Material Safety Datasheet
FLUE DUST (with Annex: Exposure Scenarios)

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Flue dust from production of cement clinker
EINECS: 270-659-9
CAS: 68475-76-3
Synonyms: Cement kiln dust, bypass dust, clinker dust
REACH registration number: 01-2119486767-17-xxxx

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

Flue dust is predominantly used for the production of common cements or other hydraulic binders in industrial installations.

1.3. Details of the supplier of the safety data sheet

CEMEX UK Operations Ltd
CEMEX House, Evreux Way
Rugby, Warwickshire CV21 2DT
Tel: 01788 517000 (out of hours 01932 568833)
Fax: 01788 517009
www.cemex.co.uk

1.4. Emergency telephone number

For further information please contact
Customer Services on:
Tel: 01788 517000
(out of hours) 01932 568833
Fax: 01788 517009
Email: gb-enquiries@cemex.com

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

2.1.1 According to Regulation (EC) No 1272/2008

Hazard class	Hazard category	Classification procedure
Skin irritation	2	On the basis of test data
Serious eye damage/eye irritation	1	On the basis of test data
Skin sensitisation	1	On the basis of literature survey
Specific target organ toxicity single exposure respiratory tract irritation	3	On the basis of literature survey

Hazard statements
H318: Causes serious eye damage
H315: Causes skin irritation
H317: May cause an allergic skin reaction
H335: May cause respiratory irritation

2.1.2 *Classification according to Council Directive 67/548/EEC*

Xi Irritant
R37/38 Irritating to respiratory system and skin
R41 Risk of serious damage to eyes
R43 May cause sensitisation by skin contact

Flue dust may cause irritation of the respiratory system.

When flue dust accidentally comes into contact with water or when flue dust becomes damp, a strong alkaline solution is produced.
Due to the high alkalinity, wet flue dust may provoke skin and eye irritation. It may also cause an allergic reaction in some individuals due to the soluble Cr(VI) content.

2.2. Label elements

2.2.1 According to Regulation (EC) No 1272/2008

Danger

H318 Causes serious eye damage
H315 Causes skin irritation
H317 May cause an allergic skin reaction
H335 May cause respiratory irritation

P280 Wear protective gloves/protective clothing/eye protection/face protection
P305+P351+P338+P310: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/physician
P302+P352+P333+P313: IF ON SKIN: Wash with plenty of soap and water. If skin irritation or rash occurs: Get medical advice/attention
P261+P304+P340+P312: Avoid breathing dust/fume/gas/mist/vapours/spray. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/physician if you feel unwell.

2.3. Other hazards

Flue dust does not meet the criteria for PBT or vPvB in accordance with Annex XIII of REACH (Regulation (EC) No 1907/2006).

SECTION 3: Composition/information on ingredients

3.1. Substances

Flue dust is a complex combination of finely divided inorganic particles separated from the exit gases formed during the manufacture of Portland cement clinker. It is defined as inorganic UVCB substance

(Substances of Unknown or Variable composition, Complex reaction products or Biological materials). Main constituents are Portland cement clinker phases, calcium oxide, calcium carbonate and alkali sulphates and alkali chlorides. The following constituents can be present in flue dust:

Constituent	Mineral name	EC	CAS	Concentration range (% w/w)
Tricalcium silicate	Alite	235-336-9	12168-85-3	0 - 55
Dicalcium silicate	Belite	233-107-8	10034-77-2	0 - 50
Tricalcium aluminate	-	234-932-6	12042-78-3	0 - 10
Tetracalcium aluminoferrite	Brownmillerite	235-094-4	12068-35-8	0 -15
Monocalcium aluminate	-	234-931-0	12042-68-1	0 - 15
Tetracalcium sulfoaluminate	Ye'elemite	na	12005-25-3	0 - 15
Calcium carbonate silicate	Spurrite	na	11140-12-8	0 - 40
Calcium oxide	Lime	215-138-9	1305-78-8	0 - 65
Calcium hydroxide	Portlandite	215-137-3	1305-62-0	0 – 35
Magnesium oxide	Periclase	215-171-9	1309-48-4	0 - 20
Dodekacalcium heptaaluminate	Mayenite	na	na	0 - 20
Monocalcium dialuminate	Grossite	na	na	0 - 10
Dicalcium (magnesium, aluminium) silicate	Melilite, akermanite, gehlenite	na	na	0 - 10
Pentacalcium tri(silicate,phosphate,sulfate) mono(fluorid, hydroxide, chloride)	Ellestadite	na	na	0 – 25
Undecacalcium tetrasilicon monosulphur octadecaoxide	Jasmundite	na	na	0 - 10
Calcium carbonate	Calcite	207-439-9	471-34-1	0 - 95
Silicon dioxide	Quartz	238-878-4	14808-60-7	0 - 20
Calcium magnesium dicarbonate	Dolomite	240-440-2	16389-88-1	0 - 20
Silicate minerals	Silicate minerals	na	na	0 - 40
Dicalcium aluminium hexahydroxy chloride trihydrate	Hydrocalumite	na	na	0 - 15
Potassium chloride	Sylvite	231-211-8	7447-40-7	0 - 65
Sodium chloride	Halite	231-598-3	7647-14-5	0 - 10
Calcium sulfate	Anhydrite, gypsum	231-900-3	7778-18-9	0 - 40
Potassium sulfate	Arcanite	231-915-5	7778-80-5	0 - 60
Potassium sodium sulfate	Aphtitalite	240-411-4	16349-83-0	0 - 30
Potassium calcium sulfate	Syngenite, Ca-Langbeinite	na	13780-13-7	0 - 25
Rest fraction not specified/Unknown	-	-	-	0-10

SECTION 4: First aid measures

4.1. Description of first aid measures

General notes

No personal protective equipment is needed for first aid responders. First aid workers should avoid contact with wet flue dust or flue dust containing preparations.

Following contact with eyes

Do not rub eyes in order to avoid possible corneal damage by mechanical stress.
Remove contact lenses if any. Incline head to injured eye, open the eyelids widely and flush eye(s) immediately by thoroughly rinsing with plenty of clean water for at least 20 minutes to remove all

particles. Avoid flushing particles into uninjured eye. If possible, use isotonic water (0.9% NaCl). Contact a specialist of occupational medicine or an eye specialist.

Following skin contact
For dry flue dust, remove and rinse abundantly with water.
For wet/damp flue dust, wash skin with plenty of water.
Remove contaminated clothing, footwear, watches, etc. and clean thoroughly before re-using them.
Seek medical treatment in all cases of irritation or burns.

Following inhalation
Move the person to fresh air. Dust in throat and nasal passages should clear spontaneously. Contact a physician if irritation persists or later develops or if discomfort, coughing or other symptoms persist.

Following ingestion
Do not induce vomiting. If the person is conscious, wash out mouth with water and give plenty of water to drink. Get immediate medical attention or contact the anti poison centre.

4.2. Most important symptoms and effects, both acute and delayed

Eyes: Eye contact with flue dust (dry or wet) may cause serious and potentially irreversible injuries.

Skin: Flue dust may have an irritating effect on moist skin (due to sweat or humidity) after prolonged contact or may cause contact dermatitis after repeated contact.
Prolonged contact between flue dust, containing Portland cement clinker phases and moist skin may cause irritation, dermatitis or burns.
For more details see Reference (1).

***Inhalation*:** Repeated inhalation of flue dust over a long period of time increases the risk of developing lung diseases.

Environment: Under normal use, flue dust is not hazardous to the environment.

4.3. Indication of any immediate medical attention and special treatment needed

When contacting a physician, take this Safety Data Sheet with you.

SECTION 5: Fire-fighting measures

5.1. Extinguishing media

Flue dust is not flammable.

5.2. Special hazards arising from the substance or mixture

Flue dusts are non-combustible and non-explosive and will not facilitate or sustain the combustion of other materials.

5.3. Advice for fire-fighters

Flue dust poses no fire-related hazards. No need for special protective equipment for fire fighters.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1 For non-emergency personnel

Wear protective equipment as described under Section 8 and follow the advice for safe handling and use given under Section 7.

6.1.2 For emergency responders

Emergency procedures are not required.
However, respiratory protection is needed in situations with high dust levels.

6.2. Environmental precautions

Do not wash flue dust down sewage and drainage systems or into bodies of water (e.g. streams).

6.3. Methods and material for containment and cleaning up

Collect spilled material and use it.
Use dry cleanup methods such as vacuum clean-up or vacuum extraction (Industrial portable units equipped with high efficiency air filters (EPA and HEPA filters, EN 1822-1:2009) or equivalent technique) which do not cause airborne dispersion. Never use compressed air.
Ensure that the workers wear appropriate personal protective equipment and prevent dust from spreading.
Avoid inhalation of flue dust and contact with skin. Place spilled material in a container for future use.

6.4. Reference to other sections

See sections 8 and 13 for more details.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

7.1.1 Protective measures

Follow the recommendations as given under Section 8.
To clean up dry flue dust, see Subsection 6.3.

Measures to prevent fire
Not applicable.

Measures to prevent aerosol and dust generation
Do not sweep. Use dry cleanup methods such as vacuum clean-up or vacuum extraction, which do not cause airborne dispersion.

Measure to protect the environment
No particular measures.

7.1.2 Information on general occupational hygiene

Do not handle or store near food and beverages or smoking materials.
In dusty environment, wear dust mask and protective goggles.
Use protective gloves to avoid skin contact.

7.2. Conditions for safe storage, including any incompatibilities

Flue dust should be stored under waterproof, dry (i.e. with internal condensation minimised) conditions, clean and protected from contamination.
Engulfment hazard: Flue dust can build-up or adhere to the walls of a confined space. The flue dust can release, collapse or fall unexpectedly. To prevent engulfment or suffocation, do not enter a

confined space, such as a silo, bin, bulk truck, or other storage container or vessel that stores or contains flue dust without taking the proper safety measures.
Do not use aluminium containers due to incompatibility of the materials.

7.3. Specific end use(s)

No additional information for specific end uses. (see section 1.2).

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

DNEL inhalation (8h): 1 mg/m³
(According to a ACGIH recommendation for a threshold limit value for respirable Portland cement particulate matter (reference 2) and a SCOEL recommendation for an 8-hour TLV-TWA for calcium oxide of 1 mg/m³ respirable dust (reference 3))
DNEL dermal: not applicable
DNEL oral: not relevant
The DNEL refers to respirable dust, but the tool used for the risk assessment (MEASE, reference (4)) works with the inhalable fraction. Therefore, an additional safety margin is inherently included in the outcome of the assessment and the derived risk management measures.
For workers, no DNEL for dermal exposure are available, neither from human hazard studies nor from human experience. Since flue dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible.

PNEC water: not applicable
PNEC sediment: not applicable
PNEC soil: not applicable
The risk assessment of the environmental compartments is based on the resulting pH impact on water. Possible pH changes in surface water, ground water and STP effluent should not increase the value 9.

8.2. Exposure controls

To control potential exposures, generation of dust should be avoided. Further, appropriate protective equipment is recommended. Eye protection equipment (e.g. goggles or visors) must be worn, unless potential contact with the eye can be excluded by the nature and type of application (i.e. closed process). Additionally, face protection, protective clothing and safety shoes are required to be worn as appropriate.

8.2.1 Appropriate engineering controls

Measures to reduce generation of dust and to avoid dust propagating in the environment such as dedusting, exhaust ventilation and dry clean-up methods which do not cause airborne dispersion.

8.2.2 Individual protection measures such as personal protection equipment

General: Do not eat, drink or smoke when working with flue dust to avoid contact with skin or mouth.
Before starting to work with flue dust, apply a barrier creme and reapply it at regular intervals.
Immediately after working with flue dust or flue dust-containing materials, workers should wash or shower or use skin moisturisers.
Remove contaminated clothing, footwear, watches, etc. and clean thoroughly before re-using them.

