia canaliculata	Higher plant	5	Strömgren, 1980
Penaeus indicus	Crustacean	6	McClurgh, 1984
Ascophyllum nodosum	Higher plant	9	Strömgren, 1980
Fucus spiralis	Higher plant	9	Strömgren, 1980
Fucus vesiculosus	Higher plant	9	Strömgren, 1980
Brachionus plicatilis	Rotifera	10	Juchelka and Snell, 1995
Fundulus heteroclitus	Fish	10	Sharp and Neff, 1980
Gracilaria tenuistipitata	Higher plant	60	Haglund et al, 1996
Dunaliella tertiolecta	Alga	330	Portman, 1972
Enhalus acoroides	Higher plant	16,020	Bonifacio and Montano, 1998

Overview of long-term effects on sediment organisms

Species	Endpoint	Value	Reference
Chironomus riparius	**NOEC (28 d): based on: development rate**	**930 mg/kg sediment dw element (meas.)**	**Thompson TS, Williams NJ and Eales GJ (1998)**

Overview of most sensitive species-specific NOEC-values for mercury in the soil environment

Species	Trophic level	NOEC-value (mg Hg/kg dry wt.)	Reference studies
Microorganisms	Microorganisms	1.4	Zelles et al, 1985
Eisenia foetida	Worm	3.7	Beyer et al, 1985
Microorganisms	Microorganisms	6	Van Faassen, 1973
Microorganisms	Microorganisms	9	Landa and Fang, 1978
Microorganisms	Microorganisms	10	Van Faassen, 1973
Microorganisms	Microorganisms	12	Spalding, 1979
Microorganisms	Microorganisms	31	Pancholy et al, 1975
Microorganisms	Microorganisms	35	Landa and Fang, 1978
Microorganisms	Microorganisms	40	Landa and Fang, 1978
Microorganisms	Microorganisms	79	Tu, 1988
Microorganisms	Microorganisms	99	Landa and Fang, 1978
Microorganisms	Microorganisms	124	Landa and Fang, 1978
Microorganisms	Microorganisms	208	Landa and Fang, 1978
Microorganisms	Microorganisms	248	Landa and Fang, 1978
Microorganisms	Microorganisms	456	Juma and Tabatabai, 1977
Microorganisms	Microorganisms	2406	Tyler, 1981

Toxicity data for micro-organisms (for STP):

Test Organisms	Endpoint	Value	Reference
STP /freshwater *non-adapted bacteria*	18h- EC10 (growth inhibition)	2.25 µg Hg/L [(1)]	Liebert; et al. (1991)

[(1)] Mercury dichloride as test substance

Resulting PNECs

PNEC aqua (freshwater): 0.0574 µg Hg/L

PNEC aqua (marine water): 0.0672 µg Hg /L

PNEC aqua (intermittent releases): no data: aquatic toxicity unlikely

PNEC sediment (freshwater): 9.3 mg Hg/kg sediment dw

PNEC sediment (marine water): 9.3 mg Hg/kg sediment dw

PNEC STP: 2.25 µg Hg/L

PNEC soil: 22 µg Hg/kg soil dw

Conclusions on classification:

Commission Directive 98/98/EC of December 1998 (which adapted Council Directive 67/548/EEC on the classification, packaging and labelling of dangerous substances to technical progress for the 25th time) introduced environmental classification and labelling for mercury as shown below.

- CLP: Aquatic Chronic 1 (Hazard statement: H410: Very toxic to aquatic life with long lasting effects). Aquatic Acute Category 1 (H400: Very toxic to aquatic life)

- Directive 98/98/EEC: N; R50/53 Dangerous for the environment; Very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

12.2 Persistence and degradability

12.2.1 Abiotic Degradation

Elemental mercury does not degrade.

12.2.2 Biodegradation:

The substance will not be biodegradable, as it is an inorganic substance.

12.3 Bioaccumulative potential

The bioaccumulation of inorganic mercury in biota is generally regarded to be of low relevance compared to that of organic forms of mercury and particularly methyl mercury (SCHER, 2007).

Most of the mercury accumulated/transferred in higher trophic levels in the food chain are found in an organic form 70-99 %), mainly methyl mercury. This is because inorganic mercury is assimilated less efficiently than methyl mercury from the ambient medium and from dietary sources and is eliminated more efficiently than methyl mercury.

12.3.1 Secondary poisoning

Predators such as mammals and birds that feed on prey (fish, mussels,…) may contain mercury of which most is organic mercury (see discussion above about bioaccumulative potential). Therefore, in line with the recommendation of the Scientific Committee on Toxicity, Ecotoxicity and the Environment (SCTEE), secondary poisoning of top predators in the food chain is only relevant for methyl mercury (SCTEE, 2004 **“”WFD””**; EC, 2005).

12.4 Mobility in soil

The studies reported refer to ionic divalent Hg species and not elemental Hg.

Distribution coefficients were taken from the voluntary risk assessment report Eurochlor, 1999 and a more recent study of EPA, 2005.

log K_D (solids-water in suspended matter): 170,000 L/kg

log K_D (solids-water in soil): 6309.57 L/kg

log K_D (solids-water in sediment): 170,000 L/kg

12.5 Results of PBT and vPvB assessment

Not relevant for inorganic substances.

12.6 Other adverse effects

Volatisation: Due to a low water solubility and high vapour pressure, elemental mercury exhibits a very high volatilization potential. The vapour pressure of mercury metal is strongly dependent upon temperature, and it vaporizes readily under ambient conditions. Its saturation vapour pressure of 14 mg/m^3 greatly exceeds the average permissible concentrations for occupational (0.05 mg/m^3) or continuous environmental exposure (0.015 mg/m^3) (WHO, 1976). Elemental mercury partitions strongly to air in the environment and is not found in nature as a pure, confined liquid. Most of the mercury encountered in the atmosphere is elemental mercury vapour.

13 DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

- In accordance with local and national regulations.
- If mercury must be disposed of as hazardous waste, it must be handled at a permitted facility or as advised by your local hazardous waste regulatory authority.

Suitable risk management measures have to be applied to avoid that mercury is released to the environment (for details on treatment see Annex of this SDS)

14 TRANSPORT INFORMATION

Mercury is classified as hazardous for transport according to Land transport ADR/RID and GGVS/GGVE; Maritime transport IMDG/GGVSea; Air transport ICAO-TI and IATA-DGR:

14.1 UN-Number

UN 2809

14.2 UN proper shipping name

Mercury

14.3 Transport hazard class(es)

8

8 (C9) Corrosive substances [ADR/RID and GGVS/GGVE]

14.4 Packing group

PG III

14.5 Environmental hazards

Environmental hazardous substance, liquid; Marine pollutant
Symbol (fish and tree)

14.6 Special precautions for user

Refer to section 4 to 8

14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

No information.

14.8 Additional information

ADR/RID and GGVS/GGVE:
Limited quantities: LQ19
Transport category: 3
Tunnel restriction code: E

IMDG/GGVSea:
Segregation groups: Heavy metals and their salts (including their organometallic compounds), mercury and mercury coumpounds

15 REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance

Mercury is listed in the following chemical inventory: Klassifizierung Gefahrstoffverordnung
Classification according to the Administrative Regulation of Substances Hazardous to Water (VwVwS): Water endangering class 3 - hazard to waters (Germany, Substance-No. 393)

Refer to section 16.2 and section 16.3.

15.2 Chemical safety assessment

A chemical safety assessment has been carried out for this substance. T+ Gefahrstoffrecht R Sätze F

16 OTHER INFORMATION

16.1 General

Data are based on our latest knowledge but do not constitute a guarantee for any specific product features and do not establish a legally valid contractual relationship.

16.2 Risk Phrases

R26 – very toxic by inhalation
R61 – may cause harm to the unborn child
R48/23 - toxic: danger of serious damage to health by prolonged exposure through inhalation
R50/53 - very toxic to aquatic organisms, may cause long-term effects in the aquatic environment

16.3 Safety Phrases

S45 – in case of accident or if you feel unwell, seek medical help advice immediately (show label where possible)
S53 – avoid exposure – obtain special instructions before use
S60 – this material and its container must be disposed of as hazardous waste
S61 - avoid release to the environment. refer to special instructions/safety data sheets

16.4 Abbreviations

(NOT ALL ARE USED IN THIS SDS)

AC	Article category
ADR	European agreement concerning the international carriage of dangerous goods by road
AND	European agreement concerning the international carriage of dangerous goods by inland waterways
BSAF	Bio soil accumulation factor
BCF	Bio concentration factor
CAS	Chemical Abstracts Service
CLP	Classification, labelling and packaging
CMR	Carcinogenic, mutagenic or toxic for reproduction
CSA/CSR	Chemical safety assessment / Chemical safety report
D_{50}	Median particle size
DNEL	Derived no effect level
DSD	Dangerous Substance Directive
EC_{10}	Concentration of a substance where 10% of the population is affected
EC_{50}	Concentration of a substance where 50% of the population is affected
ECHA	European chemicals agency
EINECS	EU list of existing chemical substances
EmS	Emergency schedule
ERC	Environmental release category
ES	Exposure scenario
eSDS	Extended safety data sheet
FOREGS	Forum of European Geological Surveys
GHS	Globally harmonised system
HERAG	Health risk assessment guidance for metals
IATA-DGR	International air transport association - dangerous goods regulations
ICAO	Technical Instructions for the Safe Transport of Dangerous Goods by Air
IU	Identified use
IUPAC	International Union of Pure and Applied Chemistry
IBC code	International code for the construction and equipment of ships carrying dangerous chemicals in bulk
IMDG	International maritime dangerous goods
K_P	Partition coefficient
LC_{10}	Lethal concentration of a substance that can be expected to cause death in 10% of the population

LC_{50}	Lethal concentration of a substance that can be expected to cause death in 50% of the population
LD_{50}	Lethal dose of a substance that can be expected to cause death in 50% of the population
MARPOL 73/78	International convention for the prevention of pollution from ships, 1973 as modified by the protocol of 1978
MMAD	Mass median aerodynamic diameter
NO(A)EC	No observed (adverse) effect concentration
NO(A)EL	No observed (adverse) effect level
OECD	Organisation for economic co-operation and development
OEL	Occupational exposure limit
PBT	Persistent, bioaccumulative, and toxic
PC	Product category
PNEC	Predicted no-effect concentration
PROC	Process category
REACH	Registration, evaluation, authorisation and restriction of chemicals (i.e. Regulation (EC) No. 1907/2006)
RID	International rule for transport of dangerous substances by railway
SDS	Safety data sheet
STOT	Specific target organ toxicant
STP	Sewage treatment plant
SU	Sector of end use
TWA	Time weighted average
vPvB	Very persistent, very bioaccumulative

16.5 Key literature references

The information provided in this eSDS is consistent with the information provided in the REACH chemical safety report (CSR) for mercury. The CSR contains a complete reference list for all data used. Non confidential data from the REACH registration dossier are published by the European Chemicals Agency ECHA, see http://apps.echa.europa.eu/registered/registered-sub.aspx

16.6 Revision

This is the first version of the eSDS of mercury. Hence, no revision information should be mentioned here.

Version 2010-12-01: New extended Safety Data Sheet in compliance with Regulation (EC) No. 1907/2006 ("REACH") and Regulation EC No. 453/2010 (Annex II). All chapters of this safety data sheet have been revised according to the results of the data evaluation for the REACH registration dossier and CSR, based on Regulation (EC) No. 1272/2008 and Regulation (EC) No. 1907/2006. The information provided in this SDS is consistent with the information provided in the REACH chemical safety report (CSR) for mercury.

Disclaimer

DELA GmbH provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. Furthermore, this safety data sheet is made up based on the legal requirements as set by EC 1907/2006 (REACH) based on information as is available per November 2010.

16.7 Identified uses:

To demonstrate the safe use of mercury, occupational exposure scenarios (see Annex) have been developed. Each scenario covers the processes related to the production and to respective identified uses of mercury and includes an assessment and risk characterisation of occupational and environmental exposure.

IU number	Exposure scenario number as referenced in the CSR	Identified Use (IU) name	Use descriptors
1	9.1	Waste recovery	**Process category (PROC):** PROC 1: Use in closed process, no likelihood of exposure PROC 3: Use in closed batch process (synthesis or formulation) PROC 5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 21: Low energy manipulation of substances bound in materials and/or articles PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature. Industrial setting **Market sector by type of chemical product:** PC 7: Base metals and alloys PC 0: Other: recycling **Environmental release category (ERC):** ERC 1: Manufacture of substances ERC 3: Formulation in materials ERC 6a: Industrial use resulting in manufacture of another substance (use of intermediates) **Sector of end use (SU):** SU 0: Other: industrial use SU 2b: Offshore industries

			SU 14: Manufacture of basic metals, including alloys **Subsequent service life relevant for that use?:** yes **Article category related to subsequent service life (AC):** AC 3: Electrical batteries and accumulators AC 0: Other: relays, switches, thermometers/barometers, dental amalgam, chlor alkali, gold production
2	9.2	Production of phenyl mercury carboxylates	**Process category (PROC):** PROC 1: Use in closed process, no likelihood of exposure PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 3: Use in closed batch process (synthesis or formulation) PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities **Market sector by type of chemical product:** PC 21: Laboratory chemicals PC 0: Other: catalysator **Environmental release category (ERC):** ERC 1: Manufacture of substances **Sector of end use (SU):** SU 0: Other: industrial and laboratory use **Subsequent service life relevant for that use?:** yes **Article category related to subsequent service life (AC):** AC 0: Other: poly-urethane
3	9.3	Chlor-alkali electrolysis	**Process category (PROC):** PROC 1: Use in closed process, no likelihood of exposure PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 3: Use in closed batch process (synthesis or formulation) PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) **Market sector by type of chemical product:**

			PC 0: Other: not relevant **Environmental release category (ERC):** ERC 1: Manufacture of substances **Sector of end use (SU):** SU 17: General manufacturing, e.g. machinery, equipment, vehicles, other transport equipment SU 20: Health services **Subsequent service life relevant for that use?:** yes **Article category related to subsequent service life (AC):** AC 0: Other: not relevant
4	9.4	Production of mercury dispensers for discharge lamps	**Process category (PROC):** PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 14: Production of preparations or articles by tabletting, compression, extrusion, pelletisation PROC 21: Low energy manipulation of substances bound in materials and/or articles PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature. Industrial setting PROC 24: High (mechanical) energy work-up of substances bound in materials and/or articles **Market sector by type of chemical product:** PC 7: Base metals and alloys **Environmental release category (ERC):** ERC 3: Formulation in materials **Sector of end use (SU):** SU 15: Manufacture of fabricated metal products, except machinery and equipment **Subsequent service life relevant for that use?:** yes **Article category related to subsequent service life (AC):** AC 2: Machinery, mechanical appliances, electrical/electronic articles

