SAFETY DATA SHEET

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Substance name:	Copper powder
Trade name:	500RL-107 -325 MESH
Chemical formula:	Cu
CAS number:	7440-50-8
EINECS number:	231-159-6
REACH Registration number:	01-2119480154-42-0048
Index number:	Not assigned

Supplier: SCM Metal Products, Inc.
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USA

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E-mail address of author/competent person responsible for the SDS:
Mark Barr
Title: Research and Development Manager
Company: SCM Metal Products, Inc.
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Identified Uses:

Downstream and Formulation stages –industrial
DM2 - Production of copper particulates and powders (including catalyst pellets) – e.g. thermal, hydrometallurgical and electrochemical productions.
F1. Production of alloys, in which copper is the main constituent, as well as where it is minor alloying element (e.g. in stainless steel, in alloy particulates, in alloy shapes, etc).
F2. Production of copper-powder containing preparations (eg brazing paste, pigment paints, etc).

Uses of copper as such or in preparation, including production of articles
U2. Production of articles made from copper and copper containing particulates (e.g. sintered products).
U3. Use as intermediate in the production of other copper containing substances.
U4. Use as brazing paste (handling of preparation by industrial worker).
U5. Use as catalyst (handling of powder by industrial worker).

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Service life stage (article or preparation in sealed container) –consumers, professional /industrial workers

S4. Use of article made from copper and copper-containing particulates - e.g. brake.

End-of-life stage

EoL1. Of industrial wastes –e.g. recycling and recovery as raw material.
EoL2. Of private wastes e.g. collecting, recovery, and disposal.

The following exposure scenarios, developed in the copper REACH Chemical Safety Report, are relevant to the production and identified uses of copper in powder forms

Scenario Number	Exposure scenario title as presented in Annex I
20	Raw material and Scrap handling of fines, milling to fines
7	Particulate/powder handling, mixing, blending and weighing
15	Handling and use of Particulate/ powder in closed processes
21	Particulates: Forming/ tabletting, reduction, stabilisation
22	Use of particulates in liquids (e.g. brazing paste)
24	Electrolytic powder production
4	Atomisation & Spray-Forming
27	Compaction & Sintering & Injection moulding
29	Brazing and use of brazing paste
17	Handling of substance or preparation in sealed containers (eg spray coating agent)
18	Consumer exposure to copper metal, copper powder or copper containing products

There are no uses advised against.

2. HAZARDS IDENTIFICATION

Classification according to Regulation (EC) No. 1272/2008 (Classification, Labelling and Packaging)

Aquatic Acute 1 (H400: Very toxic to aquatic life.)

Classification according to Directive 67/548/EEC (Dangerous Substances Directive)

N – Dangerous for the environment

R50 - very toxic to aquatic organisms

Label elements

Signal word:

Warning

Hazard pictograms:

GHS09

Hazard statements:

H400: Very toxic to aquatic life

Precautionary statements:

P501: Dispose of contents/container to... (recycling or hazardous waste)
P273: Avoid release to the environment.
P391: Collect spillage.

For more information on human health and environmental effects see section 9 to 12 of this Safety Data Sheet.

Other hazards

Copper powder does not meet the criteria for a PBT or vPvB substance.

No physico-chemical hazards identified.

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3. COMPOSITION/INFORMATION ON INGREDIENTS

Main component

Name:	Copper powder
CAS:	7440-50-8
EINECS:	231-159-6
Concentration:	>98.75 w/w
Index number:	None assigned

Impurities

No impurities are present at levels that affect the classification of the substance.

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4. FIRST AID MEASURES

General advice

Get medical attention if any discomfort develops. Show this safety data sheet to the doctor in attendance.

Following inhalation

In case of exposure move to fresh air, lay patient down and get medical attention if discomfort persists.

Following skin contact

Use general hygiene measures for contact with the material. Wash with soap and warm water.

Following eye contact

Use general measures if eye irritation occurs. Do not rub eyes. Remove any contact lenses. Flush eyes thoroughly with water, taking care to rinse under eyelids. If irritation persists, continue flushing for 15 minutes, rinsing from time to time under eyelids. If discomfort continues, consult a physician.

After ingestion

Rinse mouth thoroughly. Give 200-300 ml water to drink. Do not induce vomiting. Get medical attention if any discomfort continues.

Most important symptoms and effects, both acute and delayed

Gastro-intestinal symptoms are the first symptoms for high oral intakes of copper compounds. Vomiting may occur. The most important organ for delayed effects from “copper” excess is the liver. Nose/lung irritation may occur after inhalation of dusts.

Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

5. FIREFIGHTING MEASURES

Extinguishing media

Suitable extinguishing media

Material is non-flammable. Use fire fighting measures appropriate to surrounding materials.

Unsuitable extinguishing media

Do not use water or halogenated extinguishing media.

Special hazards arising from the substance or mixture

The solid metal is not flammable. However, finely divided metallic dust or powder may form an explosive mixture with air.

Fire or high temperatures may lead to the creation of metal oxides.

Advice for firefighters

Wear self-contained breathing apparatus and a fully protective suit and gloves.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel:

Avoid formation of dust. Ensure adequate ventilation. Avoid inhalation of dust and fumes. Wear suitable protective equipment.

For emergency responders:

Avoid formation of dust. Ensure adequate ventilation. Avoid inhalation of dust and fumes. Wear suitable protective equipment. Keep unprotected persons away.

Environmental precautions

Avoid release to the environment.
Liquids containing copper powder should be absorbed in vermiculite, dry sand, or earth before being put into a suitable container for recycling or disposal as hazardous waste.
Collect particulates using a vacuum cleaner with a HEPA filter. Place in a suitable container for recycling or disposal as hazardous waste.
Accidental releases should be prevented from reaching the sewage system or any water course and from penetrating the ground/soil.
Dispose of spilled material in accordance with the relevant local regulations.

Methods and material for containment and cleaning up

Avoid dust formation.
Sweep up all spilled material or use an appropriate industrial vacuum cleaner.

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Collect spilled material in suitable containers or closed plastic bags for recovery or disposal.
Dispose of spilled material or contaminated material as hazardous waste.

For more information on exposure controls/personal protection or disposal considerations, refer to sections 8 to 13 of this safety data sheet.

7. HANDLING AND STORAGE

Precautions for safe handling

Protective measures

Airborne concentrations should be kept low using appropriate ventilation and collection methods.

Advice on general occupational hygiene

Avoid generation and spreading of dust. Avoid inhalation of dust and small particles and contact with eyes. Provide adequate ventilation. Observe good industrial hygiene practices. Do not allow to enter drains.

Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well-ventilated place. Avoid contact with heat and acids.

Specific end use(s)

Check the identified uses in section 1 of this Safety Data Sheet. For more information see the relevant Exposure Scenario, Annex I and check section 2.1: Control of workers exposure.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control Parameters for Industrial Settings

The following national occupational exposure limit values for copper and copper compounds apply:

Area	Long Term Exposure Limit (8 h TWA**)	Short Term Exposure Limit (15 min average)	Notes	Source
UK	1 mg/m^3	2 mg/m^3	Copper, dusts & mists (as Cu)	OSHA website*
Germany	0.1 mg/m^3	0.2 mg/m^3	Copper and its inorganic compounds, Inhalable aerosol	OSHA website*
France	1 mg/m^3	2 mg/m^3	Copper, dusts & mists (as Cu)	OSHA website*

Spain	1 mg/m^3	--	Copper, dusts & mists (as Cu)	OSHA website*
Netherlands	0.1 mg/m^3	0.2 mg/m^3	Inhalable aerosol	OSHA website*

* The source of information on Occupational Exposure Limits from EU Member States is the OSHA (European Agency for Safety and Health at work) website: http://osha.europa.eu/en/topics/ds/oel/index.stm/members.stm
**TWA is the Time-Weighted Average airborne concentration over an eight-hour working day, for a five-day working week over an entire working life.

