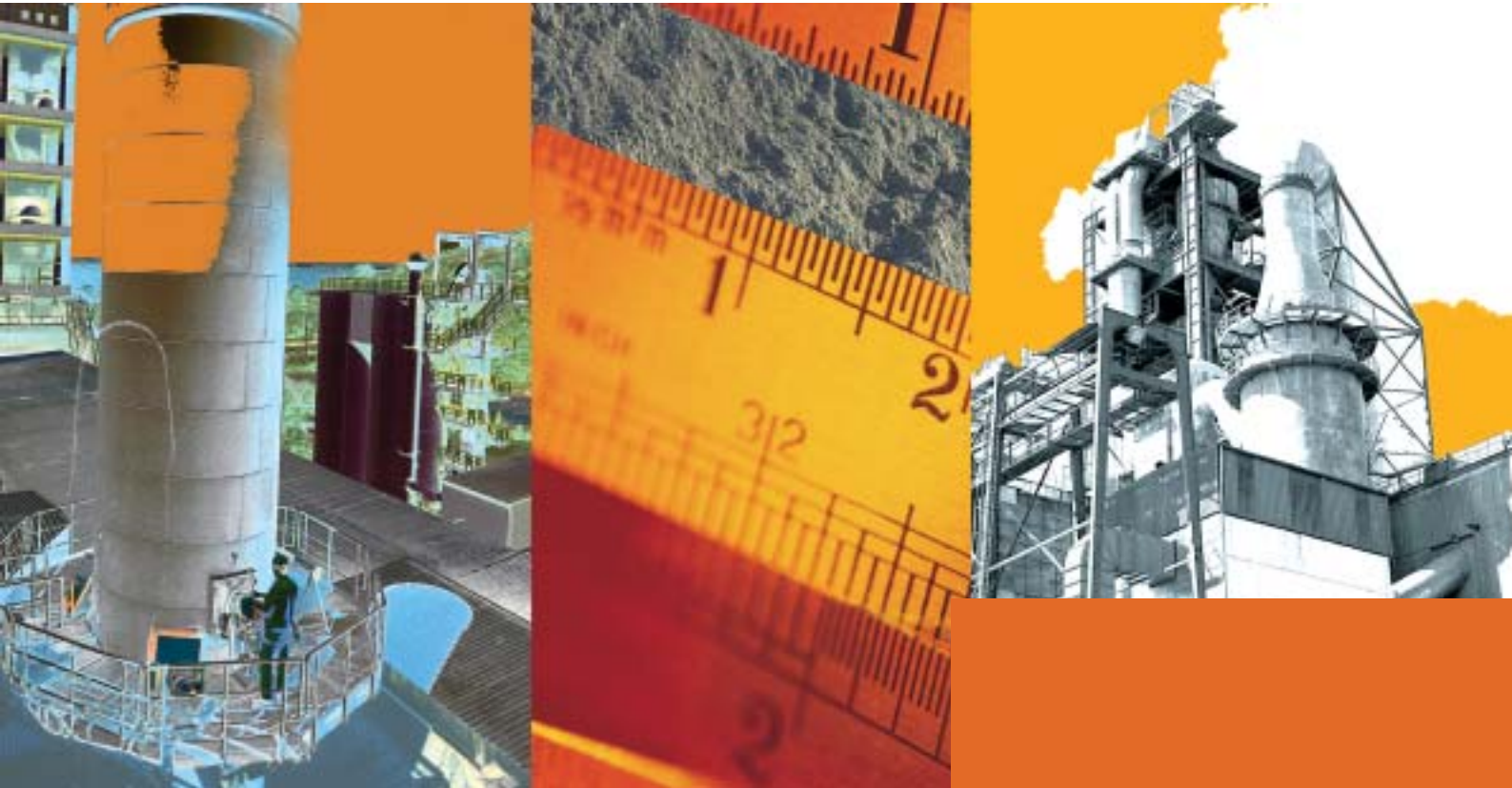


Cement Sustainability Initiative (CSI)



*Guidelines for Emissions
Monitoring and Reporting in
the Cement Industry*

Emissions monitoring and
reporting

March 2005

Version 1.0



World Business Council for
Sustainable Development



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Background

Cement is one of the most widely used man-made substances on the planet. Each year, nearly 350 kg of cement are consumed for each man, woman and child. Making cement is an energy and resource intensive process, with both local and global impacts. Recognizing these facts, several cement companies initiated the Cement Sustainability Initiative (CSI) in 1999 as a member-sponsored program of the World Business Council for Sustainable Development (WBCSD). Currently, seventeen cement companies, together representing more than half the worldwide industry outside China, sponsor the Initiative.

