European Union Network for
the Implementation and Enforcement
of Environmental Law

INSPECT-CEM

ENVIRONMENTAL INSPECTION GUIDELINES FOR THE CEMENT CLINKER INDUSTRY

Final Report
June 2009

Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation. Projects in IMPEL's Annual Working Programme are co-financed by the European Commission.

During the previous years IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 6th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at:

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Executive Summary

This report is the result of a group work involving 13 countries by the participation of experts in inspecting cement plants.

The considerations here reported are derived both from the compilation of a questionnaire submitted to all the participants with the aim of understanding similar and different aspects linked to cement plants and environmental inspections, and from four meetings involving the participants

It has been possible to identify some common critical aspects of the cement sector, that have so been analysed. In particular two issues have turned to be the most relevant environmental impacts in the cement industry: air emission and use of waste.

Concerning air emission it has to be mentioned here that the controls on CO2 emissions measurement and calculation are not included in this report, that focused on the controls to be made according to IPPS directive.

After a brief presentation of the cement plants in the 13 countries (chapter 1), the report provides in chapter 2 an overview of the most relevant environmental impacts of the cement production cycle, with special regards to those aspects who can increase inspector skills and knowledge to be used during their activity.

Chapter 3 reports a brief guideline to perform environmental inspections in cement plants; it's aimed to give inspectors an homogeneous and linear approach to this kind of inspections, providing also a small tool that can be used during on-site activities.

does not necessarily represent the views of the national administrations or the Commission

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INTRODUCTION

Cement production process is a complex industrial activity that can potentially affects environment with high impacts.

Facing different experiences and know-hows demonstrated that monitoring only stack emissions cannot be an efficient control strategy; it's important to implement an integrated control action that takes into account also production process and technologies adopted, as a stable and controlled process conduction is the first guarantee of compliance assurance.

Besides high aggregation grade of enterprises, structured into great groups set on a global geographical asset, needs an homogeneous controlling method and approach. This means using a minimum set of control criteria and exchanging experience to keep them maintained and constantly up to date.

This document aims to fix and describe the present know-how in terms of environmental controls on cement factories; it's aimed to provide a conceptual approach and operative tool to inspectors who have to perform environmental controls in these kind of plants.

The first part of the report focuses on the description of the potential environment threats caused by the cement clinker production, in order to clarify the most relevant issues that need to be controlled by the Authority. Starting from the contents of BREF in the clinker production (in its last revision as final draft of February 2009) the analysis of the cement cycle here reported is mainly based on the experiences of the participants to the project.

As result of this confrontation, it has been decided to deepen only critical aspects of cement industries so guidelines treats only main issues such as: air emission as regards monitoring and sampling activities, use of waste describing minimum criteria to verify a correct quality assurance system in accepting and using them.

The second part of the report is a description of a guideline for inspection in cement plants; derived from the consideration made in the first part of the report; it follows basic principles of the Recommendation on Minimum Criteria for Environmental Inspections and try to define a minimum set of criteria to plan and perform environmental inspections, in order to help new inspection authorities to improve their specific skills and in general to take to a higher homogeneous degree these controls in the EU member States, including Accession Countries.

1 GENERAL INFORMATION ON THE CONTEXT OF THE PROJECT

The considerations reported in this report are mainly derived from the compilation of a questionnaire submitted to all the participants with the aim of understanding similar and different aspects linked to cement plants and environmental inspections.

In this way it has been possible to identify some common critical aspects of the cement sector, that are here analysed. In particular two issues have turned to be the most relevant environmental impacts in the cement industry: air emission and use of waste.

1.1 Data and information collection

INSPECTCEM project has involved 13 countries, each with different numbers and types of cement plants. Due to different size of the countries involved, and to the consequent different number of cement plants per country, and due also to different internal organization of every country, data collection hasn't been homogeneous. Some participants could give detailed information about all the cement plants of their country, some others could give national data (as an average) and detailed data only on some plants; some others could only give data on a national level. Nevertheless the participants had been able to exchange their experiences and their know-how in environmental impact analysis thus allowing the writing of this report and of the guidelines for inspection.

As for the internal organization of the environment system in each country there are some differences among the participant members. The most relevant differences deals with the following items: whether the authority responsible for control activity is also responsible for issuing the permits; whether the authority responsible for controls can take samples during inspections or doing analysis in its own laboratories. These aspects are explained in details in Annex 2. Another important difference regards the difference level of specialization of inspectors, as it will be discussed in section 3.1.

1.2 Dimension and geographical dislocation

Inspect Cem involves 13 countries with a total number of 182 cement plants-complete cycle- that is about 70% of the plants considered in the BREF documents. Detailed data have been scheduled for 53 plants out of 182 (29%).

	Cement plants complete cycle	Cement plants studied in detail
Belgium	**5**	**5**
Croatia	**6**	**5**
Denmark	**1**	**1**
Germany	**38**	**5**
France	**29**	**2**
Italy	**58**	**6**
Cyprus	**2**	**2**
Latvia	**1**	**1**
Poland	**12**	**4**
Portugal	**6**	**6**
Romania	**8**	**-**
Slovenia	**2**	**2**
United Kingdom	**14**	**14**
total	**182**	**53**

Fig.1 – number of cement production plants in INSPECTCEM countries

1.3 Geographical distribution and plant dimensions

Need of natural raw materials have often obliged to build cement plants next to quarries, that in some cases are located near hills or mountains; this type of location creates very particular microclimatic conditions that heavily influences the dilution and deposition of gaseous emissions.

When the geography of the country allows, the plants are located by the sea, thus permitting the raw material and final products being transported also by ships.

A common characteristic of almost all the plants analysed is the fact they are quite close to urban area, in any case not farer than few kilometres.

The plants here analysed are of different dimensions and capacity. All plants considered are subjected to IPPC Directive, having a clinker production capacity exceeding 500 tonnes per day. The number of kilns per plants vary from a minimum of 1 to a maximum of 7.

The variety of kilns considered include all types of kiln processes, that is dry process; wet process and semi dry process.

The following graph shows the kiln process distribution. This type of distribution differs from the one analysed by BREF document, due to the large number of kiln from Northern Europe (in particular in Belgium and Denmark) analysed. As a matter of fact in northern Europe raw materials with higher moisture content are more easily found.

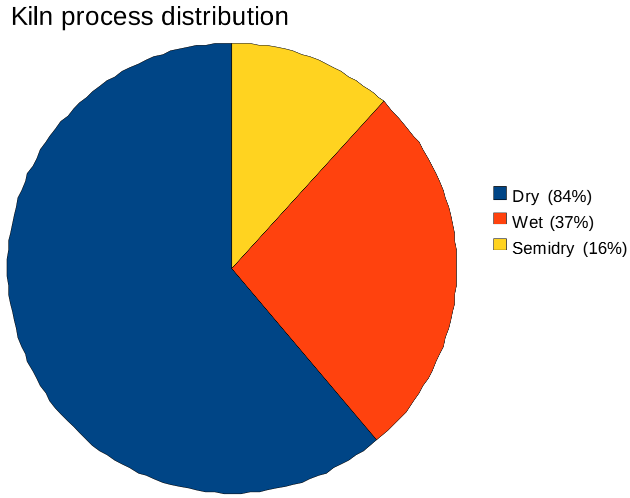

Fig.2 – Kiln process distribution in INSPECTECM production plants

The following graph shows the mean nominal clinker capacity for different type of kilns analysed.

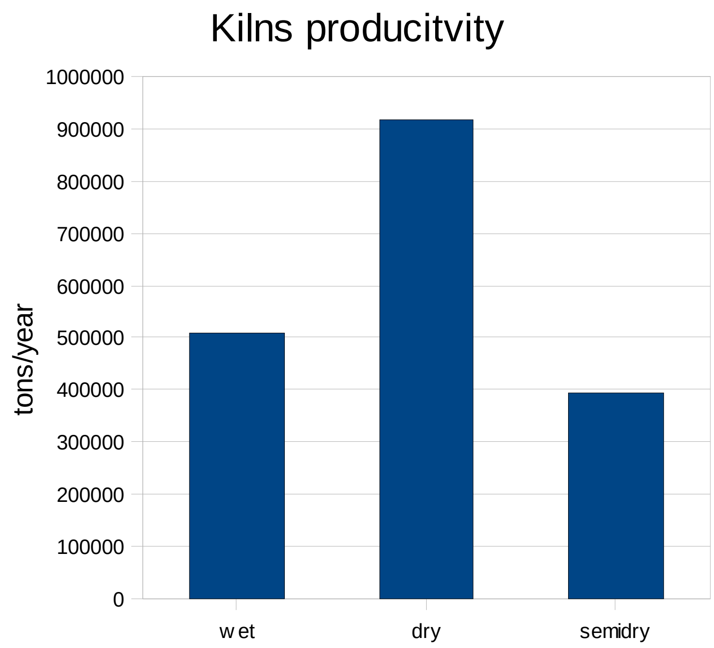

Fig.3 – Mean nominal clinker capacity of INSPECTCEM plants

2 ENVIRONMENTAL ASPECTS

2.1 Air emissions

Emission of pollutants into atmosphere is probably the most important environmental impact of cement production plants. Thus it's important to have a deep knowledge of the chemical substances that can be present in emissions, due to the production process, and to survey correctly the emission level that technological provisions and operational procedures can ensure; both regarding conveyed and treated gas flows and diffused emissions due to insufficient aspiration supplies or a wrong operational management of the plant.

INSPECTCEM project has been an occasion to discuss and to make a confrontation among participant countries situations regarding the specific themes of permitting and controlling air emissions coming from cement plants.

It has been demonstrated that EU countries, even in respect of acquis communutaire, have different approach and organization about IPPC application, permit releasing and controls; this leads environmental control authorities to different inspection techniques, aimed to answer a common question: how is the operator able to demonstrate that he can ensure continuous compliance with laws and permits?

Starting from specific contents of the integrated permit, they have different grade of complexity and can be more complete and precise in some EU countries that adopted integrated approach even before IPPC application.

Directly referring to this consideration, inspection techniques can consider technical and operational controls or only a check about compliance with integrated permit; direct measurement of emission levels by the public organization or only external accredited laboratories samples and analysis; direct survey on operator sampling activities or analysis of the report on sampling given by operator.

Cement production plant should operate with a continuous monitoring system at the critical stacks (kiln, mills,..) and perform a monitoring campaign on all the stacks, which frequencies and methods are defined by the permit.

An effective inspection has to consider all the aspects linked to those activities, so not only look at the compliance of the measured values to the emission levels on the permit but also at other aspects, such as: conditions occurring on the plant while the measures are taken (f.e. fuel feed to the kiln, that allows to understand the productive conditions,..), maintenance and calibration of the CEM system, correct application of sampling and analysis procedure during measurement campaigns.

This kind of inspections can include control on documents (registrations, measurement sheet,..), on technical equipments (state and maintenance of bagfilters, electrofilter, measurement equipments,..) and procedures regarding monitoring systems.

The present report describes in the following sections an overview an air emissions types and link with production cycle, taking then into account the common principles of monitoring systems. Then, in section 3.2, there is a description of the most common techniques that an inspector can use to perform these activities; a deeper description of all the critical aspects of inspections linked to conveyed air emissions is reported in Annex 3; it can be used by inspector to integrate the inspection program with specific activities on air emission monitoring.

Conveyed emissions

Conveyed emissions are the main environmental pressure font of a clinker production plants and the plant manager capacity to manage a good monitoring on them represents a critical part of operational controls.

A complete and correct control on air emission monitoring system can definitely ensure the capacity of the plant to maintain compliance within emission limits and environmental laws.

Main air-polluting substances relevant to cement manufacture are:

- oxides of nitrogen (NOx) and other nitrogen compounds;
- sulphur dioxide (SO2) and other sulphur compounds;
- dust.
- carbon monoxide (CO);
- volatile organic compounds (VOC).

Pollutants to be considered in relation to the production (fuels, materials) of cement are:

- polychlorinated dibenzodioxins and dibenzofurans (PCDDs and PCDFs);
- metals and their compounds;
- HF
- HCl
- BTX (benzene, toluene, xylene)
- PCB (polychlorinated biphenyls) including coplanar congeners,
- PCP
- PAH (polyaromatic hydrocarbons),

Not mentioned in the list but considered to be relevant for cement production is carbon dioxide (CO_2).

The main releases from the production of cement are releases to air from the kiln system. These derive from the physical and chemical reactions involving the raw materials and the combustion of fuels. The main constituents of the exit gases from a cement kiln are Nox and SO_2 from the combustion air; CO_2 from calcination of $CaCO_3$ and combustion of fuel; water vapour from the combustion process and from the raw materials; and excess oxygen.