Predicted No Effect Concentrations (PNECs) and Derived No Effect Levels (DNELs)

Exposure pattern	Route	Descriptor	DNEL / PNEC
Human: Long-term systemic effects	Oral, Dermal and Inhalation	Internal DNEL (Derived No Effect Level) using absorption factors of 25% for oral, 100% for inhalation (respirable) and 0.03% for dermal exposure routes.	0.041mg Cu/kg bw/day
Human: Short-term systemic effects	Oral, Dermal and Inhalation	Internal DNEL using absorption factors of 25% for oral, 100% for inhalation (respirable) and 0.03% for dermal exposure routes.	0.082mg Cu/kg bw/day
Human: Short-term effects - drinking water	Oral	NOAEL	4 mg/l
Environmental	Freshwater	PNEC including a default bioavailability correction.	7.8 µg dissolved Cu/L (1)
Environmental	Marine water	PNEC including a default bioavailability correction.	5.2 µg dissolved Cu/L (1)
Environmental	Sediment freshwater	PNEC	87 mg Cu/kg dry wt (1)
Environmental	Sediment estuarine	PNEC	288 mg Cu/kg dry wt (1)
Environmental	Sediment marine	PNEC including a default bioavailability correction.	676 mg Cu/kg dry wt (1)
Environmental	Soil	PNEC including a default bioavailability correction.	65 mg Cu/kg dry wt (1)
Environmental	STP	PNEC	0.23 mg dissolved Cu/L

(1) Default PNEC values are given. These can be refined if information on the local environment is available (see section 12)

Exposure Controls for Industrial Settings

See the individual exposure scenarios in Annex 2 for a detailed description of the required exposure controls measures. Any control measures and associated efficiency values are based on actual

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measured data at the workplace or on the MEASE tool for occupational exposure assessment (http://www.ebrc.de/ebrc/ebrc-mease.php).

For appropriate air monitoring, it is advised to assess" total" and "respirable" copper levels. An excel sheet that allows calculating the systemic internal human health exposure levels is available from: http://www.eurocopper.org/copper/reach.html

For environmental assessment, the Metal EUSES calculator for Downstream Users can be freely downloaded from http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool. For environmental monitoring, the physico-chemical characteristics of the local receiving environment should preferably be monitored (see section 12).

Appropriate Engineering Controls

Prevent formation of dust where possible. Ensure appropriate ventilation/exhaustion at machinery and places where dust can be generated.
Any deposit of dust which cannot be avoided must be regularly removed using appropriate industrial vacuum cleaners or central vacuum systems.
Waste air should only be released to the atmosphere when it has passed through suitable dust separators.
Waste water generated during the production process or cleaning operations should be collected and should preferably be treated in an on-site waste water treatment plant which ensures efficient removal of copper.

Individual Protection Measures, such as Personal Protective Equipment

Respiratory Protection

Avoid generation and spreading of dust. Use local ventilation to keep levels below established threshold values. If this is not available then an approved dust mask should be worn (see Annex 1).

Eye Protection

As a precautionary measure, it is advisable to wear suitable safety glasses.

Skin Protection

Copper is not classified as hazardous to skin (see section 11 for more details).

Thermal Hazards

Copper powder does not have any self-heating or auto-flammable properties.

Environmental Exposure Controls

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Do not allow to enter drains. Clean/scoop up spills immediately, and place in a suitable container for disposal.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	Solid, copper colour.
Odour	Odourless
Odour threshold	Not applicable, as odourless
pH	Not applicable to an inorganic solid
Melting point	1059 - 1069°C
Boiling point	Not applicable to a solid that melts >300°
Flash point	Not applicable to an inorganic solid
Evaporation rate	Not applicable to an inorganic solid
Flammability	Non-flammable
Upper/lower flammability or explosive limits	Not applicable
Vapour Pressure	Not applicable to a solid that melts >300°
Vapour density (Air = 1)	Not applicable to an inorganic solid
Relative density	8.78 g/cm^3 at 20°C
Solubility in water	Insoluble. Copper needs to be transformed into a copper compound to become soluble. A solubility test (OECD 105) demonstrated a solubility of <1mg Cu/L for copper powder.
Partition coefficient (n-octanol/water)	Not applicable to inorganic substances
Auto-ignition temperature	No auto-ignition
Decomposition temperature	Decomposition and/or melting starts at 1059°C
Viscosity	Not applicable to an inorganic solid

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Explosive properties	Not explosive. The substance does not contain chemical groups associated with explosive properties.
Oxidising properties	Not oxidising

10. STABILITY AND REACTIVITY

Reactivity	Not applicable. See section 9
Chemical stability	Stable under normal conditions
Conditions to avoid	Avoid dust formation and contact with acids.
Incompatible materials	Strong acids
Hazardous decomposition products	The element Cu° does not decompose but may be transformed into other metal forms (e.g. Cu^{2+}).
Possibility of hazardous reactions	Reaction with H^- equivalents releases soluble copper compounds.

11. TOXICOLOGICAL INFORMATION

The toxicological information was obtained from the Voluntary Risk Assessment Report (VRAR) on copper and copper compounds, assessed by the EC Technical committees for New and Existing Substances (TCNES) and the EC Scientific Committees on Health and Environmental Risks (SCHER) (see: http://echa.europa.eu/chem_data/transit_measures/vrar_en.asp), and supplemented with information gathered for the REACH registration.

Most hazard data are related soluble copper compounds (e.g. copper sulphate) and fine copper flakes (particle size around 5µm). For the hazard profile of copper powder, information on solubility, bioaccessibility and bioavailability are combined with the hazard profile of soluble copper compounds in a read-across approach to assess its potential hazards.

Absorption

Copper is an essential element and therefore, its concentration in the body is strictly and efficiently regulated by homeostatic mechanisms.

Inhalation: Absorption of the "respirable" fraction is considered to be 100%. Absorption of the "inhalable" fraction depends on the particle size and the Multiple Path Model of Particle Deposition (MPPD)[1] can be used to quantify the particle-size dependent absorption.

[1] MPPD from : Asharian and Freijer, 1999

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Oral: *In-vitro* testing showed that bio-accessibility of copper ions from a representative powder represented < 1% of the potential release (Rodriguez *et al.*, 2010).

Following administration of soluble copper compounds, a dose dependent adsorption of copper ions has been drawn from true pooled fitted data. Based on the most reliable human data (Turnlund *et al.*, 1989; 1998; 2005 and Harvey *et al.*, 2003; 2005), for a given soluble copper dose in the GIT, absorption in humans can be calculated using the mean of two functions:
Equation 1: Oral absorption% = -15.0 ln(x) + 63.2
Equation 2: Oral absorption% =72.9 $e^{-0.1167x}$
Where x= copper intake (mg/day).

Dermal: A dermal absorption of 0.3% has been adopted for soluble and insoluble copper substances in solution or suspension, based on *in- vitro* percutaneous tests with human skin (Roper, 2003; Cage, 2003). For dry exposure to copper powders, a dermal absorption value of 0.03% applies.

Acute toxicity

Oral: Acute oral effects data for CuO (Sanders, 2002a), copper sulphate (Lheritier, 1994) and coated copper flakes (Sanders, 2001a) are available. When combined with *in-vitro* bio-accessibility, these data allowed the acute toxicity of copper powder to be assessed.

Copper powder does not meet the criteria for classification (LD_{50} >2000 mg/kg bw).

Inhalation: Acute inhalation toxicity data on coated copper flakes (Wesson, 2001) and copper oxychloride (Wesson, 2003) demonstrate that these soluble materials should be classified as “harmful by inhalation” (LD_{50} rats 1-5 g/m^3 air).

Copper powder has a particle size >10 µm and down-stream uses do not lead to particles with d50 <10µm. Copper powder does not meet the criteria for classification.

Dermal: Available data on copper (coated copper flakes (Sanders, 2001b)) and copper compounds (copper sulphate (Lhertier, 1993) and copper oxide (Sanders, 2002b) indicate that the LD_{50} for “copper” bearing substances is >2000 mg/kg bw. Copper powder does not meet the criteria for classification.

STOT single exposure

Acute oral and inhalation toxicity testing resulted in mortality (see above).