Eye /face protection


Wear approved glasses or safety goggles according to EN 166 when handling dry or wet flue dust to prevent contact with eyes.

Skin protection

Use impervious, abrasion and alkali resistant gloves (made of low soluble Cr (VI) containing material) internally lined with cotton, boots, closed long-sleeved protective clothing as well as skin care products (including barrier creams) to protect the skin from prolonged contact with wet flue dust.

Respiratory protection

When a person is potentially exposed to dust levels above exposure limits, use appropriate respiratory protection. The type of respiratory protection should be adapted to the dust level and conform to the relevant EN standard (e.g. EN 149, EN 140, EN 14387, EN 1827) or national standard.

Thermal hazards

Not applicable.

8.2.3 Environmental exposure controls

According to available technology.
See engineering control measures to avoid dust propagating in the environment.
Take measures to ensure that flue dust does not reach water (sewage systems and ground or surface water).

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

(a) Appearance: Flue dust is a powdery inorganic material. The colour can vary between beige and grey, depending on the composition (UVC substance)
(b) Odour: Odourless
(c) Odour threshold: no odour threshold, odourless
(d) pH: (T = 20°C in water, water-solid ratio 1:2): about 9 - 13, strongly depending on the composition of the UVCB substance flue dust
(e) Melting point: > 850 °C
(f) Initial boiling point and boiling range: Not applicable as under normal atmospheric conditions, melting point > 850°C
(g) Flash point: Not applicable as is not a liquid
(h) Evaporation rate: Not applicable as is not a liquid
(i) Flammability (solid, gas): Not applicable as is a solid which is non combustible and does not cause or contribute to fire through friction
(j) Upper/lower flammability or explosive limits: Not applicable as is not a flammable gas
(k) Vapour pressure: Not applicable as melting point > 850 °C
(l) Vapour density: Not applicable as melting point > 850 °C
(m) Relative density: 2.7 - 3.2; Apparent density -: 0.9 - 1.5 g/cm^3
(n) Solubility(ies) in water (T = 20 °C): about 0.1-100 g/l, strongly depending on the composition of the UVCB substance flue dust
(o) Partition coefficient: n-octanol/water: Not applicable as is inorganic substance
(p) Auto-ignition temperature: Not applicable (no pyrophoricity – no organo-metallic, organo-metalloid or organo-phosphine bindings or of their derivatives, and no other pyrophoric constituent in the composition)
(q) Decomposition temperature: Not applicable as no organic peroxide are present
(r) Viscosity: Not applicable as it is not a liquid
(s) Explosive properties: Not applicable. Not explosive or pyrotechnic. Not in itself capable of producing gas by chemical reaction at temperature and pressure and at a speed as to cause damage to the surroundings. Not capable of a self-sustaining exothermic chemical reaction.
(t) Oxidising properties: Not applicable as does not cause or contribute to the combustion of other materials.

9.2. Other information

Not applicable.

SECTION 10: Stability and reactivity

10.1. Reactivity

When mixed with water, flue dust will harden into a stable mass that is not reactive in normal environments.

10.2. Chemical stability

Flue dust is stable as long as it is properly stored (see Section 7). It should be kept dry. Contact with incompatible materials should be avoided.
Wet flue dust is alkaline and incompatible with acids, with ammonium salts, with aluminium or other non-noble metals. Flue dust dissolves in hydrofluoric acid to produce corrosive silicon tetrafluoride gas. Flue dust reacts with water to form silicates and calcium hydroxide. Silicates in flue dust react with powerful oxidizers such as fluorine, boron trifluoride, chlorine trifluoride, managanese trifluoride, and oxygen difluoride.

10.3. Possibility of hazardous reactions

Not applicable.

10.4. Conditions to avoid

Humid conditions during storage may cause lump formation and loss of product quality.

10.5. Incompatible materials

Acids, ammonium salts, aluminium or other non-noble metals.

10.6. Hazardous decomposition products

Flue dust will not decompose into any hazardous products.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Hazard class	Cat	Effect	Reference
Acute toxicity - dermal	-	Limit test acc. OECD TG 402, rat, 24 hours contact, 2,000 mg/kg body weight. Based on available data, the classification criteria are not met.	(5)
Acute toxicity- inhalation	-	Limit test acc. OECD TG 436, rat, 4 hours exposure, 6 g/m³. Based on available data, the classification criteria are not met	(6)
Acute toxicity - oral	-	Dose range finding study acc. OECD TG 422, rat, 1848 mg/kg bw/d over a period of 7 days. Based on available data, the classification criteria are not met	(7)
Skin corrosion/ irritation	2	In vitro studies on skin irritation and corrosion acc. EpiDerm TM. Portland cement clinker - one of the main constituents of flue dust - in contact with wet skin may cause thickening, cracking or fissuring of the skin. Prolonged contact in combination with abrasion may cause severe burns. Based on the available data flue dust is classified as irritant to skin.	(8), (9)
Serious eye damage/irritation	1	In vitro study on eye irritation acc. OECD TG 438. Flue dust caused a mixed picture of corneal effects and the calculated irritation index was about 140. Direct contact with Portland cement clinker - one of the main constituents of flue dust - may cause corneal damage by mechanical stress, immediate or delayed irritation or inflammation. Direct contact with larger amounts of dry Portland cement clinker dust or splashes of wet clinker may cause effects ranging from moderate eye irritation (e.g. conjunctivitis or blepharitis) to chemical burns and blindness.	(10), human experience
Skin sensitisation	1	Some individuals may develop eczema upon exposure to wet cement clinker dust, which is a main constituent of flue dust, caused either by the high pH	(11), (12)

Hazard class	Cat	Effect	Reference
		which induces irritant contact dermatitis after prolonged contact, or by an immunological reaction to soluble Cr (VI) which elicits allergic contact dermatitis.	
Respiratory sensitisation	-	There is no indication of sensitisation of the respiratory system. Based on available data, the classification criteria are not met	(1)
Germ cell mutagenicity	-	No indication. Based on available data, the classification criteria are not met	(13), (14)
Carcinogenicity	-	No causal association has been established between flue dust exposure and cancer. The epidemiological literature does not support the designation of Portland cement as a suspected human carcinogen. Flue dust is mainly used in cements. Portland cement is not classifiable as a human carcinogen (According to ACGIH A4: Agents that cause concern that they could be carcinogenic for humans but which cannot be assessed conclusively because of a lack of data. In vitro or animal studies do not provide indications of carcinogenicity that are sufficient to classify the agent with one of the other notations.). Portland cement contains up to 5 % flue dust. Based on available data, the classification criteria are not met.	(1) (15)
Reproductive toxicity;	-	Repeated dose toxicity study acc. OECD TG 422, rat, up to 16,000 mg/kg diet over a period of 28 days for males and 6-7 weeks for females. Based on available data, the classification criteria are not met.	(7)
STOT-single exposure	3	Portland Cement clinker dust - a main constituent of flue dust - may irritate the throat and respiratory tract. Coughing, sneezing, and shortness of breath may occur following exposures in excess of occupational exposure limits. Overall, the pattern of evidence clearly indicates that occupational exposure to cement dust has produced deficits in respiratory function. However, evidence available at the present time is insufficient to establish with any confidence the dose-response relationship for these effects.	(1)
STOT-repeated exposure	-	There is an indication of COPD. The effects are acute and due to high exposures. No chronic effects or effects at low concentration have been observed. Based on available data, the classification criteria are not met	(16)
Aspiration hazard	-	Not applicable as flue dust is not used as an aerosol.	

Medical conditions aggravated by exposure

Flue dust may aggravate existing respiratory system disease(s) and/or medical conditions such as emphysema or asthma and/or existing skin and/or eye conditions.

SECTION 12: Ecological information

12.1. Toxicity

Hazard class	Effect	Reference
Acute toxicity to fish	NOEC (96h) = 11.1 mg/L for Zebrafish	(17)
Acute toxicity to invertebrates	NOEL (48h) = 50 mg/L, LOEL (48h) = 100 mg/L, *Flue Dust T Acute Immobilization Test to Daphnia magna Static*	(18)
Acute toxicity to algae	NOEL (72h) = 6,25 mg/L, LOEL (72h) = 12,5 mg/L, *Flue Dust T Alga, Growth Inhibition Test with Desmodesmus subspicatus*	(19)
Acute toxicity to microorganisms	EC50 (72h) = 596 mg/L, *Flue Dust T Respiration Inhibition Test with Activated Sludge*.	(20)
Sediment toxicity	NOEC = 875 mg/kg, LC50 = 9931 mg/kg of dry weight sediment, *Sediment Phase Toxicity Test Results with Corophium volutator*.	(21)

Toxicity to terrestrial arthropods	NOEC = 1000 mg/kg soil dry weight, *Flue Dust T Earthworm (Eisenia fetida), Acute Toxicity Test in Artificial Soil*.	(22)
Toxicity to terrestrial plants	NOEC = 1000 mg/kg soil dry weight, tested plant species (oats, rapes, soy beans), *Terrestrial Plant Test, Seedling Emergence and Growth Test*	(23)
Toxicity to soil microorganisms	NOEC (8d) = 1000 mg/kg soil dry weight, NOEC (28d) = 500 mg/kg soil dry weight, *Soil Micro-Organisms: Nitrogen Transformation Test*	(24)

The addition of large amounts of flue dust to water may, however, causes a rise in pH and may, therefore, be toxic to aquatic life under certain circumstances.

12.2. Persistence and degradability

Not relevant as flue dust is an inorganic material. After hydration, flue dust lumps present no toxicity risks.

12.3. Bioaccumulative potential

Not relevant as flue dust is an inorganic material. After hydration, flue dust lumps present no toxicity risks.

12.4. Mobility in soil

Not relevant as flue dust is an inorganic material. After hydration, flue dust lumps present no toxicity risks.

12.5. Results of PBT and vPvB assessment

Not relevant as flue dust is an inorganic material. After hydration, flue dust lumps present no toxicity risks.

12.6. Other adverse effects

Not relevant.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Flue dust may always be reused. Waste treatment methods do not apply.
Do not dispose of into sewage systems or surface waters.

SECTION 14: Transport information

Flue dust is not covered by the international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID); no classification is required.
No special precautions are needed apart from those mentioned under Section 8.

14.1. UN number

Not relevant.

14.2. UN proper shipping name

Not relevant.

14.3. Transport hazard class(es)

Not relevant.

14.4. Packing group

Not relevant.

14.5. Environmental hazards

Not relevant.

14.6. Special precautions for user

Not relevant.

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

Not relevant.

SECTION 15: Regulatory information

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

Flue dust is registered according to Regulation (EC) 1907/2006.

The so-called “Good practice guides” which contain advice on safe handling practices can be found from: http://www.nepsi.eu/good-practice-guide.aspx. These good practices have been adopted under the Social Dialogue "Agreement on Workers' Health Protection through the Good Handling and Use of Crystalline Silica and Products Containing it by Employee and Employer European sectoral associations.

15.2. Chemical Safety Assessment

A chemical safety assessment has been carried out, due to the flue dust registration obligation.

SECTION 16: Other information

16.1 Indication of changes

Supersedes March 2009 version and incorporates requirements of Regulation (EC) No 1272/2008.