5	9.5	Production of gas discharge lamps	**Process category (PROC):** PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 8a: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 14: Production of preparations or articles by tabletting, compression, extrusion, pelletisation PROC 21: Low energy manipulation of substances bound in materials and/or articles PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature. Industrial setting PROC 24: High (mechanical) energy work-up of substances bound in materials and/or articles **Market sector by type of chemical product:** PC 7: Base metals and alloys **Environmental release category (ERC):** ERC 3: Formulation in materials **Sector of end use (SU):** SU 16: Manufacture of computer, electronic and optical products, electrical equipment **Subsequent service life relevant for that use?:** yes **Article category related to subsequent service life (AC):** AC 2: Machinery, mechanical appliances, electrical/electronic articles
6	9.6	Production of dental amalgam	**Process category (PROC):** PROC 3: Use in closed batch process (synthesis or formulation) PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 5: Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact) PROC 8b: Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers (dedicated filling line, including weighing) PROC 21: Low energy manipulation of substances bound in materials and/or articles **Market sector by type of chemical product:** PC 0: Other: D25100 Dental alloys

			Environmental release category (ERC): ERC 3: Formulation in materials **Sector of end use (SU):** SU 20: Health services SU 0: Other: NACE C20.5.9 Manufacture of other chemical products n.e.c. **Subsequent service life relevant for that use?:** yes **Article category related to subsequent service life (AC):** AC 0: Other: TARIC 2805.40.90 mercury for use in dental amalgam

IU number	Use advised against name	Use descriptors
9	Production of thermometers and measuring devices intended for sale to the general public	**Process category (PROC):** PROC 0: Other: Measuring devices **Market sector by type of chemical product:** PC 0: Other: Measuring devices **Environmental release category (ERC):** ERC 5: Industrial use resulting in inclusion into or onto a matrix **Sector of end use (SU):** SU 0: Other: Measuring equipment **Article category related to subsequent service life (AC):** AC 01: Other (non intented to be released): measuring devices

ANNEX EXPOSURE SCENARIOS "MERCURY"

IU 1 Waste recovery

Exposure Scenario Format (1) addressing uses carried out by workers	
1.1 Title	
Free short title	Recycling of mercury metal
Systematic title based on use descriptor	PC7, PC 0 (Recycling) SU 2b, SU3 (Industrial uses), SU 14 AC 3, AC 0 (relays, switches, thermometers/barometers, dental amalgam, chlor alkali, gold production) (Appropriate PROCs and ERCs are given in Section 2 below)
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described below.
1.2 Contributing scenario (1) controlling environmental exposure	

Brief description of overall operational conditions referring to process categories (PROC) and environmental release categories (ERC)

ERC number	Name	Description	Level of containment	Dispersion of emission sources	Indoor/outdoor
ERC 1	Manufacture of chemicals	Manufacture of inorganic substances using continuous or batch processes applying dedicated or multipurpose equipment	Open/closed	Industrial	Indoor
ERC 3	Formulation in materials	Mixing or blending of substances, which will be physically or chemically bound into or onto a matrix	Open/closed	Industrial	Indoor
ERC 6a	Industrial use resulting in manufacture of another substance (use of intermediates)	Use of intermediates in primarily the chemical industry using continuous processes or batch processes applying dedicated or multi-purpose equipment, either technically controlled or operated by manual interventions, for the synthesis (manufacture) of other substances. For instance the use of chemical building blocks (feedstock) in the synthesis of agrochemicals, pharmaceuticals, monomers etc.	Open/closed	Industrial	Indoor

Number of sites using the substance (potentially required to demonstrate strictly controlled conditions of use to justify waiving of information according to Annex XI of REACH)

Workplace	Involved tasks	Involved PROCs
Raw material handling	delivery, visual content check, emptying of drums, sorting, crushing	5, 8b, 21
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)	evaporation, condensation, distillation, purification, including pre-treatment in closed systems	1, 3, 22
Filling	filling of flask or large containers	8b, 9
Logistics	internal logistics, administration, laboratory	8b, 9
Cleaning and maintenance	cleaning, maintenance	8a

1.3. Contributing exposure scenario controlling exposure for mercury recovery from waste

1.3.1. Control of workers exposure

Product characteristic

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature the fugacity is based on the dustiness of that substance. Whereas in hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, high abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. The spraying of aqueous solutions is assumed to be involved with a medium emission.

Workplace	Use in preparation	Content in preparation	Physical form	Emission potential
Raw material handling	not restricted		various (massive, solid, sludge, liquid)	very low – medium (depending on input of kinetic energy during crushing operations)
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)			various (solid, liquid, gas)	very low – high
Filling			liquid	low
Logistics			liquid	low
Cleaning and maintenance			liquid	low

Amounts used

The actual tonnage handled per shift is not considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure

Workplace	Duration of exposure
Raw material handling	not restricted
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)	
Filling	
Logistics	
Cleaning and maintenance	

Human factors not influenced by risk management

The shift breathing volume during all process steps is assumed to be 10 m3/ shift (8 hours).

Refer to occupational hygiene measures as described below (under "Organisational measures") which influence the variation in urinary mercury levels.

Other given operational conditions affecting workers exposure

Workplace	Room volume	Indoor or outdoor use	Process temperature	Process pressure
Raw material handling	>1,000m^3	indoors	ambient	not restricted
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)	>1,000m^3	indoors	up to 800°C	under pressure
Filling	not restricted	indoors	ambient	not restricted
Logistics	not restricted	indoors	ambient	not restricted
Cleaning and maintenance	not restricted	indoors	ambient	not restricted

Technical conditions and measures to control dispersion from source towards the worker

Engineering and ventilation controls: basic aspects of equipment and facility design should be such that mercury emissions that may contribute to occupational exposures are minimised. Such measures may include enclosure of process equipment such that sources of dust or aerosol emissions are minimised, negative draft exhaust systems to reduce emissions from enclosures and/or local exhaust ventilation installed at unavoidable sources of process emissions. The design characteristics of any local exhaust ventilation (e.g. exhaust hoods) will be specific to the emission source being controlled. Area ventilation should also be balanced such that air flow within a work area moves from areas of low to high exposure potential. Air captured by ventilation controls may require treatment to minimise toxic substances prior to discharge or recirculation. Details on technical measures to control exposure are given below on a workplace basis.

Workplace	Level of separation	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
Raw material handling	Any potentially required separation of workers from the emission source is indicated above under “Frequency and duration of exposure”. A reduction of exposure duration can be achieved, for example, by the installation of ventilated (positive pressure) control rooms or by removing the worker from workplaces involved with relevant exposure.	local exhaust ventilation	78 %	-
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)		local exhaust ventilation	78 %	fully or semi-automated process
Filling		local exhaust ventilation	78 %	-
Logistics		not required	n.a.	-
Cleaning and maintenance		local exhaust ventilation	78 %	-

Organisational measures to prevent /limit releases, dispersion and exposure

In this section, non-technical measures related to good housekeeping, personal hygiene and to a good culture of occupational hygiene in general are described. Additionally, it is described how exposure to mercury can be assessed based on bio-monitoring and which strategies could be followed for such monitoring to protect worker’s health. It is noted that the “Code of Practice” originally developed for the chlor-alkali industry (EUROCHLOR, 2010) has served as a basis to derive the measures as described below. The full text can be downloaded from the EUROCHLOR website.

Creating a culture of safety: Define and communicate a clear policy for controlling occupational exposure to mercury; Ensure managers set the example in terms of personal protection and hygiene; Where possible involve occupational physicians in making workers take control of their own urine mercury levels; Consider making low urine mercury levels a condition of employment, with disciplinary action taken where protective equipment and hygiene procedures are not followed; Involve managers when workers’ urine mercury levels exceed action levels; Consider publicising company urine mercury performance to workers via notices and briefings to ensure the topic remains a key priority; Provide detailed training for new personnel on the risks of mercury exposure and the procedures for protection; Provide instruction on specific mercury exposure risks for workers undertaking new tasks; Provide regular refresher courses for all employees on the risks of mercury exposure and the procedures for protection; Involve worker representatives.

Cleaning: Ensure general shop cleanliness is maintained by frequent washing/vacuuming. Clean every workplace at the end of every shift. Ensure adequate lighting to easily locate and appropriately remove any potential mercury spills.

Personal protective equipment: Assess the need to wear respiratory protective equipment (RPE) in production areas. Consider use effective masks accompanied by a compliance policy (ensure proper shaving; ensure workers do not remove RPE in production areas in order to communicate). Where masks are used, employ formal mask cleaning and filter changing strategies; For workers in areas of significant exposure, provide sufficient working clothes to enable daily change into clean clothes. In such cases all work clothing should be cleaned by the employer on a daily basis and is not permitted to leave the work site. Please also consult the section on personal protective equipment below for detailed information on PPE for specific workplaces, processes or tasks.

Personal hygiene: Ensure workers follow simple hygiene rules (e.g. do not bite nails and keep them cut short, avoid touching or scratching face with dirty hands or gloves); Ensure workers do not wipe away sweat with hands or arms, e.g. by providing disposable perspiration towels; Ensure workers use disposable tissues rather than a handkerchief; Prohibit drinking, eating and smoking in production areas; Prevent access to eating and non-production areas in working clothes; Ensure workers as a minimum wash hands, arms, faces and mouths (but preferably shower) and change into personal clothing (or clean coveralls provided by the company) before entering eating areas; For high exposure workplaces, at the end of a shift, workers may need to pass through a room containing washbasins for the cleaning of hands, followed by a ‘dirty’ room for the removal of working clothes, then through showers into a ‘clean’ room for changing into personal clothing; Ensure workers handle dirty working clothes with care; Consider making showering obligatory at the end of a shift, and provide towels and soap; Allow no personal belongings to be taken into production areas, and allow no items that have been used in production areas to be taken home.

Urine mercury monitoring: The measurement of mercury in urine (HgU) is considered to be the best determinant of mercury body burden following long-term exposure. Mercury urinary figures reflect the exposure of the 3 or 4 previous months due to the relatively slow elimination of mercury from the human body. The aim of the recommended monitoring programme is for all individual HgU samples to be always below 30 µg/g creatinine. The frequency of testing should be increased if the levels of mercury in urine increase. For individuals with HgU above 20 µg/g creatinine, testing frequency should be at least 4 times a year, depending on the pattern of exposure. When levels are below 20 µg Hg/g creatinine, the testing frequency should mainly be determined by any changes in the working environment, with a minimum of 2 times a year.

Conditions and measures related to personal protection, hygiene and health evaluation

Workplace	Specification of respiratory protective equipment (RPE)	RPE efficiency (assigned protection factor, APF)	Specification of gloves	Further personal protective equipment (PPE)
Raw material handling	half mask, Hg-P3 filter	APF=10	(nitrile) gloves are optional for process steps at ambient temperature	standard working clothes (overall) and safety shoes
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)	half mask, Hg-P3 filter	APF=10		
Filling	half mask, Hg-P3 filter	APF=10		
Logistics	not required	n.a.		
Cleaning and maintenance	half mask, Hg-P3 filter	APF=10		

Any RPE as defined above shall only be worn if the following principles are implemented in parallel: The duration of work (compare with "duration of exposure" above) should reflect the additional physiological stress for the worker due to the breathing resistance and mass of the RPE itself, due to the increased thermal stress by enclosing the head. In addition, it shall be considered that the worker's capability of using tools and of communicating are reduced during the wearing of RPE.

For reasons as given above, the worker should therefore be (i) healthy (especially in view of medical problems that may affect the use of RPE), (ii) have suitable facial characteristics reducing leakages between face and mask (in view of scars and facial hair). The recommended devices above which rely on a tight face seal will not provide the required protection unless they fit the contours of the face properly and securely.

The employer and self-employed persons have legal responsibilities for the maintenance and issue of respiratory protective devices and the management of their correct use in the workplace. Therefore, they should define and document a suitable policy for a respiratory protective device programme including training of the workers.

An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE.

1.3.2. Control of environmental exposure

Product characteristics

Mercury is used in liquid form.

Amounts used

Exposure Scenarios based on 1,000t Hg/yr at a maximum RCR of 1 (See section 10.1)

Information type	Site tonnage (tonnes mercury)
Median (50th percentile)	140
Min	26
Max	1,000
Data points	4
Selected for Generic Exposure Scenario	1,000

Frequency and duration of use

Production occurs 365 days per year per site (median 50th %)

Information type	Emission days to water per site (d/y)	Emission days to air per site (d/y)
Median (50th percentile)	290	256
Min	250	250
Max	330	330
Data points	4	4
Selected for Generic Exposure Scenario	290	265

Environment factors not influenced by risk management

A dilution factor of 1,000 is taken into account for freshwater to STP.

Other given operational conditions affecting environmental exposure

As there are no discharges of wastewater to marine water or freshwater by direct discharge, these exposure scenarios are not relevant for this sector and are therefore not included is this report. Two sites discharge their wastewater to an on-site WWTP with an effluent flow between 2 and 23 m^3/day; which then discharges to a community sewer system (STP).

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Following risk management measures (RMM), related to the environment, are implemented by the sites:

For emissions to water:

- Chemical precipitation
- Disposal of wastewater to off-site location

An overview of the applied measures is summarized in following table. The removal efficiency of the physico-chemical precipitation is 99.9 %, reported by two sites. For those having water emissions, 50 % of the waste recovery sites report an on-site WWTP and physico-chemical treatment. Both sites without water emission report wastewater disposal to an external WWTP. A third site combines all three risk management measures.

Table: Percentage of companies where the following RMMs related to water emissions are implemented

Risk management measure	Applied
Disposal of wastewater to off-site location	75 %
On-site Waste Water Treatment Plant by physico-chemical precipitation	50 %

In the actual exposure scenario where the wastewater is not only treated on-site but is followed by a biological treatment (municipal STP), the fraction of mercury removed by the STP is set at 76 % (CBS, 2008).

Emissions to air

The production sites implement the measures as stated in the following table. The removal efficiency of the active carbon filters is reported to be between 90 and 99.9 %. Three sites implemented an active carbon filter.