Copper powder does not meet the criteria for classification as STOT for a single exposure.

Skin irritation/

No skin irritation was seen in test animals exposed to “copper” bearing

corrosion	substances (coated copper flakes (Sanders, 2001c) and CuO (Sanders, 2002c)). Copper powder does not meet the criteria for classification.
Eye irritation/ corrosion	S light reversible eye irritation was seen in test animals exposed to "copper" bearing substances (coated copper flakes (Sanders 2001d) and CuO (Sanders, 2002d)). Copper powder does not meet the criteria for classification.
Skin Sensitisation	No skin sensitisation was seen in test animals exposed to "copper" bearing substances (coated copper flakes (Sanders, 2001e) and CuO (Sanders, 2002e)). Copper powder does not meet the criteria for classification.
Genotoxicity	Public domain studies report negative results for copper sulphate and copper chloride in *in-vitro* bacterial cell reverse mutation assays. An *in-vivo* unscheduled DNA synthesis test (equivalent to OECD 486) and a mouse micronucleus test (EC method B.12) performed on copper sulphate also gave negative results (Ward, 1994; Riley, 1994). Copper powder does not meet the criteria for classification.
Carcinogenicity	Based on a weight of evidence approach, it is concluded that copper and its compounds do not have carcinogenic potential. Copper powder does not meet the criteria for classification.
Toxicity for reproduction	The NOAEL for toxicity to reproduction of copper sulphate pentahydrate in rats is > 1500 mg/kg in food (> 24 mg Cu/kg bw/day). Test guideline OECD 416 (Mylchreest, 2005). Copper powder does not meet the criteria for classification.
Repeated dose toxicity and STOT-RE	A 90-day oral repeat dose study (Hébert, 1993) conducted with copper sulphate pentahydrate in rats and mice in accordance with a test method equivalent to EU B.26 resulted in inflammation of the liver in male and female animals at 260 mg $CuSO_4$/kg bw/day and above. The incidence and severity of the effects were dose-dependent. This study was used to calculate of an oral and systemic DNEL of 0.041 mg Cu/kg bw/day (including a Safety factor of 100 and an oral absorption of 25%). Copper powder does not meet the criteria for classification.

12. ECOLOGICAL INFORMATION

The ecotoxicological information was obtained from the VRAR on copper and copper compounds and supplemented with recent information gathered for the REACH registration. The additional information allowed refinement of the hazard profile for copper powder as well as the PNECs for the some compartments (soil and marine waters).

Most of the available hazard data are related to exposure of soluble copper compounds (e.g. copper sulphate). For assessment of the hazard profile of copper powder (assessed from a representative), information on solubility and bioavailability are combined with the hazard profile of soluble copper compounds in a read-across approach.

Acute aquatic toxicity test results and environmental classification:

Acute toxicity of copper ions was assessed using 451 $L(E)C_{50}$ values from studies on soluble copper compounds. The lowest species-specific geometric mean reference value of 25.0 µg Cu/L was an $L(E)C_{50}$ obtained for *Daphnia magna* at pH 5.5 - 6.5 (Van Sprang *et al*., 2010).

To assess the environmental classification of copper powder, the relative copper release from a 7 day transformation/dissolution test (release fraction 8.2%) is combined with the acute reference value for copper ions (25 µg Cu/L). This results in an acute reference value for copper powder of 305 µg/L (Van Sprang *et al*., 2010).

Copper powder is classified as very toxic to aquatic organisms.

Copper is an essential nutrient regulated by homeostatic mechanisms and does not bioaccumulate. Bio-available copper ions are rapidly removed from the water column (Rader, 2010). Copper powder is therefore not "persistent" and does not meet chronic aquatic toxicity classification criteria.

Chronic freshwater toxicity test results and PNEC derivation:

Chronic toxicity of copper ions from soluble copper compounds was assessed using 139 NOEC/EC_{10} values from 27 species representing different trophic levels (fish, invertebrates and algae). Species-specific NOECs were normalised using Biotic Ligand Models and used to derive Species Sensitivity Distributions (SSD) and a lowest HC5 (the median fifth percentile of the SSD) of 7.8 µg dissolved Cu/L. This value is considered to be protective of 90% of EU surface waters and represents a reasonable worst case. Applying an assessment factor of 1, a default chronic freshwater PNEC of 7.8 µg dissolved Cu/L is assigned to assess local risks.

Chronic marine waters toxicity test results and PNEC

Chronic toxicity of copper ions from soluble copper compounds was assessed using 51 NOEC/EC_{10} values from 24 species representing different trophic levels (fish, invertebrates and algae). Species-specific NOECs were calculated after normalizing to dissolved organic carbon (DOC) and were used to derive

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derivation:	SSDs and HC5 values. Normalisation at a typical DOC for coastal waters of 2 mg/l resulted in an HC5 of 5.2 µg dissolved Cu/L. Applying an assessment factor of 1, a default chronic marine PNEC of 5.2 µg dissolved Cu/L is assigned to assess local risks.
Chronic freshwater sediment toxicity test results and PNEC derivation:	Toxicity of copper ions from soluble copper compounds was assessed using 62 NOEC values from 6 benthic species. The NOECs were related to DOC and Acid Volatile Sulphide (AVS) and were used to derive SSDs and HC5 values. An HC5 of 1741 mg Cu/kg OC, corresponding to 87 mg Cu/kg dry weight, was calculated for a low AVS sediment with a default OC of 5%. Applying an assessment factor of 1, a default chronic freshwater sediment PNEC of 87 mg Cu/kg dry weight is assigned to assess local risks.
Chronic terrestrial toxicity test results and PNEC derivation:	Toxicity of copper ions from soluble copper compounds was assessed using 252 NOEC/EC_{10} values from 28 different species representing different trophic levels (decomposers, primary producers, primary consumers). NOEC values were adjusted to account for differences between lab-spiked soils and field-contaminated soils by the addition of a leaching ageing factor of 2. The adjusted values were then normalized to a range of EU soils using regression bioavailability models and used to derive SSDs and a lowest HC5 value of 65.5 mg Cu/kg dry weight (Oorts *et al*., 2010). Applying an assessment factor of 1, a default chronic soil PNEC of 65.5 mg Cu/kg dry weight is assigned.
Toxicity to Sewage Treatment Plant (STP) Micro-organisms	The toxicity of copper ions from soluble copper compounds was assessed using NOEC and EC_{50} values from high quality studies with STP bacteria and protozoa. The NOEC was 0.23 mg Cu/L in the STP (Cha *et al*., 2004). Applying an assessment factor of 1, a PNEC of 0.23 mg Cu/L is assigned for Sewage Treatment Plant.

For more information on how the environmental classification was derived and how to assess bio-availability, contact your supplier.

Persistence and degradability

Copper ions derived from copper powder cannot be degraded. The fate of copper ions in the water column was modelled using the Ticket Unit World Model (Rader, 2010). Removal was also assessed using data from one mesocosm and three field studies. “Rapid” removal was demonstrated, defined as 70% removal within 28 days. Literature data confirm the strong binding of copper ions to sediment, with the formation of stable Cu-S complexes. Re-mobilisation of copper ions to the water column is therefore not expected. Copper powder does not meet the criteria as “persistent”.

Bioaccumulative potential

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The “bioaccumulative” criteria are not applicable to essential metals.

Mobility in soil

Copper-ions bind strongly to soil. The median water-soil partitioning coefficient (k_p) is 2120 L/kg.

Results of PBT and vPvB assessment

The PBT and vPvB criteria of Annex XIII to the Regulation do not apply to inorganic substances, such as copper and its inorganic compounds. Copper powder is not PBT or vPvB.

Other adverse effects

Copper does not contribute to ozone depletion, ozone formation, global warming or acidification.

13. DISPOSAL CONSIDERATIONS

Copper powder that cannot be saved for recovery or recycling should be disposed of according to local and national regulations.

