TARMAC
A CRH COMPANY

Uniclass L621
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SAFETY INFORMATION

ANNEX A: EXPOSURE SCENARIO FOR TUNSTEAD CEMENTS

(CONTAINING CEMENT KILN DUST/ FLUE DUST / CEMENT FILTER DUST)*

[redacted]

*The terms cement kiln dust, flue dust and cement filter dust are interchangeable

A.1 INTRODUCTION

A.1.1 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/m^3

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/m^3 respirable particulate matter.

SCOEL made a recommendation for an 8-hour TLV-TWA for Calcium oxide of 1 mg/m^3 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/m^3

This choice is based on the SCOEL recommendation for a STEL (15 minutes) for Calcium oxide of 4 mg/m^3 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.

A.1.2 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+, Ca2+) and anions (Cl-, SO42-) 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.

A.1.3 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)	100,000t
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 km^2
Rain gauge (typical low value)	500 L/m^2 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.

A.2 EXPOSURE SCENARIOS AND COVERAGE OF SUBSTANCE LIFE CYCLE

ES number	Exposure scenario title	Manufacture	Identified uses: Formulation	Identified uses: End use	Identified uses: Consumer use	Resulting life cycle stage: Service life (for articles)	Resulting life cycle stage: waste stage	Sector of use (SU)	Product category (PC)	Process category (PROC)	Article category (AC)	Environmental release category (ERC)
A.2.1	Industrial manufacture of hydraulic building and construction materials.		X						0, 9a, 9b	2, 3, 5, 8a, 8b, 9, 14, 26		2
A.2.2	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
B.2.3	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
B.2.4	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
B.2.5	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

A.2.1 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/exposures	
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 m^3/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.

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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.

Occupational exposure				
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/m^3 (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 exposure	
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.

Environmental exposure (continued)	
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

4.1 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/m^3 (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/m^3. 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%).

4.2 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.

A.2.2 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.

1. Title: Industrial uses of dry hydraulic building and construction materials (indoor, outdoor) (continued)	
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 m^3/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/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.

Occupational exposure				
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 exposure	
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.

Environmental exposure (continued)	
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/m^3 (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/m^3. 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.

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A.2.3 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 m^3/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.

Occupational exposure				
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/m^3 (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 exposure	
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.

Environmental exposure (continued)	
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/m^3 (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/m^3. 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.

A.2.4 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 m^3/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/m^2 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/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.

Occupational Exposure				
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/m^3 (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 is expected to be negligible compared with 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 exposure	
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 km^2, the exposure is 163 kg/km^2 or 163 mg/m^2 calcium hydroxide per year. Diluted by a rain gauge of 500 L/m^2 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/m^3 (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/m^3. 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.

A.2.5 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 m^3/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.

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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/m^2 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/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.

Occupational exposure				
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/m^3 (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 exposure	
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 100,000tpa goes into wide dispersive uses. 20% are calcium oxide and the release fraction is 0.037. Therefore the release is about 444tpa (calcium oxide) or 587tpa (calcium hydroxide). Distributed on a service area of 3600km², the exposure is 163 kg/km² or 163mg/m² calcium hydroxide per year. Diluted by a rain gauge of 500L/m² per year, the exposure of the rain water is 323µg/L. 323µg calcium hydroxide comprise 149µg/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/m^3 (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/m^3. 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.

A.3 ABBREVIATIONS

AC	Article category
ACGIH	American Conference of Industrial Hygienists
APF	Assigned protection factor
DNEL	Derived no-effect level
DIY	Do-it-yourself
DU	Downstream user
dw	dry weight
ECETOC TRA	European Centre of toxicology and ecotoxicology of chemicals Targeted Risk Assessment
EFCC	European Federation for Construction Chemicals
ERC	Environmental release category
ES	Exposure scenario
EUSES	European Union System for the Evaluation of Substances
FF P	Filtering Facepiece against Particles (disposable)
FM P	Filtering Mask against Particles with filter cartridge
LC	Localised controls
MEASE	Metals estimation and assessment of substance exposure, EBRC Consulting GmbH for Eurometaux, http://www.ebrc.de/ebrc/ebrc-mease.php
PC	Product category
PPE	Personal protective equipment
PROC	Process category
OC	Occupational Conditions
OECD	Organisation for Economic Co-operation and Development
RCR	Risk characterisation ratio
RIVM	Rijksinstituut voor Volksgezondheid en Milieu, Research institute working for the Dutch government
RMM	Risk Management Measures
RPE	Respiratory protective equipment
SCOEL	Scientific Committee on Occupational Exposure Limit Values
SPERC	Specific Environmental Release Classes
STEL	Short term exposure limit
STP	Sewage treatment plant
SU	Sector of use
tpa	tonnes per annum
UVC	Substances of Unknown or Variable composition, Complex reaction products
UVCB	Substances of Unknown or Variable composition, Complex reaction products or Biological materials
TLV-TWA	Threshold limit value-time-weighted average
WWTP	Waste water treatment plants