In all kiln systems the solid material moves counter currently to the hot combustion gases. This counter current flow affects the release of pollutants, since it acts as a built-in circulating fluidised bed. Many components that result from the combustion of the fuel or from the transformation of the raw material into clinker remain in the gas phase only until they are absorbed by, or condensed on, the raw material flowing counter currently.

The adsorptive capacity of the material varies with its physical and chemical state. This in turn depends on its position within the kiln system. For instance, material leaving the calcination stage of a kiln process has an high calcium oxide content and therefore has a high absorptive capacity for acid species, such as HCl, HF and SO_2.

A brief description on the origin and the way to reduce emissions of the main pollutants is here reported:

Oxides of nitrogen

Nitrogen oxides (NOx) are of major significance with respect to air pollution from cement manufacturing plants. NO and NO_2 are the dominant nitrogen oxides in cement kiln exhaust gases (NO >90% of the nitrogen oxides). There are two main sources for production of NOx:

Thermal NOx: part of the nitrogen in the combustion air reacts with oxygen to form various oxides of nitrogen.

Fuel NOx: nitrogen containing compounds, chemically bound in the fuel, react with oxygen in the air to form various oxides of nitrogen.

NOx formation can be influenced by flame shape and temperature, combustion chamber geometry, the reactivity and nitrogen content of the fuel, the presence of moisture, the available reaction time and burner design.

BATs for NOx reduction, described in the last draft of BREF (February 2009) are:

primary measures: flame cooling; low NOx burners; mid kiln firing; mineralised clinker; staged combustion; process optimisation;

Secondary measures:SNCR and SCR techniques.

Sulphur dioxide

SO_2 emissions from cement plants are primarily determined by the content of the volatile sulphur in the raw materials. Kilns that use raw materials with little or no volatile sulphur have little problems with SO_2 emissions. The emission concentration in the flue gas are below 10 mg SO_2/m^3 without abatement at some kilns, the SO_2 emission concentration increase with increased levels of volatile sulphur in the used raw material.

BATs for SO2 reduction, described in the last draft of BREF (February 2009) are: optimised raw milling processes (for dry processes); absorbent addition; wet scrubber

Dust

Traditionally the emission of dust, particularly from kiln stacks, has been the main environmental concern in relation to cement manufacture. The main sources of dust are kilns, raw mills, clinker coolers and cement mills. In all these processes large volumes of gases are flowing through dusty materials. The design and reliability of modern electrostatic precipitators and bag filters ensure dust releases can be reduced to levels where they cease to be significant; emission levels below 20 mg/m³.

BATs for dust emission form kiln firing process reduction, described in the last draft of BREF (February 2009) are: electrostatic precipitators; fabric filters; hybrid filters

Polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs)

Any chlorine input in the presence of organic material may potentially cause the formation of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in heat (combustion) processes. PCDDs and PCDFs can be formed in/after the preheater and in the air pollution control device if chlorine and hydrocarbon precursors from the raw materials are available in sufficient quantities. The reformation of dioxins and furans is known to occur by de novo synthesis within the temperature window of cooling from 450 to 200 ℃. Thus it is important that as the gases are leaving the kiln system they should be cooled rapidly through this range. In practice this is what occurs in preheater systems as the incoming raw materials are preheated by the kiln gases.

Due to the long residence time in the kiln and the high temperatures, emissions of PCDDs and PCDFs is generally low during steady kiln conditions.

BATs for PCDDs and PCDFs reduction, described in the last draft of BREF (February 2009) are: carefully controlling copper and chlorine contents of kiln inputs, both raw materials and fuel; limiting/avoiding the use of wastes which contain chlorinated organic materials; quick cooling of kiln exhaust gases to lower than 200℃ and minimising residence time of flue gases and oxygen content in zones with temperatures range 300-450℃.

Metals and their compounds

Raw materials and fuels will always contain metals. The concentrations vary widely from one location to another. Metal compounds can be categorised into three classes, based on the volatilities of the metals and their salts:

- Metals which are or have compounds that are refractory or non-volatile: Be, Cr, As, Ni, V, Mn, Cu
- Metals that are or have compounds that are semi-volatile: Sb, Cd, Pb, Se, Zn.
- Metals that are or have compounds that are volatile: Hg and Tl.

The behaviour of these metals in the burning process is dependent on their volatility.

Balance investigations show that there is low retention of elements with high volatility in the clinker, resulting in an accumulation of these substances in the kiln system.

BATs for metals reduction, described in the last draft of BREF (February 2009) are: selecting materials with low contents of relevant metals, especially mercury; using a quality assurance system to guarantee the characteristics of the waste material used; using effective dust removal techniques.

Use of mass balances

This example shows that mass balances can be a positive help for the cement process if mass balances are used as a tool in the early stage prior to changes in the production process and changes in the use of raw materials.

Chalk-based raw materials with high moisture content are used in the DK-cement plant. The chalk is excavated by the use of heavy, slowly moving machinery. Due to the high moisture content in the chalk, the excavation machinery has some difficulties by manoeuvring on the ground. Thus, it has been necessary to use some kind of foundation underneath the excavation machinery to prevent the machine from getting fixed onto the ground (sinking). For a period the cement plant used slag from a waste incineration plant as foundation underneath the excavation machine. During the excavation of chalk, both chalk and slag was continuously excavated and transferred to the clinker production process. Mass balances later showed that the contents of lead (Pb) in the slag were concentrated in the dust from the clinker process. Since lead was not wanted in the production process, the lead-containing slag was substituted.

The example shows that if mass balances are used at an early stage – before actually implementing the use of the slag (or other materials) – it would probably have been possible to foresee that lead would concentrate in the dust. Thus, it would have been possible to use another material as foundation for the excavation machinery from the beginning.

Monitoring - Emissions

A distinction is made between continuous measurements and individual measurement. A further distinction is made between first-time and repeated measurements, function tests and calibrations, and measurement for special reasons, e.g. to determine the emissions of exaust gas components which are not continuously monitored.

The measurement-relevant parameters to be considered in measurement planning derive from regulatory requirements, e.g. the operating permit, information from the technical supervisory body responsible for the plant and from on-site inspection.

To accurately quantify the emissions, continuous measurements are recommended for the following parameters:

- exhaust volume (can be calculated but is regarded by some to be complicated),
- humidity (can be calculated but is regarded by some to be complicated),
- temperature,
- Total dust,
- O_2 volume concentration
- NOx (Nitrogen oxides)
- SO_2 (Sulphur oxides)
- CO (Carbon monoxide)
- Hg (Mercury and its compounds)

Regular periodical monitoring is appropriate to carry out for the following substances:

- metals, semi-metals and their compounds,
- TOC (Organic substances)
- HCl (Hydrogen Cloride)
- HF (Hydrogen Fluoride)
- PCDD/Fs (Dioxins and Furans)

Measurements of the following substances may be required occasionally under special operating conditions:

- BTX (benzene, toluene, xylene),
- PACs (polycyclic aromatic hydrocarbons), and
- other organic pollutants (for example chlorobenzenee, PCB (polychlorinated biphenyls) included coplanar congeners, chloronaphthalenes, etc.).

It is especially important to measure metals when wastes with enhanced metals contents are used as raw materials or fuels.

It is appropriate to have measured all these substances on at least one occasion to provide data when applying for the plant's first permit.

Emission data from kilns in operation is given in Annex 1. The emission ranges within which kilns operate depend largely on the nature of the raw materials, the fuels, the age and design of the plant, and also on the requirements laid down by the permitting authority.

2.2 USE OF WASTES

2.2.1 Use of waste as fuel

The technical standard of the co incineration plants is one of the most sensitive parameter. As the clinker burning process offers favourable conditions for waste co-processing, wastes can substitute part of these conventional fuels. Depending on their composition, wastes are burned either in the main firing system or in the secondary firing system.

Main alternative fuels fired are pre-treated industrial waste fractions and scrap tyres. Other waste streams are used as fuel substitute; the following summary shows waste groups that have in principle turned out to be suitable for the energy and material recovery in the clinker burning process:

- Plastics
- Paper
- Wood
- solvents
- Waste oil
- Electrode coke
- Animal meal
- Tyres / rubber
- Textile waste
- Sewage sludge
- Suitable fractions of municipal waste or commercial waste similar to municipal waste

The requirements for the origin and quality of the mono waste fractions have been defined by restricting the eligible waste streams to individual waste codes. In this connection, the specific conditions of the cement production process and the resultant opportunities and limitations of waste utilization have been taken into account.

Waste code	General description
02 01 04	Waste plastics (except packaging)
02 01 07	Waste from forestry
03 01 01	Waste bark and wood
03 01 05	Sawdust, shavings, cuttings, wood, particle board and veneer other than those mentioned in 03 01 04
03 03 02	Green liquor sludge (from recovery of cooking liquors)
03 03 07	Mechanically separated rejects from pulping of waste paper and cardboard
03 03 08	Wastes from sorting of paper and cardboard destined for recycling
04 02 09	Wastes from composite materials (impregnated textile, elastomer, plastomer)
04 02 21	Wastes from unprocessed textile fibres
04 02 22	Wastes from processed textile fibres
07 02 13	Waste plastic
08 01 02	Waste paint and varnish except those mentioned in 08 01 11
08 02 01	Waste coating powders
09 01 07	Photographic film and paper containing silver or silver compounds
12 01 05	Plastic shavings and turnings
15 01 01 ÷ 03	Paper and cardboard, plastic, wooden packaging
15 01 05 ÷ 06	Composite and mixed packaging
15 02 03	Absorbents, filter materials, wiping cloths and protective clothing except those mentioned in 15 02 02
16 01 03	End-of-life tyres
17 02 01	Wood
17 02 03	Plastic
19 05 01	Non-composted fraction of municipal and similar wastes
19 12 01	Paper and cardboard
19 12 04	Plastic and rubber
19 12 07	Wood other than that mentioned in 19 02 06
19 12 08	Textiles
19 12 10	Combustible waste (refuse derived fuel)

Fig.4 - Example for individual waste codes used in German permitting system

Co-incineration of Other Waste Types

The existence of a list of wastes that can be co-incinerated without a significant environmental impact does not exclude the co-incineration of other waste types. In this case, however, co-incineration shall be authorised following the procedure for activities with a significant environmental impact.

It is essential that the utilisation of these wastes should not result in significant increases in noxious emissions and in the toxic substance content of the finished product.

This can be achieved, among others, by limiting the pollutant quantity contained in the wastes used for co-incineration, the limits being set by the operator of the co-incineration plant, depending on the specific characteristics of each plant and on the technological process used to obtain the clinker.

In order to have sufficient data available to meet information requirements during the licensing procedure, before applying for a license, the operator shall perform an industrial testing of the co-incineration of the waste type under consideration.

During industrial testing, measurement programmes shall be carried out to demonstrate that the introduction of these new types of waste does not have a significant impact on the environment (thus ensuring compliance with legal requirements in force), on the technological process or the quality of the finished product.

Testing shall be carried out with consent from the competent (local/regional) authorities. The waste quantities submitted to testing and the time periods over which these tests are to be performed shall be agreed with the competent authorities.

Point of the kiln/process where waste is used

The main requirements for low emissions are uniform kiln operation and constant operating conditions when using waste materials and waste oil. From this it follows that::

- the burning process has to be monitored continuously using modern process control technology,
- Waste materials require constantly fixed inspections on arrival and comprehensive preliminary homogenisation.
- Liquid media should be sampled continuously through trickle tubes for quality control,
- the main parameters for analysis of the waste materials (calorific value, chemical composition, etc.) must be put into the process control system on a continuous basis,
- regulations of primary energy have to follow in reliance on secondary fuel data,
- the feed lance must be designed so that the waste fuel is injected centrally and is ignited at the flame front of the main fuel,
- The control units must allow the waste fuel to be supplied independently of the main fuel,
- Waste-fuels may only be supplied during normal continuous operation within the rated output range.

Strict input criteria of various secondary fuels are important for low emissions to remain under limiting values.