14. TRANSPORT INFORMATION

Road Transport (ADR)

UN Number	3077
Hazard Class	9
Packing Group	III
Hazchem Code	2Z
Proper Shipping Name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (CONTAINS COPPER)

Sea Transport (IMDG)

UN Number	3077
Hazard Class	9
Packing Group	III
IMDG EMS	NONE
Proper Shipping Name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (CONTAINS COPPER)
Marine Pollutant	P

Air Transport (IATA)

UN Number	3077
Hazard Class	9
Packing Group	III

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Proper Shipping Name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (CONTAINS COPPER)
IATA Symbol	Miscellaneous Dangerous Goods
Packaging Method	#5.9.9

15. REGULATORY INFORMATION

Worldwide Chemical Inventories

Copper is listed on the following inventories (non-exhaustive):

EC inventory (EU)
TSCA (USA)
DSL(Canada):
AICS (Australia):
NZIoC (New Zealand)
ENCS (Japan)
ECL(Korea)
PICCS (Philippines)
IECSC(China)

Other regulatory information

Copper is not a SEVESO substance, not ozone-depleting and not a persistent organic pollutant.

Chemical safety assessment

A chemical safety assessment has been carried out for the substance.

16. OTHER INFORMATION

A list of full references can be provided upon request.

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.

Non-Emergency Contact

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Safety Data Sheet Extension

New extended Safety Data Sheet in compliance with regulation (EC) No. 1907/2006 ("REACH"). The information provided in this SDS is consistent with the information provided in the REACH chemical safety report (CSR) for Copper metal. Further information can be obtained from ECI, manager of the Copper REACH Consortium.

For contact details:

European Copper Institute
Tervurenlaan 168,
B-1150 Brussel
Tel : +32 16471562
E-mail : kmd@ Eurocopper.org

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Annex 1 Exposure assessment – Development of Generic Exposure Scenarios

INTRODUCTION

For the development of Generic Exposure, the following rationale was used for human health and environment.

Human health

Most exposure scenarios were developed based on the data-collection for the copper risk assessment. When no exposure data were available for an identified process or the available data were considered insufficient (e.g. only a low number of data points were available, contextual information was lacking or the data were not considered representative of the sector of use), either data from similar uses and/or exposure situations were used to estimate exposure or, if available, MEASE modelling (Version 1.01) was used to predict exposure.

Environment

For the risk assessment and REACH data-collection, all producers have submitted environmental exposure data and therefore a site-specific exposure scenario, covering the information on a site-by site basis is provided for the producers, characterised by a full coverage.

For assessing additional environmental exposure as well as exposures for all Downstream User (DU) sectors, one generic scenario is additionally developed. Based on the considered OCs and RMMs, a default dilution factor of 10 for freshwater and 100 for marine scenarios, a generic tonnage demonstrating safe use is estimated to be 31,000 tonnes/year. If the producer/DU has higher tonnage or other OC/RMMs outside the OC/RMM specifications in the ES, then the producer/DU can evaluate whether he works inside the boundaries set by the ES through scaling. The Metal EUSES calculator for DUs can be freely downloaded from http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool. Releases to the environment were in the VRAR mostly assessed at site level, but the sector-specific release factors can be used in the absence of data. It is important to note that a site-specific assessment is already conducted for the majority of the sites in the supply chain.

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Exposure scenarios - Human Health

Contributing exposure scenario (20) controlling worker exposure		
Number of contributing ES		20
Title of contributing ES		Raw material and scrap handling of fines, milling to fines
Sector of Use (SU) – Main		3
Process category (PROC) used for exposure assessment		26
Process categories (PROC) used for descriptor purposes		26
Processes and activities covered		
"Handling of ores and concentrates, anodes, blister, cathodes, ingots, shapes and certain metallic scraps including: - Unloading from ships (where shipped break-bulk), containers, trucks and railcars - Loading onto transport. - Transfer to storage areas. - Storage (most likely in the open air, but could be under cover), usually in stacks or on pallets. - Baling (compression of loose materials into compact lumps), drying and other preparation of scrap. - Moving by forklifts, loaders, bins and skips to furnace loading areas. - Blending in open outdoor systems - Discharge into furnaces (may involve some manual handling)" - Milling of particulates		
Product characteristic		
Used in (special) preparation		Not relevant
Content in (special) preparation		Not relevant
Physical State		Powder
Dustiness	Respirable (%)	12%
	Tracho-bronchial (%)	33%
	Extra-thoracic (%)	55%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production as a worst-case approach
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Outdoors/Indoors
Process temperature		Outdoors/room temperature
Process pressure		Atmospheric pressure
Technical conditions and measures at process level (source) to prevent release		
Level of containment		closed system
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		yes if opportunity for exposure arises unless occupational monitoring demonstrate safe use without LEV
Minimum efficiency of LEV		95%
Organisational measures to prevent /limit releases, dispersion and exposure		
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		yes RPE (P3) if inhalable/ respirable dust indoor unless occupational monitoring demonstrate safe use without RPE
RPE effectiveness		95%
Specification of gloves		no
Specification of full body dermal protection		no
Specification of eye protection		no
Exposure Assessment		
Long term exposure		

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	Unit	Exposure concentration	Justification
External dermal systemic exposure	mg/d	85	Following the approach from the Cu VRAR (2008), the analogous substance" approach was taken, by extrapolating from data collected in the zinc industry. The production of Zn metal involves among other processes such as raw material handling, smelting, refining and casting, which are very similar to those involved in the production of Cu.
External inhalation exposure	mg/m3	0.13	Based on measured data from the Cu VRAR (2008)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.01	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.25	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).
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) to notify the use to the Agency, if he does not implement these measures.			

Contributing exposure scenario (7) controlling worker exposure

Number of contributing ES		7
Title of contributing ES		Particulate/ powder handling, mixing, blending and weighing
Sector of Use (SU) – Main		3
Process category (PROC) used for exposure assessment		26
Process categories (PROC) used for descriptor purposes		4, 5, 8a, 8b, 9, 26
Processes and activities covered		
- Gravity filling of bags: vertical dropping of powders in a relatively or wholly, uncontrolled manner. - Automatic weighing - Closure of bags - Opening and unloading of bags - Granulation of rejects, sprues, runners (the rejected parts and the material solified in the feeding system of injection moulding are ground in grinding machines (chopped into small bits), so that they can be added to mixes during mixing for recycling) - semi-bulk and bulk delivery of spent catalyst (IBC, drums, containers..) - filling of blender - unloading - Catalysts - Semi-bulked and bulk delivery of catalysts (IBC, drums, containers) - Reactor loading and unloading - Maintenance (and cleaning)		
Product characteristic		
Used in (special) preparation		Yes/No
Content in (special) preparation		>0 - <100%
Physical State		Powder, Pellet, Tablet
Dustiness	**Respirable (%)**	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read-across from particle size distribution of airborne copper at furnace operations in powder production. The respirable and tracho-bronchial measurements values for catalyst products are less than the ones given above, but the extra-thoracic measurement (% Extra thoracic (< 100 microns) - 75%) are above the 48% value provided.
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day

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Body weight	70 kg
Other given operational conditions affecting workers exposure	
Indoors/outdoors	Indoors/Outdoors
Process temperature	Room temperature
Process pressure	Atmospheric pressure
Technical conditions and measures at process level (source) to prevent release	
Level of containment	open/closed system
Level of automatisation	automatic process
Technical conditions and measures to control dispersion from source towards the worker	
Presence of Local Exhaust Ventilation (LEV)?	LEV is a requirement for controlling inhalation exposure to particulates. Fixed capturing hoods can be located in close proximity of and directed at the source of emission. The design should be such that the work is performed in the capture zone of the ventilation system and the capture is indicated at the workplace.
Minimum efficiency of LEV	90%
Conditions and measures related to personal protection, hygiene and health evaluation	
Specification of Respiratory Protection Equipment (RPE)	Additional RPE (P3) is used if the operator carries out some of the task (sealing and transferring the full bag) away from the LEV system unless occupational monitoring demonstrate safe use without RPE.
RPE effectiveness	95%
Specification of gloves	no
Specification of full body dermal protection	No
Specification of eye protection	No