Since 1999, the Initiative has commissioned independent research on the performance of the cement industry and the major sustainability issues it faces. The research was carried out by the Battelle Memorial Institute, a non-profit research organization in the US, and published in 2002. An external Assurance Group oversaw the research phase of the program, serving as advisor and 'referee'. Mostafa Tolba (former Director of UNEP) chaired the group, which included Bill Reilly (former USEPA Administrator), Corrine Lepage (former Environment Minister of France), Victor Urquidi (past President Colegio de Mexico), and Istvan Lang, (member and former President, Hungarian Academy of Science).

The research was supported by a series of facilitated stakeholder dialogues in seven cities (Cairo, Curitiba, Bangkok, Lisbon, Brussels, Washington DC, and Beijing). The research and consultation produced a set of independent recommendations for improving the industry's performance. In response, the Initiative developed

Introduction

an Agenda for Action to address the issues raised. These issues fell into six key areas:

- > **Climate protection:** How can the industry understand and manage the significant CO₂ emissions resulting from cement production?
- > **Responsible use of fuels and raw materials:** Can the industry use different fuels and raw materials to improve its resource efficiency and reduce its use of natural resources? What conditions are necessary to do so?
- > **Improving employee health and safety:** How can the industry improve its safety record and reduce the number of injuries and fatalities occurring in its operations?
- > **Emissions reduction:**¹ Most emissions from cement facilities are airborne pollutants. Around the world different regulatory regimes require monitoring of different sets of pollutants. What needs to be measured and reported? What do local stakeholders want to know about? What should be done in countries where no requirements are in place?
- > **Local impacts on land and communities:** Impacts from quarrying and cement plants are large and visible. How can these be properly assessed in the project-planning phase, and managed during construction, operation and after closure?
- > **Communications and progress reporting:** How can the industry communicate more effectively with key stakeholders?

The *Agenda for Action* was published in July 2002. In September 2002 the World Summit for Sustainable Development recognized the CSI as an effective voluntary (Type II) Partnership. Summary materials of the project are now available in nine languages. These and all other project documentation produced through early 2003 are available on a CD-rom through Earthprint, (www.earthprint.com/) as well as on the project website: www.wbcscement.org.

Current status of the CSI

Seven more cement companies have joined the CSI since publication of the *Agenda for Action*, bringing total membership to seventeen.² The CSI is now taking forward the commitments made in the *Agenda for Action*.

Joint efforts

Six Task Forces, each chaired by one or more of the CSI member cement companies, are developing materials to address the six major areas noted above, primarily in the form of good practice guidelines, tools, and procedures to be used by all CSI companies at their operating facilities. These materials will also be made available on a worldwide basis for other cement companies, should they choose to use them.

The Task Forces are committed to carrying out active stakeholder consultations and partnerships to develop a robust and useful set of guideline materials and implementation tools. WBCSD organized a facilitated stakeholder dialogue to discuss the guideline development in Brussels in November 2003, and some NGOs have provided additional expertise to specific Task Forces by invitation.

Individual company commitments

The CSI has not and does not plan to establish group targets for the participating companies, for two reasons:

First, individual companies are better able to set appropriate targets and timetables for their own organizations. In a global initiative such as this, different companies and different countries will necessarily have different priorities and resources available. Meaningful targets can only be set in reference to specific company values and resources.

Second, competition laws strictly limit the kinds of activities companies can engage in together. Several of the subject areas of the CSI are also strategic business issues for the companies involved, and group target setting could pose potentially serious legal issues.

Emissions monitoring and reporting

Cement manufacture is resource and energy intensive. It produces significant releases to the environment, primarily as airborne emissions. Emissions measurement, monitoring and reporting contributes to understanding, documenting and improving the industry's environmental performance. Lack of emissions information can lead to local concerns about plant operations. The initial objective (2002-2004) for the CSI Task Force on Emissions Monitoring and Reporting, as discussed in the *Agenda for Action*, was therefore to establish an emissions measurement and reporting protocol which would provide a common framework for all participants. Subsequently, individual companies will set their own emissions targets by or before 2006, and then report on progress toward those targets.

