EUROPEAN COMMISSION

Integrated Pollution Prevention and Control (IPPC)

Reference Document on the General Principles of Monitoring

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This document is one of a series of foreseen documents as below (at the time of writing, not all documents have been drafted):

Full title	BREF code
Reference Document on Best Available Techniques for Intensive Rearing of Poultry and Pigs	ILF
Reference Document on the General Principles of Monitoring	MON
Reference Document on Best Available Techniques for the Tanning of Hides and Skins	TAN
Reference Document on Best Available Techniques in the Glass Manufacturing Industry	GLS
Reference Document on Best Available Techniques in the Pulp and Paper Industry	PP
Reference Document on Best Available Techniques on the Production of Iron and Steel	I&S
Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries	CL
Reference Document on the Application of Best Available Techniques to Industrial Cooling Systems	CV
Reference Document on Best Available Techniques in the Chlor – Alkali Manufacturing Industry	CAK
Reference Document on Best Available Techniques in the Ferrous Metals Processing Industry	FMP
Reference Document on Best Available Techniques in the Non Ferrous Metals Industries	NFM
Reference Document on Best Available Techniques for the Textiles Industry	TXT
Reference Document on Best Available Techniques for Mineral Oil and Gas Refineries	REF
Reference Document on Best Available Techniques in the Large Volume Organic Chemical Industry	LVOC
Reference Document on Best Available Techniques in the Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector	CWW
Reference Document on Best Available Techniques in the Food, Drink and Milk Industry	FM
Reference Document on Best Available Techniques in the Smitheries and Foundries Industry	SF
Reference Document on Best Available Techniques on Emissions from Storage	ESB
Reference Document on Best Available Techniques on Economics and Cross-Media Effects	ECM
Reference Document on Best Available Techniques for Large Combustion Plants	LCP
Reference Document on Best Available Techniques in the Slaughterhouses and Animals By-products Industries	SA
Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities	MTWR
Reference Document on Best Available Techniques for the Surface Treatment of Metals	STM
Reference Document on Best Available Techniques for the Waste Treatments Industries	WT
Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals (Ammonia, Acids and Fertilisers)	LVIC-AAF
Reference Document on Best Available Techniques for Waste Incineration	WI
Reference Document on Best Available Techniques for Manufacture of Polymers	POL
Reference Document on Energy Efficiency Techniques	ENE
Reference Document on Best Available Techniques for the Manufacture of Organic Fine Chemicals	OFC
Reference Document on Best Available Techniques for the Manufacture of Specialty Inorganic Chemicals	SIC
Reference Document on Best Available Techniques for Surface Treatment Using Solvents	STS
Reference Document on Best Available Techniques for the Manufacture of Large Volume Inorganic Chemicals (Solids and Others)	LVIC-S
Reference Document on Best Available Techniques in Ceramic Manufacturing Industry	CER

EXECUTIVE SUMMARY

This reference document on “The General Principles of Monitoring” reflects an information exchange carried out under Article 16(2) of Council Directive 96/61/EC. The executive summary - which is intended to be read in conjunction with the preface's explanations of objectives, usage and legal terms - describes the main findings and the principal conclusions. It can be read and understood as a stand-alone document but, as a summary, it does not present all the complexities of the full text. It is therefore not intended as a substitute for the full document text as a tool in decision making.

This document provides information to guide IPPC permit writers and operators of IPPC installations in meeting their obligations under the Directive with regard to monitoring requirements of industrial emissions at source.

Permit writers are recommended to take into account the following seven considerations when establishing optimised permit monitoring conditions:

1. **"Why" monitor?** There are two main reasons why monitoring is included in IPPC requirements: (1) for compliance assessment, and (2) for the environmental reporting of industrial emissions. However, monitoring data can often be used for many other reasons and objectives and indeed it is often more cost effective when monitoring data obtained for one purpose can serve other purposes. In all cases it is important that the objectives for undertaking the monitoring are clear for all the parties involved.