The description of a safety chain and safety regulations is necessary for supervising a firm combustion to recognize defects immediately and to avoid uncontrolled combustions of secondary fuels with suitable contact systems. The parameters of the □ safety chain□, listed below, should be linked to one another by a computer-controlled logic system so that their effect on kiln operations and on emissions can be ascertained and the operation could be shut down at predetermined limits as a function of the degree of deviation from the set point value or the plant stoppage time, e.g.:

- Gas temperature less than 900 °C at kiln inlet,
- Temperature of material at kiln outlet less than 1250℃,
- CO- level above a value to be established by trial (Vol.%),
- Inadmissible control deviations in the setpoint/actual value comparison for the primary and secondary fuel feed,
- Raw-meal feed of less than 75 % of the max. possible quantity,
- Negative pressure before the exhaust gas fan below the value required at rated output,
- O_2 level lower than inspection measurements require,
- NO_x level above 500 mg/m^3,
- Failure of burner,
- Dust level above permissible limit.
- Mercury level above permissible limit

Quality assurance controls

Appropriate measures of emission restrictions start with a selection of waste fuels by the processing. The selecting process of household - and commercial - waste to obtain rich calorific valuable substitute fuels naturally affects the content of the permit that is given to each individual Cement plant. Therefore the following questions concerning the waste fuel could be asked:

- Which waste are used?
- Out of which process do the waste materials come from?
- Which pollutants does the waste contain?
- Are data of used substances (calorific value, PCB, heavy metals, chlorine content,

etc.) available?

- Is a constant quality within a certain spectrum possible?
- What is the expected emission (PCB, Dioxin/Furan, heavy metals)?
- How is the enrichment of harmful substances in clinker or cement?

A cement plant has to enclose the following documents when using waste fuels:

- a suitability proof of the processing plant, that it is recognized as a specialized waste disposal plant for the processing of residual materials of production
- proof, that the processing plant is suitable for this kind of processing
- Documentation / Declaration of every single inorganic and organic substance of the wastes and the finished mixture of secondary waste fuels.

The declaration analysis have to describe the background of the production process, the composition of the whole mixture and possible specific features or divergences. The declaration analyses have to contain at least the following data from:

- calorific value,
- heavy metal values,
- chlorine content,
- sulphur content,
- PCB content,
- etc...

A plant diary, which must include the following information, has to be written every supplied charge of secondary fuels:

- the suppliers name and adress,
- name and adress of the disposals producer,
- amount of the substances including its` disposal key number,
- the supply date and time
- name of the employee which is responsible for the acceptance,

- date and number of the declaration analyses / corresponding confirmations.

The technologies to prepare and blend certain waste fuel qualities are depending on the characteristics of the input waste materials and the requirements of the user. The following types of non-hazardous solid wastes are treated (for example sorting, crushing, pelletising) in waste facilities:

- Mono waste materials with high calorific value like use tyres, animal meal
- Mixture of different mono waste materials (e.g. production-specific textile or plastic waste)
- Separated high calorific fraction of mixed municipal waste, mixed commercial waste or mixed contraction and demolition waste

Monitoring and Quality assurance of Waste fuel by processing plant

Pre-treatment is, therefore, an integral part of the recovery operation. However, preparation of different types of combustible waste or wastes with separable high calorific fractions for use as fuel is usually performed outside the cement plant. These wastes are normally prepared by the supplier or by waste treatment specialists' organisations in special waste management facilities in such a way that they can directly be used in cement kilns without any additional treatment on their production site.

However, before being used in the cement kiln, the delivered waste material is checked and analysed by the cement plant personnel as well. Special laboratory equipment is used for checking different quality characteristics.

The technologies used to prepare and blend certain waste fuel qualities depend on the characteristics of the material input and the requirements of the users. Even mono waste materials, like production specific wastes, are treated and blended prior to use in waste facilities to ensure a homogeneous mixture with nearly constant qualities, such as thermal properties and chemical composition.

Only in some cases can wastes be used just as they are delivered without further processing, for example used tyres or used oil. Calorific fractions of inhomogeneous wastes, like mixed solid wastes from different sources or separated fractions from mixed municipal waste, have monitoring requirements set higher to attain a reliable quality with a constant low pollutant input.

Checking points for waste fuel quality

point of generation (processing plant):

- listing the waste according to type
- contractual agreement over permissible quality and composition of the waste
- documentation of quantities disposed of

processing plant (incoming):

- routine sampling and analysis*
- documentation of the quantities received and processed
- routine sampling and analysis by independent expert

processing plant (outgoing):

- routine sampling and analysis*
- documentation of the outgoing quantities

utilizing installation (cement kiln incomming):

- routine sampling and analysis*
- documentation of the outgoing quantities

*parameters investigated:

- Calorific value, moisture, chlorine, sulphur, ash and ash componenets
- Heavy metals(Cd, Tl, Hg, Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V)
- PCB, PAH, etc.
- Maximum value, median value of level pollutants in the waste mix.

The following table depicts possible typical input criteria for suitable waste fuels. If an alternative material meets the following values the recovery in the clinker burning process will be environmentally sound and safe further testing.

The following trace elements which are contained in the input substances (used materials) are limited to mean value and maximum value for every single waste in the following chart:

Heavy metals	Mean Value [mg/kg] (kiln -mixed fuel)	Maximum Value[mg/kg] (single waste)
Cadmium	4	9
Thallium	1	2
Mercury	0,6	1,2
Antimony	50	120
Arsenik	5	13
Cobalt	6	12
Nickel	25	50
Lead	190	400
Chromium	125	250
Copper	500	1000
Vanadium	10	25
Manganese	250	500
Tin	30	70

Fig. 6 - Input-criteria for heavy metals in solid substitute fuel (German contribution)

Key parameter is the quality of the substituted fossil fuel. A low difference in burden of pollutants between conventional fuel and waste fuel strengthens the advantage of co-incineration. To compare process between “with and without waste fuel” it is advised to define an average fossil fuel content of heavy metals and use it for benchmarking.

It can be used for direct comparison of different types of waste fuel qualities or even serve as basis for the development of a material specific standard. The standard could be defined as an average content of heavy metals and maximum content in the high calorific waste fuel.

Apart from that it has to pointed out that also other material that do not meet all of these values can be recovered as well. In this case it might be necessary to take plant specific aspects into consideration.

Liquid waste fuels

Liquid waste fuels are prepared by blending different wastes like used solvents and waste oil with suitable calorific values in special waste management facilities. Normally only simply pre-treatments (remove of bottoms, sediments and water) are necessary. In some cases, e.g. machining oil/emulsion, chemical processes are necessary to clean metallic pollutants and additives.

Liquid waste fuels mostly are hazardous wastes. This has to be taken into account for the handling (e.g. storage and feeding) of the liquid waste fuel.

The waste must be categorized by the operator in compliance with the decision of the committee, with an appropriate waste number.

With the liquid waste concerns ignitable liquids, from petrochemical industries e.g.:

Ethanol, Methanol, Xylol, Ethylbenzene, Toluene, Acetone, Propanol, Hexan , And other...

with different danger signs:

- highly flammable (with a flash point under 21 °C 210 C)
- flammable (flash point between 21 und 550 C)

The mean heat value lies between 18 and 25 MJ/kg, the middle water salary lies with 10 – 20%.

FOCUS: USE OF TYRES AS ALTERNATIVE FUEL

Experience shows that used tyres are a very good substitute for fuel. Tyres, which are used as secondary fuel either whole or chipped, have the same high CV as coal. In addition, the steel reinforcing oxidises in the cement kiln and replaces a portion of the iron that would otherwise be added to the raw material mix used in cement manufacturing.

End of life tyres are collected and transported to a processing centre and processed to enable use in the cement industry. Tyres used at the cement plants can be car, van or truck tyres, but the use of one particular type of tyre is maintained at each cement works. For the dry cement process, tyres are cut into five to twelve cm chips by machinery before use. Prior to chipping, the tyres are cleaned. Tyre chips are introduced into the bottom of the pre-heater tower of the cement kiln. In the wet cement process, whole tyres are inserted into the middle of the kiln.

Table: Typical constituents of the rubber content of tyres.

Constituent	Percentage
Rubber	51
Carbon black (filler)	26
Oils (paraffin and aromatic)	13
Zinc oxide	2
Sulphur (vulcanised)	1.0 - 1.5
Halogens	0.5
Others	6

Tyres contain steel, which can partially replace raw mix additives such as iron oxide and thereby help to reduce raw material costs for the cement process. The quantity of steel depends on the source of tyres, as shown in the following table

Table: Typical major components of tyres

Vehicle	Tyre type	% rubber compound	% steel	% textile
Car	Steel braced radial	86	10	4
Car	Textile braced radial	90	3	7
Car	Cross-ply	76	3	21
Truck	All steel radial	85	15	< 0.5
Truck	Cross-ply	88	3	9

Tyres chips are generally the preferred option compared to whole tyres for modern cement plants Higher addition rates can be achieved with tyre chips which are more easily combusted compared to whole tyres. Also, the addition of tyre chips rather than whole tyres provides better and smoother operational control.

FOCUS: THE USE OF CONTROLLED RUNS

In order to study the impact on the environment of the use of waste in the combustion process, a good approach for the authority is to ask the plants to make controlled “runs” in a way to monitor the different pollutants emissions, and the most important related process parameters, both in the case of use and not use of waste.

The following tables show results for Portugal, Belgium and UK.

From these data it results that the co-incineration of MBM and of tyres in these plants make no significant differences to emissions compared to conventional fuel-fired operation. Especially regards to tyres, it turns that emission of NOx and of SOx are reduced when conventional fuel is partially substituted with tyres, Portugal

Plant B Kiln 1 (*NOx abatement system: low NOx burner)*	Dust (mg/Nm³)	CO (mg/Nm³)	NO_x (mg/Nm³)	TOC (mg/Nm³)	SO_2 (mg/Nm³)	HCl (mg/Nm³)	HF (mg/Nm³)	Hg (mg/Nm³)	Cd+Ti (mg/Nm³)	Sb,As,Pb,Cr,Co,Cu,Mg,Ni,V (mg/Nm³)	Dioxin and Furans (ng/Nm³)
Without co-incineration	6,8	786,0	864,9	42,9	280,9	2,4	0,09	0,0001	0,0005	0,0087	0,0012
With co-incineration (tyres)	6,1	882,3	560,0	33,7	184,7	1,1	0,04	0,0001	0,0005	0,011	0,0013

Plant B Kiln 2 (NOx abatement system: low NOx burner)	Dust (mg/Nm³)	CO (mg/Nm³)	NO_x (mg/Nm³)	TOC (mg/Nm³)	SO_2 (mg/Nm³)	HCl (mg/Nm³)	HF (mg/Nm³)	Hg (mg/Nm³)	Cd+Ti (mg/Nm³)	Sb,As,Pb,Cr,Co,Cu,Mg,Ni,V (mg/Nm³)	Dioxin and Furans (ng/Nm³)
Without co-incineration	12,6	744,6	793,6	42,4	220,4	0,9	0,17	0,006	0,0042	0,074	0,0029
With co-incineration (tyres)	10,2	872,3	581,9	34,1	141,8	0,4	0,14	0,0001	0,0013	0,040	0,0030

Plant C Kiln 1 (NOx abatement system: low NOx burner; Staged combustion)	Dust (mg/Nm³)	CO (mg/Nm³)	NO_x (mg/Nm³)	TOC (mg/Nm³)	SO_2 (mg/Nm³)	HCl (mg/Nm³)	HF (mg/Nm³)	Hg (mg/Nm³)	Cd+Ti (mg/Nm³)	Sb,As,Pb,Cr,Co,Cu,Mg,Ni,V (mg/Nm³)	Dioxin and Furans (ng/Nm³)
Without co-incineration	2,4	641,2	831,7	13,2	0,8	0,6	0,55				
With co-incineration	1,6	771,4	687,5	10,0	0,7	0,3	0,32	0,001[1]	0,0003[1]	0,0088[1]	0,0013[1]
								0,0022[2]	0,0017[2]	0,0413[2]	0,0012[2]
								0,0015[3]	0,0041[3]	0,0172[3]	0,00067[3]

UK Summary of result of Meat and Bone Meat Trial

MBM was trialled at a federate of up to 20%thermal substitution (displacing coal and petroleum coke)

Plant B Kiln 1	Dust (mg/Nm³)	CO (mg/Nm³)	NO_x (mg/Nm³)	TOC (mg/Nm³)	SO_2 (mg/Nm³)	HCl (mg/Nm³)	HF (mg/Nm³)	Hg (mg/Nm³)	Cd+Ti (mg/Nm³)	Sb,As,Pb,Cr,Co,Cu,Mg,Ni,V (mg/Nm³)
Without co-incineration of MBM (tyres feed rate 3428 kg/hr)	1,4	341,6	398,9	16,4	25,9	2,1	0,3	0,005	0,001	0,04
With co-incineration of MBM (tyres feed rate 2182 kg/hr MBM feed rate 2536 kg/hr)	5,5	818,9	363,8	7,6	7,2	0,6	0,4	0,008	0,002	0,04

1 Animal raw meals and tyres
2 Tyres
3 Animal raw meals

2.2.2 Use of waste as raw material

Wastes used as raw materials in clinker production allow the cement industry to make a direct saving of natural raw materials. However, the chemical suitability of wastes used as raw materials is important and they have to provide the constituents required for the production of clinker. Primary desired chemical elements are lime, silica, alumina and iron as well as sulphur, alkalis and others which can be classified into different groups according to their chemical composition. The use of wastes as raw materials as in the clinker burning process involves the substitution of the oxides contained in the wastes used as raw materials. These include calcium oxide (CaO), silica (SiO_2), alumina (Al_2O_3) or iron oxide (Fe_2O_3) for the respective raw material constituents. Power station ash (fly ash), blast furnace slag, and other process residues can be used as partial replacements for the natural raw materials.