The protocol outlined here focuses on the practical task of monitoring and reporting emissions from cement production. While many analytical standards are available under various national and international regimes (e.g. Mexico, Germany, ISO, Japan, USA and the EU), not all countries use these — particularly developing economies where the cement market is growing most quickly. As a result, emissions standards may not be available nor be adequately enforced in some places. This protocol has therefore been developed to meet three main objectives:

- 1 To encourage uniform monitoring and reporting of cement process emissions.
- 2 To provide credible, relevant, and easily understandable information on emissions.
- 3 To provide internal management with a tool for gathering relevant information to plan cement emissions monitoring and reporting.

The protocol identifies the specific pollutants and emission sources which all CSI member companies have agreed to monitor. It covers cement plant main stack emissions, as these are the largest single point source, may have a significant impact on the

environment, and can be quantified with reasonable effort and accuracy. The methods proposed to quantify emissions are those established by experts in analytical chemistry and field experience in the cement industry which will produce representative results under sometimes inhospitable measurement conditions. Continuous emissions monitoring is recommended as the preferred method whenever this is possible taking into account such factors as accuracy, maintainability of instrumentation, adequate calibration, and cost.

This protocol details the actions that CSI companies have agreed to take to monitor emissions. Based on these data individual companies have agreed to set their own emissions targets and to track their progress in emissions reduction using the agreed key performance indicators (KPIs) discussed on page 12. Each CSI company has agreed to publish their emissions data regularly (at least annually), and in a clear and straight forward way.

Our hope is that the guidelines are equally helpful to all cement companies and public bodies; are widely distributed and used, particularly in countries and regions where specific requirements have not yet been identified. However, these guidelines are not meant to, and can neither replace nor supersede local, national, or international requirements, which must be followed.



Emissions from cement production

General

Emissions may come from different points in cement production processes, depending on the raw materials, preparation procedures, kiln type and emissions control systems used. The main manufacturing steps are:

- > Quarrying and preparation of raw material
- > Handling of fuels
- > Clinker production
- > Finish grinding
- > Packaging
- > Storage
- > Blending
- > Transport, and
- > Loading of material.

The largest volume substances emitted during the production of cement are carbon dioxide ², particulate matter (dust), oxides of nitrogen, and sulfur dioxide. Trace quantities of volatile organic compounds, acid gases, some trace metals, and organic micro pollutants may also be emitted. While cement kilns typically operate at steady conditions (excluding startup and shutdown), naturally occurring variations in raw materials and fuel composition can produce day-to-day variations in emissions.

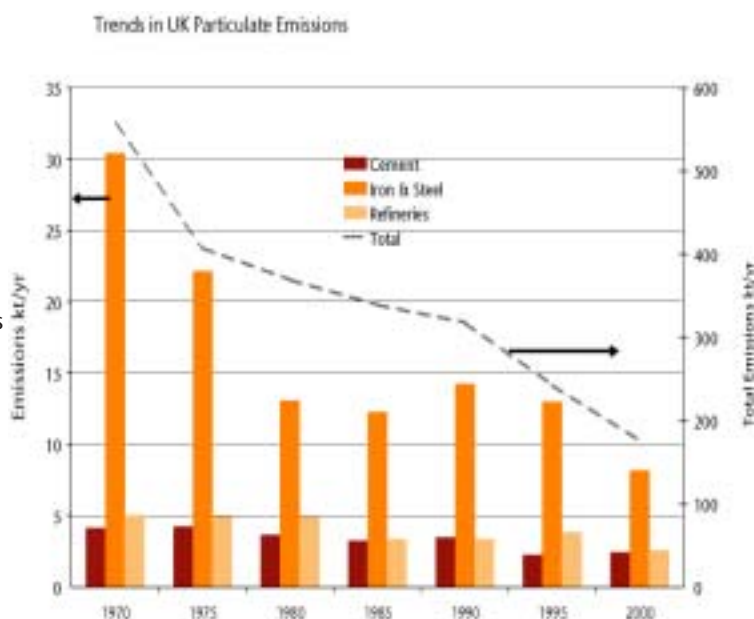
Emission components

Particulate matter/dust

The terms 'dust' or 'particulate matter' include emissions of coarse dust, fine dust, soot, particles and aerosols.

Dust emissions from cement kilns have been reduced dramatically over the last two to three

decades due to regular improvements in design and operation, including increased use of modern de-dusting equipment. Nevertheless dust emissions from poorly equipped or poorly operated kilns can be high and account in some countries for over 40% of the total industrial particulate emissions. In most countries, the cement industry is not a major source of dust and particulates, although in some countries these particulate emissions may still be of national significance. The European Integrated Pollution Prevention Control Bureau (EIPPC 2001) reported dust emissions for European cement kilns from 0.01 to 0.4 kg/tonne ³ of clinker or, on an annual basis, from 10 to 400t for an average kiln. These data are similar to those from Australian and US cement plant inventories (NPI 1999; EPA AP-42 1994).