16.2 Abbreviations and acronyms

ACGIH	American Conference of Industrial Hygienists
ADR/RID	European Agreements on the transport of Dangerous goods by Road/Railway
AFF	Assigned protection factor
CAS	Chemical Abstracts Service
CLP	Classification, labelling and packaging (Regulation (EC) No 1272/2008)
COPD	Chronic Obstructive Pulmonary Disease
DNEL	Derived no-effect level
EC50	Half maximal effective concentration
ECHA	European Chemicals Agency
EINECS	European INventory of Existing Commercial chemical Substances
EPA	Type of high efficiency air filter
EpiDerm TM	Reconstructed human epidermis for testing purposes
ES	Exposure scenario
GefStoffV	Gefahrstoffverordnung
HEPA	Type of high efficiency air filter
H&S	Health and Safety
IATA	International Air Transport Association
IMDG	International agreement on the Maritime transport of Dangerous Goods
LC50	Median lethal dose

LOEL	Lowest observed effect level
MEASE	Metals estimation and assessment of substance exposure, EBRC Consulting GmbH for Eurometaux, http://www.ebrc.de/ebrc/ebrc-mease.php
MS	Member State
NOEC	No observed effect concentration
NOEL	No observed effect level
OECD	Organisation for Economic Co-operation and Development
OECD TG	OECD Technical Guidance
OELV	Occupational exposure limit value
PBT	Persistent, bio-accumulative and toxic
PNEC	Predicted no-effect concentration
PROC	Process category
REACH	Registration, Evaluation and Authorisation of Chemicals
SCOEL	Scientific Committee on Occupational Exposure Limit Values
SDS	Safety Data Sheet
STOT	Specific target organ toxicity
STP	Sewage treatment plant
TLV-TWA	Threshold Limit Value-Time-Weighted Average
TRGS	Technische Regeln für Gefahrstoffe
UVC	Substance of Unknown or Variable composition, Complex reaction products
UVCB	Substance of Unknown or Variable composition, Complex reaction products or Biological materials
VLE-MP	Exposure limit value-weighted average in mg by cubic meter of air
vPvB	Very persistent, very bio-accumulative

16.3 Key literature references and sources of data

(1) *Portland Cement Dust - Hazard assessment document EH75/7,* UK Health and Safety Executive, 2006. Available from: http://www.hse.gov.uk/pubns/web/portlandcement.pdf.

(2) American Conference of Governmental Industrial Hygienists, 2008

(3) SCOEL/SUM/137 February 2008*, Recommendation from the Scientific Committee on Occupational Exposure Limits for Calcium oxide (CaO) and calcium hydroxide (Ca(OH)2),* European Commission, DG Employment, Social Affairs and Equal Opportunities.

(4) Metals estimation and assessment of substance exposure, EBRC Consulting GmbH for Eurometaux, http://www.ebrc.de/ebrc/ebrc-mease.php.

(5) TNO report V8816/01, *Acute dermal toxicity study with Flue Dust T (REACH) in rats*, August 2010.

(6) TNO report V8801/01, *An acute (4-hour) inhalation toxicity study with Flue Dust T (REACH)-fine in rats*, July 2010.

(7) TNO report V8899/01, *An Combined oral repeated dose toxicity study with the reproductive/development toxicity screening test with Flue dust T (REACH) in rats*, May 2010.

(8) TNO reports V8932/01 andV8932/02, *In vitro skin irritation and corrosion test with Flue Dust T (REACH) using EpiDerm reconstituted skin membranes*, August 2010.

(9) *Observations on the effects of skin irritation caused by cement*, Kietzman et al, Dermatosen, 47, 5, 184-189 (1999).

(10) TNO report V8815/15, *Evaluation of eye irritation potential of Flue Dust T (REACH) in vitro using the isolated chicken eye test*, May 2010.

(11) *Epidemiological assessment of the occurrence of allergic dermatitis in workers in the construction industry related to the content of Cr (VI) in cement*, NIOH, Page 11, 2003.

(12) *European Commission's Scientific Committee on Toxicology, Ecotoxicology and the Environment (SCTEE) opinion of the risks to health from Cr (VI) in cement* (European Commission, 2002). http://ec.europa.eu/health/archive/ph_risk/committees/sct/documents/out158_en.pdf.

(13) TNO report V8815/15, *In vitro micronucleus test with Flue Dust T-fine (REACH) in cultured human bronchial epithelial BEAS-2B cells*, August 2010.

(14) CEMBUREAU Study report, *Toxicological properties of cement related particles in relation to observed malignant effects in head-neck cancers*, Borm, December 2006.

(15) *Comments on a recommendation from the American Conference of governmental industrial Hygienists to change the threshold limit value for Portland cement*, Patrick A. Hessel and John F. Gamble, EpiLung Consulting, June 2008.

(16) *Prospective monitoring of exposure and lung function among cement workers, Interim report of the study after the data collection of Phase I-II 2006-2010*, Hilde Notø, Helge Kjuus, Marit Skogstad and Karl-Christian Nordby, National Institute of Occupational Health, Oslo, Norway, March 2010.

(17) DR.U.NOACK-LABORATORIEN study report FAZ13593, *Flue Dust T Fish (Zebrafish), Acute Toxicity Test, Static, 96 h*; March 2010.

(18) DR.U.NOACK-LABORATORIEN study report DAI13593, *Flue Dust T Acute Immobilization Test to Daphnia magna Static, 48 h*; March 2010.

(19) DR.U.NOACK-LABORATORIEN study report SSO13593, *Flue Dust T, Flue Dust T Alga, Growth Inhibition Test with Desmodesmus subspicatus, 72 h*; April 2010.

(20) DR.U.NOACK-LABORATORIEN study report BBR13593, *Flue Dust T Respiration Inhibition Test with Activated Sludge, 72 h*; April 2010.

(21) *Final report Sediment Phase Toxicity Test Results with Corophium volutator for Portland clinker* prepared for Norcem A.S. by AnalyCen Ecotox AS, 2007.

(22) DR.U.NOACK-LABORATORIEN study report RRA13593, *Flue Dust T Earthworm (Eisenia fetida), Acute Toxicity Test in Artificial Soil, Limit Test*; March 2010.

(23) DR.U.NOACK-LABORATORIEN study report TNC13593, *Flue Dust T Earthworm (Eisenia fetida), Flue Dust T Terrestrial Plant Test, Seedling Emergence and Growth Test*; May 2010.

(24) DR.U.NOACK-LABORATORIEN study report TBN13593, *Flue Dust T, Soil Micro-Organisms: Nitrogen Transformation Test*; July 2010.

16.4 Training advice

In addition to health, safety and environmental training programs for their workers, companies must ensure that workers read, understand and apply the requirements of this Safety Data Sheet.

16.5 Disclaimer

The information on this data sheet reflects the currently available knowledge and is reliable provided that the product is used under the prescribed conditions and in accordance with the application specified on the packaging and/or in the technical guidance literature. Any other use of the product, including the use of the product in combination with any other product or any other process, is the responsibility of the user.
It is implicit that the user is responsible for determining appropriate safety measures and for applying the legislation covering his/her own activities.

ANNEX: Exposure Scenarios

Introduction

Methodology used for occupational exposure assessment

According to the REACH Guidance R.14 (Occupational exposure estimation, Version: 2, May 2010, ECHA-2010-G-09-EN) an Exposure Scenario (ES) has to describe under which Occupational Conditions (OC) and Risk Management Measures (RMM) the substances can be handled safely. This is demonstrated if the estimated exposure level is below the respective derived no-effect level (DNEL), which is expressed in the risk characterisation ratio (RCR).

For workers, the repeated dose DNEL for inhalation exposure is determined to: 1 mg/m³

Since no DNELs are available from human hazard studies for Flue Dust, the DNEL is based on read across on respective recommendations of the

- American Conference of Governmental Industrial Hygienists (ACGIH) and

- Scientific Committee on Occupational Exposure Limits (SCOEL)

ACGIH made a recommendation for a threshold limit value for Portland cement of 1 mg/m³ respirable particulate matter.

SCOEL made a recommendation for an 8-hour TLV-TWA for Calcium oxide of 1 mg/m³ respirable dust.

Since Portland cement phases and calcium oxide are the main constituents of Flue Dust on the one hand, and determine the hazard profile of Flue Dust on the other hand, it is justified to use this value as a DNEL for Flue Dust. Portland cement phases and calcium oxide have comparable hazard profiles, both are irritant for humans and have the potential to increase the pH in the aquatic compartment.

For workers, the acute DNEL for inhalation is determined to: 4 mg/m³

This choice is based on the SCOEL recommendation for a STEL (15 minutes) for Calcium oxide of 4 mg/m³ respirable dust.

Since these recommendations refer to respirable dust while the exposure estimates for the MEASE tool reflect the inhalable fraction, an additional safety margin is inherently included in the exposure scenarios below when MEASE has been used to derive exposure estimates.

For workers, no Flue Dust DNELs for dermal exposure are available, neither from human hazard studies nor from human experience. Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. Therefore, dermal exposure is not assessed in the exposure scenarios. However, relevant risk reduction management measures are included.

Methodology used for environmental exposure assessment

Flue Dust is a solid UVC substance. It can consist of up to 27 different inorganic constituents. These constituents are different in molecular weight and especially in water solubility. In addition, several constituents react with water and form insoluble hydrate phases. Hence, no representative and appropriate values are applicable for the physical chemical data. Furthermore, Flue Dust is not biodegradable and even a water octanol partition coefficient is not applicable. Therefore, all common tools for performing an environmental exposure assessment, like EUSES, ECETOC TRA, etc. are not usable for Flue Dust.

To consider the broad range of constituents a qualitative approach is chosen for the environmental assessment. The main feature of this approach is to group the Flue Dust constituents into three main groups: naturally occurring inorganic minerals, alkaline sulphates and chlorides and Portland cement (clinker) phases. These three groups are regarded independently.

The naturally occurring minerals (calcite, dolomite, quartz, clay silicates and aluminates) are used as raw material constituents for the cement clinker production and not chemically modified, when they are present in Flue Dust. All of these minerals are highly insoluble. In fresh water, groundwater and sea water these phases will be sediment and increase the amount of naturally occurring soil and sediment constituents. In STP these inorganic constituents will also sediment. Since these constituents are known as non hazardous and are also exempt from registration (Regulation (EC) 1907/2006, Annex V, Item 8.), an environmental exposure assessment is not necessary.

The alkaline sulfates (cations are K, Na, Ca) and chlorides (cations are K, Na) are highly soluble. The two chlorides have the highest solubility: 347 g/L and 358 g/L. Also these constituents are naturally occurring minerals (salts). The salts dissociate in water, due to their high water solubility and ionic potential. The associated cations (K^+, Na^+, Ca^{2+}) and anions (Cl^-, SO_4^{2-}) are omnipresent in sea water and groundwater. The amount of these ions in groundwater depends on the geological formation and can vary in a broad range. Since these constituents are non hazardous and not responsible for the environmental impact of Flue Dust, an environmental exposure assessment with the focus on these constituents is not necessary.

Portland cement (clinker) phases are the most significant group of constituents in Flue Dust in terms of environmental exposure. They determine the hazard profile of the whole substance. The phases are hydraulic oxides from calcium, magnesium, silicon, aluminium and iron. They are formed by heating the raw materials in a kiln, the clinker burning process. One of these constituents, calcium oxide, is usually a minor clinker phase. In Flue Dust, calcium oxide can be one of the dominant constituents, because the transformation process from calcium carbonate to calcium silicate oxide is not finished. Calcium oxide has to be seen as an intermediate clinker phase. For the sake of completeness, it has to be mentioned that cement clinker is exempt from the obligation to register, according to Regulation (EC) 1907/2006, Annex V, Item 10.

The oxidic cement clinker phases are hydraulic, which means they will react (hydrate) in contact with water. - These reactions take place when cements, or in general cement containing hydraulic binders, are intentionally used for the production of mortar or concrete. All of the reaction products, except calcium hydroxide, are highly insoluble. The formation of calcium hydroxide is responsible for the pH shift of cement clinker containing preparations, like typical cements, during their application. An increase in pH up to more than 11 in a fresh suspension leads to the irritant behaviour of hydraulic binders containing Portland cement or even Flue Dust. In contact with fresh water or groundwater, the pH may increase up to a level, where a toxic impact on the organisms of these compartments is possible. The pH effect in ecotoxicity is well known.