Other waste materials are supplied as so-called ‘inter-ground’ additives to the grinding plants or cement blending plants. Fly ash can be used both as raw material in the production of clinker (mainly for its content of alumina) and as an inter-ground additive for cement. Fly ash can replace up to 50 % of the Portland cement clinker. Furthermore, suitable industry by-product gypsum lends itself for use as a sulphate component.

Like ash from conventional fuels, the ash from waste fuels provides mineral components for the cement clinker. During the preheating phase in the preheater, organic components may be released from the kiln feed, because of lower temperatures, which is not always enough to decompose halogenated organic substances. When processing these waste raw materials, these must be checked for potential emissions of volatile organic constituents and the feed point selected accordingly, i.e. kiln burner. Spent foundry sand, for example, should normally be fed to the kiln inlet. The residual organic binder used in chemically bonded sand cast systems can be decomposed in the preheater. Pretreatment of spent foundry sand, such as separation of dust, can reduce the content of heavy metals. By using industry gypsum and fly ash, the feeding of gypsum takes place in the blending plant. The recoverable calorific value of carbon rich ash, i.e. up to 20 % of carbon is possible, can be used in the cement clinker process.

Organic content of wastes used as raw materials

In a cement plant where clinker is produced with a dry process and the kiln gases are employed to dry the raw meal, some quantity of swarfs from slabs, made of an aggregate of marble granulate and resin, employed as a substitute of marble, was grounded in the raw meal mill along with other inorganic wastes.

The hot gases produced the pyrolysis of the resin, made of organic polymers, and the volatile products were emitted in atmosphere. Their disgusting odour created discomfort to the inhabitants of the town, who protested by the authority.

Lesson learned:

1 - When wastes with a certain organic content, or that could emit volatiles organic compounds when heated, are employed as secondary raw materials, they have to be fed to a point of the plant where the volatiles compounds can be burned in a safe way, e.g. to the precalciner. If it is necessary, they have to be milled apart from the stream of raw materials.

2 – On the other hand, secondary raw material can be employed along with ordinary inorganic raw material (marle, clay, limestone) if their organic content is less or equal 3%.

Mercury in wastes used as raw materials

Concerning the application of secondary raw materials, one of the important issues has to be the level of Mercury input. Mercury derives in particular from surcharge materials. e.g., the gypsum originated from the reduction process of SO_2 in the exhaust gas of a power station. This gypsum often contains high mercury salary.

If one uses this gypsum as a raw material in the rotary kiln from cement work, this can raise the level of mercury above the allowed limit value of 0.05 mg / m^3 (EU Directive in 2000/76). Therefore, it has-+

3 to be checked whether gypsums can be supplied to the clinker process.

The same is valid for lime mud from the chemical industry when it has to be supplied in the cement process as a secondary.

2.3 Energy consumption

Cement industry is an energy intensive industry where energy typically accounts for about 40% of operational costs.

The mean energy consumption of the plants analysed show a value higher than what can be reached by application of BATs (2900 – 3300 Mj/ton clinker according to BREF) also for the less energy consuming process, that is the dry process.

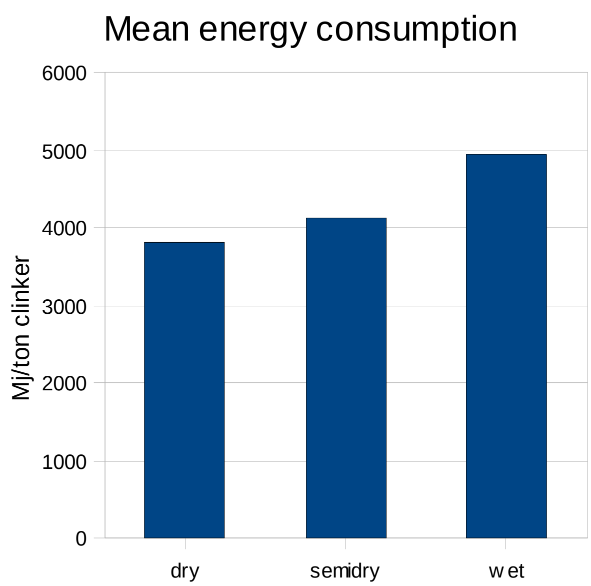

Fig. 7 – Mean energy consumpion of INSPECTCEM plants

The graph confirms the higher amount of energy required for the wet processes. The most economical in terms of energy consumption is the dry process. Nevertheless wet or semiwet processes are still present, especially in the north of Europe, due the higher humidity of the raw material.

The production of cement involves four steps:

- Preparation of a material mixture
- Thermal formation of clinker in the cement kiln
- Clinker cooling
- Grinding and mixing with additives to the cement quality required

As it is shown by the plant layout in the Fig.8, the main components of a plant for dry process are the preheater, calciner (new plants or new updated plants), rotary kiln and clinker cooler.

The conversion of the raw materials into clinker involves various processes at the following temperature ranges:

below 550℃:	Preheating, drying and dehydration;
550 to 900℃	Decarbonisation of $CaCO_3$ into CaO a nd CO_2; Decarbonisation is an endothermic reaction. A flue gas temperature exceeding 1000℃ is req uired.
900 to 1300℃:	First recrystallisation or calcina tion reactions
1300 to 1450℃:	Sintering is an endothermic react ion. A flame temperature of 1800℃ is required

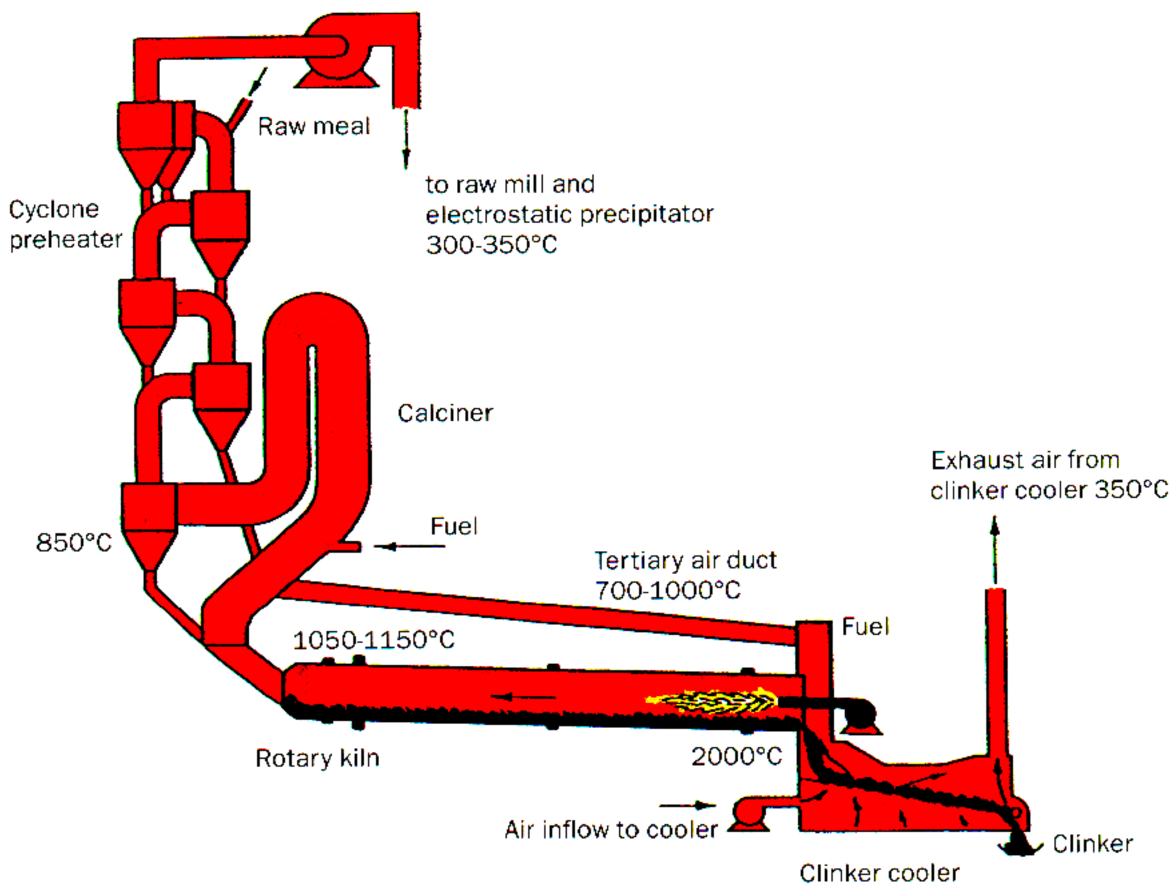

Fig. 8 – Typical dry process cycle scheme

In a typical dry process, preheating and decarbonisation take place in a series of cyclones. The dry material enters at the top of the upper cyclone and moves downwards through the cascade into the furnace. The hot flue gases from the kiln flow counter-currently. The cyclones provide a good heat and mass transfer, thereby enhancing the energy efficiency and flue gas cleaning.

Fuel energy is used in cement production mostly to burn the cement clinker. Electrical energy is used principally to drive the extensive grinding equipment and to operate the kiln systems.

There are some energy saving and energy recovery techniques for the main process in the cement industry, principally for the clinker burning process.

Heat recovery takes place by preheating the combustion air in the cooler while at same time cooling the clinker, by using the exhaust gas energy after the rotary kiln for calcining and preheating the raw meal in the calciner and preheater.

In the burning process in the rotary kiln sufficiently high material temperatures of ~ 1450 ℃ have to be reached for conversion of the clinker phases. In practise, fuels with an average net calorific value of at least 20 – 25 MJ/kg are normally used in a main firing system. Preheating the air to 950 ℃ or more is therefore a very effective measure for recovering heat and reducing energy expenditure.

In the calciner the temperature of the kiln exhaust gas falls from about 1200 ℃ to the calciner temperature of about 850 ℃ (equilibrium temperature). To maintain to the endothermic calcination reaction at this relatively low temperature level, compared with the burning process, it is also possible to use here fuels of lower calorific value.

When substituting normal fuels by replacement fuels (waste materials), the first question which usually occurs relates to effect of the replacement fuels on the process conditions of the particular process. Particular attention has to be paid to the effects of using replacement fuels on process temperatures, exhaust gas masses, harmful substances and their levels, and specific energy expenditure, or efficiency for energy. Only then it is possible to discuss the possibilities of optimizing the process regime, e.g. recovery or by interconnected operation, for the conditions which have been altered by the substitution. The evaluation of a fuel is therefore depended not only on the nature of the fuel itself but to a considerable extent also on the mode of operation of the plant and on the heat recovery.

The fuel can be fed to the kiln at the following points:

- Via the main burner;
- At the transition chamber at the rotary kiln inlet via a feed chute (large pieces of fuel);
- At the riser pipe via secondary fuel burners;
- At the precalciner via precalciner burners;
- At the precalciner via a feed chute (large pieces of fuel);

Part of the installations is equipped with a bypass and a bypass stack. A bypass is necessary when the chlorine content in the feed (raw material and fuel) is high. The presence of chlorine is a critical factor in the thermal process. Chlorine may react with calcium, giving $CaCl_2$ that ends up in the clinker. However, most of it binds to sodium or potassium which leads to the formation of NaCl and KCl respectively. These latter salts sublimate in the calcination zone and recrystallise in the decarbonisation zone, which results in an internal chloride cycle. As the chloride concentration rises, salt crusts may precipitate in the installation. This may lead to blockages, for example on the cyclone pipes, resulting in a kiln shutdown.

The bypass is installed in the zone where the salt accumulation occurs. Part of the flue gas is removed here. Before emission the gas is dedusted by an electro precipitator or bag filter.