Oxides of nitrogen (NO_x) and sulfur (SO_x)

NO_x is formed by the reaction of nitrogen in air with oxygen at the high temperatures reached during the clinker production process. SO_x emissions are predominantly (99%) in the form of sulfur dioxide (SO₂). They arise from the oxidation of volatile sulfur present in raw materials and fuels. Because of the alkaline nature of limestone and clinker, normally the sulphur compounds entering the process are oxyized and trapped in the clinker and are not emitted into the air.

The cement industry has significantly improved its performance over the last 30 years but it is still a source of NO_x and SO_x emissions. The EIPPC reported NO_x emissions for average European cement kilns in 2001 as ranging from less than 0.4 to 6 kg/t of clinker or, on an annual basis, from 400 to 6000t.⁴ The EIPPC reported SO_x emissions as ranging from less than 0.02 to 7 kg/t, with a corresponding annual emission rate of less than 20 to 7000t. These values are again similar to those for Australian and US cement plants (NPI 1999; EPA AP-42 1994).

The industry is a relatively small contributor to national emissions of these pollutants in developed countries. For example, The UK National Atmospheric Emissions Inventory (NAEI 2002) showed that the cement industry contributed about 2% of the total NO_x and 1-2% of the total SO_x emissions in the UK in the year 2000.

Oxides of carbon (CO₂ and CO)

Cement production is a source of emissions of the greenhouse gas carbon dioxide (CO₂). As much as 5% of global man-made carbon dioxide emissions originate from cement production (Battelle 2002).

The largest portion (about 50%) of the carbon dioxide emissions from production of cement worldwide originates from the chemical reaction that converts limestone (CaCO₃) to calcium oxide (CaO), the primary precursor to cement. About 40% of the industry's CO₂ emissions come from fossil fuel combustion during cement manufacturing operations. The remaining emissions come from the transport of raw materials

(about 5%) and the combustion of fossil fuel required to produce the electricity consumed by cement manufacturing operations (about 5%) (Battelle 2002).

The CSI Task Force on Climate Protection is tackling CO₂ emissions as their primary concern (www.wbcscement.org/climate.asp). A detailed measurement protocol for CO₂ emissions has been prepared and tested. To date, more than 90% of the cement kilns of CSI companies follow this protocol (www.ghgprotocol.org/standard/tools.htm) to determine and report their CO₂ emissions.

The emission of CO during the clinker production process is caused by incomplete oxidation of small quantities of organic constituents present in some natural raw materials. For most kilns the CO content is well below 2000 ppm (VDZ 2001).

Volatile Organic Compounds (VOCs)

Cement production is not a significant source of VOCs but small quantities of organic constituents can be released from the natural raw materials during the clinker production process. Under normal circumstances the VOC content of the exhaust gas from cement kilns is low, typically between 10 and 100 mg/Nm³ (EIPPC 2001). In viewing national inventories of pollutants, major sources of VOC emissions are typically road and air traffic, together with organic solvent use, oil and chemical industry processes, and industrial and domestic combustion.

Acid gases

Cement production is a minor source of hydrogen chloride (HCl) and hydrogen fluoride (HF) arising from trace amounts of chlorine and fluorine present in raw materials and fuels. The EIPPC Bureau reported values of less than 0.8 to 10g HF/t clinker and less than 2 to 50g HCl/t clinker for European cement kilns.⁵

Trace metals

Trace metals are present in raw materials and fuels, at widely variable but usually very low levels.⁶ The behavior of the trace metals in a cement kiln depends on their volatility. Non-volatile metals and metal compounds remain within the process and leave the kiln as part of the clinker. Semi-volatile metals are partly taken into the gas phase at sintering temperatures and condense on the raw material in cooler parts of the kiln system. Volatile metals can exhibit similar behavior to semi-volatile metals, or leave with combustion gases at very low levels.

Table 1: Measured emission of trace metals ranges from European cement kilns (EIPPC 2001)

Heavy metal elements	per tonne of clinker	per year
Sum of Hg, Cd, Tl	20 - 600 mg	20 - 600 kg
Sum of As, Co, Ni, Se, Te	2 - 200 mg	2 - 200 kg
Sum of Sb, Pb, Cr, Cu, Mn, V, Sn, Zn	10 - 600 mg	10 - 600 kg

Organic micro-pollutants

Organic substances of concern are:

- > Polychlorinated dibenzodioxins and polychlorinated dibenzofurans – collectively known as 'dioxins' and 'furans' abbreviated 'PCDD/Fs'
- > Polychlorinated biphenyls – usually known as 'PCBs'
- > Polyaromatic hydrocarbons – known as 'PAHs'.