Table: Percentage of companies where the following RMMs related to air emissions are implemented

Risk management measure	Applied
Fabric or bag filters	50 %
Active carbon filters	75 %
Wet scrubbers	50 %

Waste related measures

Mercury-bearing waste resulting from the processes is stored on-site and removed to an off-site location. Detailed information on the amount of Hg substances in waste, type of waste, type of external treatment and fraction of substances released into the environment was not provided.

One site reports recording the weight of all output materials in order to present a complete treatment (material) balance. The administration completes and updates all data. Thus a transparent waste management for all input and output materials is provided.

Organizational measures to prevent/limit release from site

No specific organizational measures were considered.

Conditions and measures related to municipal sewage treatment plant

STP removal rate for mercury was set at 76 % (CBS, 2008).

Conditions and measures related to external treatment of waste for disposal

Mercury-bearing waste resulting from the processes is stored on-site and removed to an off-site location. Detailed information on the amount of Hg substances in waste, type of waste, type of external treatment and fraction of substances released into the environment was not provided.

Conditions and measures related to external recovery of waste

One site reports recording the weight of all output materials in order to present a complete treatment (material) balance. The administration completes and updates all data. Thus a transparent waste management for all input and output materials is provided.

Additional good practice advice (for environment) beyond the REACH CSA

Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH, Thus, the downstream user is not obliged to

i) carry out an own CSA and

ii) ii) to notify the use to the Agency, if he does not implement these measures.

Use specific measures expected to reduce the predicted exposure beyond the level estimated based on the exposure scenario.

1.4. Exposure estimation and reference to its source

Occupational exposure

In the Column "Urinary mercury levels" below, the 90th percentile of the measured urinary mercury levels is provided. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For urinary mercury levels, the RCR is based on a DNEL for 30 µg Hg/g creatinine in urine.

Workplace	Method used for exposure assessment (refer to introduction)	Urinary mercury levels (RCR)	Method used for inhalation exposure assessment (refer to introduction)	Method used for dermal exposure assessment (refer to introduction)
Raw material handling	measured data	26.2 µg Hg/g creatinine (0.87)	not relevant because urinary mercury levels integrate all relevant paths of exposure	
Furnace treatment & distillation (under-pressure or hermetically closed furnaces)	measured data	24.7 µg Hg/g creatinine (0.82)		
Filling	measured data			
Logistics	measured data	6.5 µg Hg/g creatinine (0.22)		
Cleaning and maintenance	measured data	16.0 µg Hg/g creatinine (0.53)		

Environmental emissions

Compartment	Value	Unit	Justification
Environmental release factor to aquatic (before on-site STP)	0.58	g/tonnes	Maximum release factor reported by companies
Environmental release factor to air (before APC)	235	g/tonnes	Maximum release factor reported by companies
PEC_{local} in aquatic pelagic (freshwater)	0.028	µg Hg/L	C_{local} of 6.76 * 10^{-5} µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
PEC_{local} in sediment (freshwater)	0.31	mg Hg/kg dw	C_{local} of 2.50 * 10^{-3} mg Hg/kg dw and a $PEC_{regional}$ of 0.300 mg Hg/kg dw
PEC_{added} in soil (without sludge application)	1.68 * 10^{-2}	mg Hg/kg dw	C_{local} of 1.68 * 10^{-2} mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC in STP	2.40 * 10^{-4}	µg Hg/L	Calculated effluent concentration in on-site WWTP: 0.09 mg/L
PEC_{total} air	41.1	ng Hg/m^3	C_{local} of 38.1 ng Hg/m^3 and a $PEC_{regional}$ of 3.0 ng/m^3

1.5. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Occupational exposure

The DU works inside the boundaries set by the ES if either the proposed risk management measures as described above are met or the downstream user can demonstrate on his own that his implemented risk management measures are adequate (given that the processes, operational conditions and activities in question are covered by the PROCs listed above). This has to be done by showing that they limit the exposure (reflected in urinary mercury levels) to a level below the respective DNEL as given below:

DNEL for workers: 30 µg Hg/g creatinine in urine

Additionally, the scientific committee on occupational exposure limits has set the following limit values, which can also be used when assessing exposure:

DNEL for workers: 10 µg Hg/L blood
DNEL for workers: 0.02 mg Hg/m³ air

1.6. Risk characterisation: mercury recovery from waste

Environment

Compartment	PEC	PNEC	RCR	Justification
Aquatic pelagic (freshwater)	0.028	0.057	0.49	C_{local} of 6.76 * 10^{-5} µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
Sediment (freshwater)	0.31	9.3	0.03	C_{local} of 2.50 * 10^{-3} mg Hg/kg dw and a $PEC_{regional}$ of 0.300 mg Hg/kg dw
Soil (without sludge application)	1.68 * 10^{-2}	0.022 (added)	0.76	C_{local} of 1.68 * 10^{-2} mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
Sewage	2.40 * 10^{-4}	2.25	0.107	Calculated effluent concentration in on-site WWTP: 0.09 mg/L

IU 2 Production of phenyl mercury carboxylates

Exposure Scenario Format (1) addressing uses carried out by workers

2.1. Title

Free short title	Use of mercury metal in the chemical industry. Phenyl mercury carboxylates are used as catalyst in polyurethane production.
Systematic title based on use descriptor	SU 0 (Industrial and laboratory use) PC21, PC 0 (Catalysator) AC0 (poly-urethane) (appropriate PROCs and ERCs are given in Section 2 below)
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described in Section 2 below.

2.2. Operational conditions and risk management measures

Brief description of overall operational conditions referring to process categories (PROC) and environmental release categories (ERC)

ERC number	Name	Description	Level of containment	Dispersion of emission sources	Indoor/outdoor
ERC 1	Manufacture of chemicals	Manufacture of inorganic substances using continuous or batch processes applying dedicated or multipurpose equipment	Open/closed	Industrial	Indoor

Number of sites using the substance (potentially required to demonstrate strictly controlled conditions of use to justify waiving of information according to Annex XI of REACH)

Workplace	Involved tasks	Involved PROCs
Production of chemicals	mechanical unloading of liquid mercury, mixing, condensation, water elimination, distillation, liquid product obtained is filtered, regular cleaning and maintenance	1, 2, 3
Filling of chemicals	filling of drums	8b

2.3. Contributing ES

2.3.1. Control of workers exposure

Product characteristic

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature the fugacity is based on the dustiness of that substance. Whereas in hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, high abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. The spraying of aqueous solutions is assumed to be involved with a medium emission.

Workplace	Use in preparation	Content in preparation	Physical form	Emission potential
Production of chemicals	not restricted		liquid, slurry	low
Filling	phenyl mercury carboxylates containing 18-35 % Hg		liquid	low

Amounts used

The actual tonnage handled per shift is not considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure

Workplace	Duration of exposure
Production of chemicals	not restricted
Filling	

Human factors not influenced by risk management

The shift breathing volume during all process steps is assumed to be 10 m3/shift (8 hours).

Refer to occupational hygiene measures as described below (under “Organisational measures”) which influence the variation in urinary mercury levels.

Other given operational conditions affecting workers exposure

Workplace	Room volume	Indoor or outdoor use	Process temperature	Process pressure
Production of chemicals	> 1,000 m³	indoors	ambient – elevated temperature	not restricted
Filling	> 100 m³	indoors or outdoors	ambient	not restricted

Technical conditions and measures at process level (source) to prevent release

Workplace	Level of containment	Level of segregation
Production of chemicals	closed process	not required
Filling	closed process, transfer by pipelines	not required

Technical conditions and measures to control dispersion from source towards the worker

Engineering and ventilation controls: basic aspects of equipment and facility design should be such that mercury emissions that may contribute to occupational exposures are minimised. Such measures may include enclosure of process equipment such that sources of dust or aerosol emissions are minimised, negative draft exhaust systems to reduce emissions from enclosures and/or local exhaust ventilation installed at unavoidable sources of process emissions. The design characteristics of any local exhaust ventilation (e.g. exhaust hoods) will be specific to the emission source being controlled. Area ventilation should also be balanced such that air flow within a work area moves from areas of low to high exposure potential. Air captured by ventilation controls may require treatment to minimise toxic substances prior to discharge or recirculation. Details on technical measures to control exposure are given below on a workplace basis.

Workplace	Level of separation	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
Production of chemicals	Any potentially required separation of workers from the emission source is indicated above under "Frequency and duration of exposure". A reduction of exposure duration can be achieved, for example, by the installation of ventilated (positive pressure) control rooms or by removing the worker from workplaces involved with relevant exposure.	generic LEV	78 %	-
Filling		general ventilation	17 %	-

Organisational measures to prevent /limit releases, dispersion and exposure

In this section, non-technical measures related to good housekeeping, personal hygiene and to a good culture of occupational hygiene in general are described. Additionally, it is described how exposure to mercury can be assessed based on bio-monitoring and which strategies could be followed for such monitoring to protect worker's health. It is noted that the "Code of Practice" originally developed for the chlor-alkali industry (EUROCHLOR, 2010) has served as a basis to derive the measures as described below. The full text can be downloaded from the EUROCHLOR website.

Creating a culture of safety: Define and communicate a clear policy for controlling occupational exposure to mercury; Ensure managers set the example in terms of personal protection and hygiene; Where possible involve occupational physicians in making workers take control of their own urine mercury levels; Consider making low urine mercury levels a condition of employment, with disciplinary action taken where protective equipment and hygiene procedures are not followed; Involve managers when workers' urine mercury levels exceed action levels; Consider publicising company urine mercury performance to workers via notices and briefings to ensure the topic remains a key priority; Provide detailed training for new personnel on the risks of mercury exposure and the procedures for protection; Provide instruction on specific mercury exposure risks for workers undertaking new tasks; Provide regular refresher courses for all employees on the risks of mercury exposure and the procedures for protection; Involve worker representatives.

Cleaning: Ensure general shop cleanliness is maintained by frequent washing/vacuuming. Clean every workplace at the end of every shift. Ensure adequate lighting to easily locate and appropriately remove any potential mercury spills.

Personal protective equipment: Assess the need to wear respiratory protective equipment (RPE) in production areas. Consider use effective masks accompanied by a compliance policy (ensure proper shaving; ensure workers do not remove RPE in production areas in order to communicate). Where masks are used, employ formal mask cleaning and filter changing strategies; For workers in areas of significant exposure, provide sufficient working clothes to enable daily change into clean clothes. In such cases all work clothing should be cleaned by the employer on a daily basis and is not permitted to leave the work site. Please also consult the section on personal protective equipment below for detailed information on PPE for specific workplaces, processes or tasks.

Personal hygiene: Ensure workers follow simple hygiene rules (e.g. do not bite nails and keep them cut short, avoid touching or scratching face with dirty hands or gloves); Ensure workers do not wipe away sweat with hands or arms, e.g. by providing disposable perspiration towels; Ensure workers use disposable tissues rather than a handkerchief; Prohibit drinking, eating and smoking in production areas; Prevent access to eating and non-production areas in working clothes; Ensure workers as a minimum wash hands, arms, faces and mouths (but preferably shower) and change into personal clothing (or clean coveralls provided by the company) before entering eating areas; For high exposure workplaces, at the end of a shift, workers may need to pass through a room containing washbasins for the cleaning of hands, followed by a 'dirty' room for the removal of working clothes, then through showers into a 'clean' room for changing into personal clothing; Ensure workers handle dirty working clothes with care; Consider making showering obligatory at the end of a shift, and provide towels and soap; Allow no personal belongings to be taken into production areas, and allow no items that have been used in production areas to be taken home.

Urine mercury monitoring: The measurement of mercury in urine (HgU) is considered to be the best determinant of mercury body burden following long-term exposure. Mercury urinary figures reflect the exposure of the 3 or 4 previous months due to the relatively slow elimination of mercury from the human body. The aim of the recommended monitoring programme is for all individual HgU samples to be always below 30 µg/g creatinine. The frequency of testing should be increased if the levels of mercury in urine increase. For individuals with HgU above 20 µg/g creatinine, testing frequency should be at least 4 times a year, depending on the pattern of exposure. When levels are below 20 µg Hg/g creatinine, the testing frequency should mainly be determined by any changes in the working environment, with a minimum of 2 times a year.

Conditions and measures related to personal protection, hygiene and health evaluation

Workplace	Specification of respiratory protective equipment (RPE)	RPE efficiency (assigned protection factor, APF)	Specification of gloves	Further personal protective equipment (PPE)
Production of chemicals	half mask, Hg-P3 filter	APF=10	PVC gloves EN420338	standard working clothes (overall) and safety shoes, for handling of corrosive substances: eye and face protection: Panoramic mask NOVA STANDARD CE 015 893
Filling	half mask, Hg-P3 filter	APF=10	PVC gloves EN420338	

Any RPE as defined above shall only be worn if the following principles are implemented in parallel: The duration of work (compare with "duration of exposure" above) should reflect the additional physiological stress for the worker due to the breathing resistance and mass of the RPE itself, due to the increased thermal stress by enclosing the head. In addition, it shall be considered that the worker's capability of using tools and of communicating are reduced during the wearing of RPE.

For reasons as given above, the worker should therefore be (i) healthy (especially in view of medical problems that may affect the use of RPE), (ii) have suitable facial characteristics reducing leakages between face and mask (in view of scars and facial hair). The recommended devices above which rely on a tight face seal will not provide the required protection unless they fit the contours of the face properly and securely.

The employer and self-employed persons have legal responsibilities for the maintenance and issue of respiratory protective devices and the management of their correct use in the workplace. Therefore, they should define and document a suitable policy for a respiratory protective device programme including training of the workers.

An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE.

2.3.2. Control of environmental exposure

Product characteristics

Mercury is used in liquid form.

Amounts used

Exposure Scenarios based on 120 Hg/yr at a maximum RCR of 1 (See section 10.1)

Information type	Site tonnage (tonnes mercury)
Reported value	120
Data points	1
Selected for Generic Exposure Scenario	120

Frequency and duration of use

Production occurs 220 days per year per site (median 50th %)

Information type	Emission days to water per site (d/y)	Emission days to air per site (d/y)
Reported value	220	220
Data points	1	1
Selected for Generic Exposure Scenario	220	220

Environment factors not influenced by risk management

A default dilution factor of 10 is taken into account for freshwater to STP.