The acute aquatic toxicity testing of Flue Dust with daphnia (OECD 202) demonstrated this effect. A Flue Dust concentration of 100 mg/L resulted in a pH of 10.23 in the test system. At this level the immobilization rate was 50%. When the pH was adjusted to 7, the immobilisation rate was 0% at the same Flue Dust concentration of 100 mg/L. The measured pH value is in good agreement with the theoretical value. At a concentration of 100 mg/L a Flue Dust suspension should have a pH of 10.6.

In conclusion, the exposure assessment of the aquatic environmental compartments will therefore only treat the possible pH changes in water and STP effluent. The exposure assessment is carried out by assessing the resulting pH impact. The pH of the surface water should not increase the value 9.

A risk assessment for the atmospheric compartment is considered as not relevant and therefore not included in the exposure scenarios. On the one hand Flue Dust has no relevant vapour pressure and cannot volatilise. On the other hand, when Flue Dust particles are emitted to air, they will sediment or be washed out by rain in a relatively short time. Thus, the atmospheric emissions end up in soil and water.

A risk assessment for the terrestrial compartment is considered as not relevant and therefore not included in the exposure scenarios. On the one hand Flue Dust has an impact on the pH of the soil, and therefore on microorganism. But on the other hand Flue Dust is used for soil stabilisation and soil improvement (pH regulator for acidic soils). Moreover Flue Dust is used as a fertiliser in agriculture. The toxicity test on terrestrial plants showed a positive effect in plant growth. The toxicity test on soil macroorganisms (earthworms) showed no negative effect at the highest test concentration of 1,000 mg/kg dw soil.

Assessment for the aquatic environmental compartment based on the assumptions from the SPERC approach for construction chemicals (EFCC).

For wide dispersive uses of non-volatile substances in construction chemicals, outdoor, SpERC EFCC10 is applicable. It specifies the environmental release category ERC 8f. The following assumptions are given:

Release times per year (d/year):	365
Release fraction to air:	0
Release fraction to waste water:	0.01
Release fraction to soil:	0.037

For the environmental exposure assessment of wide dispersive uses (professional and consumer uses) the following assumptions are made:

Annual Flue Dust production per plant (maximum)	100,000 t
Percentage of industrial uses:	40 %
Percentage of professional uses:	50 %
Percentage of consumer uses:	10 %
Percentage of wide dispersive uses (prof. + cons. uses)	60 %
Amount of calcium oxide in Flue Dust:	20 %
Service area for a plant	3,600 km²
Rain gauge (typical low value)	500 L/m² per year

From these values it can be calculated how much calcium hydroxide, with the origin in calcium oxide, being a Flue Dust constituent, may end solved in fresh surface water (rain gauge) and which pH increase will be related to this exposure.

Overview on exposure scenario and coverage of substance life cycle

ES number	Exposure scenario title	Manufacture	Identified uses			Resulting life cycle stage		Sector of use (SU)	Product category (PC)	Process category (PROC)	Article category (AC)	Environmental release category (ERC)
			Formulation	End use	Consumer use	Service life (for articles)	waste stage					
9.1	Industrial manufacture of hydraulic building and construction materials		X						0, 9a, 9b	2, 3, 5, 8b, 9, 14, 26		2
9.2	Raw material for manufacture of clinker and glass	X						8, 13		1, 22		6a
9.3	Industrial uses of dry hydraulic building and construction materials (indoor, outdoor)			X		X		19	0, 9a, 9b	2, 5, 8b, 9, 14, 22, 26	4	5
9.4	Industrial uses of wet suspensions of hydraulic building and construction materials			X		X		19	0, 9a, 9b	2, 5, 7, 8b, 9, 10, 13, 14	4	5
9.5	Flue gas treatment	X						13	2,20	2, 4, 22		6a
9.6	Professional uses of dry hydraulic building and construction materials (indoor, outdoor)			X		X		19	0, 9a, 9b	2, 5, 8a, 8b, 9, 14, 19, 26	4	8c, 8f
9.7	Professional uses of wet suspensions of hydraulic building and construction materials			X		X		19	0, 9a, 9b	2, 5, 8a, 8b, 9, 10, 11, 13, 14, 19	4	8c, 8f
9.8	Waste stabilisation			X				0	0	5, 8a, 8b, 26	01	8c, 8f
9.9	Stabilisation in mining and quarries, soil stabilisation and use in agriculture			X				1, 2a	0, 9b, 12, 20	5, 8a, 8b, 11, 26	01	8f
9.10	Mineral filler in asphalt			X				19	0	5, 8a, 8b, 23, 26	4	8f
9.11	Articles in building and construction work			X		X		19	0	21, 24	4	10a, 11a, 12a
9.12	Consumer uses of hydraulic building and construction materials (DIY)				X			21	9b		4	8c, 8f

Exposure Scenario No 9.1: Industrial manufacture of hydraulic building and construction materials

Exposure Scenario addressing uses carried out by workers	
1. Title: Industrial manufacture of hydraulic building and construction materials	
Free short title	Manufacture of Flue Dust containing mixtures: cement, hydraulic binder, controlled low strength material, concrete (ready-mixed or precast), mortar, grout and others for building and construction work
Sector of uses	not applicable
Market sectors	PC 0: Building and construction products PC 9b: Fillers, putties, plasters, modelling clay PC 9a: Coatings and paints, thinners and fillers
Environmental scenario	ERC 2: Formulations of preparations
Worker scenarios	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 3: Use in closed batch process PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers PROC 14: Production of preparations or articles by tabletting, compression extrusion, pelletisation PROC 26: Handling of solid inorganic substances at ambient temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is based on a qualitative approach, described in the introduction. Relevant parameter is the pH in water and soil.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product is irritating, due to the pH, which is above 11. Finally, the end product is hardened (e.g. as mortar, concrete) and not irritating, since no free alkaline moisture remains.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 2, 3, 5, 8b, 9, 14, 26 (all)	not restricted (480 minutes)

Human factors not influenced by risk management

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

Other given operational conditions affecting workers exposure

Operational conditions like process temperature and process pressure are not considered relevant for occupational exposure assessment of the conducted processes.

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

Risk management measures at the process level are generally not required in the process.

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

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 2, 3	general ventilation	17 %	-
PROC 5, 8b, 9, 14, 26	generic local exhaust ventilation	78 %	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 2, 3	not required	not applicable	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 5, 8b, 9	FFP2 mask	APF = 10		
PROC 14, 26	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic
Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product is irritating, due to the pH, which is above 11. Finally, the end product is hardened (e.g. as mortar, concrete) and not irritating, since no free alkaline moisture remains.
Amounts used
The daily and annual amount per site (for point source) is not considered to be the main determinant for the environmental exposure.
Frequency and duration of use
Intermittent (used < 12 times per year for not more than 24 h) or continuous use/release
Environment factors not influenced by risk management
Flow rate of receiving surface water: 18,000 m^3/d
Other given operational conditions affecting environmental exposure
Effluent discharge rate: 2,000 m^3/d
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. Regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. The justification for this risk management measure can be found in the introduction.
Organizational measures to prevent/limit release from site
Training for the workers, based on the chemical safety data sheet.
Conditions and measures related to municipal sewage treatment plant
The pH of the wastewater going into the municipal sewage treatment plant has to be controlled on a regularly base and neutralized if necessary. Solid Flue Dust constituents have to be separated from the sewage effluent.
Conditions and measures related to waste
Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.
3 Exposure estimation and reference to its source
3.1 Occupational exposure
The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For inhalation exposure, the RCR is based on the DNEL of 1 mg/m^3 (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 2, 3, 5, 8b, 9, 14, 26	MEASE	< 1 mg/m³ (0.44 - 0.83)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions is expected to be negligible compared to the potential pH effect. Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The production of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust production is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust production sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the

	groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or washed out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required, because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

For that assessment, a stepwise approach is recommended.

Tier 1: Retrieve information on effluent pH and the contribution of flue dust on the resulting pH. Should the pH be above 9 and be predominantly attributable to flue dust, then further actions are required to demonstrate safe use.

Tier 2: Retrieve information on receiving water pH after the discharge point. The pH of the receiving water shall not exceed the value of 9.

Tier 3: Measure the pH in the receiving water after the discharge point. If pH is below 9, safe use is reasonably demonstrated and the ES ends here. If pH is found to be above 9, risk management measures have to be implemented: the effluent has to undergo neutralisation, thus ensuring safe use of flue dust during production or use phase.

Exposure Scenario No 9.2: Raw material for manufacture of cement clinker and glass production - industrial use

Exposure Scenario addressing uses carried out by workers	
1. Title: Industrial use - Raw material for manufacture of cement clinker and glass production	
Free short title	Flue Dust used as a raw material for cement clinker production and glass production, including the manufacture of glass fibres, fibre products etc. - Industrial use
Sector of uses	SU 8: Manufacture of bulk, large scale chemicals SU 13: Manufacture of other non-metallic mineral products, eg. plasters, cement
Market sectors	not applicable
Environmental scenario	ERC 6a: Industrial use resulting in manufacture of another substance (use of intermediates)
Worker scenarios	PROC 1: Use in closed process, no likelihood of exposure PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is based on a qualitative approach, described in the introduction. Relevant parameter is the pH in water and soil.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Flue Dust is a highly dusty powder. It is used together with other inorganic raw materials for the manufacture process.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
PROC	Duration of exposure
PROC 1	not restricted (480 minutes)
PROC 22	≤ 240 minutes
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
Operational conditions like process temperature and process pressure are not considered relevant for occupational exposure assessment of the conducted processes.	
Technical conditions and measures at process level (source) to prevent release	
Risk management measures at the process level are generally not required in the process.	
Technical conditions and measures to control dispersion from source towards the worker	

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 1	not required	0 %	-
PROC 22	general ventilation	17 %	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 1	not required	not applicable	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 22	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic

Flue Dust is a highly dusty powder. It is used together with other inorganic raw materials for the manufacture process.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for environmental exposure.

Frequency and duration of use

Intermittent (used < 12 times per year for not more than 24 h) or continuous use/release

Environment factors not influenced by risk management

Flow rate of receiving surface water: 18,000 m³/d

Other given operational conditions affecting environmental exposure

Effluent discharge rate: 2,000 m³/d

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

Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH

changes. Regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. The justification for this risk management measure can be found in the introduction.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to municipal sewage treatment plant

The pH of the wastewater going into the municipal sewage treatment plant has to be controlled on a regularly base and neutralized if necessary. Solid Flue Dust constituents have to be separated from the sewage effluent.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 1, 22	MEASE	< 1 mg/m³ (0.01 - 0.87)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect. Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The production of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust production is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust production sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly

	insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

For that assessment, a stepwise approach is recommended.

Tier 1: Retrieve information on effluent pH and the contribution of flue dust on the resulting pH. Should the pH be above 9 and be predominantly attributable to flue dust, then further actions are required to demonstrate safe use.

Tier 2: Retrieve information on receiving water pH after the discharge point. The pH of the receiving water shall not exceed the value of 9.

Tier 3: Measure the pH in the receiving water after the discharge point. If pH is below 9, safe use is reasonably demonstrated and the ES ends here. If pH is found to be above 9, risk management measures have to be implemented: the effluent has to undergo neutralisation, thus ensuring safe use of flue dust during production or use phase.