These substances are sometimes collectively referred to as 'organic micro pollutants' as the absolute mass of their releases from a given process is normally orders of magnitude lower than releases of NO_x or other air pollutants. Formation of dioxins occurs at relatively low

temperatures – most typically in exhaust gases from a variety of combustion processes (including forest fires, and backyard outdoor cooking) as the gases cool through a temperature range of 450°C to 200°C. To minimize the possibility of dioxin formation it is important that the kiln gases are cooled as quickly as possible through this critical temperature range (EIPPC 2001).

At the request of WBCSD, the Foundation for Scientific and Industrial Research (SINTEF) of Norway considered more than 1,700 emission data sets from public databases and new data provided by CSI companies, including a number from developing countries. The study concluded that emissions of dioxins and furans from well-operated, dry preheater / precalciner kilns are usually below 0.1 ng TEQ/Nm³, and slightly lower than emissions from wet process kilns. In most cases the data for dry kilns includes co-processing waste and alternative raw materials, as this is common practice in many countries. The comparisons of performance of kilns with traditional and with alternative fuels showed that there is no direct relationship between dioxin emissions and the fuel used (SINTEF 2004).⁷

A number of countries have conducted national dioxin inventories. For developed countries, these show that the cement industry is generally a minor contributor (less than 3% of the total). Major sources include municipal waste incinerators, residential wood combustion, agricultural burning, and steel mills among others.⁸



This initial protocol aims to ensure that CSI companies focus on measuring, monitoring and reporting on the most important emission sources and pollutants from the cement industry. This section identifies the key sources and pollutants for this protocol.

Selection of the main emission source

Some regulatory systems designate specific measurement points for specific processes. The main stack of the clinker production process has been shown to be the most important source of emissions to air by the cement industry, based on comparisons of plants with different kiln systems, de-dusting installations and geographical locations. This reflects the fact that the volumetric flows as well as emission concentrations are comparatively high at this point in the process.

Near-ground fugitive releases of dust originate in most cases grinding operations, truck traffic, wind, and other natural sources and not from the combustion process. Fugitive emissions of this sort are difficult to measure and impact mainly on the local environment (and are therefore the responsibility of the local plant management), whereas releases from high stacks may have an impact on air quality over a much larger area.

This initial protocol therefore considers emissions from the main kiln stack only.

Selection of the main emission source and pollutants

Selection of the main pollutants

The following emissions have been identified as the main focus for this protocol, and therefore for reporting within the CSI, due to their volume and/or significance:

- > Dust / particulate matter
- > Oxides of nitrogen and other nitrogen compounds (NO_x)
- > Sulfur dioxide and other sulfur compounds (SO_x).

Selection of other pollutants

Other pollutants which are of concern to stakeholders (including local communities and regulatory authorities) and which will be measured are:

- > Trace metals and their compounds (Hg, Cd and Tl as a minimum, as these are the most volatile).
- > Volatile organic compounds (VOCs)
- > Polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs).

This selection is in keeping with other important international guidelines (e.g. the Integrated Pollution Prevention and Control (IPCC) Directive of the EU, US EPA documentation AP-42, the Australian NPI Guideline).



Emissions monitoring (measurements)

Emissions can be monitored by using either continuous or discontinuous measurements. The measurements will be taken according to the recognized rules of metrology (e.g. ISO norms or national guidelines, like VDI/DIN or USEPA) and according to the methods recognized in corresponding national environmental regulations.

International ISO Standards (see: www.iso.org) are available for most pollutants (see Tables 2 and 3), although there are currently no ISO Standards for VOCs, PCDD/Fs and trace metals available. If methods other than ISO or accepted national standards are used, these procedures must be evaluated against the accepted reference methods.

Recommended methods for continuous measurements

Table 2: Reference methods for continuous measurements	
Pollutant	ISO Standard
Dust	ISO 10155
Nitrogen monoxide / dioxide	ISO 10849
Sulfur dioxide	ISO 7935

Recommended methods for discontinuous measurements

Table 3: Reference methods for discontinuous measurements*	
Pollutant	ISO Standard
Dust	ISO 9096
Nitrogen monoxide/ dioxide	ISO 11564
Sulfur dioxide	ISO 7934 ISO 11632

* If discontinuous measurements are used, the frequency of measurement should also be recorded.