Other given operational conditions affecting environmental exposure

Generic exposure scenarios for the freshwater compartment with direct discharge and the marine compartment were not included as they are not relevant for this sector. The selected dilution factor for the exposure scenario to STP is 10. An effluent flow of 18 m^3/d is applied for the on-site WWTP and 475.200 m^3/d for the STP discharge rate.

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk management measures (RMM), related to the environment, are implemented by the site.

For emissions to water:

- Chemical precipitation: used primarily to remove the metal ions
- Selective resin

An overview of the applied measures is summarized in the following table. The removal efficiency of the chemical precipitation and selective resin is > 99.99 %. An automatic sewage compartment captures any accidental spillage of pollutant substances.

Table: Percentage of companies where the following RMMs related to water emissions are implemented

Risk management measure	%
On-site Waste water treatment plant	100
Chemical precipitation	100
Selective resin	100

In the actual exposure scenario, where the wastewater is not only treated on-site but is followed by a biological treatment (municipal STP), the fraction of mercury removed by a STP is set at 76% (CBS, 2008). Furthermore, by default, the sludge from a municipal STP is applied to agricultural soil.

For emissions to air:

A synopsis of the applied measures is summarized in the following table. The reported removal efficiency for the wet scrubbers is reported as > 99.99999 %. Fugitive site emissions are handled by absorption by inert carbons.

Table: Percentage of companies where the following RMMs related to air emissions are implemented

Risk management measure	%
Fabric or bag filters	100
Wet scrubbers	100

Organizational measures to prevent/limit release from site

No specific organizational measures were considered.

Conditions and measures related to municipal sewage treatment plant

STP removal rate for mercury was set at 76 % (CBS, 2008).

Conditions and measures related to external treatment of waste for disposal

Mercury-bearing waste resulting from the processes is stored on-site and removed to an off-site location. Detailed information on the amount of Hg substances in waste, type of waste, type of external treatment and fraction of substances released into the environment was not provided.

Conditions and measures related to external recovery of waste

In order to produce phenyl mercury carboxylates mercury metal is moved through an air-pressurized pipeline into a reactor where nitric acid is added. The generated nitrogen oxides are captured in scrubbers producing nitric acid. The nitric acid is used again in the process. 50% sodium hydroxide solution is added to control the pH value. The mercury oxide slurry is pumped to another reactor where by means of reflux, condensation, water elimination and distillation are carried out and the liquid final product is obtained. These processes are performed under closed conditions. After quality control the liquid product is filtered and transferred via pipelines to the final containers.

Additional good practice advice (for environment) beyond the REACH CSA

Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH, Thus, the downstream user is not obliged to

iii) carry out an own CSA and

iv) ii) to notify the use to the Agency, if he does not implement these measures.

Use specific measures expected to reduce the predicted exposure beyond the level estimated based on the exposure scenario.

2.4. Exposure estimation and reference to its source

Occupational exposure

In the Column "Urinary mercury levels" below, the 90th percentile of the measured urinary mercury levels is provided. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For urinary mercury levels, the RCR is based on a DNEL for 30 µg Hg/g creatinine in urine.

Workplace	Method used for exposure assessment (refer to introduction)	Urinary mercury levels (RCR)	Method used for inhalation exposure assessment (refer to introduction)	Method used for dermal exposure assessment (refer to introduction)
Production of chemicals	measured data	27.0 µg Hg/g creatinine (0.90)	not relevant because urinary mercury levels integrate all relevant paths of exposure	
Filling	measured data	20.9 µg Hg/g creatinine (0.70)		

Environmental emissions			
Compartment	**Value**	**Unit**	**Justification**
Environmental release factor to aquatic (before on-site STP)	0.71	g/tonnes	Maximum release factor reported by company
Environmental release factor to air (before APC)	1.79	g/tonnes	Maximum release factor reported by company
PEC_{local} in aquatic pelagic (freshwater)	0.028	µg Hg/L	C_{local} of 5.12 * 10^{-5} µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
PEC_{local} in sediment (freshwater)	0.30	mg Hg/kg dw	C_{local} of 8.60 * 10^{-4} mg Hg/kg dw and a $PEC_{regional}$ of 0.300 mg Hg/kg dw
PEC_{added} in soil (with sludge application)	1.06 * 10^{-4}	mg Hg/kg dw	C_{local} of 1.06 * 10^{-4} mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC_{added} in soil (without sludge application)	7.21 * 10^{-5}	mg Hg/kg dw	C_{local} of 7.21 * 10^{-5} mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC in STP	1.80 * 10^{-4}	µg Hg/L	Measured effluent concentration in on-site WWTP: 20 µg/L
PEC_{total} air	3.2	ng Hg/m^3	C_{local} of 0.2 ng Hg/m^3 and a $PEC_{regional}$ of 3.0 ng/m^3

2.5. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Occupational exposure

The DU works inside the boundaries set by the ES if either the proposed risk management measures as described above are met or the downstream user can demonstrate on his own that his implemented risk management measures are adequate (given that the processes, operational conditions and activities in question are covered by the PROCs listed above). This has to be done by showing that they limit the exposure (reflected in urinary mercury levels) to a level below the respective DNEL as given below:

DNEL for workers: 30 µg Hg/g creatinine in urine

Additionally, the scientific committee on occupational exposure limits has set the following limit values, which can also be used when assessing exposure:

DNEL for workers: 10 µg Hg/L blood

DNEL for workers: 0.02 mg Hg/m³ air

2.6. Risk characterisation

Environmental emissions				
Compartment	**PEC**	**PNEC**	**RCR**	**Justification**
Aquatic pelagic (freshwater)	0.028	0.057	0.49	C_{local} of 5.12 * 10^{-5} µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
Sediment (freshwater)	0.30	9.3	0.03	C_{local} of 8.60 * 10^{-4} mg Hg/kg dw and a $PEC_{regional}$ of 0.300 mg Hg/kg dw
Soil (with sludge application)	1.06 * 10^{-4}	0.022 (added)	0.005	C_{local} of 1.06 * 10^{-4} mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
Soil (without sludge application)	7.21 * 10^{-5}	0.022 (added)	0.003	C_{local} of 7.21 * 10^{-5} mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
Sewage	1.80 * 10^{-4}	2.25	8.1 * 10-5	

IU 3 Chlor-alkali electrolysis

Exposure Scenario Format (1) addressing uses carried out by workers

3.1. Title

Free short title	Use of mercury metal in the chlor-alkali industry
Systematic title based on use descriptor	SU 3 (Industrial uses),SU 17, SU 20 (appropriate PROCs and ERCs are given in Section 2 below)
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described in Section 2 below.

3.2. Operational conditions and risk management measures

Brief description of overall operational conditions referring to process categories (PROC) and environmental release categories (ERC)

ERC number	Name	Description	Level of containment	Dispersion of emission sources	Indoor/outdoor
ERC 1	Manufacture of chemicals	Manufacture of inorganic substances using continuous or batch processes applying dedicated or multipurpose equipment	Open/closed	Industrial	Indoor

Number of sites using the substance (potentially required to demonstrate strictly controlled conditions of use to justify waiving of information according to Annex XI of REACH)

Workplace	Involved tasks	Involved PROCs
Chlor-alkali process*	refilling of cells to compensate for losses, sampling	8b, 9
	electrolysis, mercury cell process, reaction	1, 2, 3
	liquid amalgam flows from the electrolytic cell to a separate reactor, reaction with water, mercury is fed back into the electrolyser and reused	1, 2, 3

3.3.1 Control of workers exposure

Product characteristic

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature, the fugacity is based on the dustiness of that substance. Whereas in hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, high abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. The spraying of aqueous solutions is assumed to be involved with a medium emission.

Workplace	Use in preparation	Content in preparation	Physical form	Emission potential
Chlor-alkali process	not restricted		liquid	low

Amounts used

The actual tonnage handled per shift is not considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure

Workplace	Duration of exposure
Chlor-alkali process	not restricted

Human factors not influenced by risk management

The shift breathing volume during all process steps is assumed to be 10 m^3/ shift (8 hours).

Refer to occupational hygiene measures as described below (under "Organisational measures") which influence the variation in urinary mercury levels.

* Mercury flows in a closed circuit

Other given operational conditions affecting workers exposure				
Workplace	**Room volume**	**Indoor or outdoor use**	**Process temperature**	**Process pressure**
Chlor-alkali process	>1,000m^3	Indoors and outdoors	up to 130°C	not restricted

Technical conditions and measures at process level (source) to prevent release		
Workplace	**Level of containment**	**Level of segregation**
Chlor-alkali process	closed process, mercury flows in closed circle (all sub-processes except for occasional refills)	not required

Technical conditions and measures to control dispersion from source towards the worker

Engineering and ventilation controls: basic aspects of equipment and facility design should be such that mercury emissions that may contribute to occupational exposures are minimised. Such measures may include enclosure of process equipment such that sources of dust or aerosol emissions are minimised, negative draft exhaust systems to reduce emissions from enclosures and/or local exhaust ventilation installed at unavoidable sources of process emissions. The design characteristics of any local exhaust ventilation (e.g. exhaust hoods) will be specific to the emission source being controlled. Area ventilation should also be balanced such that air flow within a work area moves from areas of low to high exposure potential. Air captured by ventilation controls may require treatment to minimise toxic substances prior to discharge or recirculation. Details on technical measures to control exposure are given below on a workplace basis.

Workplace	Level of separation	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further informatio n
Chlor-alkali process	Any potentially required separation of workers from the emission source is indicated above under "Frequency and duration of exposure". A reduction of exposure duration can be achieved, for example, by the installation of ventilated (positive pressure) control rooms where the risk of chlorine leaks exists, or by removing the worker from workplaces involved with relevant exposure.	Localised controls, such as local exhaust ventilation or separation of workers from potential emission sources, shall be selected in accordance to the "code of practice" described below.		-

Organisational measures to prevent /limit releases, dispersion and exposure

In this section, non-technical measures related to good housekeeping, personal hygiene and to a good culture of occupational hygiene in general are described. Additionally, it is described how exposure to mercury can be assessed based on bio-monitoring and which strategies could be followed for such monitoring to protect worker's health. It is noted that the "Code of Practice" originally developed for the chlor-alkali industry (EUROCHLOR, 2010) has served as a basis to derive the measures as described below. The full text can be downloaded from the EUROCHLOR website.

Creating a culture of safety: Define and communicate a clear policy for controlling occupational exposure to mercury; Ensure managers set the example in terms of personal protection and hygiene; Where possible involve occupational physicians in making workers take control of their own urine mercury levels; Consider making low urine mercury levels a condition of employment, with disciplinary action taken where protective equipment and hygiene procedures are not followed; Involve managers when workers' urine mercury levels exceed action levels; Consider publicising company urine mercury performance to workers via notices and briefings to ensure the topic remains a key priority; Provide detailed training for new personnel on the risks of mercury exposure and the procedures for protection; Provide instruction on specific mercury exposure risks for workers undertaking new tasks; Provide regular refresher courses for all employees on the risks of mercury exposure and the procedures for protection; Involve worker representatives.

Cleaning: Ensure general shop cleanliness is maintained by frequent washing/vacuuming. Clean every workplace at the end of every shift. Ensure adequate lighting to easily locate and appropriately remove any potential mercury spills.

Personal protective equipment: Assess the need to wear respiratory protective equipment (RPE) in production areas. Consider use effective masks accompanied by a compliance policy (ensure proper shaving; ensure workers do not remove RPE in production areas in order to communicate). Where masks are used, employ formal mask cleaning and filter changing strategies; For workers in areas of significant exposure, provide sufficient working clothes to enable daily change into clean clothes. In such cases all work clothing should be cleaned by the employer on a daily basis and is not permitted to leave the work site. Please also consult the section on personal protective equipment below for detailed information on PPE for specific workplaces, processes or tasks.

Personal hygiene: Ensure workers follow simple hygiene rules (e.g. do not bite nails and keep them cut short, avoid touching or scratching face with dirty hands or gloves); Ensure workers do not wipe away sweat with hands or arms, e.g. by providing disposable perspiration towels; Ensure workers use disposable tissues rather than a handkerchief; Prohibit drinking, eating and smoking in production areas; Prevent access to eating and non-production areas in working clothes; Ensure workers as a minimum wash hands, arms, faces and mouths (but preferably shower) and change into personal clothing (or clean coveralls provided by the company) before entering eating areas; For high exposure workplaces, at the end of a shift, workers may need to pass through a room containing washbasins for the cleaning of hands, followed by a 'dirty' room for the removal of working clothes, then through showers into a 'clean' room for changing into personal clothing; Ensure workers handle dirty working clothes with care; Consider making showering obligatory at the end of a shift, and provide towels and soap; Allow no personal belongings to be taken into production areas, and allow no items that have been used in production areas to be taken home.

Urine mercury monitoring: The measurement of mercury in urine (HgU) is considered to be the best determinant of mercury body burden following long-term exposure. Mercury urinary figures reflect the exposure of the 3 or 4 previous months due to the relatively slow elimination of mercury from the human body. The aim of the recommended monitoring programme is for all individual HgU samples to be always below 30 µg/g creatinine. The frequency of testing should be increased if the levels of mercury in urine increase. For individuals with HgU above 20 µg/g creatinine, testing frequency should be at least 4 times a year, depending on the pattern of exposure. When levels are below 20 µg Hg/g creatinine, the testing frequency should mainly be determined by any changes in the working environment, with a minimum of 2 times a year.

Conditions and measures related to personal protection, hygiene and health evaluation

Workplace	Specification of respiratory protective equipment (RPE)	RPE efficiency (assigned protection factor, APF)	Specification of gloves	Further personal protective equipment (PPE)
Chlor-alkali process	RPE shall be selected in accordance to the “code of practice” described above.		(nitrile) gloves are optional for process steps at ambient temperature	standard working clothes (overall) and safety shoes

Any RPE as defined above shall only be worn if the following principles are implemented in parallel: the duration of work (compare with “duration of exposure” above) should reflect the additional physiological stress for the worker due to the breathing resistance and mass of the RPE itself, due to the increased thermal stress by enclosing the head. In addition, it shall be considered that the worker’s capability of using tools and of communicating are reduced during the wearing of RPE.

For reasons as given above, the worker should therefore be (i) healthy (especially in view of medical problems that may affect the use of RPE), (ii) have suitable facial characteristics reducing leakages between face and mask (in view of scars and facial hair). The recommended devices above, which rely on a tight face seal, will not provide the required protection unless they fit the contours of the face properly and securely.