9.3. Industrial uses of dry hydraulic building and construction materials

Exposure Scenario addressing uses carried out by workers	
1. Title: Industrial uses of dry hydraulic building and construction materials (indoor, outdoor)	
Free short title	Use of dry cement, hydraulic binder, controlled low strength material, ready-mixed concrete, mortar, grout etc. in building and construction (indoor and outdoor)
Sector of uses	SU 19: Building and construction work
Market sectors	PC 0: Building and construction products PC 9a: Coatings and paints, thinners and fillers PC 9b: Fillers, putties, plasters, modelling clay
Environmental scenario	ERC 5: Industrial use resulting in inclusion into or onto a matrix
Worker scenarios	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers PROC 14: Production of preparations or articles by tabletting, compression extrusion, pelletisation PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature Industrial setting PROC 26: Handling of solid inorganic substances at ambient temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is based on a qualitative approach, described in the introduction. Relevant parameter is the pH in water and soil.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product is irritating, due to the pH, which is above 11. Finally, the end product is hardened (e.g. as mortar, concrete) and not irritating, since no free alkaline moisture remains.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 22	≤ 240 minutes
PROC 2, 5, 8b, 9, 14, 26	not restricted (480 minutes)

Human factors not influenced by risk management

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

Other given operational conditions affecting workers exposure

Operational conditions like process temperature and process pressure are not considered relevant for occupational exposure assessment of the conducted processes.

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

Risk management measures at the process level are generally not required in the process.

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

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 2	general ventilation	17 %	-
PROC 5, 8b, 9, 14, 22, 26	local exhaust ventilation	78 %	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 2	not required	not applicable	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 5, 8b, 9	FFP2 mask	APF = 10		
PROC 14, 22, 26	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic
Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product is irritating, due to the pH, which is above 11. Finally, the end product is hardened (e.g. as mortar, concrete) and not irritating, since no free alkaline moisture remains.
Amounts used
The daily and annual amount per site (for point source) is not considered to be the main determinant for environmental exposure.
Frequency and duration of use
Intermittent (used < 12 times per year for not more than 24 h) or continuous use/release
Environment factors not influenced by risk management
Flow rate of receiving surface water: 18,000 m^3/d
Other given operational conditions affecting environmental exposure
Effluent discharge rate: 2000 m^3/d
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. Regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. The justification for this risk management measure can be found in the introduction.
Organizational measures to prevent/limit release from site
Training for the workers, based on the chemical safety data sheet.
Conditions and measures related to municipal sewage treatment plant
The pH of the wastewater going into the municipal sewage treatment plant has to be controlled on a regularly base and neutralized if necessary. Solid Flue Dust constituents have to be separated from the sewage effluent.
Conditions and measures related to waste
Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.
3. Exposure estimation and reference to its source
3.1 Occupational exposure
The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use. For inhalation exposure, the RCR is based on the DNEL of 1 mg/m^3 (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 2, 5, 8b, 9, 14, 22, 26	MEASE	< 1 mg/m³ (0.23-0.83)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect. Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The production of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust production is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust production sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the

	groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

For that assessment, a stepwise approach is recommended.

Tier 1: Retrieve information on effluent pH and the contribution of flue dust on the resulting pH. Should the pH be above 9 and be predominantly attributable to flue dust, then further actions are required to demonstrate safe use.

Tier 2: Retrieve information on receiving water pH after the discharge point. The pH of the receiving water shall not exceed the value of 9.

Tier 3: Measure the pH in the receiving water after the discharge point. If pH is below 9, safe use is reasonably demonstrated and the ES ends here. If pH is found to be above 9, risk management measures have to be implemented: the effluent has to undergo neutralisation, thus ensuring safe use of flue dust during production or use phase.

9.4. Industrial uses of wet suspensions of hydraulic building and construction materials

Exposure Scenario addressing uses carried out by workers	
1. Title: Industrial uses of wet suspension of hydraulic building and construction materials	
Free short title	Use of Flue Dust as a constituent in wet suspensions of hydraulic binders (cement paste, fresh mortar, concrete, plaster, filler, grout etc.) in building and construction work - industrial use
Sector of uses	SU 19: Building and construction work
Market sectors	PC 0: Building and construction products PC 9a: Coatings and paints, thinners and fillers PC 9b: Fillers, putties, plasters, modelling clay
Environmental scenario	ERC 5: Industrial use resulting in inclusion into or onto a matrix
Worker scenarios	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 7: Industrial spraying PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers PROC 10: Roller application or brushing PROC 13: Treatment of articles by dipping and pouring PROC 14: Production of preparations or articles by tabletting, compression extrusion, pelletisation
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is based on a qualitative approach, described in the introduction. Relevant parameter is the pH in water and soil.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product is irritating, due to the pH, which is above 11. Finally, the end product is hardened (e.g. as mortar, concrete) and not irritating, since no free alkaline moisture remains.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
all PROCs	not restricted (480 minutes)
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
Operational conditions like process temperature and process pressure are not considered relevant for	

occupational exposure assessment of the conducted processes.

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

Risk management measures at the process level are generally not required in the process.

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

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 7	generic local exhaust ventilation	82 %	-
PROC 2, 5, 8b, 9, 10, 13, 14	not required	not applicable	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 7	FFP1 mask	APF = 4	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 2, 5, 8b, 9, 10, 13, 14	not required	not required		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic

Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder.

At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product is irritating, due to the pH, which is above 11. Finally, the end product is hardened (e.g. as mortar, concrete) and not irritating, since no free alkaline moisture remains.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for environmental exposure.

Frequency and duration of use

Intermittent (used < 12 times per year for not more than 24 h) or continuous use/release

Environment factors not influenced by risk management

Flow rate of receiving surface water: 18,000 m^3/d

Other given operational conditions affecting environmental exposure

Effluent discharge rate: 2000 m^3/d

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

Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. Regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. The justification for this risk management measure can be found in the introduction.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to municipal sewage treatment plant

The pH of the wastewater going into the municipal sewage treatment plant has to be controlled on a regularly base and neutralized if necessary. Solid Flue Dust constituents have to be separated from the sewage effluent.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m^3 (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 2, 5, 7, 8b, 9, 10, 13, 14	MEASE	< 1 mg/m³ (0.01-0.90)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect. Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The production of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust production is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust production sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the

	groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

For that assessment, a stepwise approach is recommended.

Tier 1: Retrieve information on effluent pH and the contribution of flue dust on the resulting pH. Should the pH be above 9 and be predominantly attributable to flue dust, then further actions are required to demonstrate safe use.

Tier 2: Retrieve information on receiving water pH after the discharge point. The pH of the receiving water shall not exceed the value of 9.

Tier 3: Measure the pH in the receiving water after the discharge point. If pH is below 9, safe use is reasonably demonstrated and the ES ends here. If pH is found to be above 9, risk management measures have to be implemented: the effluent has to undergo neutralisation, thus ensuring safe use of flue dust during production or use phase.

9.5. Flue gas treatment - industrial use

Exposure Scenario addressing uses carried out by workers	
1. Title: Industrial use - Flue gas treatment	
Free short title	Flue Dust used for flue gas desulfurization - Industrial use
Sector of uses	SU 13: Manufacture of other non-metallic mineral products, e.g. plasters, cement
Market sectors	PC 2: Adsorbents PC 20: Products such as pH-regulators, flocculants, precipitants, neutralisation agents
Environmental scenario	ERC 6a: Industrial use resulting in manufacture of another substance (use of intermediates)
Worker scenarios	PROC 2: Used in closed, continuous process with occasional controlled exposure PROC 4: Use in batch and other process (synthesis) where opportunity for exposure arises PROC 22: Potentially closed processing operations with minerals/metals at elevated temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is based on a qualitative approach, described in the introduction. Relevant parameter is the pH in water and soil.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Flue Dust and Flue Dust containing products for the flue gas desulfurization are highly dusty powders. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance. During the process the alkaline reactive Flue Dust constituents react with sulphur dioxide and other acidic impurities of the flue gas. The reaction products, alkaline salts like calcium sulphate, together with the non reacting Flue Dust constituents, will be removed from the gas stream at the end of the process.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 2, 4	not restricted (480 minutes)
PROC 22	≤ 240 minutes
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
Operational conditions like process temperature and process pressure are not considered relevant for occupational exposure assessment of the conducted processes.	
Technical conditions and measures at process level (source) to prevent release	
Risk management measures at the process level are generally not required in the process.	

Technical conditions and measures to control dispersion from source towards the worker			
Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 2, 22	general ventilation	17 %	-
PROC 4	generic local exhaust ventilation	78 %	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 2	not required	not applicable	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 4	FFP2 mask	APF = 10		
PROC 22	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic

Flue Dust and Flue Dust containing products for the flue gas desulfurization are highly dusty powders. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance.

During the process the alkaline reactive Flue Dust constituents react with sulphur dioxide and other acidic impurities of the flue gas. The reaction products, alkaline salts like calcium sulphate, together with the non reacting Flue Dust constituents, will be removed from the gas stream at the end of the process.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for environmental exposure.

Frequency and duration of use

Intermittent (used < 12 times per year for not more than 24 h) or continuous use/release

Environment factors not influenced by risk management

Flow rate of receiving surface water: 18,000 m³/d

Other given operational conditions affecting environmental exposure

Effluent discharge rate: 2000 m³/d

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

Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. Regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. The justification for this risk management measure can be found in the introduction.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to municipal sewage treatment plant

The pH of the wastewater going into the municipal sewage treatment plant has to be controlled on a regularly base and neutralized if necessary. Solid Flue Dust constituents have to be separated from the sewage effluent.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 2, 4, 22	MEASE	< 1 mg/m³ (0.55 - 0.87)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect. Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The production of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the

	effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust production is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust production sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

For that assessment, a stepwise approach is recommended.

Tier 1: Retrieve information on effluent pH and the contribution of flue dust on the resulting pH. Should the pH be above 9 and be predominantly attributable to flue dust, then further actions are required to demonstrate safe use.

Tier 2: Retrieve information on receiving water pH after the discharge point. The pH of the receiving water shall not exceed the value of 9.

Tier 3: Measure the pH in the receiving water after the discharge point. If pH is below 9, safe use is reasonably demonstrated and the ES ends here. If pH is found to be above 9, risk management measures have to be implemented: the effluent has to undergo neutralisation, thus ensuring safe use of flue dust during production or use phase.

9.6. Professional uses of dry hydraulic building and construction materials

Exposure Scenario addressing uses carried out by workers	
1. Title. Professional use of dry hydraulic building and construction material (indoor, outdoor)	
Free short title	Use of Flue Dust as a constituent in dry cement, hydraulic binder, controlled low strength material, ready-mixed concrete, mortar, grout etc. in building and construction (indoor and outdoor) - Professional use
Sector of uses	SU 19: Building and construction work
Market sectors	PC 0: Building and construction products PC 9a: Coatings and paints, thinners and fillers PC 9b: Fillers, putties, plasters, modelling clay
Environmental release categories	ERC 8c: Wide dispersive indoor use resulting in inclusion into or onto a matrix ERC 8f: Wide dispersive outdoor use resulting in inclusion into or onto a matrix
Process categories	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8a: Transfer of substance or preparation from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers PROC 14: Production of preparations or articles by tabletting, compression extrusion, pelletisation PROC 19: Hand-mixing with intimate contact and only PPE available PROC 26: Handling of solid inorganic substances at ambient temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is a qualitative approach, using SPERC data for construction chemicals, described in the introduction section.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic binders are mixtures. The content of Flue Dust in cement, the main application, is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage the product is irritating, due to the pH, which is above 11. Finally, the end product will be hardened.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 5, 8a, 8b, 9, 14, 19, 26	≤ 240 minutes
PROC 2	not restricted (480 minutes)

Human factors not influenced by risk management

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

Other given operational conditions affecting workers exposure

No other operational conditions.

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

Risk management measures at the process level are generally not required in the process.