Although there are no ISO standards for VOCs, PCDD/Fs and trace metals available, a number of countries have established well-documented test methods for these materials. A method should be used which is well accepted by local authorities.

Recommended frequency of measurements

Pollutants	Frequency
Main pollutants (Dust, NO _x , SO _x)	Continuously but at least once a year.
Other pollutants (VOCs, trace metals, PCDD/Fs)	Status analysis (fingerprint) for each kiln. Repeated analysis necessary, if significant changes in process, raw material composition, fuels or operations occur.

The frequency and intensity of the measurements will need to be based to some extent on distinguishing between the main emissions identified here and those of most concern to stakeholders (which may be different). In general, however, the main emissions (dust, NO_x and SO_x) of each kiln have to be measured at least on an annual basis according to the methods described above. Continuous measurements are recommended for main pollutants. Cement kilns equipped with high efficient filters having very low dust emission rates may use an approved continuous leak detection system instead of a continuous measurement device (e.g. EPA-454/R-98-015 or equivalent).

For VOCs, trace metals and PCDD/Fs, a status analysis (fingerprint) of the kilns for all cement plants has to be established. On the basis of those results each plant will need to decide if further measurements are necessary (e.g. to evaluate the effectiveness of further emission reduction measures).

Significant changes in the process (e.g. fuel mixture, raw material composition, use of alternative fuels) require a new status analysis.

Quality assurance

General principles

The objective of quality assurance (QA) is to ensure that the quality of the measurement results is suitable for the intended purpose. Quality assurance can be done either by independent external assessors, or by the company's own personnel, or both. The quality assurance process should be done in accordance with ISO 17025 or comparable local standards accepted by the relevant authorities.

ISO 17025 describes the criteria for operating testing laboratories, which includes institutions that perform emissions measurements. The aim of ISO 17025 is to bolster confidence in testing labs that comply with ISO 17025. This section covers only those key aspects of ISO 17025 that relate to emission measurements (especially technical competence).

Essentially, ISO 17025 describes measures aimed at ensuring the representative sampling, accuracy, precision, and completeness of measurement results. The management and organization of the operation are also included in the quality assurance system.

The following points play a central role in this:

- > Neutrality, independence, and integrity
- > Legal aspects
 - Legal recognition
 - Collaboration with the client and sub-contractors
- > Technical competence
 - Management and organization
 - Personnel
 - Physical facilities and equipment
 - Working methods.

Quality assurance actions in measurement procedure

Objective	Testing method
Accuracy (systematic error)	Parallel measurement by an independent measurement procedure
Precision (random error)	Parallel measurement by same measurement procedure

Quality assurance actions that affect the application of measurement procedures

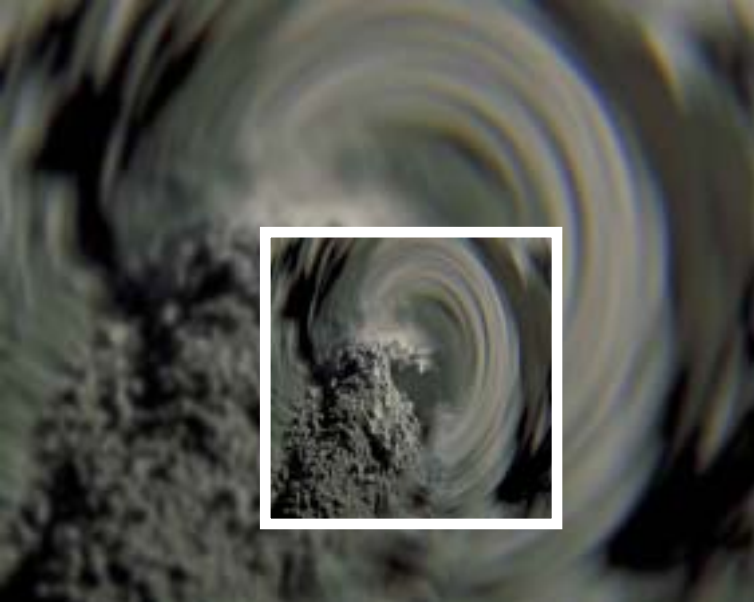
- > Ensuring the use of measuring devices (or measurement procedures) that, due to their technical specifications (systematic error, measurement uncertainty, determination limit, etc.), can meet the prescribed criteria.
- > Checking and verifying standards (calibration gases, reference values).
- > Standardizing measurement procedures, calibration procedures, and reference materials.