The employer and self-employed persons have legal responsibilities for the maintenance and issue of respiratory protective devices and the management of their correct use in the workplace. Therefore, they should define and document a suitable policy for a respiratory protective device programme including training of the workers.

An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE.

3.3.2 Control of environmental exposure

Product characteristics

Mercury is used in liquid form.

Amounts used

Exposure Scenarios based on 193,600 T Cl/yr at a maximum RCR of 1 (See section 10.1)

Information type	Site tonnage (tonnes Cl)
Data points	37
Median	125,276
90th percentile	193,600
Min	10,417
Max	346,000
Selected for Generic Exposure Scenario	193,600

Frequency and duration of use

Production occurs 220 days per year per site (median 50th %)

Information type	Emission days to water per site (d/y)	Emission days to air per site (d/y)
Selected for Generic Exposure Scenario	300 (default)	300 (default)

Environment factors not influenced by risk management

A default dilution factor of 100 is taken into account for marine.

For the freshwater compartments, a dilution factor of 100 was chosen.

Other given operational conditions affecting environmental exposure

It is unclear for the moment if there are sites discharging their wastewater after a Sewage Treatment Plant (STP) (biological treatment) or directly after a physico-chemical Waste Water Treatment Plant (WWTP)

Currently two generic exposure scenarios have been developed. An STP scenario is included as a generic freshwater exposure scenario (ES 1) next to a direct discharge scenario (ES 2). Next to both freshwater scenarios, a generic ES is proposed for the marine environment. The selected dilution factors for the generic exposure scenarios are 100 for both freshwater ES, and 100 –as default- for the marine environment. A default effluent flow of 2000 m^3/d is applied for the on-site WWTP and STP.

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

The following risk management measures related to the environment are implemented (Source BAT reference document, 2001).

Water emissions

Mercury emitted from mercury cell facilities mainly arises from:

- the process: bleed from brine purification, condensate from hydrogen drying, condensate from caustic soda concentration units, brine leakage, ion-exchange eluate from process- water treatment
- the wash water from the cell cleaning operations: inlet and outlet boxes
- the rinsing water from the electrolysis hall: cleaning of the floors, tanks, pipes and dismantled apparatus
- the rinsing water from maintenance areas outside the electrolysis hall, if they are cleaned with water

Mercury-contaminated waste water streams are collected from all sources and generally treated in a waste-water treatment plant. The amount of waste water can be reduced by filtration and washing of the sludges to remove mercury before feeding the condensate back into the brine.

Several processes are in use which are capable of purifying both depleted brine as it leaves the plant and all other mercury-containing waste-water streams. For example the mercury in the depleted brine can be removed by precipitation as sulphide and recycled in the brine.

One or more of the following measures (as set out in in the BAT Reference Document on Chlor-alkali manufacturing plants), are to be taken for emissions to water:

- Treatment with hydrazine
- Sedimentation
- Sand filtration
- Carbon filtration
- Reverse osmosis: extensively used for the removal of dissolved metals
- Ion exchange

The percentage of sites which implements one of the above mentioned risk management measures (RMM) related to environmental water emissions is unknown. EUROCHLOR (personal communication) reports the use of on-site WWTP but removal efficiency is not known.

By default, the generic exposure scenario where the wastewater is treated on-site but followed by a biological treatment (e.g.; a municipal STP is also considered. The fraction of mercury removed by an STP is set at 76% (CBS, 2008). Furthermore, by default, the sludge from a municipal STP is applied to agricultural soil.

Air emissions

Air emissions consist of mercury vapour coming from:

- cell-room ventilation
- process exhausts
- brine purification
- stack of caustic evaporators
- hydrogen burnt or vented to atmosphere
- mercury retorting
- maintenance outside cell room

Mercury is removed by:

- scrubbing with hypochlorite, chlorinated brine or using a calomel reaction, or
- using a sulphurised charcoal system.

The removal efficiency of the RMM is not reported neither is the percentage of sites that implement one of the above mentioned risk management measures (RMM) related to environmental air emissions known.

Organizational measures to prevent/limit release from site

No specific organizational measures were considered.

Conditions and measures related to municipal sewage treatment plant

STP removal rate for mercury was set at 76 % (CBS, 2008).

Conditions and measures related to external treatment of waste for disposal

Solid wastes can arise at several points in the process. Wastes containing mercury include: sludges from waste water treatment, solids generated during brine purification (filter residue), spent graphite from decomposer cells, sludges from caustic filters (spent caustic filters from the filtration of caustic solution such as graphite candles), etc.

Mercury-bearing wastes resulting from the processes described above is removed by a licensed waste removal company and landfilled after stabilization, incinerated, or recycled for reuse.

Conditions and measures related to external recovery of waste

No specific data is available.

3.4 Exposure estimation and reference to its source

Occupational exposure

In the Column "Urinary mercury levels" below, the 90th percentile of the measured urinary mercury levels is provided. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For urinary mercury levels, the RCR is based on a DNEL for 30 µg Hg/g creatinine in urine.

Workplace	Method used for exposure assessment (refer to introduction)	Urinary mercury levels (RCR)	Method used for inhalation exposure assessment (refer to introduction)	Method used for dermal exposure assessment (refer to introduction)
Chlor-alkali process	approximated from aggregated measured data	< 30 µg Hg/g creatinine (< 1)	not relevant because urinary mercury levels integrate all relevant paths of exposure	

Environmental emissions

Compartment	Value	Unit	Justification
Environmental release factor to aquatic (before on-site STP)	0.02	g Hg/tonnes Cl_2 capacity	Median release factor reported by company
Environmental release factor to air (before APC)	0.3	g Hg/tonnes Cl_2 capacity	BAT release factor
PEC_{local} in aquatic pelagic (freshwater to STP)	0.032	µg Hg/L	C_{local} of 0.0044 µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
PEC_{local} in aquatic pelagic (freshwater with direct discharge)	0.046	µg Hg/L	C_{local} of 0.0182 µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
PEC_{local} in aquatic pelagic (marine)	0.021	mg Hg/L	C_{local} of 0.0182 mg Hg/L and a $PEC_{regional}$ of 0.003 mg Hg/L
PEC_{local} in sediment (freshwater to STP)	1.03	mg/kg dw	C_{local} of 0.73 mg Hg/kg dw and a $PEC_{regional}$ of 0.3 mg Hg/kg dw
PEC_{local} in sediment (freshwater with direct discharge)	3.35	mg/kg dw	C_{local} of 3.05 mg Hg/kg dw and a $PEC_{regional}$ of 0.3 mg Hg/kg dw
PEC_{local} in sediment (marine)	3.15	mg/kg dw	C_{local} of 3.05 mg Hg/kg dw and a $PEC_{regional}$ of 0.1 mg Hg/kg dw
PEC_{added} in soil (direct discharge)	0.0126	mg Hg/kg dw	C_{local} of 0.0017 mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC_{added} in soil (STP without sludge application)	0.0195	mg Hg/kg dw	C_{local} of 0.0017 mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC in STP	1.55	µg Hg/L	Calculated effluent concentration in on-site WWTP: 6 µg/L
PEC_{total} air	47.2	ng Hg/m^3	C_{local} of 44.2 ng Hg/m^3 and a $PEC_{regional}$ of 3.0 ng/m^3

3.5 Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Occupational exposure

The DU works inside the boundaries set by the ES if either the proposed risk management measures as described above are met or the downstream user can demonstrate on his own that his implemented risk management measures are adequate (given that the processes, operational conditions and activities in question are covered by the PROCs listed above). This has to be done by showing that they limit the exposure (reflected in urinary mercury levels) to a level below the respective DNEL as given below:

DNEL for workers: 30 µg Hg/g creatinine in urine

Additionally, the scientific committee on occupational exposure limits has set the following limit values, which can also be used when assessing exposure:

DNEL for workers: 10 µg Hg/L blood

DNEL for workers: 0.02 mg Hg/m^3 air

3.6 Risk characterisation

Environment

Compartment	PEC	PNEC	RCR	Justification
Aquatic pelagic (freshwater to STP)	0.032	0.057	0.56	C_{local} of 0.0044 µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
Aquatic pelagic (freshwater with direct discharge)	0.046	0.057	0.80	C_{local} of 0.0182 µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
Aquatic pelagic (marine)	0.021	0.067	0.32	C_{local} of 0.0182 µg Hg/L and a $PEC_{regional}$ of 0.003 µg Hg/L
PEC_{local} in sediment (freshwater to STP)	1.03	9.3	0.11	C_{local} of 0.73 mg Hg/kg dw and a $PEC_{regional}$ of 0.3 mg Hg/kg dw
PEC_{local} in sediment (freshwater with direct discharge)	3.35	9.3	0.36	C_{local} of 3.05 mg Hg/kg dw and a $PEC_{regional}$ of 0.3 mg Hg/kg dw
PEC_{local} in sediment (marine)	3.15	9.3	0.34	C_{local} of 3.05 mg Hg/kg dw and a $PEC_{regional}$ of 0.1 mg Hg/kg dw
Soil (direct discharge)	0.0126	0.022 (added)	0.57	C_{local} of 0.0017 mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
Soil (STP without sludge application)	0.0195	0.022 (added)	0.89	C_{local} of 0.0017 mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
Sewage	1.55	2.25	0.69	Selected for freshwater ES to STP

IU 4 Production of mercury dispensers for discharge lamps

Exposure Scenario Format (1) addressing uses carried out by workers	
4.1 Title	
Free short title	Manufacture of mercury dispensers for discharge lamps
Systematic title based on use descriptor	SU 3 (industrial uses), SU 15 PC 7 AC2 (appropriate PROCs and ERCs are given below)
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described below.
4.2 Operational conditions and risk management measures	
Brief description of overall operational conditions referring to process categories (PROC) and environmental release categories (ERC)	

ERC number	Name	Description	Level of containment	Dispersion of emission sources	Indoor/outdoor
ERC 3	Formulation in materials	Mixing or blending of substances, which will be physically or chemically bound into or onto a matrix (material) such as plastics additives in master batches or plastic compounds. For instance a plasticizers or stabilizers in PVC master-batches or products, crystal growth regulator in photographic films etc.	Open/closed	Industrial	Indoor

Number of sites using the substance (potentially required to demonstrate strictly controlled conditions of use to justify waiving of information according to Annex XI of REACH)

Workplace	Involved tasks	Involved PROCs
Mercury handling	delivery (mercury in bottles), weighing, filling of reaction vessel	8b, 9
Formulation, pre-treatment	thermal cycle in a chamber of the resistance oven	2, 4, 22
Mechanical processing	grinding, milling, bonding (by compression) onto metal strip, cutting of strips, forming	4, 14, 24
Lamp production	dosing liquid mercury in the lamp or placing mercury capsule in the lamp	9, 21
Handling of lamps / recycling of lamps	packaging of lamps, unloading of end-of-life-lamps, loading of the feeder in the recycling unit, disassembly of lamps	21
Logistics	internal logistics, also including administration, R&D, supervision	8b, 9, 21
Cleaning, maintenance and handling of waste	overhaul and cleaning of production equipment, maintenance	8a, 8b

4.3 Contributing exposure scenarios

4.3.1 Control of workers exposure

Product characteristic

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature the fugacity is based on the dustiness of that substance. Whereas in hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, high abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. The spraying of aqueous solutions is assumed to be involved with a medium emission.

Workplace	Use in preparation	Content in preparation	Physical form	Emission potential
Mercury handling	not restricted		liquid	low
Formulation, pre-treatment	not restricted		liquid	low (high for hot processes)
Mechanical processing	not restricted		massive / powder	very low - high
Lamp production	not restricted		liquid or massive	very low - low
Handling of lamps / recycling of lamps	article	<300 mg Hg in the lamps or 0.001 wt.% Hg	massive	very low
Logistics	not restricted		liquid	low
Cleaning, maintenance and handling of waste	not restricted		liquid	low

Amounts used

The actual tonnage handled per shift is not considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure

Workplace	Duration of exposure
Mercury handling	not restricted
Formulation, pre-treatment	
Mechanical processing	
Lamp production	
Handling of lamps / recycling of lamps	
Logistics	
Cleaning, maintenance and handling of waste	

Human factors not influenced by risk management

The shift breathing volume during all process steps is assumed to be 10 m3/shift (8 hours).

Refer to occupational hygiene measures as described below (under "Organisational measures") which influence the variation in urinary mercury levels.

Other given operational conditions affecting workers exposure

Workplace	Room volume	Indoor or outdoor use	Process temperature	Process pressure
Mercury handling	> 1,000 m^3	indoors	ambient	not restricted
Formulation, pre-treatment	> 1,000 m^3	indoors	ambient – high temperature	not restricted
Mechanical processing	> 1,000 m^3	indoors	ambient	not restricted
Lamp production	> 1,000 m^3	indoors	ambient	not restricted
Handling of lamps / recycling of lamps	not restricted	indoors	ambient	not restricted
Logistics		indoors	ambient	not restricted
Cleaning, maintenance and handling of waste		indoors	ambient	not restricted

Technical conditions and measures at process level (source) to prevent release		
Workplace	**Level of containment**	**Level of segregation**
Mercury handling	weighing and batch preparation in a glove box	not required
Formulation, pre-treatment	hermetically sealed vessel, placed in a secondary chamber (furnace)	not required
Mechanical processing	operation under controlled atmosphere	not required
Lamp production	closed process (sealed conditions) during dosing, glove box	not required
Handling of lamps / recycling of lamps	not required	not required
Logistics	not required	not required
Cleaning, maintenance and handling of waste	not required	not required

Technical conditions and measures to control dispersion from source towards the worker

Engineering and ventilation controls: basic aspects of equipment and facility design should be such that mercury emissions that may contribute to occupational exposures are minimised. Such measures may include enclosure of process equipment such that sources of dust or aerosol emissions are minimised, negative draft exhaust systems to reduce emissions from enclosures and/or local exhaust ventilation installed at unavoidable sources of process emissions. The design characteristics of any local exhaust ventilation (e.g. exhaust hoods) will be specific to the emission source being controlled. Area ventilation should also be balanced such that air flow within a work area moves from areas of low to high exposure potential. Air captured by ventilation controls may require treatment to minimise toxic substances prior to discharge or recirculation. Details on technical measures to control exposure are given below on a workplace basis.