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

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 5, 8a, 8b, 9, 14, 26	generic local exhaust ventilation	72 %	-
PROC 19	not applicable	-	only in good ventilated rooms or outdoor (efficiency 50%)
PROC 2	not required	-	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 9, 26	FFP1 mask	APF = 4	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 19	FFP3 mask	APF = 20		
PROC 2, 5, 8a, 8b, 14	FFP2 mask	APF = 10		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic

Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder.

At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product may increase the pH of the environmental compartment. It is an intrinsic property of the hydraulic binder that after a relatively short time the end product will harden (e.g. as concrete or mortar) and enclose calcium hydroxide and residual alkaline moisture. Due to the intended use of construction materials the structure is dense and the leaching potential is low. Over the time calcium hydroxide will react with carbon dioxide from air and form calcium carbonate, beginning from the surface of the hardened products.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for the environmental exposure.

Frequency and duration of use

300 d per year

Environment factors not influenced by risk management

Rain gauge: 500 L/m² per year.

Other given operational conditions affecting environmental exposure

Due to the control of workers exposure, local exhaust ventilation is used for many processes. Those filtered dusts will not reach the environmental compartment.

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

Use of local exhaust ventilation to minimise the exposure. Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. If applicable, regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. Control of the pH of effluents, when possible and neutralisation when necessary. The justification for this risk management measure can be found in the introduction section.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL for calcium oxide of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)

PROC 2, 5, 8a, 8b, 9, 14, 19, 26	MEASE	< 1 mg/m³ (0.50 - 0,83)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect.

Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The use of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust application is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust use sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the

	bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}). Due to the assumption from the SPERC approach for construction chemicals (EFCC) - described in the introduction - a maximum pH increase can be estimated for wide dispersive uses. 60% of a production of 100,000 tpa goes into wide dispersive uses. 20% are calcium oxide and the release fraction is 0.037. Therefore the release is about 444 tpa (calcium oxide) or 587 tpa (calcium hydroxide). Distributed on a service area of 3600 km², the exposure is 163 kg/km² or 163 mg/m² calcium hydroxide per year. Diluted by a rain gauge of 500 L/m² per year, the exposure of the rain water is 323 µg/L. 323 µg calcium hydroxide comprise 149 µg/L hydroxide ions, equal 8,8 µmol/L. Assumed that all hydroxide is solved and not neutralized by carbon dioxide, the pH will be increased from 7 to 8.9 and not exceed 9.
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

Not relevant

9.7. Professional uses of wet suspensions of hydraulic building and construction materials

Exposure Scenario addressing uses carried out by workers	
1. Title: Professional uses of wet suspensions of hydraulic building and construction materials	
Free short title	Use of Flue Dust as a constituent in wet suspensions of hydraulic binders (cement paste, fresh mortar, concrete, plaster, filler, grout etc.) in building and construction work - Professional use
Sector of uses	SU 19: Building and construction work
Market sectors	PC 0: Building and construction products PC 9a: Coatings and paints, thinners and fillers PC 9b: Fillers, putties, plasters, modelling clay
Environmental release categories	ERC 8c: Wide dispersive indoor use resulting in inclusion into or onto a matrix ERC 8f: Wide dispersive outdoor use resulting in inclusion into or onto a matrix
Process categories	PROC 2: Use in closed, continuous process with occasional controlled exposure PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8a: Transfer of substance or preparation from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 9: Transfer of substance or preparation into small containers PROC 10: Roller application or brushing PROC 11: Non-Industrial spraying PROC 13: Treatment of articles by dipping and pouring PROC 14: Production of preparations or articles by tabletting, compression extrusion, pelletisation PROC 19: Hand-mixing with intimate contact and only PPE available
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is a qualitative approach, using SPERC data for construction chemicals, described in the introduction section.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic binders are mixtures. The content of Flue Dust in cement, the main application, is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage the product is irritating, due to the pH, which is above 11. Finally, the end product will be hardened.	
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 PROC) is the main determinant of the process intrinsic emission potential.	

Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 11	≤ 240 minutes
PROC 2, 5, 8a, 8b, 9, 10, 13, 14, 19	not restricted (480 minutes)

Human factors not influenced by risk management
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).

Other given operational conditions affecting workers exposure
No other operational conditions.

Technical conditions and measures at process level (source) to prevent release
Risk management measures at the process level are generally not required in the process.

Technical conditions and measures to control dispersion from source towards the worker			
Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 11	generic local exhaust ventilation	72 %	-
PROC 2, 5, 8a, 8b, 9, 10, 13, 14, 19	not required	-	-

Organisational measures to prevent/limit releases, dispersion and exposure
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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

Conditions and measures related to personal protection, hygiene and health evaluation				
Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 11	FFP1 mask	APF = 4	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 2, 5, 8a, 8b, 9, 10, 13, 14, 19	not required	not applicable		
Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process). An overview of the APFs of different RPE (according to BS EN 529:2005) can be found in the glossary of MEASE. 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.

2.2 Control of environmental exposure

Product characteristic

Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder.

At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product may increase the pH of the environmental compartment. It is an intrinsic property of the hydraulic binder that after a relatively short time the end product will harden (e.g. as concrete or mortar) and enclose calcium hydroxide and residual alkaline moisture. Due to the intended use of construction materials the structure is dense and the leaching potential is low. Over the time calcium hydroxide will react with carbon dioxide from air and form calcium carbonate, beginning from the surface of the hardened products.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for the environmental exposure.

Frequency and duration of use

300 d per year

Environment factors not influenced by risk management

Rain gauge: 500 L/m² per year.

Other given operational conditions affecting environmental exposure

Due to the control of workers exposure, local exhaust ventilation is used for many processes. Those filtered dusts will not reach the environmental compartment.

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

Use of local exhaust ventilation to minimise the exposure. Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. If applicable, regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. Control of the pH of effluents, when possible and neutralisation when necessary. The justification for this risk management measure can be found in the introduction section.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)

PROC 2, 5, 8a, 8b, 9, 10, 11, 13, 14, 19	MEASE	< 1 mg/m³ (0.001 - 0,68)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect.

Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The use of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust application is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust use sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the

	bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}). Due to the assumption from the SPERC approach for construction chemicals (EFCC) - described in the introduction - a maximum pH increase can be estimated for wide dispersive uses. 60% of a production of 100,000 tpa goes into wide dispersive uses. 20% are calcium oxide and the release fraction is 0.037. Therefore the release is about 444 tpa (calcium oxide) or 587 tpa (calcium hydroxide). Distributed on a service area of 3600 km², the exposure is 163 kg/km² or 163 mg/m² calcium hydroxide per year. Diluted by a rain gauge of 500 L/m² per year, the exposure of the rain water is 323 µg/L. 323 µg calcium hydroxide comprise 149 µg/L hydroxide ions, equal 8,8 µmol/L. Assumed that all hydroxide is solved and not neutralized by carbon dioxide, the pH will be increased from 7 to 8.9 and not exceed 9.
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

Not relevant

9.8. Waste stabilisation

Exposure Scenario addressing uses carried out by workers	
1. Title: Waste stabilisation	
Free short title	Use of Flue Dust as a constituent in hydraulic binder for stabilisation in mining and quarries and soil stabilisation - Professional use
Sector of uses	SU 0: Waste treatment
Market sectors	PC 0: Hydraulic binder
Environmental release categories	ERC 8c: Wide dispersive indoor use resulting in inclusion into or onto a matrix ERC 8f: Wide dispersive outdoor use resulting in inclusion into or onto a matrix
Process categories	PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8a: Transfer of substance or preparation from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 26: Handling of solid inorganic substances at ambient temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is a qualitative approach, using SPERC data for construction chemicals, described in the introduction section.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic binders are mixtures. The content of Flue Dust in cement, the main application, is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage the product is irritating, due to the pH, which is above 11. Finally, the end product will be hardened.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 5, 8a, 8b, 26	≤ 240 minutes
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
No other operational conditions.	

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

Risk management measures at the process level are generally not required in the process.

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

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 5, 8a, 8b, 11, 26	generic local exhaust ventilation	72 %	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 5, 8a, 8b	FFP2 mask	APF = 10	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 26	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder.

At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product may increase the pH of the environmental compartment. It is an intrinsic property of the hydraulic binder that after a relatively short time the end product will harden (e.g. as concrete or mortar) and enclose calcium hydroxide and residual alkaline

moisture. Due to the intended use of construction materials the structure is dense and the leaching potential is low. Over the time calcium hydroxide will react with carbon dioxide from air and form calcium carbonate, beginning from the surface of the hardened products.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for the environmental exposure.

Frequency and duration of use

300 d per year

Environment factors not influenced by risk management

Rain gauge: 500 L/m² per year.

Other given operational conditions affecting environmental exposure

Due to the control of workers exposure, local exhaust ventilation is used for many processes. Those filtered dusts will not reach the environmental compartment.

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

Use of local exhaust ventilation to minimise the exposure. Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. If applicable, regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. Control of the pH of effluents, when possible and neutralisation when necessary. The justification for this risk management measure can be found in the introduction section.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 5, 8a, 8b, 26	MEASE	< 1 mg/m³ (0.83)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect.

Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The use of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust application is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust use sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}). Due to the assumption from the SPERC approach for construction chemicals (EFCC) - described in the introduction - a maximum pH increase can be estimated for wide dispersive uses. 60% of a production of 100,000 tpa goes into wide dispersive uses. 20% are calcium oxide and the release fraction is 0.037. Therefore the release is about 444 tpa (calcium oxide) or 587 tpa (calcium hydroxide).

	Distributed on a service area of 3600 km², the exposure is 163 kg/km² or 163 mg/m² calcium hydroxide per year. Diluted by a rain gauge of 500 L/m² per year, the exposure of the rain water is 323 µg/L. 323 µg calcium hydroxide comprise 149 µg/L hydroxide ions, equal 8,8 µmol/L. Assumed that all hydroxide is solved and not neutralized by carbon dioxide, the pH will be increased from 7 to 8.9 and not exceed 9.
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

Not relevant

9.9. Stabilisation in mining and quarries, soil stabilisation and use in agriculture

Exposure Scenario addressing uses carried out by workers	
1. Title: Stabilisation in mining and quarries, soil stabilisation, agriculture	
Free short title	Use of Flue Dust as a constituent in hydraulic binder for stabilisation in mining and quarries and soil stabilisation - Professional use
Sector of uses	SU 1: Agriculture, forestry and fishing SU 2a: Mining (without offshore industries)
Market sectors	PC 0: Hydraulic binder PC 9b: Fillers, putties, plasters, modelling clay PC 12 Fertilisers PC 20 Products such as pH-regulator, flocculants, precipitants, neutralisation agents
Environmental release categories	ERC 8f: Wide dispersive outdoor use resulting in inclusion into or onto a matrix
Process categories	PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8a: Transfer of substance or preparation from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 11: Non-industrial spraying PROC 26: Handling of solid inorganic substances at ambient temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is a qualitative approach, using SPERC data for construction chemicals, described in the introduction section.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Hydraulic binders are mixtures. The content of Flue Dust in cement, the main application, is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance. At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage the product is irritating, due to the pH, which is above 11. Finally, the end product will be hardened.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 5, 8a, 8b, 26	≤ 240 minutes
PROC 11	≤ 60 minutes
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
No other operational conditions.	
Technical conditions and measures at process level (source) to prevent release	

Risk management measures at the process level are generally not required in the process.

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

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 5, 8a, 8b, 11, 26	generic local exhaust ventilation	72 %	-

Organisational measures to prevent/limit releases, dispersion and exposure

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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 5, 8a, 8b	FFP2 mask	APF = 10	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 11	FFP3 mask	APF = 20		
PROC 26	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder.