Exposure Assessment

Long term exposure

	Unit	**Exposure concentration**	**Justification**
External dermal systemic exposure	mg/d	952	Based on measured data from the Cu VRAR (2008)
External inhalation exposure	mg/m3	0.22	Based on measured data from the Cu VRAR (2008)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.014	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.34	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

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

Contributing exposure scenario (15) controlling worker exposure

Number of contributing ES	15
Title of contributing ES	Handling and use of particulate/ powder in closed processes
Sector of Use (SU) – Main	3
Process category (PROC) used for exposure assessment	3
Process categories (PROC) used for descriptor purposes	1,2,3,14

Processes and activities covered

- mixing
- blending
- forming/tabletting/extrusion/pelleting
- particle classifiying
- pouring
- drying of powders
- reduction
- stabilisation
- maintenance and cleaning

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Product characteristic		
Used in (special) preparation		Yes/No
Content in (special) preparation		>0 - <100%
Physical State		Powder
Dustiness	Respirable (%)	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors
Process pressure		Atmospheric pressure
Technical conditions and measures at process level (source) to prevent release		
Level of containment		closed system
Level of automatisation		automatic process
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		yes if opportunity for exposure arises unless occupational monitoring demonstrate safe use without LEV
Minimum efficiency of LEV		90%
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		yes RPE (P3) if opportunity for exposure arises unless occupational monitoring demonstrate safe use without RPE
RPE effectiveness		95%
Specification of gloves		no
Specification of full body dermal protection		no
Specification of eye protection		no

Exposure Assessment

Long term exposure			
	Unit	Exposure concentration	Justification
External dermal local exposure	mg/cm2		
External dermal systemic exposure	mg/d	120	Based on MEASE predictions (Version 1.01)
External inhalation exposure	mg/m3	1	Based on MEASE predictions (Version 1.01)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.026	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.65	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

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

Contributing exposure scenario (21) controlling worker exposure		
Number of contributing ES		21
Title of contributing ES		Particulates:Forming/ tabletting, reduction, stabilisation
Sector of Use (SU) – Main		3
Process category (PROC) used for exposure assessment		14
Process categories (PROC) used for descriptor purposes		1, 2, 3, 4, 5, 14
Processes and activities covered		
Catalyst manufacture: - Handling pre-tablets - Mixing - Tabletting/pelleting - Screening - Filling of catalyst into storage container - Maintenance and cleaning		
Product characteristic		
Used in (special) preparation		Yes/No
Content in (special) preparation		>0 - <100%
Physical State		Powder
Dustiness	**Respirable (%)**	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors
Process temperature		Room temperature
Pellets: The reduction step might be followed by a stabilisation step, where the metal-containing catalyst will be partially reoxidised. Droplets: For catalyst droplets preparation the metal containing catalyst powder is suspended in molten organic matrix and solidified as droplets. High level of workplace cleanliness and prevention of dust or powder accumulation on surfaces, including floors. Use of water or vacuum cleaner fitted with a HEPA filter to remove dusts and powders during cleaning.		
Technical conditions and measures at process level (source) to prevent release		
Level of containment		closed system with the possiblility of exposure during specific tasks
Level of separation		
Level of automatisation		automatic process
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		yes if opportunity for exposure arises unless occupational monitoring demonstrate safe use without LEV
Minimum efficiency of LEV		90%
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		Use of RPE (Particle filter with high efficiency for solid and liquid particles (e.g. EN 143 or 149, Type P3 or FFPE)) for cleaning and maintenance operations and where exposure to Cu dust or powder is possible. Use of air fed RPE, if entry to the reactor is required. unless occupational monitoring demonstrate safe use without RPE
RPE effectiveness		95%
Specification of gloves		no
Specification of full body dermal protection		no

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Specification of eye protection	no		
Exposure Assessment			
Long term exposure			
	Unit	**Exposure concentration**	**Justification**
External dermal systemic exposure	mg/d	120	Based on MEASE predictions (Version 1.01)
External inhalation exposure	mg/m3	1	Based on MEASE predictions (Version 1.01)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.027	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.66	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).
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) to notify the use to the Agency, if he does not implement these measures.			

Contributing exposure scenario (22) controlling worker exposure		
Number of contributing ES		22
Title of contributing ES		Use of particulates in liquids (e.g. brazing paste)
Sector of Use (SU) – Main		3
Process category (PROC) used for exposure assessment		5
Process categories (PROC) used for descriptor purposes		1, 2, 3, 4, 5, 26
Product characteristic		
Used in (special) preparation		Yes/No
Content in (special) preparation		>0 - <100%
Physical State		Aqueous solution: Brazing paste vehicles can use organic solvents or water
Dustiness	**Respirable (%)**	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors
Process temperature		Room temperature
Process pressure		Atmospheric pressure
Technical conditions and measures at process level (source) to prevent release		
Level of containment		Closed
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		Hoods, ductwork connected to an exhaust fan, spark proof equipment (depending on the flashpoint of the solvent)
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		Respiratory masks with the appropriate filters would be necessary
RPE effectiveness		Not relevant
Specification of gloves		Yes (but not necessarily driven by Cu)

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Specification of full body dermal protection	Yes (but not necessarily driven by Cu)
Specification of eye protection	Yes (but not necessarily driven by Cu)

Exposure Assessment			
Long term exposure			
	Unit	**Exposure concentration**	**Justification**
External dermal systemic exposure	mg/d	Negligible	Use of properly selected gloves
External inhalation exposure	mg/m3	Negligible	In many cases with traditional paste application methods worker exposure is very limited. The actual brazing operation with brazing paste is usually performed in a furnace that is vented to the outside of the building. In this circumstance the worker is not exposed to the vehicle decomposition gases or the protective furnace atmosphere employed for the brazing operation. In the rare instances where a brazing torch is used workers will need respiratory PPE and/or mechanical fume collection as well ass PPE for the eyes.
Internal dermal + inhalation systemic (occupational)	mg/kg/d	Not relevant	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	Not relevant	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

Contributing exposure scenario (24) controlling worker exposure		
Number of contributing ES		24
Title of contributing ES		Electrolytic powder production
Sector of Use (SU) – Main		3
Process category (PROC) used for exposure assessment		27b
Process categories (PROC) used for descriptor purposes		2, 3, 5, 22, 26, 27b
Processes and activities covered		
production of copper particulates by electrolytic deposition. This includes: - Loading of anodes in tank. - Deposition of copper powder on cathodes. - - Discharge of powder, washing and drying. - Removal of spent anodes.		
Product characteristic		
Used in (special) preparation		Yes/No
Content in (special) preparation		>0 - <100%
Physical State		Powder
Dustiness	Respirable (%)	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors
Process temperature		Room temperature

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Process pressure	Atmospheric pressure
Technical conditions and measures at process level (source) to prevent release	
Level of containment	open system
Technical conditions and measures to control dispersion from source towards the worker	
Presence of Local Exhaust Ventilation (LEV)?	yes
Minimum efficiency of LEV	State of the art
Conditions and measures related to personal protection, hygiene and health evaluation	
Specification of Respiratory Protection Equipment (RPE)	P1 (in the processes after powder drying) unless occupational monitoring demonstrate safe use without RPE
RPE effectiveness	75%
Specification of gloves	no
Specification of full body dermal protection	no
Specification of eye protection	no

Exposure Assessment

Long term exposure

	Unit	Exposure concentration	Justification
External dermal systemic exposure	mg/d	952	Based on MEASE predictions (Version 1.01)
External inhalation exposure	mg/m3	0.625	Based on MEASE predictions (Version 1.01)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.025	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.6	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

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

Contributing exposure scenario (4) controlling worker exposure

Number of contributing ES	4
Title of contributing ES	Atomisation & Spray-Forming
Sector of Use (SU) – Main	3
Process category (PROC) used for exposure assessment	27a
Process categories (PROC) used for descriptor purposes	1, 2, 3, 5, 22, 26, 27a

Processes and activities covered

In the spray forming process, a melt is converted into solid state by the intermediate step of atomization. Spray forming is a process in between powder metallurgy and continuous casting.
- Copper, usually cathodes, master alloys and high purity scrap, is melted in a vacuum furnace. Some metallurgical reactants for covering the melt surface are used. - Temp: 1250 °C, LEV, face piece and protection class required
- The degassed melt is transferred to a gas fired holding furnace; the molten metal is poured in a thin stream and atomized by a nitrogen or another inert gas jet. The spray of atomized droplets is then collected on a rotating disc, were the droplets solidify.
- The disc is withdrawn with the same speed as the layer of deposited droplets grows. Therefor a compact preform is produced. The preform is a billet which is further processed in conventional forming processes.

