Global Cement and Concrete Association

GCCA Sustainability Guidelines for the monitoring and reporting of emissions from cement manufacturing

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Executive Summary

Airborne emissions measurement, monitoring and reporting contributes to understanding, documenting and improving the environmental performance of the industry. Lack of emissions information can lead to local concerns about plant operations.

The Global Cement and Concrete Association (GCCA) is committed to support all of its members and the sector to establish emissions measurement and reporting, and consequently, to reduce airborne emissions. This document introduces the monitoring and reporting process, specifies the emissions, and defines the Key Performance Indicators (KPIs) considered most relevant for the cement industry.

GCCA full members are committed to set targets, monitor and annually report these KPIs to the GCCA and to report these KPIs at company level to their stakeholders. These KPIs can also be used to benchmark company performance. The GCCA publishes aggregated results taking into account legal constraints and confidentiality limitations.

1. Introduction

1.1 The Global Cement and Concrete Association

The Global Cement and Concrete Association (GCCA) is the global voice of the cement and concrete sector. One of the objectives is to develop and strengthen the sector's contribution to sustainable construction across the value chain. The GCCA aims to foster innovation throughout the construction value chain in collaboration with industry associations as well as architects, engineers, developers, contractors and innovators. In this way, the association demonstrates how concrete solutions can meet global construction challenges and sustainable development goals while showcasing responsible industrial leadership in the manufacture and use of cement and concrete. The GCCA was established in January 2018 and is headquartered in London.

1.2 GCCA Sustainability Charter

These *Guidelines for the monitoring and reporting of emissions from cement manufacturing* are part of a package of guidelines developed to support compliance with the *GCCA Sustainability Charter*[1]. The GCCA Sustainability Charter has identified five key pillars, which encompass the sustainability spectrum of the cement and concrete sector, and has set out requirements for full members against each of these:

- Health & Safety
- Climate Change and Energy
- Social Responsibility
- Environment and Nature
- Circular Economy

In applying these guidelines GCCA members must implement the general requirements of the *GCCA Sustainability Framework Guidelines*[2].

1.3 Background

Cement production is an energy and resource intensive process, with local and global impacts. Airborne emissions take up a prominent position in local concerns about cement manufacturing. Recognising this, cement companies monitor and manage their emissions monitoring and reporting as well as other mechanisms to further improve their emission performance.

1.4 Relation to other documents

This document, in conjunction with the '*GCCA Sustainability Framework Guidelines*' provides guidance to GCCA full members to fulfil the requirements of the GCCA Sustainability Charter relating to Environment and Nature. It is partially based on and supersedes the WBCSD-CSI document "*Guidelines for Emissions Monitoring and Reporting in the Cement Industry*", version 2.0, March 2012.

1 GCCA Sustainability Charter, June 2019

2 GCCA Sustainability Framework Guidelines, June 2019

2. Relevance

Emissions may come from different points in the cement manufacturing process, depending on raw materials and fuels, kiln type and the mechanisms used to control the emissions. While cement kilns typically operate at steady conditions (excluding startup and shutdown), naturally occurring variations in raw materials and fuel composition can lead to day-to-day variations in emissions.

3. Objectives

This document, in conjunction with the '*GCCA Sustainability Framework Guidelines*', provides guidance to GCCA full members to fulfil the requirements of the GCCA Sustainability Charter relating to Environment & Nature. However, the importance of emission monitoring and reporting should not be reduced to a requirement under the GCCA Sustainability Charter, it is the basis of all efforts to manage and reduce airborne emissions and supports transparent communication with stakeholders.

While many analytical standards are available under various national and international regimes, these standards are not used systematically in all parts of the world. The main objective of this document is to guide cement companies in practical tasks like the definition of the main emissions, the minimum requirements of monitoring and the calculation and reporting of performance indicators.

These guidelines have the following objectives:

- To promote a uniform monitoring and reporting of emissions data;
- To promote internal management of emissions;
- To provide credible, practical and relevant information on emission.

4. Operational Context

4.1 Selection of sources and emissions

4.1.1 Selection of source

These guidelines consider the emissions from the main kiln stack because it is the most important source of emissions in a cement plant, considering all different kiln systems and abatement technologies. This is due to the high volumetric flow of the main stack combined with concentrated emissions at this point of the process.