Quality assurance objectives

The following quality assurance objectives are especially important in emissions measurement:

- > Organizing work flows
- > Assurance of employee qualification
- > Participating in inter-laboratory testing.





Key performance indicators (KPIs)

The CSI companies are aware of the need to track the progress of improvements, and to make this progress clear to all their stakeholders. This protocol therefore includes a number of simple, reliable and representative Key Performance Indicators (KPIs).

Coverage rates

KPI 1: Overall Coverage Rate

This KPI is designed to show the percentage of clinker produced by kilns covered by a monitoring system (continuous or discontinuous measurements) meaning dust, NO_x, SO_x, Hg, Cd, TI, VOC and PCDD/F. Only when all emissions of the pollutants (previously identified) are monitored at a kiln will the full amount of clinker produced from this kiln be included in the calculation of the KPI.

Calculation example for KPI 1:

Company A operates 50 kilns producing 50 million tonnes of clinker per year. In the reported time frame, all emissions of the main and other pollutants were monitored at 35 kilns (producing 40 million tonnes of clinker).

In this case we get:

$$\text{KPI 1} = (40,000,000\text{t} / 50,000,000\text{t}) \times 100 = 80 (\%)$$

The KPI 1 of Company A is therefore 80%, meaning that 80% of its clinker is produced in kilns covered by monitoring systems which meet this protocol.

KPI 2: Coverage Rate Continuous Measurement

This KPI indicates the percentage of clinker produced by kilns which have installed continuous measurements for dust, NO_x and SO_x.

Emissions data

KPI 3 is designed to show the releases of emissions of dust, NO_x or SO_x from the kiln to air (the main pollutants identified above). There are separate KPIs for each of these pollutants.

Whereas the absolute values are calculated by addition of the total emissions of each kiln, the calculation of the specific values has to be done using the mass weighted averages of the kilns to ensure accurate data.

KPI 3a: Emissions Data Dust

The data for the 'dust' KPI will be given as both specific (g/tonne clinker) and absolute values (tonne/year). Dust is the total mass of particulate matter.

KPI 3b: Emissions Data NO_x

The data for the NO_x KPI will be given as both specific (g/tonne clinker) and absolute values (tonne/year). NO_x is the total mass of nitrogen monoxide + nitrogen dioxide, expressed as nitrogen dioxide.

KPI 3c: Emissions Data SO_x

The data for the SO_x KPI will be given as both specific (g/tonne clinker) and absolute values (tonne/year). SO_x is the total mass of sulfur dioxide and other sulfur compounds, expressed as sulfur dioxide.

Calculation example for specific dust emissions:

Company A operates 3 kilns:

- > Kiln A produces 1 million tonnes of clinker per year with a specific dust emission of 10 g/t clinker.
- > Kiln B produces 0.5 million tonnes of clinker per year with a specific dust emission of 40 g/t clinker.
- > Kiln C produces 0.4 million tonnes of clinker per year with a specific dust emission of 100 g/t clinker.

$$\text{KPI 3a} = \frac{(10 \text{ g/t} \times 1,000,000 \text{ t} + 40 \text{ g/t} \times 500,000 \text{ t} + 100 \text{ g/t} \times 400,000 \text{ t})}{(1,000,000 \text{ t} + 500,000 \text{ t} + 400,000 \text{ t})} = 36.8 \text{ g/t}$$



Reporting

The objective of environmental reporting is to provide the reader with a fair picture of the environmental footprint of the reporting entity. Reporting of emissions therefore needs to meet a number of criteria:

- > Data must be consistent, transparent and credible
- > Data must be presented in a clear, standard format
- > Data must meet quality assurance (QA) requirements
- > Data must allow emissions to be reported in absolute as well as specific terms
- > Data must be applicable at different levels (individual plant, company, and country)
- > Reports must provide a flexible tool to suit the needs of different monitoring and reporting purposes.

Which installations are covered?

This protocol covers those emissions of a company where the company has either:

- > the majority of ownership (> 50%) or
- > the management control.

In both cases the protocol requires the reporting company to include 100% of their emissions (unlike the CSI CO₂ emission protocol, which allows pro-rata reporting according to ownership share).

The WBCSD definition of control is used for this protocol, as follows:

"Control is defined as the ability of a company to direct the operating policies of another entity/facility. Usually, if the company owns more

than 50 percent of the voting interests, this implies control. The holder of the operating license often exerts control. However, holding the operating license is not a sufficient criterion for being able to direct the operating policies of an entity/facility. In practice, the actual exercise of dominant influence itself is enough to satisfy the definition of control without requiring any formal power or ability through which it arises."