A third stack emits the air used for rapid cooling of the clinker. The gas is dedusted before emission into the atmosphere. This heated air may also be used as combustion air, which gives a more energy-efficient process.

In general the following energy information in the application is important

- total energy balance
- assessment of energy efficiency
- energy consumption
- energy saving plan
- description on energy use

3. DOING ENVIRONMENTAL INSPECTIONS

3.1 Planning: what and when?

Planning inspections is an important aspect of the regulatory system, fixed also by the RMCEI; a correct planning and preparation of environmental inspections allows to face efficiently all critical aspects due to the presence of cement production plants, besides it helps to maintain a high degree of survey on compliance maintenance of enterprises.

The different territorial context influence in decisive way the type of planning and more effective programming. The analysis leaded during the project on participant member States, taking into account all the burden of inspections standing on environmental control bodies, has put in evidence two different territorial and organizational scenarios, where is possible to remark structural differences connected to the type and number of plants in the territory (all types, not only cement production sites), to the type of organization of the control authority and to operating procedures of execution applied for environmental inspections

Main differences between these situations are:

Site approach	Areal approach
Few and bigger plants	Many and smaller plants
Low territorial diffusion	High density areas
National planning and organization Specialized inspectors working mostly on single plants	regional/local planning and organization Non-specialized inspectors working in areal diffusion organization

Site approach allows higher frequency of control activities, deepening of specific topics and a collaborative relationship with the company; in this context the compliance is quite simple to assure and integrated approach is more facilitated. Nevertheless there can be difficulties tied to the insufficient possibility of comparison between similar situations or in the identification of solutions to specific problems for lack of national case-histories sufficiently complete.

The areal approach on the other hand, does not lead to highly deep inspections because of the insufficient frequency of controls due to a greater number of plants and lower possibility of specialization of the inspectors. The presence of areas with elevated concentration of plants, thus, helps to find easily solutions to common problems with similar adoptions.

A good strategy of control has to point to a good level of specialization by a correct planning and frequency of inspections, and also by using correctly and effectively the human resources in order to improve single inspector's skills.

If not already adopted, an effective risk assessment method can help to fix appropriate frequencies to inspection taking into account priority criteria and resources at disposal for the inspections. General criteria can be found in IMPEL reports on ERA (f.e. Compliance indicators, operation performance, complexity, location...); considering cement plants, proper criteria can be adopted and they must consider:

Item	**Lower rate**	**Higher rate**
Complexity	Dry process with pre-calcination	Wet process
	New plant	Aged plant
Location	Single plant	High density plant area
	Isolated plant	Urban area in the nearby (1-2 km)
	Local quarry	Far from quarries
Emissions	SNCR-SCR DeNOx system	No DeNox abatment
	Only natural raw materials	Use of waste as fuel

It can be helpful also to create a net for the exchange of experience between inspectors and to define and use tools that helps to perform precise and homogeneous inspections.

3.2 Site visit

An effective inspection starts from an accurate program, both as regards office preparation and site visit organization. Many useful and effective information can be achieved in 'IMPEL Reference book for Environmental Inspection', these guide-lines propose elements and tools that give specific application to that report (exp. Chapters 5, 9 and 10), aimed to environmental inspections on cement production plants.

1. It's necessary to verify the presence and, eventually, collect every information and document useful to perform a complete site visit:

- environmental integrated permit;
- other environmental permits;
- annual reports of self-monitoring;

- old inspection reports.

2 a preliminary analysis for identification of critical aspects and supplies of the installation can result helpful for the inspector to create a site-specific plant analysis that consider all the environmental issue that has to be inspected referring to specific technological solutions adopted and single vulnerable aspects of the surrounding.

An helpful tool to conduct this analysis is Table 3.1 below, that indicates a general definition of environmental issues affected by single production cycle phases; inspector can complete single cells with a description of critical aspects related to technology or surrounding;

Table 3.1 - Environmental aspects of cement production process

		AIR EMISSIONS	WATER DISCHARGE	WASTE USE	NOISE	ODOUR
RAW MATERIALS, FUELS, WASTES	arrival	X	X	X	X	
	storage raw materials	X	X			
	storage solid fuels	X	X			
	storage liquid fuels	X	X			
	storage wastes	X	X	X		X
	Storage alternative fuels	X	X	X		X
RAW MEAL AND FUEL PREPARATION	Grinding raw materials	X			X	
	Grinding fuel	X			X	X
	Raw meal storage	X				
CLINKER PRODUCTION	Pre-heating liquid fuels	X				
	Pre-calcination	X		X		
	kiln	X		X		
	Clinker cooling	X				
	Air abatment plant	X				
	Clinker storage	X				

CEMENT PRODUCTION	Clinker grinding	**X**			**X**	
	Additives miscelation	**X**				
	Cement storage	**X**				
PACKAGING AND DISPATCH	packaging	**X**	**X**		**X**	
	Dispatch	**X**	**X**			

3. on the basis of table 3.1 results (or, in general, results of activity at point 2) single inspector, or leader of the inspecting team, has to identify specific control activities needed to face every issue treated in preliminary analysis and to personalize inspection tools (see control forms intable 3.2)

4. leader inspector has finally to define a precise inspection program, considering all the activities indicated during point 3. identification, and completing it with informations about: name and skills of inspectors involved in the inspection, time and scheduled duration of inspection activities, specific sampling and analysis needed.

The following table represents a good starting point for the inspectors to individuate minimum aspects to be checked during on-site visit; the structure of the table allows to use it as an inspection tool, to perform and check all control items but also to write down any findings and results.

Table 3.2 - Control activities forms

	env. issue	**check-point**	**control activity**		**specific documents/ parameters**
RAW MATERIALS, FUELS, WASTES					
	production process	liquid fuel storages	Is heating system regularly maintained? Is there a temperature remote control? Do operators follow a specific procedures to manage the		

			storage use (charging, discharging, maintain)?		
	air emissions	emissions from transport	which kind of transport are used by plants? Is there a control on external societies who transport raw materials to the plant?		
		diffused emissions from open-field storages	Are they protected from predominant wind? Is there a system to keep the materials wet?		
		emissions from storage systems	are there conveyed dust emissions? Which kind of abatement is used?	--> air treatment plant controls	
	water discharge	collected water from open-field storages	Is the storage area impermeabilization kept in good conditions? Is the rainfall water of storage area collected and treated before discharge? Which kind of WWT is the plant using?	--> WWT plant controls	
		Liquid fuels storage	Is the containing basin in good conditions?		
		Fire protection water	Is there a by-pass system for water collected from plant area? Does it allow to collect in a separate basin polluted water in case of emergency situation?		
		Washing trucks wheels	Is water coming from washing of truck wheels correctly collected and treated?	--> WWT plant controls	
	consumption of wastes	arrival and storage of wastes	Are there present procedures to regulate acceptation of wastes taken to the plant after checking their compliance to cement use? Are storage areas correctly separated for each kind of waste?		Transportation documents of wastes, chemical analysis

	noise	conveyor belts for raw materials and fuels	are conveyor belt covered? Are conveyor belt engines complete of a silencing system?		
		Transportatio n	Transportation period is correctly defined in order to avoid disturbing noise?		
	Odour	Bone meal storages	Is the air coming from this storage correctly treated or taken to the kiln as combustion air?		
RAW MEAL AND FUEL PREPARATION					
	Production process	Raw materials composition	Do the operator keep a system to control raw materials composition?		Chlorides, sulfides concentration, heavy metals, VOC
		Cyclon pre-heater	Can raw meal composition and temperature profile lead to stripping of organic compounds in the cyclone pre heater?		
		Mills	which kind of mill are used?	--> BAT for milling process	
	air emissions	emissions from raw meal mill	Is raw mill meals air conveyed to a single stack? Is it used a correct abatement plant?	--> air treatment plant controls	
		emissions from solid fuel mill	Is it present a system to prevent or control the presence of potentially explosive atmospheres?		
		emissions from alternative fuel preparation	Is it present any waste preparation process, before using them as secondary fuel?		
		diffused emissions	Do operator apply proper procedures to avoid diffused emissions from raw meal and coal milling?		
	Noise	Mills	Are mills in a closed building? Are there proper noise mitigation supplies?		
	Odor	Alternative fuel preparation	Is it present and correctly maintained any equipment to prevent odor release?		

CLINKER PRODUCTION					
	production process	Fuel feed	Is the solid fuel feed system precise and stable? Is It regularly calibrated and maintained?	--->BAT compliance	Fuel feed flow
		Kiln Shut down and start-up	Is the operational procedure for shut-down well applied?		
		Waste use as fuel	Is there a quality assurance control system with registration for single type and supplier of waste? Are alternative fuel used in a proper size and state (powder, liquid, small size pieces...)? Is waste feed under continuous measurement and control?	→ see 2.2	Waste feed flow
	air emissions	Dry process: pre-heating, calcination and kiln	Are operational procedures present and applied? Do operators knows and use these procedures? Are critical parameters under control, both in normal and in emergency conditions? Is secondary fuel feed controlled automatically and linked to calcination temperature?		Pre-heating and calcinator temperatures, raw meal feed, primary and secondary fuel feed, kiln temperature profiles,
		Semi-dry and Wet process: kiln	Are operational procedures present and applied? Do operators knows and use these procedures? Are critical parameters under control, both in normal and in anomalous conditions?	--> air treatment plant controls	
		Air treatment – Electrostatic Precipitator	Is there an automatic alarm and shut-down system linked to CO concentration in kiln? Is there a simple by-pass in case of emergency shut down? In this case is important to minimize this occurrence. Is electric current absorption and tension measured and surveyed by operators?		CO concentration in kiln, gas temperature in EP, electric current absorption (ampere) and tension (Volts)
		Air treatment –	Is the ammonia feed control		NH_3 flow, gas

		SNCR	automatic and linked to stack emission monitoring system? Is gas temperature measurement linked to ammonia feed system?		temperature, NH3 and NO_x concentration at stack
		Air treatment – Bag filters	Is there a continuous monitoring of gas pressure drop across the filter? Is there a single measurement point for each sector of the filter? Is it monitored the temperature of the off-gas flow? Is there an emergency shut-down system? Is the cleaning system regularly checked and maintained? Is there a preventive maintenance of bags? Do the operator keep a bag reserve in order to substitute immediately broken one?		Gas pressure drop (mmH2O); temperature;
CEMENT PRODUCTION					
	Production process	Waste used as raw materials	Is there a quality assurance control system with registration for single type and supplier of waste? Are wastes used in a proper size and point of the plant? Is waste feed under continuous measurement and control?	→ see 2.2	Waste feed flow
		Additives	Are additives under continuous measurement and control?		
	Air emissions	Clinker mill off-gas treatment and miscelation	Is there a proper abatement system?	--> air treatment plant controls	Specific emission parameters derived from additives
	Noise	Clinker mill	Are cement mills in a closed building? Are there proper noise mitigation supplies?		
PACKAGING AND DISPATCH					

	Air emissions	Diffused emissions from packaging and loading	Is there a proper aspiration system for each point of load and transfer of cement? Do operators apply specific operational procedures for loading cement on trucks?		
	Noise	Packaging plants	Are packaging plants in a closed building? Are there proper noise mitigation supplies?		

ANNEX 1 – TYPICAL EMISSIONS IN PLANTS PLACED IN PARTICIPANT COUNTRIES.