In the atomisation process, a melt is converted into fine particles.
- Copper, usually cathodes, master alloys and high purity scrap, is melted in a furnace. Somemetallurgical reactants for covering the melt surface are used. - Temp: 1250 °C, LEV, face piece and protection class required
- The melt is transferred to a holding furnace; the molten metal is poured in a thin stream and atomized by an air, nitrogen or another inert gas jet or by a water jet. The atomized droplets are solidifying while falling down in a container where they are stored temporarily before going into further processing like (in case of water atomisation) drying or sieving."

Product characteristic

Used in (special) preparation	Yes/No
Content in (special) preparation	>0 - <100%
Physical State	Powder

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Dustiness	**Respirable (%)**	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production as a worst-case approach
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors
Process temperature		1000-1350°C
Technical conditions and measures at process level (source) to prevent release		
Level of containment		open/closed
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		yes
Minimum efficiency of LEV		90% on furnace and vacuum for atomisation
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		P3 in case of exposure to powder or dust (e.g. at furnace when opportunity for exposure arises) unless occupational monitoring demonstrate safe use without RPE or with less stringent RPE efficiencies. Data from companies producing atomized powder observed lower exposure values.
RPE effectiveness		95%
Specification of gloves		yes
Specification of full body dermal protection		no
Specification of eye protection		no

Exposure Assessment

Long term exposure

	Unit	Exposure concentration	Justification
External dermal systemic exposure	mg/d	Negligible	Based on protection due to gloves
External inhalation exposure	mg/m3	1.12	Based on "analogous process" approach by extrapolating from measured data on powder production from the Cu VRAR (2008)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.029	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.72	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

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

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Contributing exposure scenario (27) controlling worker exposure

Number of contributing ES		27
Title of contributing ES		Compaction & Sintering & Injection moulding
Sector of Use (SU) – Main		3
Process category (PROC) used for exposure assessment		14
Process categories (PROC) used for descriptor purposes		14, 21, 22, 23, 24, 25
Processes and activities covered		
- Hot/cold pressing, compaction: application of a pressure to produce a compact part having sufficient cohesion to enable it to be handled safely and transferred to the next step (sintering). Heating the compact, usually in a protective atmosphere, to a temperature below the melting point of the main constituent for 20 to 60 minutes. - Sintering:heating the compact, usually in protective atmosphere, to a temperature below the melting point of the main constituent for 30 min to 3-4 hours. The sintering of parts is usually done either in walking beam furnace or in a batch vacuum/hydrogen/inert gas furnace. - Injection moulding: melting the mix in a hot cylinder, inject the mass in the steel mould, wait for cooling and solidification, open mould, eject and collect part.		
Product characteristic		
Used in (special) preparation		Yes
Content in (special) preparation		0 - 92%
Physical State		Powder
Dustiness	**Respirable (%)**	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production as a worst-case approach
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors
Process temperature		compaction: RT-100°C sintering: 1120°C (1200 - 1380 °C)
Process pressure		compaction: 100-900 MPa sintering: Atmospheric pressure
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		no
Minimum efficiency of LEV		Not relevant
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		P2 in case of exposure to powder or dust unless occupational monitoring demonstrate safe use without RPE
RPE effectiveness		90%
Specification of gloves		no
Specification of full body dermal protection		no
Specification of eye protection		no

Exposure Assessment

Long term exposure

	Unit	Exposure concentration	Justification
External dermal systemic exposure	mg/d	240	Based on MEASE predictions
External inhalation exposure	mg/m3	1	Based on MEASE predictions (Version 1.01)

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Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.027	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.66	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).
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) to notify the use to the Agency, if he does not implement these measures.			

Contributing exposure scenario (29) controlling worker exposure		
Number of contributing ES		29
Title of contributing ES		Brazing and use of brazing paste
Sector of Use (SU) – Main		3,21?
Process category (PROC) used for exposure assessment		25
Process categories (PROC) used for descriptor purposes		25
Processes and activities covered		
Using brazing paste to join steel parts in an controlled atmospheric furnace. The temperature is brought in the furnace above the melting point of the brazing paste to complete the brazed joint.		
Product characteristic		
Used in (special) preparation		Yes
Content in (special) preparation		>0 - <100%
Physical State		Massive, potential exposure to fumes
Dustiness	**Respirable (%)**	12%
	Tracho-bronchial (%)	33%
	Extra-thoracic (%)	55%
	Justification	Read-across from particle size distribution of airborne copper at the smelter, converter based on measured data
Amounts used		
Not relevant		
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Indoors/outdoors		Indoors/outdoors
Technical conditions and measures at process level (source) to prevent release		
Level of containment		Closed
Technical conditions and measures to control dispersion from source towards the worker		
Presence of Local Exhaust Ventilation (LEV)?		No, only general ventilation is required (only in rare instances whee a brazing torch is used, workers will need respiratory LEV)
Minimum efficiency of LEV		Not relevant
Conditions and measures related to personal protection, hygiene and health evaluation		
Specification of Respiratory Protection Equipment (RPE)		No (only in rare instances whee a brazing torch is used, workers will need respiratory PPE)
RPE effectiveness		Not relevant
Specification of gloves		Yes (but not necessarily driven by Cu)
Specification of full body dermal protection		Yes (but not necessarily driven by Cu)

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Specification of eye protection	Yes (but not necessarily driven by Cu)

Exposure Assessment

Long term exposure

	Unit	Exposure concentration	Justification
External dermal systemic exposure	mg/d	Negligible	Based on protection due to gloves
External inhalation exposure	mg/m3	Negligible	In many cases with traditional paste application methods worker exposure is very limited. The actual brazing operation with brazing paste is usually performed in a furnace that is vented to the outside of the building. In this circumstance the worker is not exposed to the vehicle decomposition gases or the protective furnace atmosphere employed for the brazing operation. In the rare instances where a brazing torch is used workers will need respiratory PPE and/or mechanical fume collection as well ass PPE for the eyes.
Internal dermal + inhalation systemic (occupational)	mg/kg/d	Not relevant	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	Not relevant	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

Contributing exposure scenario (17) controlling worker exposure

Number of contributing ES		17
Title of contributing ES		Handling of substance or preparation in sealed containers (eg spray coating agent)
Sector of Use (SU) – Main		21, 22
Process category (PROC) used for exposure assessment		11
Process categories (PROC) used for descriptor purposes		11, 10
Processes and activities covered		
Spraying with a can that contain an emulsion or paint containing copper. Spraying in view to obtain a thin coating of copper paint on a (usually metal) surface		
Product characteristic		
Used in (special) preparation		Yes
Content in (special) preparation		>0 - <15%
Physical State		Powder
Dustiness	Respirable (%)	16%
	Tracho-bronchial (%)	36%
	Extra-thoracic (%)	48%
	Justification	Read across from particle size distribution of airborne copper at furnace operations in powder production as a worst-case approach
Frequency and duration of use/exposure		
Duration		8h/d
Frequency		260d/yr
Human factors not influenced by risk management		
Respiration volume under conditions of use		10 m3/day
Body weight		70 kg
Other given operational conditions affecting workers exposure		
Process temperature		Room temperature

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Process pressure	Atmospheric pressure
Technical conditions and measures at process level (source) to prevent release	
Level of containment	Sealed
Technical conditions and measures to control dispersion from source towards the worker	
Presence of Local Exhaust Ventilation (LEV)?	yes
Minimum efficiency of LEV	78%
Conditions and measures related to personal protection, hygiene and health evaluation	
Specification of Respiratory Protection Equipment (RPE)	Filtering half mask FF P3 unless occupational monitoring demonstrate safe use without RPE. Companies with pre-liminary exposure measurements demonstrate that exposure inhalation values are lower than predicted by MEASE.
RPE effectiveness	95%
Specification of gloves	no
Specification of full body dermal protection	no
Specification of eye protection	no

Exposure Assessment

Long term exposure

	Unit	Exposure concentration	Justification
External dermal systemic exposure	mg/d	Negligible	Use of gloves
External inhalation exposure	mg/m3	0.55	Based on MEASE predictions (Version 1.01)
Internal dermal + inhalation systemic (occupational)	mg/kg/d	0.013	Calculated from external exposure based on the methodology outlined in section 9.3.1.4 and the VRAR of Copper (2008).
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.32	The internal DNELs and RCRs are derived from internal NOAELs and absorbed doses. The method for derivation of RCR values for occupational and combined exposure is outlined in section 9.3.1.4 and the VRAR of Copper (2008).