2. **"Who" carries out the monitoring?** The responsibility for monitoring is generally divided between the competent authorities and the operators, although competent authorities usually rely to a large extent on “self monitoring” by the operator, and/or third party contractors. It is highly important that monitoring responsibilities are clearly assigned to all relevant parties (operators, authorities, third party contractors) so that they are all aware of how the work is divided and what their own duties and responsibilities are. It is also essential that all parties have appropriate quality requirements in place.

3. **"What" and "How" to monitor.** The parameters to be monitored depend on the production processes, raw materials and chemicals used in the installation. It is advantageous if the parameters chosen to be monitored also serve the plant operation control needs. A risk-based approach can be used to match various levels of potential risk of environmental damage with an appropriate monitoring regime. To determine the risk the main elements to assess are the likelihood of exceeding the emission limit value (ELV) and the severity of the consequences (i.e. harm to the environment). An example of a risk-based approach is presented in Section 2.3.

4. **How to express ELVs and monitoring results.** The way ELVs, or equivalent parameters, are expressed depends on the objective for monitoring these emissions. Different types of units can be applied: concentration units, units of load over time, specific units and emission factors, etc. In all cases, the units to be used for compliance monitoring purposes should be clearly stated, they should preferably be internationally recognised and they should match the relevant parameter, application and context.

5. **Monitoring timing considerations.** Several timing considerations are relevant for setting monitoring requirements in permits, including the time when samples and/or measurements are taken, the averaging time, and the frequency.

   The determination of monitoring timing requirements depend on the type of process and more specifically on the emission patterns, as discussed in Section 2.5., and should be such that the data obtained are representative of what is intended to be monitored and comparable with data from other plants. Any timing requirement of the ELV and associated compliance monitoring must be clearly defined in the permit so as to avoid ambiguity.

6. **How to deal with uncertainties.** When monitoring is applied for compliance checking it is particularly important to be aware of measurement uncertainties during the whole monitoring process. Uncertainties need to be estimated and reported together with the result so that compliance assessment can be carried out thoroughly.

7. **Monitoring requirements to be included with ELVs in permits.** These requirements should cover all relevant aspects of the ELV. To this end it is good practice to take into account the issues specified in Section 2.7, i.e. with regard to the:

   - legal and enforceable status of the monitoring requirement
   - pollutant or parameter being limited
   - location for sampling and measurements
   - timing requirements of sampling and measurements
   - feasibility of limits with regard to available measurement methods
   - general approach to the monitoring available for relevant needs
   - technical details of particular measurement methods
   - self-monitoring arrangements
   - operational conditions under which the monitoring is to be performed
   - compliance assessment procedures
   - reporting requirements
   - quality assurance and control requirements
   - arrangements for the assessment and reporting of exceptional emissions.

The production of monitoring data follows several consecutive steps that all need to be performed according to either standards or method-specific instructions to ensure good quality results and harmonisation between different laboratories and measurers. This **data production chain** consists of the following seven steps, described in Section 4.2:

1. Flow measurement.
2. Sampling.
3. Storage, transport and preservation of the sample.
4. Sample treatment.
5. Sample analysis.
6. Data processing.
7. Reporting of data.

The practical value of the measurements and the monitoring data depends on the degree of confidence, i.e. reliability, that can be placed on the results, and their validity when compared to other results from other plants, i.e. comparability. Therefore, it is important to ensure the appropriate **reliability and comparability** of the data. In order to allow a proper comparison of the data, it should be ensured that all relevant information is indicated together with the data. Data that have been derived under different conditions should not be directly compared, in these cases a more elaborate consideration may be necessary.

The **total emissions** of an installation, or unit, are given not only by the normal emissions arising from the stacks and pipes, but also by taking into account diffuse, fugitive and exceptional emissions. It is therefore recommended that IPPC permits, where appropriate and reasonable, include provisions to properly monitor these emissions.

As progress has been made in reducing channelled emissions then the relative importance of other emissions have become increasingly important, for instance more attention is now paid to the relative importance of **diffuse and fugitive emissions.** It is recognised that these emissions can potentially cause damage to health or the environment, and that sometimes their losses may also have economic significance for a plant. Similarly, the relative importance of **exceptional emissions** has also increased. These are classed as occurring under foreseeable conditions or unforeseeable conditions.