Example Denmark 2008

Cement Plant Data	A		B		C		D		E		F		G	
Process/kiln	Semiwet, precalciner and main firing system		Wet, only main firing system		Wet, only main firing system		Wet, only main firing system		Wet, only main firing system		Wet, only main firing system		Wet, only main firing system	
Capacity in t/d	4800		1650		410		410		675		510		510	
NOx - Reduction	SNCR		SNCR		Mixing Air *1		Mixing Air *1		Mixing Air *1		Mixing Air *1		Mixing Air *1	
SO2 - Reduction	None		None		Wet Scrubber		Wet Scrubber		Wet Scrubber		Wet Scrubber		Wet Scrubber	
Dust – Reduction	Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator	
Part of secondary fuel until	22 % *2		0 % *2		8 % *2		8 % *2		0 % *2		8 % *2		8 % *2	
Waste gas elements [mg/m^3]	Permit limits	Emission levels ***	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels
Dust *3	30	11	50	25	30	< 9	30	< 9	50	< 4	30	< 8	30	< 8
Nitrogen oxide (NOx) *3	800	< 545	800	< 701	800	< 455	800	< 455	800	< 634	800	< 309	800	< 309
Sulphor dioxide (SO_2) *3	10	No ata	500	< 227	500	< 189	500	< 189	500	< 149	10	< 204	500	< 204
Total organic compounts (C) *3	10	< 2	10	No data	10	< 3	10	< 3	NoELV	No data	10	< 3	10	< 3
Inorganic gaseous clorine (HCl) *3	10	< 4	10	< 9	10	< 5,8	10	< 5,8	No ELV	< 3	10	< 4	10	< 4
Inorganic gaseous fluorine (HF) *3	1	< 0,4	1	0,5	1	< 1	1	< 1	No ELV	< 0,13	1	< 0,4	1	< 0,4
Mercury (Hg) *4	0,05	0,0027	0,05	0,0061	0,05	0,00084	0,05	0,00084	No ELV	No data	0,05	0,0012	0,05	0,0012
Σ Cadmium (Cd), **Thallium** (Tl) *4	0,05	0,00028	0,05	0,0005	0,05	0,0062	0,05	0,0062	No ELV	No data	0,05	0,00054	0,05	0,00054
Σ Arsenic (As), Cadmium (Cd), **Cobalt** (Co), **Chromium (Cr)** *4 **Σ Antimony (Sb), Lead** (Pb), **Chromium** (Cr), **Cobalt** (Co), **Copper** (Cu), **Manganese** (Mg), **Nickel** (Ni), **Vanadium** (V), **Tin** (Sn) *4	0,5	< 0,01	0,5	< 0,01	0,5	0,19	0,5	0,19	No ELV	No data	0,5	< 0,02	0,5	< 0,02
PCDD / PCDF ng/m^3 *5	0,1	< 0,0007	0,1	0,0063	0,1	0,0058	0,1	0,0058	No ELV	No data	0,1	0,0027	0,1	0,0027

*1 The Mixing Air technology is not described in the BREF. More info can be found on website: http://www.cadencerecycling.com/pages/MixingTechnology.html
*2 Percentage of the burning value
*3 Automated Measurement Daily Average Value
*4 Spot measurement for at least half an hour
*5 Spot measurement for 6-8 hours

Example Poland 2008

Cement Plant Data	A		B		C		D		E	
Process/kiln	Dry method, 1 rotary kiln, 4-degrees heat-exchanger with calciner ILC, grate cooler		Dry method, 2 rotary kilns, 3-degrees heat-exchanger with „quasi" precalciner		Dry method, rotary kiln No. 1 and No. 2, cyclone exchanger		Dry method, rotary kiln no. 3, cyclone exchanger		Wet metod, 2 rotary kiln	
Capacity in t/d	8500[1]/8307[2] t/d		2 x 2 100		4200		1700		2x385	
NOx - Reduction	N/A		Low NO_x burner, staged combustion		N/A		N/A		SNCR	
SO2 - Reduction	N/A		N/A		N/A		N/A		N/A	
Dust - Reduction	Elekrtrostatic precipitator		Kiln No. 1, No. 2 - elekrtrostatic precipitator Kiln No. 2 – 2 bag filters		bag filters		bag filters		bag filters	
Part of secondary fuel until	6.9%		13,68%		47%		22%		22%	
Waste gas elements [mg/m³]	Permit limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels
Dust	30	10,13	30	0,5 – 27	30	9,5	30	3,2	30	7,1
Nitrogen oxide (NOx)	800	520,69	800	100 – 590	800	383	800	581	800	530,4
Sulphor dioxide (SO_2)	50 [3]	122,68	50 [3]	10 – 470	50 [3]	230	50 [3]	304	50 [3]	691,1
Total organic compounds (C)	10 [4]	29,04	10 [4]	18 – 160	10 [4]	2,5	10 [4]	1,8	10 [4]	6,2
Inorganic gaseous clorine(HCl)	10	2,92	10	0,6 – 2,2	10	1	10	0,7	10	9,275
Inorganic gaseous fluorine (HF)	1	0,47	1	0,04-0,39	1	0,13	1	0,26	1	0,06
Mercury* (Hg)	0,05	0,015	0,05	0,0002-0,036	0,05	0,009	0,05	0,026	0,05	0,00252
Σ Cadmium (Cd)**, Thallium**(Tl)	0,05	0,0016	0,05		0,05	0,005	0,05	pwm	0,05	0,0119
Σ Arsenic (As), Cadmium (Cd)**, Cobalt** (Co)**, Chromium (Cr)**	--	0,0112	---	,001 – 0,021	---	0,08	---	0,009	---	0,0101
Σ Antimony (Sb**), Lead** (Pb)**, Chromium** (Cr)**, Cobalt** (Co)**, Copper** (Cu)**, Manganese** (Mg)**, Nickel** (Ni)**, Vanadium** (V)**, Tin** (Sn)	0,5	0,0234	0,5	0,017 – 0,38	0,5	0,015	0,5	0,002	0,5	0,03614
PCDD / PCDF ng/m³	0,1	0,0348	0,1	0,002 – 0,026	0,1	…	0,1	…	0,1	0,02133

1) –max. capacity
2) –capacity in year 2008
3) – it is not used because the substance did not appear in the results of the burned waste
4) - it is not used because the substance did not appear in the results of the burned waste

Example Portugal 2007

Cement Plant Data	A		B				C		E			
	Kiln 3		Kiln 1		Kiln 2		Kiln 2		Kiln 1		Kiln 2	
Process/kiln	Precalciner		Multi-stage pre-heater		Multi-stage pre-heater		Precalciner		Multi-stage pre-heater		Multi-stage pre-heater	
Capacity in t/d	4250		1400		1400		1400		2300		3500	
NOx - Reduction	Low NOx burner Staged combustion		Low NOx burner		Low NOx burner		Low NOx burner, Staged combustion		Low NOx burner, SNCR		Low NOx burner SNCR	
SO2 - Reduction	Absorvent injection (CaOH Natural Hydraulic Lime)		-		-		-		-		-	
Dust - Reduction	Wooven Glass Baghouse filters		Fabric filters		Fabric filters		Fabric filters,		Fabric filters, Electrostatic precipitator		Fabric filters, Electrostatic precipitator	
Part of secondary fuel until	20%		25% (tyres) (Wihout vegetable wastes)		25% (tyres) (Wihout vegetable wastes)		50%		89% ***		89% ***	
Waste gas elements [mg/Nm^3]	**Permit limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**
Dust	30	1,5	30	6,1	30	10,2	20	1,6	20	1,5	20	0,3
CO	1000	647,1	no limit	882,3	no limit	872,3	1000	771,4	1000	486	1000	607
Nitrogen oxide(NO_2)	800	502,6	800	560,0	800	581,9	800	687,5	800	334	800	268
Total organic compounds (COT)	39	25,6	44	33,7	44	34,1	36	10,0	35	13	35	16
Sulphor dioxide (SO_2)	305	261,4	346	184,7	346	141,8	276	0,7	290	8	290	12
Inorganic gaseous clorine (HCl)	10	0,9	10	1,1	10	0,4	10	0,3	10	1	10	1
Inorganic gaseous fluorine (HF)	1	0,0	1	0,04	1	0,14	1	0,32	1	0,01	1	0,01
Mercury (Hg)	0,05	0,0001	0,05	<0,0001	0,05	<0,0001	0,05	0,0018	0,05	0,005	0,05	0,0006
Σ Cadmium (Cd)**, Thallium** (Tl)	0,05	<0,0003	0,05	0,0005	0,05	0,0013	0,05	0,0007	0,05	0,001	0,05	0,0004
Σ Antimony (Sb**), Arsenic (As), Lead** (Pb)**, Chromium (Cr), Cobalt** (Co)**, Copper** (Cu), **Manganese** (Mn)**, Nickel** (Ni)**, Vanadium** (V)**,**	0,5	<0,0044	0,5	0,011	0,5	0,040	0,5	0,031	0,5	0,016	0,5	0,016
PCDD / PCDF ng/m^3	0,1	<0,0009	0,1	0,0013	0,1	0,0030	0,1	0,0015	0,1	0,04	0,1	0,0014

Example UK 2008 (1/2)

Cement Plant Data	1		2		5				6				13	
Process/kiln	Dry process. Pre-heater SP4 kiln and planetary clinker cooling		Dry process. Pre-calciner AS-SP4 kiln and grate clinker cooling		Dry process. Two preheater SP4 kilns. Single Stack.				Wet process. Two wet kilns with grate clinker cooler. Single stack.				Dry process. One SP4 pre-calciner kiln with grate clinker cooler	
Capacity in '000 tpa	500		1000		1300				765				800	
NOx - Reduction	SNCR - NH_3		SNCR - NH_3		SNCR - NH_3				SNCR - urea				-	
SO2 - Reduction	-		-		-				-					
Dust - Reduction	Bag filters for kiln		ESP for kiln Bag filters clinker cooler		Bag filters for kiln. ESP clinker cooler.				Refurbished ESPs for kiln				Bag filters for kiln. and clinker cooler.	
Part of secondary fuel until	MBM 22%		PSP 45% Chiped Tyes 40% RFO 30% SRF (trial) 25%		Tyres 23% MBM (trial) 25%				Tyres 24%				Tyres 50% MBM (trial) 20%	
Waste gas elements [mg/m³]	**Permit limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**
Dust	30	11	30	7	30	7	30	6	30	10	30	13	30	2
Nitrogen oxide (NOx)	1200	1113	800	579	800	697	800	689	1200	957	1200	989	500	382
Sulphor dioxide (SO_2)	800	339	750	39	1760	742	1760	781	1000	675	1000	532	220	3
Carbon monoxide (CO)	1000	591	2200	1432	3000	1144	3000	1220	700	274	700	291	4000	413

MBM – Meat and Bone Meal, PSP – Processed Sewage Pellets, SLF – Secondary Liquid Fuel (includes Cemfuel), SRF - Solid Recovered Fuels (includes Climafuel and Profuel), RFO – Recovered Fuel Oil

Example UK 2008 (2/2)

Cement Plant Data	10		11		12		9		7				8	
Process/kiln	Wet process. One wet kiln with planetary cooler		Dry process. One SP2 pre-calciner kiln with grate clinker cooler		Semi-dry process. Two semi-dry kiln with grate clinker coolers		Dry process. One SP5 pre-calciner kiln with grate clinker cooler		Dry process. SP4 pre-heater kiln with planetaruyclinker cooler		Dry process. SP4 AS pre-heater kiln with grate clinker cooler		Dry process. One SP4 pre-calciner kiln with grate clinker cooler	
Capacity in '000 tpa	300		1500		700		800		1400				750	
NOx - Reduction	-		-		SNCR - urea		SNCR - NH_3		SNCR - NH_3				-	
SO2 - Reduction	-		-		-				-					
Dust - Reduction	ESP for kiln		Bag filters for kiln and clinker cooler		ESP for kiln.		Bag filters for kiln		ESPs for kilns and clinker coolers.				ESP and Wet Scrubber for kiln. Cooler exhaust reheats stack gases.	
Part of secondary fuel until	SLF 40% Climafuel 20%		Chipped Tyres 40% Climafuel (trial) 30%		SLF 40% Climafuel 30%		Cemfuel 40% Profuel 55% Chipped Tyres 25% SRF (trial) 68% MBM (trial) 84%		Cemfuel 40% Profuel 40% Whole Tyres 25% MBM 40%				Cemfuel 40% Chipped Tyres 25% MB; 60%	
Waste gas elements [mg/m³]	**Permit limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**	**Permit Limits**	**Emission levels**
Dust	30	11	30	3	30	18	30	2	10	8	30	14	30	2
Nitrogen oxide (NOx)	1200	763	800	493	1200	663	500	407	800	400	800	400	800	573
Sulphor dioxide (SO_2)	2300	150	250	5	1750	642	200	48	200	10	200	10	220	69
Carbon monoxide (CO)	150	32	600 hourly	83	700	309	1200	625	1650	400	1650	400	3000	1004

MBM – Meat and Bone Meal, PSP – Processed Sewage Pellets, SLF – Secondary Liquid Fuel (includes Cemfuel), SRF - Solid Recovered Fuels (includes Climafuel and Profuel), RFO – Recovered Fuel Oil