9.1.1.27 Contributing exposure scenario (18) controlling consumer exposure

Number of contributing ES	18
Title of contributing ES	Consumer exposure to copper metal, copper powder or copper containing products
Sector of Use (SU) – Main	21.22
Product Categories (PC)	3, 5,7,8,9,14,18,21,24,25,26,31,32,35,39

Processes and activities covered

This scenario includes a variety of downstream uses:
- Spraying, dipping, pouring, curing, film formation (heat, UV) of coatings and inks
- End use of cosmetics
- End use of cleaning and body care
- Plastics
- Aerosol, spray can
- Biocidal use
- Lubricants, additives in combination with inks and coatings
- End use of friction linings
- End use of sintered parts/bearing
- End use of diamond tools

Product characteristic

A distinction is made between copper powder containing consumer products and massive copper products:

- Copper powder concentrations in consumer products is usually low (<1%). Copper content in paint (to give a metallic look) can be as high as 25%. The physical state is usually liquid/slurry.

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- Massive and sintered copper products are solid (low dustiness) and can contain higher copper concentrations such as for jewellery cutlery and coins.

Exposure Assessment

Consumer exposure scenario for combined occupational and consumer assessment

The consumer exposure scenarios are not directly relevant to these workers. It is also assumed that copper industry workers are unlikely to take copper in dietary supplements. Therefore, for the purpose of combining occupational and consumer exposures for this group, a separate consumer scenario is considered following the Cu VRAR. As typical consumer scenario for workers, it will be assumed workers are exposed via the dermal route to 0.14 mg Cu/day to coins and to 4.3E-6 mg Cu/day via haircare products (Cu VRAR, 2008). As RWC consumer scenario for workers it will be assumed workers are exposed via the dermal route to 0.28 mg Cu/day to coins, to 1.4E-5 mg Cu/day via haircare products and via the inhalation route to 0.001 mg Cu/person/day by smoking cigarettes (Cu VRAR, 2008).

Consumer exposure scenario

The exposure estimation for the consumer exposure only can be found below.

Routes of exposure

The most relevant routes of exposures are summarized below. Selection of the worst-case exposure route is based on consumer exposure estimations from Cu VRAR (2008), summarized in **Error! Reference source not found.**.

	Inhalation	Dermal	Oral
Massive or sintered copper products	Not relevant	Dermal contact to handling of coins, copper jewellery	Not relevant
Copper powder containing preparations	Inhalation exposure through unintentional use cigarette smoking	Dermal contact to face cream, haircare products, paint	Oral exposure through food supplements
Worst-case exposure considered in generic consumer exposure scenario	Inhalation exposure through unintentional use cigarette smoking	Dermal exposure through paint	Oral exposure through food supplements
External exposure (mg/person/day)	Typical: none Reasonable worst-case: 0.0005	Typical: none Reasonable worst-case: 4.03	Typical: nonen Reasonable worst-case: 2

Long term exposure

	Unit	Exposure concentration	Justification
Internal dermal + inhalation systemic (occupational)	mg/kg BW/d	1.9E-2	Reasonable worst-case internal exposure estimate from Cu VRAR (2008)
Risk Characterisation Ratio (combined dermal and inhalation)	-	0.46	Based on NOAEL for repeated dose effects of 4.075 mg/kg/day and an assessment factor of 100 (Cu VRAR, 2008)

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

If a DU has OC/RMMs outside the OC/RMM specifications in the ES, then the DU can evaluate whether he works inside the boundaries set by the ES through scaling.

Occupational

The occupational calculator for DUs can be freely downloaded from the http://www.eurocopper.org/copper/reach.html

In the simple and easy-to-use DU-interface, measured inhalation and/or dermal values can be entered. An internal Cu concentration is calculated and risk conclusion is given.

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Exposure scenario - Environment

Exposure scenario (01) controlling environmental exposure for copper producers

Product characteristic

Solid, liquid (powder solutions), concentration ranges >0% - <100%

Amounts used

In the VRAR, safe use could be demonstrated using site-specific assessments for tonnages up to 366,000 Tonnes/year (Reference period 2002-2006)

Frequency and duration of use

230-365 days/year.

Environment factors not influenced by risk management

Site-specific flow rate of receiving surface water, site-specific bio-availability corrections and region - specific copper background values were used, where possible

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

The releases to water and air have been reduced with RRM, resulting in a 90th P water emission factor of 3.9 and 90th P air emission factor of 13.1

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

Release to air: Fume/dust collection and abatement system where relevant (such as hot processes). Options are electrostatic precipitators, fabric or bag filters, ceramic filters, wet scrubbers, dry- or semi-dry scrubbers. High dust removal/filtration efficiency between 95% and 99.9% is required for stack emissions. For raw material storage and handling: spraying with water is needed for small particles.
Release to water: On-site wastewater treatment and if needed, additional municipal wastewater treatment

Organizational measures to prevent/limit release from site

- Regular inspection/maintenance of workplace to prevent fugitive releases.
- Housekeeping and hygiene procedures: work area, equipment and floors regularly cleaned, water spraying to suppressant dust formation
- Competence and training: activities should only be executed by specialists or authorized personnel, regular training and instruction of workers, procedures for process control to minimise release/exposure
- In case of dust formation, regular monitoring

Conditions and measures related to municipal sewage treatment plant

A copper removal rate of 80% has been considered if relevant. Justification for this value can be found in the VRAR of Copper (2008).
The scenario of use of municipal sludge on agricultural soil was used.

Conditions and measures related to external treatment of solid waste for disposal

Solid wastes generated from industrial sites are disposed as “hazardous wastes”.

Conditions and measures related to external recovery of solid waste

Copper is a valuable material and therefore, the generation of waste is minimized The use of copper scrap is key element of the industrial copper production/use process.