The handling of **values under the limit of detection** and **outliers** values can affect comparability and also require agreement in practice. Five different possibilities for handling values below the detection limit are presented in Section 3.3, however, none of them have been singled out as the preferred option. Outliers are generally identified by expert judgement on the basis of a statistical test (e.g. Dixon test) together with other considerations, such as an abnormal emission pattern in the particular facility.

Several **approaches to monitoring** a parameter are listed and briefly described below and in greater detail in Chapter 5:

- direct measurements
- surrogate parameters
- mass balances
- calculations
- emission factors.

In principle, it is more straightforward, but not necessarily more accurate, to use a method involving direct measurements (specific quantitative determination of the emitted compounds at the source); however, in cases where this method is complex, costly and/or impractical other methods should be assessed to find the best option. Whenever direct measurements are not used the relationship between the method used and the parameter of interest should be demonstrated and well documented.

When deciding whether to approve the use of an approach in a relevant regulatory situation the competent authority is generally responsible for deciding whether the method is acceptable, based on considerations of fitness for purpose, legal requirements, and available facilities and expertise.

Monitoring techniques for **direct measurements** can be divided mainly into continuous and discontinuous techniques. Continuous monitoring techniques have the advantage that they provide a greater number of data points, however, they may have also some drawbacks, e.g. their higher costs, they are not much use for very stable processes, and the accuracy of on-line process analysers can be lower than laboratory measurements. When considering the use of continuous monitoring for a particular case it is good practice to take into account the relevant issues listed in the Chapter 5.1.

The use of **surrogate parameters** may offer several advantages, including greater cost-effectiveness, reduced complexity, and a larger number of data. However, it may also lead to several disadvantages, including the need for calibration against direct measurements, they may only be valid over part of the entire emissions range and they may not be valid for legal purposes.

Mass balances consist of accounting for inputs, accumulations, outputs and the generation or destruction of the substance of interest, and account for the difference by classifying it as a release to the environment. The result of a mass balance is usually a small difference between a large input and a large output, also taking into account the uncertainties involved. Therefore, mass balances are only applicable in practice when accurate input, output and uncertainties quantities can be determined.

The use of **calculations** to estimate emissions requires detailed inputs and is a more complex and more time consuming process than emission factors. On the other hand they provide a more accurate estimate given that they are based on specific conditions of the facility. In any emission estimation calculations, the **emission factors** need reviewing and prior approval by the authorities.

Compliance assessments generally involve a statistical comparison between the measurements, or a summary statistics estimated from the measurements, the uncertainty of the measurements and the emission limit value or equivalent requirements. Some assessments may not involve a numerical comparison, for example they may just involve a check of whether a condition is complied with. The measured value can be compared with the limit, taking account of the associated uncertainty in measurements, and determined as belonging in one of three zones: (a)compliant, (b)borderline or (c)non-compliant, as described in Chapter 6.

The reporting of monitoring results involves summarising and presenting monitoring results, related information and compliance findings in an effective way. Good practice is based on consideration of: the requirements and audiences for reports, responsibilities for producing reports, the categories of reports, scope of reports, good reporting practices, legal aspects of reporting and quality considerations, as described in Chapter 7.

In carrying out the monitoring, optimisation of the **monitoring costs** should be undertaken whenever possible, but always without losing sight of the monitoring objectives. Cost-effectiveness of the monitoring may be improved by applying some actions including: selecting appropriate quality performance requirements, optimising the number of parameters and the monitoring frequency, complementing routine monitoring by special studies, etc.

The EC is launching and supporting, through its RTD programmes, a series of projects dealing with clean technologies, emerging effluent treatment and recycling technologies and management strategies. Potentially these projects could provide a useful contribution to future BREF reviews. Readers are therefore invited to inform the EIPPCB of any research results which are relevant to the scope of this document (see also the preface of this document).