Workplace	Level of separation	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
Mercury handling	Any potentially required separation of workers from the emission source is indicated above under "Frequency and duration of exposure". A reduction of exposure duration can be achieved, for example, by the installation of ventilated (positive pressure) control rooms or by removing the worker from workplaces involved with relevant exposure.	local exhaust ventilation, the chamber is valved off and equipped with a cold trap	10 ACH	-
Formulation, pre-treatment				-
Mechanical processing		dust/vapour extractor with dust/vapour collector	10 ACH	-
Lamp production		local exhaust ventilation	78 %	fully automated operation
Handling of lamps / recycling of lamps		local exhaust ventilation	78 %	manual operation for the handling of lamps, recycling is conducted in fully automated processes
Logistics		not required	n.a.	-
Cleaning, maintenance and handling of waste		local exhaust ventilation	78 %	-

Organisational measures to prevent /limit releases, dispersion and exposure

In this section, non-technical measures related to good housekeeping, personal hygiene and to a good culture of occupational hygiene in general are described. Additionally, it is described how exposure to mercury can be assessed based on bio-monitoring and which strategies could be followed for such monitoring to protect worker's health. It is noted that the "Code of Practice" originally developed for the chlor-alkali industry (EUROCHLOR, 2010) has served as a basis to derive the measures as described below. The full text can be downloaded from the EUROCHLOR website.

Creating a culture of safety: Define and communicate a clear policy for controlling occupational exposure to mercury; Ensure managers set the example in terms of personal protection and hygiene; Where possible involve occupational physicians in making workers take control of their own urine mercury levels; Consider making low urine mercury levels a condition of employment, with disciplinary action taken where protective equipment and hygiene procedures are not followed; Involve managers when workers' urine mercury levels exceed action levels; Consider publicising company urine mercury performance to workers via notices and briefings to ensure the topic remains a key priority; Provide detailed training for new personnel on the risks of mercury exposure and the procedures for protection; Provide instruction on specific mercury exposure risks for workers undertaking new tasks; Provide regular refresher courses for all employees on the risks of mercury exposure and the procedures for protection; Involve worker representatives.

Cleaning: Ensure general shop cleanliness is maintained by frequent washing/vacuuming. Clean every workplace at the end of every shift. Ensure adequate lighting to easily locate and appropriately remove any potential mercury spills.

Personal protective equipment: Assess the need to wear respiratory protective equipment (RPE) in production areas. Consider use effective masks accompanied by a compliance policy (ensure proper shaving; ensure workers do not remove RPE in production areas in order to communicate). Where masks are used, employ formal mask cleaning and filter changing strategies; For workers in areas of significant exposure, provide sufficient working clothes to enable daily change into clean clothes. In such cases all work clothing should be cleaned by the employer on a daily basis and is not permitted to leave the work site. Please also consult the section on personal protective equipment below for detailed information on PPE for specific workplaces, processes or tasks.

Personal hygiene: Ensure workers follow simple hygiene rules (e.g. do not bite nails and keep them cut short, avoid touching or scratching face with dirty hands or gloves); Ensure workers do not wipe away sweat with hands or arms, e.g. by providing disposable perspiration towels; Ensure workers use disposable tissues rather than a handkerchief; Prohibit drinking, eating and smoking in production areas; Prevent access to eating and non-production areas in working clothes; Ensure workers as a minimum wash hands, arms, faces and mouths (but preferably shower) and change into personal clothing (or clean coveralls provided by the company) before entering eating areas; For high exposure workplaces, at the end of a shift, workers may need to pass through a room containing washbasins for the cleaning of hands, followed by a 'dirty' room for the removal of working clothes, then through showers into a 'clean' room for changing into personal clothing; Ensure workers handle dirty working clothes with care; Consider making showering obligatory at the end of a shift, and provide towels and soap; Allow no personal belongings to be taken into production areas, and allow no items that have been used in production areas to be taken home.

Urine mercury monitoring: The measurement of mercury in urine (HgU) is considered to be the best determinant of mercury body burden following long-term exposure. Mercury urinary figures reflect the exposure of the 3 or 4 previous months due to the relatively slow elimination of mercury from the human body. The aim of the recommended monitoring programme is for all individual HgU samples to be always below 30 µg/g creatinine. The frequency of testing should be increased if the levels of mercury in urine increase. For individuals with HgU above 20 µg/g creatinine, testing frequency should be at least 4 times a year, depending on the pattern of exposure. When levels are below 20 µg Hg/g creatinine, the testing frequency should mainly be determined by any changes in the working environment, with a minimum of 2 times a year.

Conditions and measures related to personal protection, hygiene and health evaluation

Workplace	Specification of respiratory protective equipment (RPE)	RPE efficiency (assigned protection factor, APF)	Specification of gloves	Further personal protective equipment (PPE)
Mercury handling	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	standard working clothes (overall) and safety shoes
Formulation, pre-treatment	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	
Mechanical processing	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	
Lamp production	not required	na	gloves are optional for process steps at ambient temperature	
Handling of lamps / recycling of lamps	not required	na		
Logistics	not required	na		
Cleaning, maintenance and handling of waste	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	

Any RPE as defined above shall only be worn if the following principles are implemented in parallel: The duration of work (compare with "duration of exposure" above) should reflect the additional physiological stress for the worker due to the breathing resistance and mass of the RPE itself, due to the increased thermal stress by enclosing the head. In addition, it shall be considered that the worker's capability of using tools and of communicating are reduced during the wearing of RPE.

For reasons as given above, the worker should therefore be (i) healthy (especially in view of medical problems that may affect the use of RPE), (ii) have suitable facial characteristics reducing leakages between face and mask (in view of scars and facial hair). The recommended devices above which rely on a tight face seal will not provide the required protection unless they fit the contours of the face properly and securely.

The employer and self-employed persons have legal responsibilities for the maintenance and issue of respiratory protective devices and the management of their correct use in the workplace. Therefore, they should define and document a suitable policy for a respiratory protective device programme including training of the workers.

An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE.

4.3.2 Control of environmental exposure

Product characteristics

Mercury is used in liquid form.

Amounts used

Exposure Scenarios based on 12.7 tonnes/yr at a maximum RCR of 1 (See section 10.1)

Information type	Site tonnage (tonnes)
Data points	1
Value	12.7
Selected for Generic Exposure Scenario	120

Frequency and duration of use

Production occurs 220 days per year per site (median 50th %)

Information type	Emission days to water per site (d/y)	Emission days to air per site (d/y)
Selected for Generic Exposure Scenario	0 (not applicable)	228

Environment factors not influenced by risk management

No exposure scenario for the water compartment was build as there are no emissions to water.

Other given operational conditions affecting environmental exposure

For the exposure scenario a tonnage of 12.7 tonnes is used. Mercury is emitted to the environment via the air (stack and diffuse air emissions). As the manufacturing process is a dry procedure, there are no emissions to water.

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk management measures (RMM) related to the environment are implemented by the site.

For emissions to water:

As there are no emissions to wastewater, RMM for the water compartment are not relevant for this sector.

Emissions to air

A synopsis of the applied measures in the sector is summarized in the following table. The reported removal efficiency for cold trap and fabric or bag filters is reported as 99.9 %.

Table Percentage of companies where the following RMMs related to air emissions are implemented

Risk management measure	Applied
Cold trap	100%
Fabric or bag filters	100%

Organizational measures to prevent/limit release from site

No specific organizational measures were considered.

Conditions and measures related to municipal sewage treatment plant

None.

Conditions and measures related to external treatment of waste for disposal

Detailed information on the amount of mercury substances in waste, type of waste, type of external treatment, fractions of substances released into the environment was not provided. However, waste removal to off-site location is reported.

Conditions and measures related to external recovery of waste

No specific data is available.

Additional good practice advice (for environment) beyond the REACH CSA
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH, Thus, the downstream user is not obliged to 1. carry out an own CSA and v) ii) to notify the use to the Agency, if he does not implement these measures.
Use specific measures expected to reduce the predicted exposure beyond the level estimated based on the exposure scenario.

4.4 Exposure estimation and reference to its source

Occupational exposure

In the Column "Urinary mercury levels" below, the 90th percentile of the measured urinary mercury levels is provided. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For urinary mercury levels, the RCR is based on a DNEL for 30 µg Hg/g creatinine in urine.

Workplace	**Method used for exposure assessment (refer to introduction)**	**Urinary mercury levels (RCR)**	**Method used for inhalation exposure assessment (refer to introduction)**	**Method used for dermal exposure assessment (refer to introduction)**
Mercury handling	measured data	8.2 µg Hg/g creatinine (0.27)	not relevant because urinary mercury levels integrate all relevant paths of exposure	
Formulation, pre-treatment	measured data	4.3 µg Hg/g creatinine (0.14)		
Mechanical processing	measured data	5.0 µg Hg/g creatinine (0.17)		
Lamp production	measured data	2.8 µg Hg/g creatinine (0.09)		
Handling of lamps / recycling of lamps	measured data	1.3 µg Hg/g creatinine (0.04)		
Logistics	measured data	3.3 µg Hg/g creatinine (0.11)		
Cleaning, maintenance and handling of waste	measured data	2.5 µg Hg/g creatinine (0.08)		

Environmental emissions

Compartment	**Value**	**Unit**	**Justification**
Environmental release factor to air (before APC)	1.022	g Hg/tonnes	Reported by company
PEC_{added} in soil	$4.35 * 10^{-5}$	mg Hg/kg dw	C_{local} of $4.35 * 10^{-5}$ mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC_{total} air	3.01	ng Hg/m³	C_{local} of $9.87 * 10^{-3}$ Hg/m³ and a $PEC_{regional}$ of 3.0 ng/m³

4.5 Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Occupational exposure

The DU works inside the boundaries set by the ES if either the proposed risk management measures as described above are met or the downstream user can demonstrate on his own that his implemented risk management measures are adequate (given that the processes, operational conditions and activities in question are covered by the PROCs listed above). This has to be done by showing that they limit the exposure (reflected in urinary mercury levels) to a level below the respective DNEL as given below:

DNEL for workers: 30 µg Hg/g creatinine in urine

Additionally, the scientific committee on occupational exposure limits has set the following limit values, which can also be used when assessing exposure:

DNEL for workers: 10 µg Hg/L blood

DNEL for workers: 0.02 mg Hg/m³ air

4.6 Risk characterisation

Environment

Compartment	**PEC**	**PNEC**	**RCR**	**Justification**
Soil (direct discharge)	$4.35 * 10^{-5}$	0.022 (added)	$1.98 * 10^{-4}$	C_{local} of $4.35 * 10^{-5}$mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw

IU 5 Production of gas discharge lamps

Exposure Scenario Format (1) addressing uses carried out by workers	
5.1 Title	
Free short title	Manufacture and use of mercury for the production of gas discharge lamps
Systematic title based on use descriptor	PC 7 SU 3 (industrial uses), SU 16 AC2 (appropriate PROCs and ERCs are given in Section 2 below)
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described below.

5.2 Operational conditions and risk management measures

Brief description of overall operational conditions referring to process categories (PROC) and environmental release categories (ERC)

ERC number	Name	Description	Level of containment	Dispersion of emission sources	Indoor/outdoor
ERC 3	Formulation in materials	Mixing or blending of substances, which will be physically or chemically bound into or onto a matrix (material) such as plastics additives in master batches or plastic compounds. For instance a plasticizers or stabilizers in PVC master-batches or products, crystal growth regulator in photographic films etc.	Open/closed	Industrial	Indoor

Number of sites using the substance (potentially required to demonstrate strictly controlled conditions of use to justify waiving of information according to Annex XI of REACH)

Workplace	Involved tasks	Involved PROCs
Mercury handling	delivery (mercury in bottles), weighing, filling of reaction vessel	8b, 9
Formulation, pre-treatment	thermal cycle in a chamber of the resistance oven	2, 4, 22
Mechanical processing	grinding, milling, bonding (by compression) onto metal strip, cutting of strips, forming	4, 14, 24
Lamp production	dosing liquid mercury in the lamp or placing mercury capsule in the lamp	9, 21
Handling of lamps / recycling of lamps	packaging of lamps, unloading of end-of-life-lamps, loading of the feeder in the recycling unit, disassembly of lamps	21
Logistics	internal logistics, also including administration, R&D, supervision	8b, 9, 21
Cleaning, maintenance and handling of waste	overhaul and cleaning of production equipment, maintenance	8a, 8b

5.3 Contributing exposure scenarios

5.3.1 Control of workers exposure

Product characteristic

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature the fugacity is based on the dustiness of that substance. Whereas in hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, high abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. The spraying of aqueous solutions is assumed to be involved with a medium emission.

Workplace	Use in preparation	Content in preparation	Physical form	Emission potential
Mercury handling	not restricted		liquid	low
Formulation, pre-treatment	not restricted		liquid	low (high for hot processes)
Mechanical processing	not restricted		massive / powder	very low - high
Lamp production	not restricted		liquid or massive	very low - low
Handling of lamps / recycling of lamps	article	<300 mg Hg in the lamps or 0.001 wt.% Hg	massive	very low
Logistics	not restricted		liquid	low
Cleaning, maintenance and handling of waste	not restricted		liquid	low

Amounts used

The actual tonnage handled per shift is not considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure

Workplace	Duration of exposure
Mercury handling	not restricted
Formulation, pre-treatment	
Mechanical processing	
Lamp production	
Handling of lamps / recycling of lamps	
Logistics	
Cleaning, maintenance and handling of waste	

Human factors not influenced by risk management

The shift breathing volume during all process steps is assumed to be 10 m3/shift (8 hours).

Refer to occupational hygiene measures as described below (under “Organisational measures”) which influence the variation in urinary mercury levels.