4.1.2 Selection of emissions

The largest volume substances emitted are particulate matters (PM), nitrogen oxides and sulphur dioxides. Trace quantities of the following substances may also be emitted:

- Volatile organic compounds (VOCs) or total hydrocarbons (THC); which include methane and ethane as well other hydrocarbons, and will be reported as carbon;
- Heavy metals and their compounds; which include mercury (Hg), cadmium (Cd), thallium (Tl), antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), and vanadium (V);
- Polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs); they include the 17 congeners of the NATO scheme adopted internationally and are reported as International Toxic Equivalent (I-TEQ).

4.2 Frequency of Measurement

Emissions can be monitored using continuous and discontinuous measurements. The measurements must be taken according to recognised rules of metrology and local environmental standards and regulations. The emissions were divided into two groups according to their volume and/or significance:

Group 1:
The main emissions (PM, NO_x and SO_2) must be measured continuously using continuous emissions monitors (CEMs). They must also be monitored at least once a year by discontinuous measurement. GCCA members must monitor and report the Group 1 emissions.

Group 2:
VOC/THC, mercury and other heavy metals as well as PCDD/F. It is recommended to monitor continuously the volatile organic compounds (VOCs) or total hydrocarbons (THC) with CEMs or at least once a year by discontinuous measurement. Heavy metals and PCDD/F, must be monitored periodically according to the frequency given in Table 1.

It is mandatory that discontinuous measurement reflect the normal operating conditions of the cement manufacturing process. In case of any significant change in process, like a change in raw materials, fuels, or air pollution control devices, the measurements should be remeasured within one year.

Table 1: Frequency of Measurement

Priority Group	Emissions	Frequency of measurement
Group 1	PM	Continuously
Group 1	NO_x	Continuously
Group 1	SO_2	Continuously
Group 2	VOC/THC	Continuously or at least once a year
Group 2	Hg	Once every year
Group 2	Other heavy metals	Once every two years
Group 2	PCDD/F	Once every two years

If the result of mercury was below the threshold of 25 µg/Nm³, the frequency of measurement could be reduced for once every two years. The frequency of measurement must return to the normal frequency when the emission will be higher than threshold. When mercury or PCDD/F is monitored continuously, it is not necessary to measure periodically.

4.3 Quality Assurance

Full members must implement a quality assurance process to ensure that the data measured correctly represents real emissions. This process shall include the definition of clear responsibilities for each step (sampling, analysis and reporting), training of employees in operational and maintenance checks and data validation, as well as:

- Technical assessment of data: it is necessary to evaluate whether the data is within the usual range of the process;
- Comparison of the data for the kiln and pollutant with results of previous months and years;

Continuous measurements with CEMs must include routine checks, proper maintenance and periodical checks/calibration of equipment.

When a company receives new CEMs, they must ensure the quality of measurement by making sure the CEMs are appropriately commissioned. This process includes equipment testing and instrument protection routines, leak check, and zero and span checks using reference materials. After commissioning, member's plants must include this process in an operational routine.

The particulate matters and gaseous emissions analysers must be calibrated. The calibration must be made using standard reference methods and analysis functions must be defined. Any significant modification in the process, like a change in the emission abatement system, etc., or a pollutant concentration significantly out of the calibration range will require a new analysis function to be established. CEMs are to be verified against standard reference method measurements annually using the data obtained during the annual stack tests.

The company must implement maintenance routines, which includes checks of sampling point, gas treatment system, analysers and auxiliary devices, and replacement of used parts according to manufacturer's recommendations. The maintenance staff of each plant must be trained to solve problems that may arise in a daily operation of CEMs.

4.4 Data Management

It is recommended that companies have a system to process and evaluate emissions data or, at least, a tool enabling fast and accurate acquisition and reporting of emission data from each kiln. Therefore, it is easier to achieve the standardisation of emissions reporting.

The system for data acquisition and management has to satisfy the following requirements:

- Concentration of PM, NO_x, SO_2, and VOC/THC when available – average on hourly, daily, monthly and annual basis.
- Mass of PM, NOx, SO_2, and VOC/THC when available – determined on hourly, daily, monthly and annual basis.
- Data validation in accordance with all legal requirements.
- Concentration and flow used for the determination of mass must be converted to the same reference for the determination of mass.
- All concentration and flow values must be converted to the O_2 reference value (10%), dry gases. If the local environmental regulator defines other conversions, it must be undertaken in addition to the GCCA requirement.
- The operational period is defined by the local regulator. In the absence of a local requirement, the operational period is defined according to effective operating hours, excluding start-up and shutdown periods.

4.4.1 Convention for reporting

The reference values for temperature (T), pressure (P), moisture (W) and oxygen (O_2) are.

