**Small guidance related to sampling & monitoring of emissions**

*Project MK-10-IPA-EN-01-14 (MK-10-IB-EN-01)*

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**List of Acronyms**

|  |  |
| --- | --- |
| BATs | Best Available Techniques |
| BREFs  | Best Available Techniques Reference Document |
| EC  | European Commission  |
| EIA  | Environmental Impact Assessment  |
| IED | Industrial Emissions Directive 2010/75/EU |
| IMPEL | European Union network for the implementation and enforcement of environmental law |
| IPPC  | Integrated Pollution Prevention and Control  |
| LDAR | Leak Detection And Repair |
| LCP | Large Combustion Plant |
| MoEPP  | Ministry for Environment and Physical Planning  |
| RMCEI | Recommendation 2001/331/EC of the European Parliament and the Council providing for minimum criteria for environmental inspections in the Member States |
| SEI  | State Environmental Inspectorate  |
| TA | Technical Assistance |

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# Introduction

This document has been prepared upon the request of some participants in the training on sampling and control of self-monitoring reports held during the period 8th – 10th of June 2016. It does not pretend to be a comprehensive guidance in any of the items discussed below, but to provide some hints and recommendations based in practice, to improve different aspects related to the sampling and self-monitoring reports linked to the control of environmental performance of industrial activities.

The document is structured as follows:

1. In section 2 are discussed some issues that can be sometimes neglected during the setting of conditions related to air & water emissions in environmental permits.
2. Section 3 proposes a set of minimum contents for the self-monitoring reports of industrial activities.
3. Section 4 provides some tips on how to control the work done by external accredited laboratories.
4. Section 5 discusses some aspects which are essential to assess a self-monitoring report
5. Annex 1 provides some useful links & references for further reading.

# Suggested contents for monitoring reports

## Air emissions

For industrial activities emitting pollutants to the atmosphere, it is suggested to request from them this information in their self-monitoring reports:

1. Features of each emission point including: the associated process, operating hours per year, pollutants emitted, corrective measures installed and necessary to minimize emissions, as well as the operating hours in reality of these measures.
2. In the case of emission points linked to combustion, it will be specified the type, brand and serial number of the boiler, year of construction, type of fuel, fuel consumption and rated output in kW or MW; if the emission point has not suffered any variation from the previous report, only its number and name will be stated.
3. In the case of stacks the shape and dimensions of the stack (height and inside diameter) and the description of existing layout for sampling will be indicated. The safety of personnel performing the sampling must be taken into account.
4. List of emission points in which emissions are to be measured. Main characteristics of each point.
5. If applicable, it will be justified why no measurements are made ​​on certain emission points.
6. In the case of diffuse sources of emission, points of emission thereof have to be identified.
7. Emission limit values ​​applicable to each focus:
	* The emission limit values ​​(maximum allowable concentration) for each pollutant and the related applicable legislation shall be specified.
8. Sampling and determination of contaminants:
	* Date and responsible for carrying out the measurements.
	* Complementary pollutants and parameters measured in each emission point (% oxygen, moisture, etc.). In this way an eventual dilution can be discarded.
	* Methodology used in performing measurements (sampling procedures and procedures for the determination of pollutants will be identified, and the standard or reference method in which they are based).
	* List of equipment used in sampling and measurements (serial number or registration / code assigned by the accredited external laboratory, manufacturer and model)
9. Calibration certificates of the used equipment shall be available to the customer and competent authority.
10. Sampling procedure and sampling plan, including:
	* Number of samples in each emission point
	* Sampling Type
	* Duration specifying the start and end times of sampling
11. In the case of diffuse emissions sampling it must be justified and specified the number and location of the sampling points where sampling was made (particle sensors at critical points of the installation).
12. In the case of having to outsource some of the work of inspection, the results of this work have to be clearly identified.
13. Representativity of the measures. Technical conditions of production during sampling. Operating conditions of the installation during sampling.

1. Representativity of the measures. Technical conditions of production during sampling. It must be included a statement by the person responsible for the installation certifying that the data on production the day of the inspection correspond to normal operating conditions and are representative thereof (expressed as a % of utilization of nominal capacity and the % of production under normal conditions). Such declaration shall be recorded in the internal record of the accredited external laboratory. The report shall necessarily include the data.
2. Results:
	* Concentration of pollutants in the gases emitted.
	* Process parameters.
	* For particulate contaminants:% of isokinetism.
	* Each pollutant mass flow rates (kg / h).
3. Conclusions and observations:
	* Declaration of conformity stating that the measurements taken in all emission sources in the installation show that the activity meets / fails to meet the emission limit values ​​set out in the legislation.
	* In case that changes in the production process with an impact on pollutant emissions or emission sources are detected, it must be specified.
	* A statement that the report includes the measurements results required by law in all sources of installation. Where appropriate number of emission points in which no measurements are made and reason or justification.
	* Date of the next measurement of emissions in accordance with applicable legislation.