Reporting frequency and periods

The KPI values have to be reported on an annual basis by each company individually. Companies can make their own decisions about which kind of documentation will be used for the reporting (e.g. an environmental or sustainability report, web site, etc.).

Reporting emissions can be based on financial years, rather than calendar years. This can help to reduce reporting costs and causes no problems provided that it is done consistently over time, with no gaps or overlaps. Any changes in the reporting year should be clearly indicated. National regulations should be taken into account.

Emissions targets

As agreed in the CSI Agenda for Action, each CSI member company will establish, publish and report on their own individual target values for each KPI.

Format for an emissions monitoring report

Identification		
Name of the company		
Reporting period		
Key Performance Indicators Coverage rates		
	%	
KPI 1 (Overall Coverage Rate)		
KPI 2 (Coverage Rate Continuous Measurement)		
Key Performance Indicators	Releases to air	
Emissions data	Specific (g/t clinker)	Absolute (t/year)
KPI 3a (Dust)		
KPI 3b (NO _x)		
KPI 3c (SO _x)		

References

EIPPC 2001

Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries. EIPPC (European Integrated Pollution Prevention and Control Bureau), Seville, December 2001.

NPI 1999

Emission Estimation Technique Manual for Cement Manufacturing. National Pollutant Inventory, August 1999.

EPA AP-42 1994

Emission Factor Documentation for AP-42 Section 11.6, Portland Cement Manufacturing. Final Report for U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, May 1994.

NAEI 2002

UK National Atmospheric Emissions Inventory, 2002. Data taken from research by the Battelle Memorial Institute (Battelle 2002). See <http://www.naei.org.uk> for data.

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VDZ 2001

Environmental data of the German cement industry 2001. Verein Deutscher Zementwerke e.V., Düsseldorf 2002.

SINTEF 2004

Formation and Release of POP's in the Cement Industry. The Foundation for Industrial and Scientific Research of Norway, Draft report, WBCSD, March 2004. See endnote 5.

End notes

1 The task force name was subsequently changed to Emissions Monitoring and Reporting, reflecting the joint work of the participants. Individual companies remain responsible for setting specific emissions reduction targets and reporting their progress.

2..CEMEX acquired RMC in 2005 reducing the CSI membership from seventeen to sixteen companies.

3 Carbon dioxide emissions are covered by the CSI CO₂ Accounting and Reporting Standard for the Cement Industry

4 metric tonne (t), 1000kg

5 Mass figures are based on process gas volumes of 2000m³/t clinker and million t clinker/yr. Emission ranges are one-year averages and are indicative values based on various measurement techniques. Reference oxygen content is normally 10%.

6 See, for example, typical concentrations as identified by a separate CSI task force dealing with fuels and materials use LINK

7 Regulatory agencies from the US and the UK have reached conclusions similar to the SINTEF study results, see:

- > Federal Register, 1999. "National Emissions Standards for Hazardous Air Pollutants - US EPA - Final Rule". Part II, 40 CFR Part 60, et al, September 30, 52876.
- > "Proposals to Revise the Substitute Fuels Protocol for use on Cement and Lime Kilns," Consultation Paper, Environment Agency (UK) (2004)

8 For example, Canada's 1999 dioxin emissions inventory showed municipal waste incineration as responsible for 58% of total dioxin releases. Emissions from the cement sector accounted for less than 1%. "Dioxins and Furans and Hexachlorobenzene, Inventory of Releases," Environment Canada, January 1999. Can be downloaded from the CEPA website.

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) is a coalition of 170 international companies united by a shared commitment to sustainable development via the three pillars of economic growth, ecological balance and social progress. Our members are drawn from more than 35 countries and 20 major industrial sectors. We also benefit from a global network of 50 national and regional business councils and partner organizations involving some 1,000 business leaders.

Our mission

To provide business leadership as a catalyst for change toward sustainable development, and to promote the role of eco-efficiency, innovation and corporate social responsibility.

Our aims

Our objectives and strategic directions, based on this dedication, include:

- > **Business leadership:** to be the leading business advocate on issues connected with sustainable development
- > **Policy development:** to participate in policy development in order to create a framework that allows business to contribute effectively to sustainable development
- > **Best practice:** to demonstrate business progress in environmental and resource management and corporate social responsibility and to share leading-edge practices among our members
- > **Global outreach:** to contribute to a sustainable future for developing nations and nations in transition

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