Other given operational conditions affecting workers exposure

Workplace	Room volume	Indoor or outdoor use	Process temperature	Process pressure
Mercury handling	> 1,000 m^3	indoors	ambient	not restricted
Formulation, pre-treatment	> 1,000 m^3	indoors	ambient – high temperature	not restricted
Mechanical processing	> 1,000 m^3	indoors	ambient	not restricted
Lamp production	> 1,000 m^3	indoors	ambient	not restricted
Handling of lamps / recycling of lamps	not restricted	indoors	ambient	not restricted
Logistics		indoors	ambient	not restricted
Cleaning, maintenance and handling of waste		indoors	ambient	not restricted

Technical conditions and measures at process level (source) to prevent release		
Workplace	**Level of containment**	**Level of segregation**
Mercury handling	weighing and batch preparation in a glove box	not required
Formulation, pre-treatment	hermetically sealed vessel, placed in a secondary chamber (furnace)	not required
Mechanical processing	operation under controlled atmosphere	not required
Lamp production	closed process (sealed conditions) during dosing, glove box	not required
Handling of lamps / recycling of lamps	not required	not required
Logistics	not required	not required
Cleaning, maintenance and handling of waste	not required	not required

Technical conditions and measures to control dispersion from source towards the worker

Engineering and ventilation controls: basic aspects of equipment and facility design should be such that mercury emissions that may contribute to occupational exposures are minimised. Such measures may include enclosure of process equipment such that sources of dust or aerosol emissions are minimised, negative draft exhaust systems to reduce emissions from enclosures and/or local exhaust ventilation installed at unavoidable sources of process emissions. The design characteristics of any local exhaust ventilation (e.g. exhaust hoods) will be specific to the emission source being controlled. Area ventilation should also be balanced such that air flow within a work area moves from areas of low to high exposure potential. Air captured by ventilation controls may require treatment to minimise toxic substances prior to discharge or recirculation. Details on technical measures to control exposure are given below on a workplace basis.

Workplace	**Level of separation**	**Localised controls (LC)**	**Efficiency of LC (according to MEASE)**	**Further information**
Mercury handling	Any potentially required separation of workers from the emission source is indicated above under “Frequency and duration of exposure”. A reduction of exposure duration can be achieved, for example, by the installation of ventilated (positive pressure) control rooms or by removing the worker from workplaces involved with relevant exposure.	local exhaust ventilation, the chamber is valved off and equipped with a cold trap	10 ACH	-
Formulation, pre-treatment				-
Mechanical processing		dust/vapour extractor with dust/vapour collector	10 ACH	-
Lamp production		local exhaust ventilation	78 %	fully automated operation
Handling of lamps / recycling of lamps		local exhaust ventilation	78 %	manual operation for the handling of lamps, recycling is conducted in fully automated processes
Logistics		not required	n.a.	-
Cleaning, maintenance and handling of waste		local exhaust ventilation	78 %	-

Organisational measures to prevent /limit releases, dispersion and exposure

In this section, non-technical measures related to good housekeeping, personal hygiene and to a good culture of occupational hygiene in general are described. Additionally, it is described how exposure to mercury can be assessed based on bio-monitoring and which strategies could be followed for such monitoring to protect worker's health. It is noted that the "Code of Practice" originally developed for the chlor-alkali industry (EUROCHLOR, 2010) has served as a basis to derive the measures as described below. The full text can be downloaded from the EUROCHLOR website.

<u>Creating a culture of safety</u>: Define and communicate a clear policy for controlling occupational exposure to mercury; Ensure managers set the example in terms of personal protection and hygiene; Where possible involve occupational physicians in making workers take control of their own urine mercury levels; Consider making low urine mercury levels a condition of employment, with disciplinary action taken where protective equipment and hygiene procedures are not followed; Involve managers when workers' urine mercury levels exceed action levels; Consider publicising company urine mercury performance to workers via notices and briefings to ensure the topic remains a key priority; Provide detailed training for new personnel on the risks of mercury exposure and the procedures for protection; Provide instruction on specific mercury exposure risks for workers undertaking new tasks; Provide regular refresher courses for all employees on the risks of mercury exposure and the procedures for protection; Involve worker representatives.

<u>Cleaning</u>: Ensure general shop cleanliness is maintained by frequent washing/vacuuming. Clean every workplace at the end of every shift. Ensure adequate lighting to easily locate and appropriately remove any potential mercury spills.

<u>Personal protective equipment</u>: Assess the need to wear respiratory protective equipment (RPE) in production areas. Consider use effective masks accompanied by a compliance policy (ensure proper shaving; ensure workers do not remove RPE in production areas in order to communicate). Where masks are used, employ formal mask cleaning and filter changing strategies; For workers in areas of significant exposure, provide sufficient working clothes to enable daily change into clean clothes. In such cases all work clothing should be cleaned by the employer on a daily basis and is not permitted to leave the work site. Please also consult the section on personal protective equipment below for detailed information on PPE for specific workplaces, processes or tasks.

<u>Personal hygiene</u>: Ensure workers follow simple hygiene rules (e.g. do not bite nails and keep them cut short, avoid touching or scratching face with dirty hands or gloves); Ensure workers do not wipe away sweat with hands or arms, e.g. by providing disposable perspiration towels; Ensure workers use disposable tissues rather than a handkerchief; Prohibit drinking, eating and smoking in production areas; Prevent access to eating and non-production areas in working clothes; Ensure workers as a minimum wash hands, arms, faces and mouths (but preferably shower) and change into personal clothing (or clean coveralls provided by the company) before entering eating areas; For high exposure workplaces, at the end of a shift, workers may need to pass through a room containing washbasins for the cleaning of hands, followed by a 'dirty' room for the removal of working clothes, then through showers into a 'clean' room for changing into personal clothing; Ensure workers handle dirty working clothes with care; Consider making showering obligatory at the end of a shift, and provide towels and soap; Allow no personal belongings to be taken into production areas, and allow no items that have been used in production areas to be taken home.

<u>Urine mercury monitoring</u>: The measurement of mercury in urine (HgU) is considered to be the best determinant of mercury body burden following long-term exposure. Mercury urinary figures reflect the exposure of the 3 or 4 previous months due to the relatively slow elimination of mercury from the human body. The aim of the recommended monitoring programme is for all individual HgU samples to be always below 30 µg/g creatinine. The frequency of testing should be increased if the levels of mercury in urine increase. For individuals with HgU above 20 µg/g creatinine, testing frequency should be at least 4 times a year, depending on the pattern of exposure. When levels are below 20 µg Hg/g creatinine, the testing frequency should mainly be determined by any changes in the working environment, with a minimum of 2 times a year.

Conditions and measures related to personal protection, hygiene and health evaluation

Workplace	Specification of respiratory protective equipment (RPE)	RPE efficiency (assigned protection factor, APF)	Specification of gloves	Further personal protective equipment (PPE)
Mercury handling	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	standard working clothes (overall) and safety shoes
Formulation, pre-treatment	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	
Mechanical processing	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	
Lamp production	not required	na	gloves are optional for process steps at ambient temperature	
Handling of lamps / recycling of lamps	not required	na		
Logistics	not required	na		
Cleaning, maintenance and handling of waste	half and full face mask with Hg vapour filter HgP3 EN14387	APF=10	latex and nitrile gloves	

Any RPE as defined above shall only be worn if the following principles are implemented in parallel: The duration of work (compare with "duration of exposure" above) should reflect the additional physiological stress for the worker due to the breathing resistance and mass of the RPE itself, due to the increased thermal stress by enclosing the head. In addition, it shall be considered that the worker's capability of using tools and of communicating are reduced during the wearing of RPE.

For reasons as given above, the worker should therefore be (i) healthy (especially in view of medical problems that may affect the use of RPE), (ii) have suitable facial characteristics reducing leakages between face and mask (in view of scars and facial hair). The recommended devices above which rely on a tight face seal will not provide the required protection unless they fit the contours of the face properly and securely.

The employer and self-employed persons have legal responsibilities for the maintenance and issue of respiratory protective devices and the management of their correct use in the workplace. Therefore, they should define and document a suitable policy for a respiratory protective device programme including training of the workers.

An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE.

5.3.2 Control of environmental exposure

Product characteristics

Mercury is used in liquid form.

Amounts used

Exposure Scenarios based on 4 tonnes/yr at a maximum RCR of 1 (See section 10.1)

Information type	Site tonnage (tonnes Cl)
Data points	2
Median	2.5
Min	1
Max	4
Selected for Generic Exposure Scenario	4

Frequency and duration of use

Production occurs 220 days per year per site (median 50^{th} %)

Information type	Emission days to water per site (d/y)	Emission days to air per site (d/y)
Data points	1	2
Median	200	267
Min	200	200
Max	200	333
Selected for Generic Exposure Scenario	200	267

Environment factors not influenced by risk management

A default dilution factor of 10 is taken into account for the freshwater compartment after STP.

Other given operational conditions affecting environmental exposure

One site discharges its wastewater to an on-site WWTP with an effluent flow of 3 m^3/week (i.e. 0.43 m^3/day); which then discharges to a community sewer system (STP). For the other site wastewater emissions are not relevant since there is no mercury released to wastewater during the process. This scenario automatically covers sites not discharging to wastewater.

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Following risk management measures (RMM), related to the environment, are implemented by the sites:

For emissions to water:

- Chemical precipitation
- Ultra filtration

An overview of the applied measures is summarized in the following table. The removal efficiency of the chemical precipitation and ultra filtration are both 99.9 % for one of the sites. An automatic sewage compartment captures any accidental spillage of pollutant substances. For those having water emissions, 100 % of the gas discharge lamp production sites report an on-site WWTP.

Table: Percentage of companies where the following RMMs related to water emissions are implemented

Risk management measure	Applied
On-site Waste Water Treatment Plant	100 %
Chemical precipitation	100 %
Ultra filtration	100 %

In the actual exposure scenario where the wastewater is not only treated on-site but is followed by a biological treatment (municipal STP), the fraction of mercury removed by the STP is set at 76 % (CBS, 2008). Furthermore, by default, the sludge from a municipal STP is applied to agricultural soil.

Emissions to air

The production sites implement the measures as stated in the following table. The removal efficiency of the active carbon filters is reported to range between 95.0 and 99.9 %. Both sites implemented an active carbon filter.

Table: Percentage of companies where the following RMMs related to air emissions are implemented

Risk management measure	Applied
Active carbon filters	100%

Organizational measures to prevent/limit release from site

No specific organizational measures were considered.

Conditions and measures related to municipal sewage treatment plant

STP removal rate for mercury was set at 76 % (CBS, 2008).

Conditions and measures related to external treatment of waste for disposal
Detailed information on the amount of mercury substances in waste, type of waste, type of external treatment and fractions of substances released into the environment, was not available. However, waste removal to an off-site location is reported. Waste is kept only on site for a very limited period of time in controlled conditions, until being collected by designated companies.
Conditions and measures related to external recovery of waste
No specific data is available.
Additional good practice advice (for environment) beyond the REACH CSA Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH, Thus, the downstream user is not obliged to i) carry out an own CSA and ii) ii) to notify the use to the Agency, if he does not implement these measures.
Use specific measures expected to reduce the predicted exposure beyond the level estimated based on the exposure scenario.

5.4 Exposure estimation and reference to its source

Occupational exposure

In the Column "Urinary mercury levels" below, the 90th percentile of the measured urinary mercury levels is provided. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For urinary mercury levels, the RCR is based on a DNEL for 30 µg Hg/g creatinine in urine.

Workplace	**Method used for exposure assessment (refer to introduction)**	**Urinary mercury levels (RCR)**	**Method used for inhalation exposure assessment (refer to introduction)**	**Method used for dermal exposure assessment (refer to introduction)**
Mercury handling	measured data	8.2 µg Hg/g creatinine (0.27)	not relevant because urinary mercury levels integrate all relevant paths of exposure	
Formulation, pre-treatment	measured data	4.3 µg Hg/g creatinine (0.14)		
Mechanical processing	measured data	5.0 µg Hg/g creatinine (0.17)		
Lamp production	measured data	2.8 µg Hg/g creatinine (0.09)		
Handling of lamps / recycling of lamps	measured data	1.3 µg Hg/g creatinine (0.04)		
Logistics	measured data	3.3 µg Hg/g creatinine (0.11)		
Cleaning, maintenance and handling of waste	measured data	2.5 µg Hg/g creatinine (0.08)		

Environmental emissions

Compartment	**Value**	**Unit**	**Justification**
Environmental release factor to aquatic (before on-site STP)	0.22	g Hg/tonnes	Maximum release factor reported by company
Environmental release factor to air (before APC)	8,000	g Hg/tonnes	Maximum release factor reported by companies
PEC_{local} in aquatic pelagic (freshwater to STP)	0.028	µg Hg/L	C_{local} of $1.45 * 10^{-5}$ µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
PEC_{local} in sediment (freshwater to STP)	0.30	mg/kg dw	C_{local} of $2.43 * 10^{-3}$ mg Hg/kg dw and a $PEC_{regional}$ of 0.3 mg Hg/kg dw
PEC_{added} in soil (STP with sludge application)	0.0108	mg Hg/kg dw	C_{local} of 0.0108 mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC_{added} in soil (STP without sludge application)	0.0107	mg Hg/kg dw	C_{local} of 0.0107 mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC in STP	0.51	ng Hg/L	Measured effluent concentration in on-site WWTP: 0.01 mg/L
PEC_{total} air	9.1	ng Hg/m^3	C_{local} of 6.1 ng Hg/m^3 and a $PEC_{regional}$ of 3.0 ng/m^3

5.5 Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Occupational exposure

The DU works inside the boundaries set by the ES if either the proposed risk management measures as described above are met or the downstream user can demonstrate on his own that his implemented risk management measures are adequate (given that the processes, operational conditions and activities in question are covered by the PROCs listed above). This has to be done by showing that they limit the exposure (reflected in urinary mercury levels) to a level below the respective DNEL as given below:

DNEL for workers: 30 µg Hg/g creatinine in urine

Additionally, the scientific committee on occupational exposure limits has set the following limit values, which can also be used when assessing exposure:

DNEL for workers: 10 µg Hg/L blood

DNEL for workers: 0.02 mg Hg/m³ air

5.6 Risk characterisation

Environment

Compartment	PEC	PNEC	RCR	Justification
Aquatic pelagic (freshwater to STP)	0.028	0.057	0.49	C_{local} of 1.45 * 10^{-5} µg Hg/L and a $PEC_{regional}$ of 0.028 µg Hg/L
PEC_{local} in sediment (freshwater to STP)	0.30	9.3	0.03	C_{local} of 2.43 * 10^{-3} µg Hg/L and a $PEC_{regional}$ of 0.300 µg Hg/L
Soil (STP with sludge application)	0.0108	0.022 (added)	0.49	C_{local} of 0.0108 µg Hg/L and a $PEC_{regional}$ of 0.037 µg Hg/L
Soil (STP without sludge application)	0.0107	0.022 (added)	0.49	C_{local} of 0.0107 µg Hg/L and a $PEC_{regional}$ of 0.037 µg Hg/L
Sewage	0.51	2.25	2.29 10^{-4}	

IU 6 Production of dental amalgam

Exposure Scenario Format (1) addressing uses carried out by workers

6.1 Title

Free short title	Formulation of dental amalgam
Systematic title based on use descriptor	SU 20, SU 0 (Formulation NACE C20.5.9 (Manufacture of other chemical products n.e.c.)), PC 0 (D25100: Dental products) AC 0 (TARIC 2805 40 90 (mercury – for use in dental amalgam)) (appropriate PROCs and ERCs are given below)
Processes, tasks and/or activities covered	Processes, tasks and/or activities covered are described below.