## Water Sampling (surface waters)

For industrial activities discharging pollutants to the water, it is suggested to request from them the following information in their self-monitoring reports:

1. Reason to draft the report
	* Obligation stated in a permit of the installation
	* Prompted by an accidental episode
2. Features of the point where the sample is taken
3. Rationale for exclusion or substitution of the points where samples are performed periodically.
4. Limit values ​​associated with sampling point:
	* The limit values ​​(maximum allowable concentration) for each pollutant and the specific rules of application shall be specified.
5. Sampling and determination of contaminants:
	* Date and responsible person conducting sample taking.
	* Pollutants and complementary parameters evaluated.
	* Methodology used in conducting the samplings and measurements (sampling procedures and determination of pollutants will be identified, and the standard or reference method in which they are based).
	* List of equipment used in sampling and in situ measurements (serial number or registration / code assigned by the accredited external laboratory, manufacturer and model).
6. Calibration certificates of the equipment used on site shall be available to the customer and competent authority.
7. Procedure and sampling plan, including:
	* Number of samples at each point
	* Sampling Type
	* Duration specifying the start and end times of sampling
	* Sampling containers (size and number of containers)
8. In the case of having to subcontract part of the assignment (e.g. analysis), the results of that work and the company that has made them shall ​​be clearly identified.
9. Reepresentativity of the samples with respect to the usual processes (sampling obligations stated in the permit). The % of utilization of rated capacity and% production in normal operation will be stated.
10. Results:
	* Pollutant concentration.
	* Process parameters.
	* The discharge flow.
11. Conclusions and observations:
	* Declaration of conformity stating that the measurements taken at the facility show that the activity meets / fails to meet the limit values ​​set out in the legislation.
	* If changes in the production process with an impact on the flow analyzed or the contaminants is detected, this fact will be expressly indicated.

# How to check if an accredited laboratory or/and body performing inspection is performing sampling & measurements as it should

## General recommendations

**Inspectors should**, from time to time, request to the external accredited laboratory or/and body performing inspection that performs the sampling and monitoring for a given installation, to **be present** during one of their visits to the installation to perform such sampling and monitoring. If the results that come out during that sampling and monitoring session differ substantially from the results of measurements done when the inspector was not present, it can be an indication that the accredited lab is not doing things properly.

In any case, in both air emissions and surface water discharges, the use of the right methods according to the final goal seeked shall be sought, as well as the standards if stipulated in the legislation and permits, and in the absence of standards, application of methods recognized by national or international bodies.

## Recommendations related to air sampling

In typical industrial processes may **vary the emission conditions** because multiple reasons. If the inspector accompanies an external accredited laboratory he/she should consider the following:

• The **sampling** must be **designed** so as to **prevent** **these variations** in the sample taken.

• The data collected should accurately represent the **real conditions** of the emission source.

• When making any determination of pollutants it is essential to **know** the **facility** to be inspected, as well as **details that can affect** the **sampling** to perform, as well as the process duration, or if it is continuous or cyclic. Therefore, it is necessary to have information prior to the realization of sampling for the external accredited laboratory to prepare a proper sampling plan.

• **If deemed necessary** an **initial meeting** will be requested with a responsible person of the installation, where the following aspects shall be checked:

-           The operation of the productive activity of the installation, reviewing the processes and their relationship with plant emission points (It is advisable to define a minimum nominal production capacity during air emissions sampling to ensure that the measure is representative of the activity).

-           The operation of the various corrective measures of produced emissions by the plant and its maintenance status.

-           Availability of operation records of the plant that can be used to characterize the process to be checked, and relate such records with emission values ​​obtained. If adequate records are not available, possibility of characterization of these operating conditions during sampling periods.

• In the case of **cyclic processes,** as a general rule, the samples must be performed during a full cycle or, depending on the duration of this cycle, if necessary for several complete cycles, but not including parts of a cycle and discarding others.

In the event that the cycle has a duration exceeding the one that can take the reference method based on its maximum range, the cycle should be divided into several phases and in each of these phases sampling shall be made to characterize the emissions of each of them.

• In any case, in each sampling result it shall be **indicated the production conditions very clearly,** and always **in relation to** a production **parameter** or any parameter that can influence emissions, for example, inputs from different raw materials or process temperature conditions. In no case it may be assumed that the production conditions are normal in the company and therefore the samples are representative.