T reference = 273 K
P reference = 101.3 kPa (1013 mbar)
w reference = 0% H_2O
O_2 reference = 10% O_2

The conversions must be calculated according to the standardised formulas.

In a discontinuous measurement, when the data obtained is lower than the detection limit, the value to be reported will correspond to one half of the detection limit. If two or more measurements, where at least one value is reported with a "<" character (lower than detection limit), the value of the latter will be calculated as one half of the detection limit, and the final average will be calculated accordingly.

5. Key Performance Indicators

The GCCA is aware of the need to track the progress of improvements, and to communicate this progress clearly to stakeholders. These guidelines therefore include a number of simple, reliable and representative KPIs.

KPI 1: Overall coverage rate

This KPI gives the percentage of clinker produced by kilns covered by continuous and discontinuous measurements of the emissions defined in Table 1 of these guidelines: PM, NO_x, SO_2, VOC/THC, heavy metals (Hg, Cd, Tl, Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V) and PCDD/F. Clinker production can only be included if all 17 emissions are measured.

Example 1:
Company A operates 30 kilns producing 30 million tonnes of clinker per year. In the reported time frame, all emissions of emissions (previously identified) were monitored at 15 kilns producing 20 million tonnes of clinker.

In this case we get: KPI 1 = (20000000 tonnes/30000000 tonnes) x 100 = 67%
The KPI 1 of company A is therefore 67%, meaning that 67% of its clinker is produced in kilns covered by monitoring systems and discontinuous measurements as required by these guidelines.

If heavy metals or PCDD/F are not monitored for the year as they follow the frequency established in these guidelines, the last available specific value measured will be considered.

KPI 2: Coverage rate continuous measurement

This KPI gives the percentage of clinker produced by continuous measurement of PM, NO_x and SO_2. Clinker production will be considered only if all emissions (PM, NOx and SO_2) are monitored continuously, otherwise the clinker production will be considered zero.

Example 2:
Company B operates 50 kilns producing 40 million tonnes of clinker per year. In the reported time frame, PM, NO_x and SO2 were monitored continuously at 45 kilns producing 35 million tonnes of clinker.

In this case we get: KPI 2 = (35000000 tonnes/40000000 tonnes) x 100 = 87.5%
The KPI 2 of company B is therefore 87.5%, meaning that 87.5% of its clinker is produced in kilns covered by continuous monitoring systems of main emissions that meet these guidelines.

If continuous emission monitoring systems are not available for at least 50% of the year due to operational problems or maintenance, the clinker production of this period has to be disregarded from the clinker produced covered by continuous monitoring for KPI 2.

KPI 3: Emission data pollutant (absolute and specific)
This KPI gives the absolute emissions of PM, NO_x, SO_2, VOC/THC, Hg, heavy metals 1 (sum of Cd, Tl), heavy metals 2 (sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V) and PCDD/F. There is a specific KPI for each pollutant or group of emissions as indicated in Table 2.

Table 2: Definition of KPI 3 for each pollutant

Indicator	Comments
KPI 3 "PM"	Total particulate matters emissions.
KPI 3 "NO_x"	Sum of nitrogen monoxide and nitrogen dioxide, expressed as nitrogen dioxide.
KPI 3 "SO_2"	
KPI 3 "VOC/THC"	Volatile Organic Compounds or Total Hydrocarbons including methane and ethane expressed as carbon (C).
KPI 3 "PCDD/F"	Sum of 17 congeners of NATO scheme expressed as I-TEQ.
KPI 3 "Hg"	Mercury and its compounds expressed as mercury (Hg).
KPI 3 "HM1"	Sum of cadmium and thallium and their compounds expressed as cadmium (Cd) and thallium (Tl).
KPI 3 "HM2"	Sum of antimony, arsenic, lead, chromium, cobalt, cooper, manganese, nickel and vanadium and their compounds, expressed as antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), cooper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

The calculation of emissions on a specific basis (g/tonne clinker, mg/tonne clinker, ng/tonne clinker) must be done using the mass weighted averages of the kilns to ensure accurate data, whereas the absolute values of emissions (t/year, kg/year, g/year) are calculated by adding the total emissions of each kiln.

Heavy metals (Hg, Cd, Tl, Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V) and PCDD/F do not need to be measured on installations with a utilisation (operational capacity or time) below 50% in a year. In these circumstances, to avoid any impact on the coverage rates of KPI 1 and KPI 4, the clinker produced from these installations will not be considered for the determination of these KPIs. The absolute values are extrapolated to the total quantity of clinker produced by the company.