At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product may increase the pH of the environmental compartment. It is an intrinsic property of the hydraulic binder that after a relatively short time the end product will harden (e.g. as concrete or mortar) and enclose calcium hydroxide and residual alkaline moisture. Due to the intended use of construction materials the structure is dense and the leaching potential is low. Over the time calcium hydroxide will react with carbon dioxide from air and form calcium carbonate, beginning from the surface of the hardened products.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for the environmental exposure.

Frequency and duration of use

300 d per year

Environment factors not influenced by risk management

Rain gauge: 500 L/m² per year.

Other given operational conditions affecting environmental exposure

Due to the control of workers exposure, local exhaust ventilation is used for many processes. Those filtered dusts will not reach the environmental compartment.

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

Use of local exhaust ventilation to minimise the exposure. Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. If applicable, regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. Control of the pH of effluents, when possible and neutralisation when necessary. The justification for this risk management measure can be found in the introduction section.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 5, 8a, 8b, 11, 26	MEASE	< 1 mg/m³ (0.55 - 0,83)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect.

Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The use of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust application is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust use sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction,

	the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}). Due to the assumption from the SPERC approach for construction chemicals (EFCC) - described in the introduction - a maximum pH increase can be estimated for wide dispersive uses. 60% of a production of 100,000 tpa goes into wide dispersive uses. 20% are calcium oxide and the release fraction is 0.037. Therefore the release is about 444 tpa (calcium oxide) or 587 tpa (calcium hydroxide). Distributed on a service area of 3600 km², the exposure is 163 kg/km² or 163 mg/m² calcium hydroxide per year. Diluted by a rain gauge of 500 L/m² per year, the exposure of the rain water is 323 µg/L. 323 µg calcium hydroxide comprise 149 µg/L hydroxide ions, equal 8,8 µmol/L. Assumed that all hydroxide is solved and not neutralized by carbon dioxide, the pH will be increased from 7 to 8.9 and not exceed 9.
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

Not relevant

9.10. Mineral filler in asphalt

Exposure Scenario addressing uses carried out by workers	
1. Title. Mineral filler in asphalt	
Free short title	Use of Flue Dust as a filler in asphalt and bituminous products - Professional use
Sector of uses	SU 19: Building and construction work
Market sectors	PC 0: Hydraulic binder
Environmental release categories	ERC 8f: Wide dispersive outdoor use resulting in inclusion into or onto a matrix
Process categories	PROC 5: Mixing or blending in batch process for formulation of preparations and articles. PROC 8a: Transfer of substance or preparation from/to vessels/large containers at non-dedicated facilities PROC 8b: Transfer of substance or preparation from/to vessels/large containers at dedicated facilities PROC 23: Open processing and transfer operations with minerals/metals at elevated temperatures PROC 26: Handling of solid inorganic substances at ambient temperature
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is a qualitative approach, using SPERC data for construction chemicals, described in the introduction section.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Flue Dust is a highly dusty powder. Therefore, the assessment, using the MEASE tool, is based on the dustiness / fugacity of the substance. Flue Dust can be used as such or in mixtures. The content in the mixture is not restricted.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 5, 8a, 8b, 23, 26	≤ 240 minutes
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
No other operational conditions.	
Technical conditions and measures at process level (source) to prevent release	
Risk management measures at the process level are generally not required in the process.	

Technical conditions and measures to control dispersion from source towards the worker			
Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 5, 8a, 8b, 23, 26	generic local exhaust ventilation	72 %	-

Organisational measures to prevent/limit releases, dispersion and exposure
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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

Conditions and measures related to personal protection, hygiene and health evaluation				
Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 5, 8a, 8b	FFP2 mask	APF = 10	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 23	not required	not applicable		
PROC 26	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Hydraulic building and construction materials are inorganic binders. Generally, these products are mixtures of Portland cement clinker and other hydraulic or non hydraulic constituents. Flue Dust can be part of common cements, like Portland cement. In this main application, the Flue Dust content is below 5 %. In other hydraulic binders the Flue Dust content could be up to 50 %. Generally, the content in a hydraulic mixture is not restricted. Flue Dust is a highly dusty powder.

At all end uses, the substance will intentionally come into contact with water. Partly, the substance reacts with water and forms hydration products. At this stage of a wet or pasty suspension, the product may increase the pH of the environmental compartment. It is an intrinsic property of the hydraulic binder that after a relatively short time the end product will harden (e.g. as concrete or mortar) and enclose calcium hydroxide and residual alkaline moisture. Due to the intended use of construction materials the structure is dense and the leaching potential is low. Over the time calcium hydroxide will react with carbon dioxide from air and form calcium carbonate, beginning from the surface of the hardened products.

Amounts used

The daily and annual amount per site (for point source) is not considered to be the main determinant for the environmental exposure.

Frequency and duration of use

300 d per year

Environment factors not influenced by risk management

Rain gauge: 500 L/m² per year.

Other given operational conditions affecting environmental exposure

Due to the control of workers exposure, local exhaust ventilation is used for many processes. Those filtered dusts will not reach the environmental compartment.

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

Use of local exhaust ventilation to minimise the exposure. Risk management measures related to the environment aim to avoid discharging suspensions containing Flue Dust into municipal wastewater or to surface water, in case such discharges are expected to cause significant pH changes. If applicable, regular control of the pH value during introduction into open waters is required. In general discharges should be carried out such that pH changes in receiving surface waters are minimised (e.g. through neutralisation). In general most aquatic organisms can tolerate pH values in the range of 6-9. This is also reflected in the description of standard OECD tests with aquatic organisms. Control of the pH of effluents, when possible and neutralisation when necessary. The justification for this risk management measure can be found in the introduction section.

Organizational measures to prevent/limit release from site

Training for the workers, based on the chemical safety data sheet.

Conditions and measures related to waste

Solid industrial waste of Flue Dust should be reused or discharged after hardening and/or neutralisation.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 5, 8a, 8b, 23, 26	MEASE	< 1 mg/m³ (0.83)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

Significant emissions or exposure to air are not expected due to the low vapour pressure of Flue Dust.

Emissions or exposure to the terrestrial environment are not expected and therefore not relevant for this exposure scenario.

The environmental exposure assessment is only relevant for the aquatic environment as emissions of Flue Dust in the different life-cycle stages (production and use) mainly apply to ground and waste water. The aquatic effect and risk assessment covers the effect on organisms/ecosystems due to possible pH changes related to hydroxide discharges. The toxicity of the different solved inorganic ions are expected to be negligible compared to the potential pH effect.

Only the local scale is being addressed, including municipal sewage treatment plants (STPs) or industrial waste water treatment plants (WWTPs) when applicable, both for production and industrial use as any effects that might occur would be expected to take place on a local scale. The exposure assessment is approached by assessing the resulting pH impact. The pH of surface water should not exceed 9.

Environmental emissions	The use of Flue Dust can potentially result in an aquatic emission, whereby locally the pH and the amount of the following ions can be increased in the aquatic environment: K^+, Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-. When the pH is not neutralised, the effluent of the production sites may impact the pH of the receiving water. Generally, the pH of the effluents is measured frequently and can be neutralised easily as often as required by national legislation.
Exposure concentration in waste water treatment plant (WWTP)	Waste water from Flue Dust application is an inorganic wastewater stream, for which no biological treatment is necessary. Wastewater streams from Flue Dust use sites will normally not be treated in biological waste water treatment plants (WWTPs), but can be used for pH control of acid wastewater streams that are treated in biological WWTPs.
Exposure concentration in aquatic pelagic compartment	When Flue Dust is emitted to surface water the following happens. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are highly or moderate soluble and will remain in water. These chloride and sulphate salts are naturally occurring in sea water and groundwater. The amount in groundwater depends on the geological soil formation and varies between different regions. Some constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the water may increase, depending on the buffer capacity of the water. The higher the buffer capacity of the water, the lower the effect on pH will be. In general the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}).
Exposure concentration in sediments	A risk assessment for the sediment compartment is considered as not relevant and therefore not included. When Flue Dust is emitted to this compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the sediment. Some Flue Dust constituents react with water and form highly insoluble inorganic hydration products. Even these products have no bioaccumulation potential. Other constituents are highly soluble and will remain in water.
Exposure concentrations in soil and groundwater	When Flue Dust is emitted to the soil and groundwater compartment the following happens. Some Flue Dust constituents are inert and insoluble (calcite, quartz, clay minerals), they are naturally occurring minerals and will have no impact on the soil. Some Flue Dust constituents (sulphate and chloride salts from sodium, potassium, calcium and magnesium) are moderate or highly soluble and will remain in groundwater. These chloride and sulphate salts are naturally occurring in sea water und ground water. The amount in groundwater depends on the geological soil formation and is therefore variable. Some other constituents react with water and form highly insoluble inorganic hydration products. Due to the hydration reaction, the pH of the groundwater may increase, depending on the buffer capacity of the groundwater. The higher the buffer capacity of the groundwater, the lower the effect on pH will be. In general, the buffer capacity preventing shifts in acidity or alkalinity in natural waters is regulated by the equilibrium between carbon dioxide (CO_2), the bicarbonate ion (HCO_3^-) and the carbonate ion (CO_3^{2-}). Due to the assumption from the SPERC approach for construction chemicals (EFCC) - described in the introduction - a maximum pH increase can be estimated for wide dispersive uses. 60% of a production of 100,000 tpa goes into wide dispersive uses. 20% are calcium oxide and the release fraction is 0.037. Therefore the release is about 444 tpa (calcium oxide) or 587 tpa (calcium hydroxide). Distributed on a service area of 3600 km², the exposure is 163 kg/km² or 163 mg/m² calcium hydroxide per year. Diluted by a rain gauge of 500 L/m² per year, the exposure of the rain water is 323 µg/L. 323 µg calcium hydroxide comprise 149 µg/L hydroxide ions, equal 8,8 µmol/L. Assumed that all hydroxide is solved and not neutralized by carbon dioxide, the pH will be increased from 7 to 8.9 and not exceed 9.
Exposure concentration in atmospheric compartment	A risk assessment for the air compartment is considered as not relevant and therefore not included. When Flue Dust particles are emitted to air, they will sediment or wash out by rain in a reasonable short time. Thus, the atmospheric emissions end up in soil and water.
Exposure concentration relevant for the food chain (secondary poisoning)	A risk assessment for secondary poisoning is not required because bioaccumulation in organisms is not relevant for Flue Dust, which is an inorganic substance.
4 Guidance to DU to evaluate whether he works inside the boundaries set by the ES	

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

Not relevant

9.11. Articles in building and construction work

Exposure Scenario addressing uses carried out by workers	
1. Articles in building and construction work	
Free short title	Uses of articles containing Flue Dust in building and construction work - Professional uses
Sector of uses	SU 19: Building and construction work
Market sectors	PC 0: Building and construction articles
Environmental release categories	ERC 10a: Wide dispersive outdoor use of long-life articles and materials with low release ERC 11a: Wide dispersive indoor use of long-life articles and materials with low release ERC 12a: Industrial processing of articles with abrasive techniques (low release)
Process categories	PROC 21: Low energy manipulation of substances bound in materials and/or articles PROC 24: High (mechanical) energy work-up of substances bound in materials and/or articles
Assessment method	The assessment of inhalation exposure is based on the dustiness / fugacity of the substance, using the exposure estimation tool MEASE. The environmental assessment is based on a qualitative approach, described in the introduction. Relevant parameter is the pH in water and soil.
2. Operational conditions and risk management measures	
2.1 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. Articles are massive objects, without dustiness.	
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 PROC) is the main determinant of the process intrinsic emission potential.	
Frequency and duration of use/exposure	
Processes	Duration of exposure
PROC 21, 24	480 minutes (not restricted)
Human factors not influenced by risk management	
The shift breathing volume during all process steps reflected in the PROCs is assumed to be 10 m³/shift (8 hours).	
Other given operational conditions affecting workers exposure	
No other operational conditions.	
Technical conditions and measures at process level (source) to prevent release	
Risk management measures at the process level are generally not required in the process.	
Technical conditions and measures to control dispersion from source towards the worker	

Processes	Localised controls (LC)	Efficiency of LC (according to MEASE)	Further information
PROC 21, 24	not required	not applicable	-

Organisational measures to prevent/limit releases, dispersion and exposure
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 eating and smoking at the workplace, the wearing of standard working clothes and shoes unless otherwise stated below. Shower and change clothes at end of work shift. Do not wear contaminated clothing at home. Do not blow dust off with compressed air.