## Aspects to take into account related to water sampling planning and implementation

**Definition of the goal of the sampling:**

It is essential to clearly define the purpose of sampling, no sampling plan is applicable to all cases. Example of different possible targets:

* Concentration of chemical or microbiological parameters (N, P, Hydrocarbons….)
* Estimate the flow of materials
* Assess trends in space and time
* Verifying compliance with criteria or standards
* Measures for quality control of water treatment plants or sewage treatment plants
* Measures to characterize and evaluate water quality (FWD)
* Identification and control of pollution sources

**Definition of the kind of sampling to be made, as starting point:**

Survey samples: A sample collected in a given place and time. It can only represent the composition of the source at that time and place. When the source is fairly constant in its composition, they can be well represented by a single sample probe.

Set of simple composite samples collected at the same point at different times (for example, every hour to see how the spill is going).

Integrated samples: set of individual samples collected at different points at the same time or with the least possible temporary separation. For example, to rivers or streams whose composition varies according to width and depth. The preparation of integrated samples usually requires special equipment.

**Definition of sampling point:**

* A single point
* Various points along the river basin. E.g.: before and after the point of discharge to evaluate the influence of discharge into the receiving environment

**Sample size:**

* Size in relation to the representativity of the water body analyzed
* Size relative to the amount of analysis that are requested

**Container**

Containers must have appropriate characteristics with regard to the type of analyte in terms of size, composition and color, in addition to avoiding sample contamination.

**Preservation of samples**

* For chlorinated water consumption it is necessary to add sodium thiosulfat
* Temperature

**Preservation of samples (add preservative?)**

* Parameters (analysis)
* It should maintain the chain of custody, to respect the sameness of the sample.

**Sample identification and registration**

* Identification of sample (Reference)
* Sampling site
* Details of sampling, including plane if necessary
* Date (and time) sampling
* Identification of the person taking the sample
* Type of sample
* Conditions of sampling (weather, temperature)
* Treatment given to samples (if applicable)

**Labels**

* At least, identification of sample (Reference)
* According to the laboratory

**Sample management requirements**

It must be consulted with the laboratory, to avoid the cancellation of results due to a bad practice, the following:

* Maximum period between sampling and start of analysis.
* The way to preserve the samples.

**Aspects to consider in** **episodes due to incidents** **related to aquatic environment:**

Besides all issues related to sampling plans developed on a regular basis, the following shall be taken into account:

In cases where sampling is due to an unforeseen incident, it is important to record all aspects that can influence in the analysis of the causes and consequences of the incident, for example, in a case of spillage with fish mortality aspects to consider are:

* Map of the area identifying discharge area (upstream and downstream), the point where the mortality was detected and points where samples are taken.
* Parameters analyzed "in situ" as dissolved oxygen, pH and conductivity.
* Physical appearance and tests on the animals infected or foreign material located in the study area. Accompanied by photographs and visual description.

## Aspects to take into account related to soil & groundwater monitoring

Different kinds of activities often cause soil and groundwater pollution, due to potential leakages of products from underground or surface tanks and pipes at several stages of the processes. The environmental impact that pollution can cause may be extreme, pointing out the need for immediate remediation actions, as well as uptake of adequate prevention measures.

The appearance, characteristics and particularities of the existing pollution may lead the necessity to develop an appropriate program, which should be capable of providing a realistic and credible picture of the pollution of the area the possibility of timely detection of future potential leakages, a useful database, on which the choice of appropriate remediation activities could be based.

### Monitoring Program

Conduction of a site investigation and development of an integrated monitoring and, if necessary, remediation system are essential. A complete monitoring programme can consist of three different, but correlating, stages:

Stage 1: Site investigation / characterization of the existing contamination;

Stage 2: Monitoring;

Stage 3: Remediation.

**Stage 1: Site investigation / characterization of the existing contamination**

The aim of this stage is to record, as detailed and as precisely as possible, the site conditions and significant parameters that are related to the geology, the hydrology and the existing pollution levels in the area. The main activities of this stage are:

Mapping of the site including:

* The positions of the process and storage units (including closed units; because of its probable historical pollution)
* The flow lines of groundwater.
* The groundwater sensitivity (the groundwater sensitivity of locations will be influenced mainly by aquifer type).

Geological and Hydro-geological studies of the area.

* Sampling and analysis of groundwater, soil and soil air, in order to identify the type of the existing pollutants.
* Sampling and analysis of floating free phase, if exists, in order to determine its composition and possibly its origin.
* Analysis and identification of the critical points in order to implement the permanent monitoring network.

The determination of the pollutants allows the definition of the leakage points, among the different treatment stages and facilities. This way the prevention of the observed leakages becomes feasible, limiting to a great extent the magnitude of the pollutants inflow in the soil and groundwater. The main goals must be to obtain for pollutants:

* Current distribution map in the facility area.
* Potential distribution map of the facility area.