Example 3:
Company A operates 2 kilns:

- Kiln A produces 0.5 million tonnes of clinker per year with a specific PM emission of 40 g/tonne clinker and an absolute PM emission of 10.0 tonnes/year,
- Kiln B produces 0.4 million tonnes of clinker per year with a specific PM emission of 100 g/tonne clinker and an absolute PM emission of 20.0 tonnes/year,

KPI 3 "PM" = (40 g x 500000 tonnes + 100 g x 400000 tonnes)/(500000 tonnes + 400000 tonnes) = 66.7 g/tonne clinker, and
KPI 3 "PM" = 20.0 tonnes + 40.0 tons = 60.0 tonnes/year

If Company A had operated a kiln C producing 1 million tonnes of clinker per year and no specific PM emission would have been reported, the indicator would have been:

KPI 3 "PM" = 66.7 g/tonne clinker, and
KPI 3 "PM" = 60.0 tonnes x (500000 tonnes + 400000 tonnes + 1000000 tonnes)/ (500,000 tonnes + 400000 tonnes) = 126.7 tonnes/year

If heavy metals or PCDD/F are not monitored for the year as they follow the frequency established in these guidelines, the last available specific value measured will be considered for the reporting. The absolute value will be defined by multiplying the last specific value for the clinker produced in the year of reporting.

Example 4:
Calculation example for specific mercury emissions:

A specific mercury emission of 10 mg/tonne clinker has been measured in 2016 at the stack of kiln A. In 2017, no measurement has been made; kiln A has produced 1.0 million tonnes of clinker. Mercury emission reported in 2017 will be:

KPI 3 "Hg" = 10.0 mg/tonne clinker, and
KPI 3 "Hg" = 10 mg x 1000000 tonnes = 10.0 kg/year

KPI 4"X": Coverage rate pollutant "X"
This KPI gives the percentage of clinker produced by kilns that have monitored pollutant "X". There is a specific KPI for each pollutant or group of emissions as indicated in Table 2. The KPI must be reported in the format shown in Table 3.

Table 3: KPI reporting form

Reporting Period	
Organisational boundaries	
KPI 1 Overall coverage rate	%
KPI 2 Coverage rate continous measurement	%
KPI 3 Emission data and KPI 4 Coverage rate	

Pollutant	Specific Mission	Absolute Emission	Coverage
PM	g/tonne clinker	tonne/year	%
NO_x	g/tonne clinker	tonne/year	%
SO_2	g/tonne clinker	tonne/year	%
VOC/THC	g/tonne clinker	tonne/year	%
Hg	mg/tonne clinker	kg/year	%
HM1	mg/tonne clinker	kg/year	%
HM2	mg/tonne clinker	kg/year	%
PCDD/F	ng/tonne clinker	mg/year	%

6. Glossary and Definitions

Absolute Emission:
Absolute emissions are expressed as a mass stream, for example in tons of a pollutant per year (t/yr).

GCCA:
Global Cement and Concrete Association.

KPI:
Key Performance Indicator is an industry used term for a type of Measure of Performance. KPIs are commonly used by organisations to evaluate its success or the success of a particular activity in which it is engaged.

Nm^3:
Normal cubic metres (at 1013 hPa and 0 °C).

PM:
Particulate matters.

NO_x:
Sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2.

SO_2:
Sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3), expressed as SO_2.

Specific emissions:
Specific emissions are emissions expressed on a per unit output basis, for instance in g of pollutant per ton of clinker.

Analysis function:
The (mathematical) correlation between the response of the instrument and the (apparent) true value, determined by using a standard reference procedure.

Continuous Emission Monitoring System:
Measuring system permanently installed on site for continuous monitoring of emissions.

Calibration:
Determining the variance of response of a measuring device by comparing it against values produced by a reference method. Calibration is a means of establishing or checking the analysis function of measuring equipment in a continuous operation at a plant.

Concentration:
The mass of an emitted substance in relation to the volume of the exhaust gas (e.g. in milligrams per cubic metre [mg/m^3]).

Data validation:
A method for assuring the correct (right) data is used in analysis.

Detection Limit:
The lowest detectable amount of a substance.

Volume Flow:
Volume of emitted exhaust gas per unit of time (e.g. metre cubes per hour [m^3/h]).

Standard Reference Method (SRM):
Recognised and standardised methodology for carrying out measurements, temporarily installed on site for verification purposes.

7. References

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