Example Germany 2008

Cement Plant Data	A		B		C		D		E	
Process/kiln	Dry process. Cyclon pre heater and precalciner firing system		Dry process. Cyclon pre heater and secondary firing sytem		Dry process. Cyclon pre heater only main firing system		Dry process. Cyclon pre heater and secondary firing sytem		Dry process. Cyclon pre heater and precalciner firing system	
Capacity in t/d	3700		3500		1400		3500		1500	
NOx - Reduction	Low NOx burner, Staged combustion		Low NOx burner, SNCR		Low NOx burner		Low NOx burner, SNCR		Low NOx burner, Staged combustion	
SO2 - Reduction			Calciumhydroxide Injection in the exaust gas path				Calciumhydroxide Injection in the exaust gas path			
Dust - Reduction	Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator		Electrostatic precipitator	
Part of secondary fuel until	75%		90%		60%		80%		60%	
Waste gas elements [mg/m^3]	Permit limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels
Dust	13	3	11	5	12	3	12	7	20	7
Nitrogen oxide (NOx)	275	250	350	300	500	500	350	340	500	330
Sulphor dioxide (SO_2)	350	110	350	180	350	200	350	270	350	50
Total organic compounts (C)	20	15	20	20	20	20	20	25	20	7
Inorganic gaseous clorine (HCl)	10	4	10	7	10	8	10	6	10	7
Inorganic gaseous fluorine (HF)	1	< 0,1	1	< 0,1	1	< 0,1	1	< 0,1	1	< 0,1
Mercury (Hg)	0,03	0,01	0,03	0,01	0,03	0,01	0,03	0,01	0,03	0,01
Σ Cadmium (Cd), **Thallium** (Tl)	0,02	< 0,005	0,05	< 0,005	0,05	< 0,005	0,05	< 0,005	0,02	<0,005
Σ Arsenic (As), Cadmium (Cd), **Cobalt** (Co), **Chromium (Cr)**	0,05	< 0,001	0.05	<0,001	0,05	< 0,001	0,05	< 0,001	0,05	< 0,001
Σ Antimony (Sb), **Lead** (Pb), **Chromium** (Cr), **Cobalt** (Co), **Copper** (Cu), **Manganese** (Mg), **Nickel** (Ni), **Vanadium** (V), **Tin** (Sn)	0,5	< 0,05	0,5	< 0,05	0,5	< 0,05	0,5	< 0,05	0,5	< 0,05
PCDD / PCDF ng/m^3	0,05	< 0,0001	0,05	< 0,008	0,05	< 0,004	0,05	< 0,0005	0,05	< 0,0001

Example Italy 2008

Cement Plant Data	A		B		C		E (data 2007)			
Process/kiln	Dry process. 4 Cyclone pre heater		Dry process. 4 Cyclone pre heater		Semi-dry process. Long kiln		Semi-dry process. 2Lepol kilns			
Capacity in t/d	600		400		1200		470			
NOx - Reduction	SCR		Low NOx burner,		-					
SO2 - Reduction										
Dust - Reduction	Electrostatic precipitator		Electrostatic precipitator (substituted in 2009 with bag filter)		Electrostatic precipitator		Electrostatic precipitator			
Part of secondary fuel until	0		0		0		0			
Waste gas elements [mg/m³]	Permit limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels	Permit Limits	Emission levels
Dust	30	0,3	30	8	30	15	25	9	25	6
Nitrogen oxide (NOx)	1800	360	1800	1400	1800	700	1650	640	1650	760
Sulphor dioxide (SO_2)	400	3	400	15	400	200	400	8	400	23

ANNEX 2 - LEGISLATION AND ORGANIZATION

POLAND

In Poland there are 16 Regional Environmental Agencies which function on the same principle and 1 Main Environmental Agency in Warsaw who supervises their work.

Regional Environmental Agencies control firms, factories, and other businesses, including individual farmers.

Inspectors supervise in cases of sudden disasters or other events dangerous to the environment, measure emissions, take test samples, measure noise levels, radiation, dust in the air, river pollution. Monitoring of air and water is handled by monitoring branch.

The Polish Regional Environmental Agency does not release any permits. Permits are issued by the local government branch of the environment. The Polish Regional Environmental Agency is only responsible for controlling to ensure that conditions are met.

In the Polish Regional Environmental Agency there are different kinds of controls such as:

2 inspections according schedule

3 unscheduled inspections.

The specific types of inspections are:comprehensive environmental control (looks at everything as a whole);dealing with specific issues; dealing with residential complaints; inspections of the use of special measurement tools; inspections as regards market and packaging; inspections to give instruction (information); inspections as in case of a failure, breakdowns

During inspections the technical condition of equipment and their efficiency, the management style of the plant is checked alongside obedience to the environmental law. There are 15 inspectors in the Regional Environmental Agency for Swietokrzyskie Region (county). Regional environmental agencies have guidelines and inspectors prepare protocols according these. Procedures are available too for cement production plants, including timing methods and inspectors involved. The duration of inspection in a cement plant varies – usually from 1 to 10 days. Usually a cement plant is checked by one or two inspectors. Each inspector has a portable computer removing the need for hand-written reports. The head of the department is responsible for creating up annual and weakly control schedules. At present, a list of factories and guidelines for controlling them is being prepared by the head environmental agency.

ROMANY

In Romany National Environmental Guard (NEG) is a public institution for inspection and control and it functions as a body of the central public administration, with juridical status, completely financed from the central budget, under the subordination of the Ministry of Environment and Sustainable Development. The National Environmental Guard is managed by a General Commissar high-ranking state secretary, and by a Deputy General Commissar.

National Environmental Guard has under its subordination 41 county commissariats, the Commissariat of Bucharest City and the Commissariat of “Danube ’s Delta” Biosphere Reservation, institutions with juridical status.

UK

UK has Environmental Permitting Regulations, which implement the PPC Directive, Waste Incineration Directive, Public Participation Directive, Landfill Directive and Waste Management Regulations

- Environment Agency has a National Permitting Service, which handles preparation of permits
- Compliance / inspection is done by Area offices close to the sites
- ELV’s for waste-burning sites derived from Waste Incineration Directive
- BAT assessment as part of IPPC application / BAT review with new BREF

The Responsible authorities for inspections are: Environment Agency in England & Wales; Scottish Environment Protection Agency in Scotland; Department of Environment Northern Ireland – Accredited and certified EMS – Certification Bodies under UK Accreditation Service. The types of inspections are defined by a Compliance Assessment Plan (CAP), which is derived from the Environment Protection Operator Risk Appraisal (EPOPRA) score. This sets the number of compliance units available for each site and is a risk based approach to regulation.

Cement plants are inspected on average 2 to 3 times per year. Each site inspection results in a Compliance Assessment Report (CAR), which is either completed at the site or at the office after the visit – it identifies general observations / non-compliances / actions / timescales. Can be used as a formal site warning notice. This is publicly available

DENMARK

DK has Environmental Permitting Regulations, which implement the IPPC Directive, Waste Incineration Directive, Public Participation Directive, Landfill Directive and Waste Management Regulations

The Ministry of Environment has three Regional Environment Agencies, which both

handles preparation of permits for cement plants and inspections
For cement plants the competent authority is the government environment authority.
When using waste products as raw materials or fuels, emission limits have to – at least - comply with the emission limits given in the waste incineration directive.

Though, more strict emission levels based on BAT are implemented in the permit during IPPC revisions and when issuing new permits. Emission limits does not apply during start-ups and stops of the kilns. BAT emission limits are applied to the permit, but the use of technology is up to the plant to decide. Thus, the permitting system does not prescribe any specific technology.

The Responsible authorities for inspections is the same authority that gives the permits.

Inspections are normally conducted by 2 inspectors. Inspections are planned together with the plant, though inspections can be made without the knowledge of the plant. There are written manuals with guidelines on how to perform and plan the inspection.
Basic contents of the inspection report may include: date and purpose of the inspection; who was attending the inspection – from the company, the authority, others; when was the inspection noticed/planned; what background notes have been distributed prior to the inspection; what were the results from the inspection ; was there any breach of terms? If yes, what responses will be made?; If there are any follow-ups to be made based on the inspection, it is specified who (by name) is responsible for the follow-up; when (by date) the response should be given by the latest; who (name/authority/company/other) is the receiver of the follow-up

CROATIA

Ministry of Environmental Protection, Physical Planning and Construction (MEPPPC) has overall responsibility for environmental policy in Croatia, with the exception of water and nature protection as well as noise.
The Ministry's responsibility includes drafting of legislation regarding environment in general, air protection, waste management, emergency plans, protection of the maritime area, soil, quality of fuels, ozone depleting substances. It is also responsible for permitting, carrying out EIA and inspection.
MEPPPC coordinates cooperation in the field of environmental protection with other line state bodies such as the central state administration, state administration offices in the counties, units of local and regional self- government, the Croatian Environment Agency

and the Environmental Protection and Energy Efficiency Fund, as well as with industry and NGOs.

The Directorate for Inspection within MEPPPC, which consists of the head office and 20 branch units in the seats of counties, includes within its structure three inspections – environmental protection, urban planning and construction.

The Environmental inspection is responsible for compliance checking and enforcement of laws; its activities are planned on the basis of annual and monthly working plans, with the exception of site visits on an ad hoc basis and in cases of emergency.

The Environmental protection inspection within the head office is organized in the Department for inspection control of environmental protection, whose structure includes three sections: *Section for inspection control*, *Section for advancement of operation of branch units for inspection control of environmental protection* and *Section for international co-operation*. The advantage of such an organisation is in the possibility to link and coordinate the proceeding of all inspections in emergency interventions as well as in more efficient sanctioning of violators by simultaneous enforcement of several laws. Inspectors have the obligation and duty, as a priority capacity building and sector specialisation by certain branches and improving permanent in case of non-compliance, to undertake sanctions against the operator for offences or to press administrative and criminal charges. Inspectors have still a role in informing/advising as well as carrying out inspection.

The capacity of the inspection is going to be strengthened in order to provide a satisfactory degree of regulations implementation. MEPPPC has set coordination of the activities with inspections in other line bodies.

The Environmental inspection is strongly involved in the process of proposing and adopting new legislation as well as in pertaining in its implementation.

Environmental protection inspectors do not take samples, it is done through authorised laboratories.

BELGIUM

The Responsible authorities for inspections are Public Utilities of Wallonia General Directorate of Agriculture, Natural Resources and Environment Police and Inspections Department .

IPPC inspections (one inspection every three years) and inspections following a complaint. Every inspection is performed by 1 or 2 inspectors.

CYPRUS

In Cyprus the authorities responsible for implementation of the environmental legislation are the Department of Labour Inspection and the Environment Service.

The Department of Labour Inspection of the Ministry of Labour and Social Insurance is responsible for the implementation of the legislation on atmospheric pollution control, air quality and the management and control of chemicals.

The Environment Service of the Ministry of Agriculture, Natural Resources and Environment coordinates the programmes for the environment. It has the responsibility for environmental impact studies, the laws on the control of water and soil pollution, the waste management and the protection of nature.

The Department of Labour Inspection is responsible for issuing the environmental permit for cement plants that covers air emissions whilst the Environment Service is responsible for issuing the permit that covers releases to land and water.

The emission permits issued implement the IPPC Directive, Waste Incineration Directive, Public Participation Directive, Landfill Directive and Waste Management Regulations. Furthermore the provisions of the relevant BREF are taken into consideration.

The inspections for compliance with the emissions permit conditions are carried out by inspectors from the above authorities that check compliance with the corresponding permit. Inspections are unannounced except in special cases. The inspections are based on an inspection program issued at the beginning of the year. The Inspectors, for ease during the inspection use checklists based on the emission permit conditions. The Department of Labour Inspection also carries out air emission measurements to check compliance with emission limit values. At the end of each inspection or measurement a report is completed and filed. Following the inspection/measurement action is taken if and where necessary.

PORTUGAL

The competent authority for issuing the IPPC permit is the Portuguese Environmental Agency. The environmental permit is a detailed description of monitoring and reporting conditions. The proposal regarding the monitoring and reporting arrangements, is made by the permit authority, that collects data from operator, regional environmental authorities (CCDR) and from supervisory authority. The decision is made by the permit authority.

The emission limits are applied or calculated according to the Directive of Incineration and Co-incineration and actual BREF for the sector. Some limits will be redefined after the publication of the new BREF for Cement and Lime.

Concerning exercise conditions, there are no limits, ELV´s, concerning the start-up and shut-down of kiln, although there is no specific definition for those conditions. Concerning co-incinerations it is specified in the permits that: co-incineration has to be stopped if there is a malfunction of the treatment plant for air pollution or if the temperature is below 850ºC in the pre-heater or 1100ºC in the kiln burners or if the ELVs are above the limit for four consecutive hours or 60 hours during one year. Concerning a cement plant without co-incineration, authorities have to notified when a situation of ELVs above the limit during one day occurred, considering 30 % above the limit value for day average concentration, for parameters measured continuously.