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

Processes	Specification of respiratory protective equipment (RPE)	RPE efficiency - assigned protection factor (APF)	Specification of gloves	Further personal protective equipment (PPE)
PROC 21	not required	not applicable	Impervious, abrasion and alkali resistant gloves, internally lined with cotton. The use of gloves is mandatory, since the Flue Dust is classified as irritating to skin.	Safety goggles or visors (acc. EN 166) are mandatory, since Flue Dust is classified as highly irritating to eyes. Additional face protection, protective clothing and safety shoes are required to be worn as appropriate.
PROC 24	FFP1 mask	APF = 4		

Gloves and eye protective equipment must be worn, unless potential contact with the skin and eyes can be excluded by the nature and type of application (i.e. closed process).

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

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.

2.2 Control of environmental exposure

Product characteristic

The reaction products from the hydration process which are responsible for the alkalinity are chemically bound into/onto a matrix with a very low release potential. Therefore no relevant exposure for the environment arose.

3. Exposure estimation and reference to its source

3.1 Occupational exposure

The exposure estimation tool MEASE was used for the assessment of inhalation exposure. The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m³ (as respirable dust) and the respective inhalation exposure estimate derived using MEASE (as inhalable dust). Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

Processes	Method used for inhalation exposure assessment	Inhalation exposure estimate (RCR)	Method used for dermal exposure assessment	Dermal exposure estimate (RCR)
PROC 21, 24	MEASE	< 1 mg/m³ (0.05 - 0.50)	Since Flue Dust is classified as irritating to skin and eyes, dermal exposure has to be minimised as far as technically feasible. A DNEL for dermal effects has not been derived. Therefore, dermal exposure is not assessed in this exposure scenario.	

3.2 Environmental emissions

The Flue Dust constituents are chemically bound into a matrix (hardened concrete, mortar, etc.): there is no intended release of Flue Dust during normal and conditions of use. Releases are negligible and insufficient to cause a pH-shift in soil, wastewater or surface water.

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

Occupational exposure

A 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 operational conditions and implemented risk management measures are adequate. This has to be done by showing that they limit the inhalation and dermal exposure to a level below the respective DNEL (given that the processes and activities in question are covered by the PROCs listed above) as given below. If measured data are not available, the DU may make use of an appropriate scaling tool such as MEASE (www.ebrc.de/mease.html) to estimate the associated exposure.

DNEL inhalation : 1 mg/m³ (as respirable dust)

Important note: The DU has to be aware of the fact that apart from the long-term DNEL given above, a DNEL for acute effects exists at a level of 4 mg/m³. By demonstrating a safe use when comparing exposure estimates with the long-term DNEL, the acute DNEL is therefore also covered (according to R.14 guidance, acute exposure levels can be derived by multiplying long-term exposure estimates by a factor of 2). When using MEASE for the derivation of exposure estimates, it is noted that the exposure duration should only be reduced to half-shift as a risk management measure (leading to an exposure reduction of 40 %).

Environmental exposure

Not relevant

9.12. Consumer uses of hydraulic building and construction materials (DIY)

Exposure Scenario addressing uses carried out by workers	
1. Title: Consumer uses of hydraulic building and construction materials (DIY)	
Free short title	Use of Flue Dust as a constituent in hydraulic building and construction materials (DIY products), as cement, mortar, plaster, filler, putty etc. - Consumer use
Sector of uses	SU 21: Building and construction work
Market sectors	PC 9b: Fillers, putties, plasters, modelling clay
Environmental release categories	ERC 8c: Wide dispersive indoor use resulting in inclusion into or onto a matrix ERC 8f: Wide dispersive outdoor use resulting in inclusion into or onto a matrix
Processes, activities, tasks covered	Handling (mixing and filling) of mainly powder products, mixing with water, sand and/or gravel. Handling and application of resulting suspension (fresh mortar, cement paste, fresh concrete, filler, putty, plaster etc).
Assessment method	Human health: A qualitative assessment has been performed for oral and dermal exposure as well as exposure to eye. The dust exposure has been assessed by the Dutch model (van Hemmen, 1992). Environment: A qualitative justification assessment is provided.
2. Operational conditions and risk management measures	
2.1 Control of consumers exposure	
Product characteristic	
Hydraulic binders are mixtures. In the main application, cement, the content of Flue Dust is below 5 %. In other hydraulic binders of the DIY sector, the Flue Dust content is much below 5 %, since these hydraulic binders (mortars, plasters, fillers, putties etc.) are mixtures between cement and other inorganic solid ingredients. Flue Dust is a highly dusty powder. Even cement is a highly dusty powder. As part of other hydraulic binders, like mortars, plasters etc. the dustiness could be between low and high. Mixed with water, the hydraulic binder will give an alkaline suspension, due to the hydration reaction of Flue Dust and cement constituents. At this stage the product is irritating, due to the pH, which is above 11. Finally, the end product will be hardened. Flue dust containing hydraulic binders are packed in bags (up to 40 kg) or in smaller containers.	
Amounts used	
The amount used per event can vary in a broad range, depending on the task/application in building and construction work (use of mortar, plaster, concrete etc. at home)	
Frequency and duration of use/exposure	
The number of uses and the duration of a use can vary in a broad range, depending on the task/application in building and construction work (use of mortar, plaster, concrete etc. at home)	
Task	Duration / Frequency
Loading and mixing of Flue Dust containing products	1 to 10 minutes / 2/year (DIY fact sheet)
Application of fresh mortar, concrete, plaster, putty, filler etc.	several minutes to hours / 2/year (DIY fact sheet)

Human factors not influenced by risk management				
Task	Population exposed	Breathing rate	Exposed body part	Corresponding skin area [cm^2]
Loading and mixing of the dry products	Adult	1.25 m^3/h	Half of both hands	430 (DIY fact sheet)
Application of fresh mortar, concrete, plaster, putty, filler etc.	Adult	not relevant	Hands and forearms	1900 (DIY fact sheet)

Other given operational conditions affecting workers exposure			
Task	Indoor/outdoor	Room volume	Air exchange rate
Loading and mixing of the dry products	indoor	1 m^3 (personal space around the user)	0.6/h (unspecified room)
Loading and mixing of the dry products	outdoor	>>1 m^3 (depending on the wind speed)	>> 1/h (depending on the wind speed)
Application of fresh mortar, concrete, plaster, putty, filler etc.	indoor	not relevant	not relevant
Application of fresh mortar, concrete, plaster, putty, filler etc.	outdoor	not relevant	not relevant

Conditions and measures related to information and behaviour advice to consumers

In order to avoid health damage DIY consumers should comply with the same strict protective measures which apply to professional workplaces:

- Change wet clothing, shoes and gloves immediately.
- Protect uncovered areas of skin (arms, legs, face): there are various effective skin protection products which should be used in accordance with a skin protection plan (skin protection, cleansing and care). Clean the skin thoroughly after the work and apply a care product.

Conditions and measures related to personal protection, hygiene

In order to avoid health damage DIY consumers should comply with the same strict protective measures which apply to professional workplaces:

- When preparing or mixing building materials, during demolition or caulking and, above all, during overhead work, wear protective goggles as well as face masks during dusty work.
- Choose work gloves carefully. Leather gloves become wet and can facilitate burns. When working in a wet environment, cotton gloves with a plastic covering (nitrile) are better. Wear gauntlet gloves during overhead work because they can considerably reduce the amount of humidity which permeates the working clothes.

2.2 Control of environmental exposure

Product characteristic

Not relevant for exposure assessment.

Amounts used

Not relevant for exposure assessment.

Frequency and duration of use

Not relevant for exposure assessment.

Environment factors not influenced by risk management

Default river flow and dilution.

Other given operational conditions affecting environmental exposure

Avoid the direct discharge to wastewater.

Conditions and measures related to municipal sewage treatment plant

Default size of municipal sewage system/treatment plant and sludge treatment technique

Conditions and measures related to external treatment of waste for disposal

Not relevant for exposure assessment.

Conditions and measures related to external recovery of waste

Not relevant for exposure assessment.

3. Exposure estimation and reference to its source

The risk characterisation ratio (RCR) is the quotient of the refined exposure estimate and the respective DNEL (derived no-effect level) and has to be below 1 to demonstrate a safe use.

For inhalation exposure, the RCR is based on the DNEL of 1 mg/m^3 (as respirable dust) and the respective

inhalation exposure estimate as inhalable dust. Thus, the RCR includes an additional safety margin since the respirable fraction being a sub-fraction of the inhalable fraction according to EN 481.

3.1 Human exposure

Handling of powder

Route of exposure	Exposure estimate	Methods used, comments
Oral	-	Qualitative assessment: Oral exposure does not occur, due to the intended product use.
Dermal	Small task: 0.1 µg/cm² Large task: 1 µg/cm²	Qualitative assessment: If risk reduction measures are taken into account no human exposure is expected. However, dermal contact to dust from loading of Flue Dust containing hydraulic binders or direct contact to these binders cannot be excluded if no protective gloves are worn during application. This may occasionally result in mild irritation easily avoided by prompt rinsing with water. Quantitative assessment: The constant rate model of ConsExpo has been used. The contact rate to dust formed while pouring powder has been taken from the DIY-fact sheet (RIVM report 320104007).
Eye	Dust	Qualitative assessment: If risk reduction measures are taken into account no human exposure is expected. Dust from loading of Flue Dust containing hydraulic binders cannot be excluded if no protective goggles are used. Prompt rinsing with water and seeking medical advice after accidental exposure is advisable.
Inhalation	Small task: 12 µg/cm³ (0.003) Large task: 120 µg/cm³ (0.03)	Quantitative assessment: Dust formation while pouring the powder has been addressed by using the Dutch model (van Hemmen, 1992)

Application of suspensions of Flue Dust containing hydraulic binders

Route of exposure	Exposure estimate	Methods used, comments
Oral	-	Qualitative assessment: Oral exposure does not occur, due to the intended product use.
Dermal	Splashes	Qualitative assessment: If risk reduction measures are taken into account no human exposure is expected. However, splashes on the skin cannot be excluded, if no protective gloves or clothing are worn during application. Splashes may occasionally result in mild irritation easily avoided by prompt rinsing with water.

Eye	Splashes	Qualitative assessment: If appropriate goggles are worn no exposure to the eyes needs to be expected. However, splashes into the eyes cannot be excluded, if no protective goggles are worn during the application of Flue Dust containing hydraulic binder suspensions, especially during overhead work. Prompt rinsing with water and seeking medical advice after accidental exposure is advisable.
Inhalation	-	Qualitative assessment: Not expected, since the vapour pressure is low and no generation of dust or aerosols takes place.

3.2 Environmental exposure

Avoid discharging Flue Dust containing solutions from hydraulic binder suspensions (cement, mortar, plaster, filler, putties) directly into municipal wastewater, the pH of the influent of a municipal wastewater treatment plant is circum-neutral and therefore, there is no exposure to the biological activity. The influent of a municipal wastewater treatment plant is often neutralized anyway and the alkaline constituents of Flue Dust may even be used beneficially for pH control of acid wastewater streams that are treated in biological WWTPs. Since the pH of the influent of the municipal treatment plant is circum neutral, the pH impact is negligible on the receiving environmental compartments, such as surface water, sediment and terrestrial compartment.