Exposure Assessment – Environment

Compartment	Risk characterisation ratio’s observed for the producing sites
Aquatic pelagic (freshwater)	≤ 0.6
Aquatic pelagic (marine)	≤ 0.4
Sediment (freshwater)	≤ 0.5
Sediment (marine)	≤ 0.2
Agricultural soil	≤ 0.5
Sewage Treatement plant	≤ 0.1
Oral exposure concentration predator	Copper is an essential trace element, well regulated in all living organisms. Difference in copper uptake rates are related to essential needs, varying with the species, size, life stage, seasons... Copper homeostasic mechanisms are applicable across species with specific processes being active depending on the species,

	life stages…. Simple estimations on secondary poisoning are therefore not adequate.
Oral exposure concentration top predator	There is overwhelming evidence to show the absence of copper biomagnification across the tropic chain in the aquatic and terrestrial food chains. Differences in sensitivity among species are not related to the level in the trophic chain but to the capability of internal homeostasis and detoxification. Field evidence has further provided evidence on the mechanisms of action of copper in the aquatic and terrestrial environment and the absence of a need for concern for secondary poisoning.
Exposure concentration in earthworm	
Comment : a producer can evaluate if he is (still) working within the boundaries of the exposure scenario by considering section 9.3.2.0 contributing exposure scenario (1) generic scenario for controlling environmental exposure	
4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES	
If a DU has OC/RMMs outside the OC/RMM specifications in the ES, then the DU can evaluate whether he works inside the boundaries by considering section 9.3.2.02 Contributing exposure scenario (1) controlling environmental exposure	

Contributing exposure scenario (02) generic scenario for controlling environmental exposure
ERC 1, 2, 3, 4, 5, 6a, 6b, 6c, 6d, 7, 12a, 12b
Product characteristic
Solid, liquid (powder solutions), concentration ranges >0% - <100%
Amounts used
31,000 Tonnes/year (generic value). Higher tonnages can be covered through scaling (see section on DU compliance checking). In the VRAR, safe use could be demonstrated using site-specific assessments for tonnages up to 366,000 Tonnes/year (refere,c year 2002-2006) using site-specific emission factors, site-specific dilution factors, addiontal municipal sewage treatments and site-specific bio-availability corrections where relevant.
Frequency and duration of use
365 days/year. Sites with smaller number of emission days can be covered through scaling.
Environment factors not influenced by risk management
Flow rate of receiving surface water is set at the worst-case level 18,000 m3/day (EUSES default). For the generic scenario, this results in a dilution factor of 10. For the marine scenarios, a default dilution factor of 100 was used. In the VRAR, dilution factors up to 1,000 are demonstrated. Sites with deviatating flow can be covered through scaling
Technical conditions and measures at process level (source) to prevent release
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Release to air: The median sector-specific release factor for producers of 4.52 g/tonnes for air was selected as a reasonal worst case for the whole industry (all sectors considered). The factor includes fume/dust collection and abatement system where relevant (such as hot processes). Options are electrostatic precipitators, fabric or bag filters, ceramic filters, wet scrubbers, dry- or semi-dry scrubbers. High dust removal/filtration efficiency between 95% and 99.9% is required for stack emissions. For raw material storage and handling: spraying with water is needed for small particles. **Release to water**: The median sector-specific release factor for producers of 0.89 g/tonnes for water was selected as a reasonal worst case for the whole industry (all sectors considered). It is assumed that there is on-site wastewater treatment and that the waste-water is not connected to municipal sewage treatment plant.
Organizational measures to prevent/limit release from site
• Regular inspection/maintenance of workplace to prevent fugitive releases. • Housekeeping and hygiene procedures: work area, equipment and floors regularly cleaned, water spraying to suppressant dust formation • Competence and training: activities should only be executed by specialists or authorized personnel, regular training and instruction of workers, procedures for process control to minimise release/exposure • In case of dust formation, regular monitoring
Conditions and measures related to municipal sewage treatment plant
In the scaling tool, the EUSES default settings were used but can be adapted to site-specific information. The presence of a municipal sewage treatment plant was not assumed but can be included if relevant. A copper removal rate of 80% can be considered for municipal sewage treatment plant if relevant. Justification for this value can be found in the VRAR of Copper (2008). The default scenario of use of municipal sludge on agricultural soil was used.
Conditions and measures related to external treatment of solid waste for disposal
Solid wastes generated from industrial sites are disposed as “hazardous wastes”.
Conditions and measures related to external recovery of solid waste
Copper is a valuable material and therefore, the generation of waste is minimized The use of copper scrap is key element of the industrial copper

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production/use process.

Exposure Assessment - Environment

Compartment	Unit	PEC regional	PEC local (incl. PECreg)	RCR	Justification
Environmental release factor to aquatic (after on-site STP)	g/g	NR	0,89E-6	NR	This is value is the maximum 50th percentile observed in one sector with more than two company data points. The few sites with higher release factor to wastewater can be covered through scaling.
Environmental release factor to air (direct + STP)	g/g	NR	4.52E-6	NR	This is value is the maximum 50th percentile observed in one sector. The few sites with higher release factor to wastewater can be covered through scaling.
Exposure concentration in sewage treatment plant (STP) effluent	mg/L	0	0.0075	0.03	Calculation based on EUSES in case municipal STP is present.
Exposure concentration in aquatic pelagic (freshwater)	mg/L	0.0029	0.0055	0.7	Calculation based on EUSES
Exposure concentration in aquatic pelagic (marine)	mg/L	0.0011	0.0032	0.2	Calculation based on EUSES
Exposure concentration in sediment (freshwater)	mg/kg dw	67	145.21	0.9	Calculation based on EUSES. For the RCR full binding of the regional Cu-PEC to Acid Volatile Sulphides (AVS) and thus, on-availability of the regional Cu-PEC is considered. Justification od provided in the copper VRAR
Exposure concentration in sediment (marine)	mg/kg dw	16.1	28.9	0.05	Calculation based on EUSES
Exposure concentration in agricultural soil	mg/kg dw	24.4	24.4	0.4	Calculation based on EUSES
Oral exposure concentration predator	Copper is an essential trace element, well regulated in all living organisms. Difference in copper uptake rates are related to essential needs, varying with the species, size, life stage, seasons... Copper homeostasic mechanisms are applicable across species with specific processes being active depending on the species, life stages…. Simple estimations on secondary poisoning are therefore not adequate. There is overwhelming evidence to show the absence of copper biomagnification across the tropic chain in the aquatic and terrestrial food chains. Differences in sensitivity among species are not related to the level in the trophic chain but to the capability of internal homeostasis and detoxification. Field evidence has further provided evidence on the mechanisms of action of copper in the aquatic and terrestrial environment and the absence of a need for concern for secondary poisoning.				
Oral exposure concentration top predator					
Exposure concentration in earthworm					

Note that the regional risk characterisation also demonstrates safe use (see Cu VRAR and follows automatically from local risk characterisation).

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

If a DU has OC/RMMs outside the OC/RMM specifications in the ES, then the DU can evaluate whether he works inside the boundaries set by the ES through scaling.

Environment

The Metal EUSES calculator for DUs can be freely downloaded from the http://www.eurocopper.org/copper/reach.html or http://www.arche-consulting.be/Metal-CSA-toolbox/du-scaling-tool.

In the registrant-interface, the generic default OCs and RMMs can be entered. Some of them are very relevant for metals, such as the possibility to provide measured regional concentrations and solid-water partition coefficients.

In the simple and easy-to-use DU-interface, key OC and RMM can be changed according to the site-specific OC and RMMs of the DU. This includes general parameters as release factors, dilution, presence/absence of municipal sewage treatment plant, etc… It also allows the DU to enter bioavailability-corrected PNECs (Predicted No Effect Concentrations).

In the background, the full EUSES model is run to calculate exposure and risks. The resulting risk characterisation ratios allow the DU to assess safe use. In this way, the DU scaling tool enables the DU to check compliance with the ES if his OCs or RMMs differ from those in the ES.

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

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- Environmental Management System (ISO 14001, EMAS)
- Reduce the fugitive emissions where possible
- **Release to water**: Direct cooling water and effluents are treated to remove dissolved Cu. Options: chemical precipitation, sedimentation, filtration or electrolysis. Copper removal efficiency of the on-site treatment varies between 90% and 99.9%. Alternatively, waste-waters can be connected to municipal sewage treatment plants.

Exposure assessment - indirect exposure of humans via the environment

External exposure through	Unit	Value	Justification
Inhalation – Local	mg/person /day	0.093	Reasonable worst-case values taken from Cu VRAR (2008) basis: TGD default 24 hr inhalation volume (20m3)
	mg/person /day	0.057	Typical values taken from Cu VRAR (2008) basis: TGD default 24 hr inhalation volume (20m3) Value used in combined exposure and taken forward to risk characterisation.
Dietary intake – Local	mg/person /day	2.35	Reasonable worst-case values taken from Cu VRAR (2008) regional dietary intake included
	mg/person /day	1.44	Typical values taken from Cu VRAR (2008) regional dietary intake included Value used in combined exposure and taken forward to risk characterisation.