It exist a reporting method "emergency situations" that are defined as technical failure of production equipment that can lead to a potential emergency situation; malfunction of monitoring or control equipment that can lead to losses from the abatement equipment; not programmed releases of pollutants to air/water/wastes due to human failure and/or external causes (natural or not), the operator has to notify authorities by fax in a maximum period of 24 hours and as to give information about the time and hour of the occurrence, the causes, the circumstances, the measures adopted to mitigate the consequences and avoid repetition of those facts. The authorities decide the actions that should be taken to control the situation and that may include a visit to the site (there is always an inspector that has to be available 24 h a day). In a two weeks time the operator has to make another report, more detailed and that has to include the corrective and preventive measures.

Responsible authorities for inspections

The inspections are carried out by central administration, by the General Inspectorate for the Environment and Spatial Planning. The authority responsible for supervision is the General Inspectorate for the Environment (IGAOT) and Spatial Planning, although inspections concerning particular subjects can be made by CCDR, municipalities and the National Republican Guard - GNR (Division of Environment).

Normally the inspections are carried out by two inspectors, and there is a specific report that has to be filled in and that covers the main aspects to be seen (permits, water, wastewater, air emissions, noise, complaints, new projects) although specific site conditions, particularly those set by the permit are also inspected. The time for an inspection is minimum 8 hours, and maximum 16 hours (not more than two days; usually we need two days when air emissions are measured). The central administration uses accredited laboratories for collection and analyse of samples of emissions to air and to the analyse of samples of wastewater, solid wastes. The monitoring of air emissions by authorities only occurred one time, for each installation, only for kilns.

The results of inspection include a report that is filled with the basic information:

Identification of operator; Production: Information concerning the installation, production capacity and real production, industrial process, main equipments and characteristics, industrial permit; Water: Sources of water, consumption of water, permits to use water; Wastewater: Origin and main characteristics of wastewater (quality and quantity), permit to discharge wastewater;   Waste: Origin and main characteristics of waste (quality and quantity), permit of the operators of waste used, documents for transportation and final destination; Noise: Monitoring of noise, outside of installation; Documentation: all permits and data that by law must be send to Permit Authorities; Complaints, treatment of complaints;

The Inspection report is send to the competent authority and to the operator.

If there is an infringement to the law, there will be one internal notice, the operator will be officially notified to defend himself, and the General Inspectorate will then decide if there is an application of a fine or the process will be closed. If there is a fine, the operator can pay, or else go to court of law.

For more harmful situations, with impact on the environment or health, there can be an additional notification for the operator to make sure he will correct or prevent a determined situation, in a certain period of time, to comply with legislation. If the operator doesn't comply, the process will be send to the Public Prosecutor.

The General Inspectorate for the Environment and Spatial Planning has a specific database, computerized, where reports and all other information concerning the reports are stored.

FRANCE

In France DRIRE is the Responsible authorities for inspections (regional directorates for industry, research and the environment). It is composed of About 1,500 inspectors (engineers, technicians) to check classified installations. Every cement plant is controlled an average of once a year. The results of the inspections are summarized in reports that contains penal and/or administrative sanctions and time for setting in conformity

LATVIA

In Latvia the State Environment Service is both responsible for the release of permits and for inspections. IPPC permits covers emission limitis and connction with use of waste, exercise conditions (start-up, emergency stop of the kiln..); prescriptions and application of BATs to different technologies. There are several types of inspections – integrated, thematic (e.g. implementation of the best available techniques, management of chemicals etc.), unplanned, follow up inspection. At least one integrated inspection per year is conducted in cement plant. For integrated inspection devote three days (including preparing etc., one or three inspectors make inspection) There is written manual for inspectors, that describes all steps of inspection. During inspections inspector fulfils inspection report.

The results of the insopection are summarized in the inspection report that contains a brief description of enterprise, review of reports about emissions to air and water, usage of chemicals and other important environmental impacts, information about changes of techniques etc. Also in inspection report is part for orders

ITALY

Italian IPPC law indicates Regional or Provincial governments as Competent bodies for emitting Integrated Environmental Permits; not all regions have released permits, as IPPC implementation is strongly late, so it's not completely defined how to apply specific emission limits and exercise conditions (expecially regarding transition phase); also in the application of BATs cometent authorities are trying to understand which criteria could be used to compare environmental performances of different technologies in order to apply specific prescription to update plants.

Italian laws define Regional Environmental Agencies as control authorities for IPPC cement production plants.

Some regional environmental agencies (Lombardia, Veneto, ..) are developing integrated inspections techniques for IPPC plants; Guide-lines, protocols and procedures are available for cement production plants, including timing methods and inspectors involved.

ANNEX 3 – FOCUS ON AIR EMISSIONS MONITORING AND SAMPLING

Periodic measurements and Continuous emissions monitoring.

There are many reasons to undertake emission measurements, e.g. collecting data to evaluate emissions factors, to assess process efficiency and process control, environmental impact and so on. In connection to IPPC Directive the main reason is to verify the compliance with the emission limit values (ELVs) stated in the permit.

This duty must be undertaken by the plant operator to supply the competent authority with the emissions monitoring results.

This can be accomplished by means of

- Periodic Measurements, campaigns carried out at time intervals, for example every three months, using instrumental analytical techniques which give immediately the results or sampling the pollutants and analysing them in a laboratory,
- by means of Continuous Emissions Monitoring Systems (CEM), with few if any gaps in data set produced. These system are also referred to as Automated Monitoring Systems (AMS).

The monitoring requirements, like the sampling methodology and the sample frequency collection, evaluation procedures and the communication procedure to the competent authority, are contained in the permit.

Stack emission measurements must be undertaken by the responsible authority during its inspections within the installations, in order to verify the compliance with the limits stated in the permit. In this case the monitoring is carried out by means of periodic measurements.

Calibrations and quality checks on AMS have the same requirements of periodic measurement.

Locating a sampling position in a duct.

Representative and undisturbed sampling section.

Most continuous and periodic measurements require the diverting a tiny stream of the stack gases into a device and there blocking a pollutant to be analyzed later in a chemical laboratory or measuring instrumentally its concentration.

So we can speak equivalently of "emission measurements or emission sampling"

Like all sampling activities, the sampled stream has to be representative of the overall gas flowing in the duct.

If the gas is homogenous a little number of samples have to be taken. If the gas emitted is not homogeneous a higher number of samples must be collected.

So uniformity in temperature, velocity and chemical composition must be searched, to avoid the effects of stratification of different fluid streams and swirling.

This requirement is even tight in sampling gases carrying particulates, because inertial effects introduced by gravity and the duct geometry lead to the particles being unevenly distributed in the stack.

Thus the determination of dust in stack emissions requires the sampling plane, the section of the duct where the samples are collected, to be situated at a length of a straight duct, preferably vertical, with constant shape and constant cross-sectional area.

It should be located as far as possible downstream and upstream from any disturbance, like bends of the duct, fans, dampers and so on.

As stated in the standard method "EN 13284-1:2002– Stationary source emissions – Determination of low range mass concentration of dust", the sampling plane should be five hydraulic diameters downstream and two upstream from any disturbance, five hydraulic diameters upstream from the top of the stack.

A hydraulic diameter Dh is:

Dh = (4x area of sampling plane)/(sampling plane perimeter)

In order to determinate the concentration of dust in the low range (EN 13284-1), preliminary velocity measurement should ensure this condition in the sampling plane:

highest local velocity / lowest local velocity < 3.

Safe working platform.

Emissions sampling and measurements require a safe and permanent access to the sampling plane.

Thus a working platform is needed near the sampling plane of a duct.

It should be located about 1,5 m downward the sampling plane (and sockets), in order to allow the handling of the probes, it should have a surface of a minimum of 5 m^2 The minimum width of the platform in front of the access ports should be the probe length plus 1 m.

As indicated by EN 15259 : 2008, a sampling operation can require from two to six persons and equipment of 50 to 300 kg, depending on the pollutant to be measured.

Method EN 13284-1 : 2002 states as a weight criteria a 400 kg point load.

A guard rail and other safety devices are also necessary and there must be a ladder with a safety cage or a stairway.

EN ISO 14122 about safety of machinery is the reference norm on the design of platform, walkways, stairways, guard rails and so on.

Lifting equipment is required for raising and lowering the apparatus and a socket to get the necessary electrical power must be available close to the sampling platform.

<u>In no way</u> mobile platforms, “Cherry pickers” or ladders can be accepted.

They represent serious risks to the sampling staff and measurements can’t be done with the accuracy required by EN methods on air emissions.

A scaffolding can be accepted only in case of exploratory measurements, not in periodic measurements required by the permit, but must offer the same safety of a permanent platform.

Anyway, the sampling activities present always a high level of risk, thus the responsible of the sampling team has to perform beforehand an accurate evaluation.

Access ports.

Measurements and sampling are made along axes in the sampling plane. Thus this plane must be accessible through openings. Methods EN 13284-1 and EN 15259 give hints for access ports suitable for medium and large diameter ducts.

In practice we have three kind of ducts, depending on diameter D:

1) small D < 0,7 m
2) medium 0,7 m ≤ D ≤ 3 m
3) large D > 3 m

- Small and medium ducts require at least two openings, corresponding to two perpendicular axes in the sampling plane
- large ducts require at least four openings, at the ends of two perpendicular axes in the sampling planes, in order to allow the handling of probes in the measurements.

Openings must terminate with sockets suitable to supporting the probes.

For medium and large ducts are necessary pipe and flanges with an internal diameter of 100-125 mm and with eight holes (flanges PN6 DN125 or PN10 DN100 as in EN 1092-1 : 2001).

For small ducts, smaller sockets must be used.

In Italy probes can be purchased with a diameter suitable to sockets with an inner diameter of 2 inches.

Anyway, sockets with flanges are recommended so that probes and other instruments can be supported easily.

Accepting compromises.

Many times to find a perfect sampling position in a duct of a functioning plant is almost impossible, because it has been built without any foresight of sampling requirements.

So a compromise has to be achieved, with the goal of building a sampling platform which ensures the personnel safety.

Sometimes a price has to be paid for it: an inhomogeneous sampling plane.

This means that the concentrations of gaseous pollutants, are not evenly distributed in the duct cross section.

The standard EN 13259 requires a preliminary homogeneity measurement, performing in the same time a fixed point measurement and grid measurement in the sampling plane.

Then a statistical evaluation of the two series of results allows to draw conclusions about emission homogeneity in the cross section and the "position uncertainty" that affects the sampling in one point of the cross section.

Then we can have three cases:

1) the sampling plane is quite homogeneous: we can collect samples in any point of the plane.
2) the sampling plane is not homogeneous and the "position uncertainty" is less than one half the allowed final measurement uncertainty: we have to find a "representative point" in the sampling plane. Such point behaves as the average of the grid measurements and the same is for the samples.
3) the sampling plane is not homogeneous and the "position uncertainty" is greater than or equal one half the allowed final measurement uncertainty: a grid sampling must be performed.

With AMS there are some little differences, that are dealt with in the standard.

Marking stacks.

All ducts of emission to air must be marked with a number, letters or both, in order to have an unambiguous reference to the emission.

The identification number or letter must be equal, or at least referable, to the identification symbol reported in the permit or the application for it.

The symbol must be clearly identifiable and indelible.

Quality requirements on emission measurements.

Quality assurance of automated measuring systems

Quality assurance of AMS should be performed in many stage process, as indicated in the standard EN 14181 : 2004 with the acronym QAL.

QAL1 (Instrument certification) is the group of tests carried out by a Certification Body mostly in the laboratory conditions and in agreement with the manufacturer in order to establish the performance characteristics of the instrument.
These tests are set in the norm EN ISO 14956 : 2002

QAL2 (Calibration) are a series of tests which has to be performed when the AMS is in use in the plant, periodically, at least every five years, and every time there is a malfunctioning of the instrument or a major change in the plant.
It must be performed by a laboratory able to do measurements on stack-emissions.
It involves a set of function tests and a series of parallel measurements with a Standard Reference Method (SRM) to establish a calibration function of the instrument and to evaluate the compatibility of bias and the scattering of the AMS measures with the uncertainty stated in the norms (e.g. EC Directives). The number of parallel measurements with the SRM are at least 15 and must be performed in a range of at least 3 days.

QAL3 (On-going Quality Assurance) is a process for detecting any adverse change in the performance of the instrument. It is implemented using either automatic or manual zero and span checks. The test is carried out systematically by plant operators.
The readings of this test are evaluated with the certified performances of the instruments and are statistically evaluated by means of control chart, CUSUM or Shewart.

The Annual Surveillance Test (**AST)** must be performed by a laboratory every year and involves a smaller set of parallel measurements with a SRM. Only 5 measures are required, and a linearity test to be performed by means ofa reference material.