6.2 Operational conditions and risk management measures

Brief description of overall operational conditions referring to process categories (PROC) and environmental release categories (ERC)

ERC number	**Name**	**Description**	**Level of containment**	**Dispersion of emission sources**	**Indoor/outdoor**
ERC 3	Formulation in materials	Mixing or blending of substances, which will be physically or chemically bound into or onto a matrix (material) such as plastics additives in master batches or plastic compounds. For instance a plasticizers or stabilizers in PVC master-batches or products, crystal growth regulator in photographic films etc.	Open/closed	Industrial	Indoor

Number of sites using the substance (potentially required to demonstrate strictly controlled conditions of use to justify waiving of information according to Annex XI of REACH)

Workplace	**Involved tasks**	**Involved PROCs**
Mercury handling	receipt, decanting into machines for automated filling	8b, 9
Formulation / Filling of pillows/capsules	automatic filling and sealing into plastic pillows, sampling of pillows, if capsuled: mixing of mercury with alloy for quality control	3, 4, 5, 8b, 9
Packaging	packaging of pillows in sealed capsules or in plastic cans	21

6.3 Contributing exposure scenarios

6.3.1 Control of workers exposure

Product characteristic

According to the MEASE approach, the substance-intrinsic emission potential is one of the main exposure determinants. This is reflected by an assignment of a so-called fugacity class in the MEASE tool. For operations conducted with solid substances at ambient temperature the fugacity is based on the dustiness of that substance. Whereas in hot metal operations, fugacity is temperature based, taking into account the process temperature and the melting point of the substance. As a third group, high abrasive tasks are based on the level of abrasion instead of the substance intrinsic emission potential. The spraying of aqueous solutions is assumed to be involved with a medium emission.

Workplace	**Use in preparation**	**Content in preparation**	**Physical form**	**Emission potential**
Mercury handling	not restricted		liquid	low
Formulation / Filling of pillows/capsules	mercury and other amalgam constituents are kept in separate pillows (to be mixed by dental personnel)	not restricted	liquid	low
Packaging			solid/massive (pillows, capsules, plastic cans)	very low

Amounts used

The actual tonnage handled per shift is not considered to influence the exposure as such for this scenario. Instead, the combination of the scale of operation (industrial vs. professional) and level of containment/automation (as reflected in the PROCs and technical conditions) is the main determinant of the process-intrinsic emission potential.

Frequency and duration of use/exposure				
Workplace	**Duration of exposure**			
Mercury handling	< 15 minutes (approximately 10 flasks per shift)			
Formulation / Filling of pillows/capsules	not restricted			
Packaging				
Human factors not influenced by risk management				
The shift breathing volume during all process steps is assumed to be 10 m3/shift (8 hours). Refer to occupational hygiene measures as described below (under "Organisational measures") which influence the variation in urinary mercury levels.				
Other given operational conditions affecting workers exposure				
Workplace	**Room volume**	**Indoor or outdoor use**	**Process temperature**	**Process pressure**
Mercury handling	not restricted	indoors	ambient	not restricted
Formulation / Filling of pillows/capsules	not restricted	indoors		not restricted
Packaging	not restricted	indoors		not restricted
Technical conditions and measures at process level (source) to prevent release				
Workplace	**Level of containment**		**Level of segregation**	
Mercury handling	manual filling of automated apportioning machines		not required	
Formulation / Filling of pillows/capsules	closed apportioning machines		not required	
Packaging	not required		not required	
Technical conditions and measures to control dispersion from source towards the worker				
Engineering and ventilation controls: basic aspects of equipment and facility design should be such that mercury emissions that may contribute to occupational exposures are minimised. Such measures may include enclosure of process equipment such that sources of dust or aerosol emissions are minimised, negative draft exhaust systems to reduce emissions from enclosures and/or local exhaust ventilation installed at unavoidable sources of process emissions. The design characteristics of any local exhaust ventilation (e.g. exhaust hoods) will be specific to the emission source being controlled. Area ventilation should also be balanced such that air flow within a work area moves from areas of low to high exposure potential. Air captured by ventilation controls may require treatment to minimise toxic substances prior to discharge or recirculation. Details on technical measures to control exposure are given below on a workplace basis.				
Workplace	**Level of separation**	**Localised controls (LC)**	**Efficiency of LC (according to MEASE)**	**Further information**
Mercury handling	Any potentially required separation of workers from the emission source is indicated above under "Frequency and duration of exposure". A reduction of exposure duration can be achieved, for example, by the installation of ventilated (positive pressure) control rooms or by removing the worker from workplaces involved with relevant exposure.	local exhaust ventilation	78 %	-
Formulation / Filling of pillows/capsules		local exhaust ventilation, general exhaust ventilation at bottom	78 % 17 %	automatic apportioning and sealing of pillows/capsules
Packaging		not required	n.a.	-

Organisational measures to prevent /limit releases, dispersion and exposure
In this section, non-technical measures related to good housekeeping, personal hygiene and to a good culture of occupational hygiene in general are described. Additionally, it is described how exposure to mercury can be assessed based on bio-monitoring and which strategies could be followed for such monitoring to protect worker's health. It is noted that the "Code of Practice" originally developed for the chlor-alkali industry (EUROCHLOR, 2010) has served as a basis to derive the measures as described below. The full text can be downloaded from the EUROCHLOR website.
Creating a culture of safety: Define and communicate a clear policy for controlling occupational exposure to mercury; Ensure managers set the example in terms of personal protection and hygiene; Where possible involve occupational physicians in making workers take control of their own urine mercury levels; Consider making low urine mercury levels a condition of employment, with disciplinary action taken where protective equipment and hygiene procedures are not followed; Involve managers when workers' urine mercury levels exceed action levels; Consider publicising company urine mercury performance to workers via notices and briefings to ensure the topic remains a key priority; Provide detailed training for new personnel on the risks of mercury exposure and the procedures for protection; Provide instruction on specific mercury exposure risks for workers undertaking new tasks; Provide regular refresher courses for all employees on the risks of mercury exposure and the procedures for protection; Involve worker representatives.
Cleaning: Ensure general shop cleanliness is maintained by frequent washing/vacuuming. Clean every workplace at the end of every shift. Ensure adequate lighting to easily locate and appropriately remove any potential mercury spills.
Personal protective equipment: Assess the need to wear respiratory protective equipment (RPE) in production areas. Consider use effective masks accompanied by a compliance policy (ensure proper shaving; ensure workers do not remove RPE in production areas in order to communicate). Where masks are used, employ formal mask cleaning and filter changing strategies; For workers in areas of significant exposure, provide sufficient working clothes to enable daily change into clean clothes. In such cases all work clothing should be cleaned by the employer on a daily basis and is not permitted to leave the work site. Please also consult the section on personal protective equipment below for detailed information on PPE for specific workplaces, processes or tasks.
Personal hygiene: Ensure workers follow simple hygiene rules (e.g. do not bite nails and keep them cut short, avoid touching or scratching face with dirty hands or gloves); Ensure workers do not wipe away sweat with hands or arms, e.g. by providing disposable perspiration towels; Ensure workers use disposable tissues rather than a handkerchief; Prohibit drinking, eating and smoking in production areas; Prevent access to eating and non-production areas in working clothes; Ensure workers as a minimum wash hands, arms, faces and mouths (but preferably shower) and change into personal clothing (or clean coveralls provided by the company) before entering eating areas; For high exposure workplaces, at the end of a shift, workers may need to pass through a room containing washbasins for the cleaning of hands, followed by a 'dirty' room for the removal of working clothes, then through showers into a 'clean' room for changing into personal clothing; Ensure workers handle dirty working clothes with care; Consider making showering obligatory at the end of a shift, and provide towels and soap; Allow no personal belongings to be taken into production areas, and allow no items that have been used in production areas to be taken home.
Urine mercury monitoring: The measurement of mercury in urine (HgU) is considered to be the best determinant of mercury body burden following long-term exposure. Mercury urinary figures reflect the exposure of the 3 or 4 previous months due to the relatively slow elimination of mercury from the human body. The aim of the recommended monitoring programme is for all individual HgU samples to be always below 30 µg/g creatinine. The frequency of testing should be increased if the levels of mercury in urine increase. For individuals with HgU above 20 µg/g creatinine, testing frequency should be at least 4 times a year, depending on the pattern of exposure. When levels are below 20 µg Hg/g creatinine, the testing frequency should mainly be determined by any changes in the working environment, with a minimum of 2 times a year.

Conditions and measures related to personal protection, hygiene and health evaluation

Workplace	Specification of respiratory protective equipment (RPE)	RPE efficiency (assigned protection factor, APF)	Specification of gloves	Further personal protective equipment (PPE)
Mercury handling	HgP3	APF=10	gloves are optional for process steps at ambient temperature	standard working clothes (overall) and safety shoes
Formulation / Filling of pillows/capsules	not required	na		
Packaging	not required	na		

Any RPE as defined above shall only be worn if the following principles are implemented in parallel: The duration of work (compare with "duration of exposure" above) should reflect the additional physiological stress for the worker due to the breathing resistance and mass of the RPE itself, due to the increased thermal stress by enclosing the head. In addition, it shall be considered that the worker's capability of using tools and of communicating are reduced during the wearing of RPE.

For reasons as given above, the worker should therefore be (i) healthy (especially in view of medical problems that may affect the use of RPE), (ii) have suitable facial characteristics reducing leakages between face and mask (in view of scars and facial hair). The recommended devices above which rely on a tight face seal will not provide the required protection unless they fit the contours of the face properly and securely.

The employer and self-employed persons have legal responsibilities for the maintenance and issue of respiratory protective devices and the management of their correct use in the workplace. Therefore, they should define and document a suitable policy for a respiratory protective device programme including training of the workers.

An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE.

6.3.2 Control of environmental exposure

Product characteristics

Mercury is used in liquid form.

Amounts used

Exposure Scenarios based on 30 tonnes/yr at a maximum RCR of 1 (See section 10.1)

Information type	Site tonnage (tonnes)
Data points	1
Value	30
Selected for Generic Exposure Scenario	30

Frequency and duration of use

Production occurs 252 days per year per site (median 50th %)

Information type	Emission days to water per site (d/y)	Emission days to air per site (d/y)
Selected for Generic Exposure Scenario	0 (not applicable)	252

Environment factors not influenced by risk management

No exposure scenario for the water compartment was build as there are no emissions to water. There is no regular point source emission to ambient water or sewage systems during the production process.

Other given operational conditions affecting environmental exposure

For the exposure scenario a tonnage of 30tonnes is used. Mercury is emitted to the environment via the air (stack and diffuse air emissions). As the manufacturing process is a dry procedure, there are no emissions to water.

Technical conditions and measures at process level (source) to prevent release

None

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk management measures (RMM) related to the environment are implemented by the site.

For emissions to water:

As there are no emissions to wastewater, RMM for the water compartment are not relevant for this sector.

Emissions to air

There are no RMM implemented for the air compartment.

Organizational measures to prevent/limit release from site

No specific organizational measures were considered.

Conditions and measures related to municipal sewage treatment plant

None.

Conditions and measures related to external treatment of waste for disposal

Detailed information on the amount of mercury substances in waste, type of waste, type of external treatment, fractions of substances released into the environment was not provided. However, waste removal to off-site location is reported.

Conditions and measures related to external recovery of waste

No specific data is available.

Additional good practice advice (for environment) beyond the REACH CSA

Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH, Thus, the downstream user is not obliged to

i) carry out an own CSA and
ii) ii) to notify the use to the Agency, if he does not implement these measures.

Use specific measures expected to reduce the predicted exposure beyond the level estimated based on the exposure scenario.

6.4 Exposure estimation and reference to its source

Occupational exposure

In the Column "Urinary mercury levels" below, the 90th percentile of the measured urinary mercury levels is provided. The risk characterisation ratio (RCR) is the quotient of the exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For urinary mercury levels, the RCR is based on a DNEL for 30 µg Hg/g creatinine in urine.

Workplace	Method used for exposure assessment (refer to introduction)	Urinary mercury levels (RCR)	Method used for inhalation exposure assessment (refer to introduction)	Method used for dermal exposure assessment (refer to introduction)
Mercury handling	analogous data	8.2 µg Hg/g creatinine (0.27)	not relevant because urinary mercury levels integrate all relevant paths of exposure	
Formulation / Filling of pillows/capsules	analogous data	4.3 µg Hg/g creatinine (0.14)		
Packaging	analogous data	1.3 µg Hg/g creatinine (0.04)		

Environmental emissions

Compartment	Value	Unit	Justification
Environmental release factor to air (before APC)	7.05	g Hg/tonnes	Reported by company
PEC_{added} in soil	$7.09 * 10^{-5}$	mg Hg/kg dw	C_{local} of $7.09 * 10^{-5}$ mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw
PEC_{total} air	3.2	ng Hg/m^3	C_{local} of 0.2 ng Hg/m^3 and a $PEC_{regional}$ of 3.0 ng/m^3

6.5 Guidance to DU to evaluate whether he works inside the boundaries set by the ES

Occupational exposure

The DU works inside the boundaries set by the ES if either the proposed risk management measures as described above are met or the downstream user can demonstrate on his own that his implemented risk management measures are adequate (given that the processes, operational conditions and activities in question are covered by the PROCs listed above). This has to be done by showing that they limit the exposure (reflected in urinary mercury levels) to a level below the respective DNEL as given below:

DNEL for workers: 30 µg Hg/g creatinine in urine

Additionally, the scientific committee on occupational exposure limits has set the following limit values, which can also be used when assessing exposure:

DNEL for workers: 10 µg Hg/L blood

DNEL for workers: 0.02 mg Hg/m³ air

6.6 Risk characterisation

Environment

Compartment	PEC	PNEC	RCR	Justification
Soil	$7.09 * 10^{-5}$	0.022 (added)	$3.22 * 10^{-3}$	C_{local} of $7.09 * 10^{-5}$mg Hg/kg dw and a $PEC_{regional}$ of 0.037 mg Hg/kg dw

End of the Safety Data Sheet