**Stage 2.- Monitoring**

The purpose of this stage is the continuous registration of the site and more specifically the pollution characteristics. The need for close monitoring of the area is necessary to prevent conditions that may prevail due to unexpected activities: potential leakage can lead to even greater or extended pollution of the site, changing the known pollution status of the area completely. This is the main objective of the monitoring program: the continuous knowledge of the site pollution and, therefore, the “Pollution plume”. Therefore, continuous monitoring of the site is considered to be more than essential. The scope of monitoring must include at least:

* Piezometers.
* Periodical sampling and analysis of soil, soil gas, groundwater and free phase (if exists),
* Samples from several points of the facilities.
* Scope of these samplings.
* Image representations of the variation of the contamination in connection with space and time: graphical representation.
* Assessment of contamination and its potential changes of position (pollution plume)

**Stage 3: Remediation**

If high pollution levels are detected a remediation method should be chosen based on:

* The existing components of the pollutant and their concentrations.
* The prevailing hydro-geological conditions on site.

## Aspects to take into account related to waste sampling & monitoring

The control of the production and management of wastes implies different stages:

* Characterization of the produced wastes.
* Procedures of storage and management.
* Temporary storages: position and logistics.
* Documentary control.

In this sense, sampling and analysis often is employed to determine whether a waste is hazardous or not[[1]](#footnote-1), to determine if a waste should be subject to treatment and, when applicable, it it has been adequately treated in line with the prescriptions of the Landfill Directive 1999/31/EC.

When a waste handler conducts testing to determine if the waste exhibits any of the four characteristics of a hazardous waste, he or she must obtain a representative sample.

**SAMPLING IMPLEMENTATION**

The tools, devices, and methods used for sampling waste materials will vary with the form, consistency, and location of the waste materials to be sampled.

**Step 1:** Identify the Waste Type or Medium to be Sampled

**Step 2:** Identify the Site or Point of Sample Collection

* Drums and Sacks or Bags: Drums and sacks or bags are portable containers used to store, handle, or transport waste materials
* Surface Impoundments
* Tanks
* Pipes, Point Source Discharges, or Sampling Ports
* Waste Piles
* Conveyors
* Structures and Debris
* Surface or Subsurface Soil

**Step 3:** Consider Device-Specific Factors

* Sample Type
* Sample Volume

**Step 4:** Select the Sampling Device

It is strongly recommended to **take as a reference** the technical guidance on waste sampling from the US EPA (**see Annex 1** for the link).

## Aspects to take into account related to noise monitoring

The noise monitors must be installed around the site at strategic locations, typically on the boundary of the site nearest to the local population. The number and locations will depend of different factors:

* Number, height and characteristics of emission points.
* Distance from population.
* Complexity of the facilities.

The distribution of monitoring points must be, therefore, properly balanced being, at the same time, sufficiently representative, attending the above aspects.

The measurements shall fulfil the Assessment and Management of Environmental Noise (2002/49/EC), according to which the environmental noise criteria for industrial plants are the following:

* ISO 8297: Acoustics -- Determination of sound power levels of multisource industrial plants for evaluation of sound pressure levels in the environment – “Engineering Method”.
* EN ISO 3744: Acoustics -- Determination of sound power levels of noise using sound pressure engineering method in an essentially free field over a reflecting plane.
* EN ISO 3746: Acoustics -- Determination of sound power levels of noise sources using an enveloping measurement surface over a reflecting plane.

## Contents suggested for the (general) Environmental Monitoring Plan of a given installation

The scope of the environmental monitoring plan can be:

1. Programme of monitoring and control of the production process
	* Parameters to control
	* Other indicators
2. Rain waters management
	* Description of channelling
	* Description of regulation and storages
	* Control procedures of the level controls
	* Maintenance operations
	* Procedures under stormy conditions
3. Control of the production and management of wastes
	* Characterization of the produced wastes
	* Procedures of storage and management
	* Temporary storages: position and logistics
	* Documentary control
4. Description of the control of channeled (i.e., non-diffuse) emissions
* Description of stacks
* Description of equipment
* Frequency and scope of sampling, regulatory controls and parallel measurements
* Monitoring and control of diffuse and fugitive emissions of Volatile Organic Compounds (VOCs)
* Inventory
* LDAR Programme (if it is appropiate)
* Detection and repair of leaks
* Air quality control at the perimeter of the facilities
1. Odour controls
2. Water discharges monitoring and control
	* Characteristics of effluents
	* Control and analysis (points, equipment, procedures, frequency of controls)
3. Soil and groundwater monitoring
	* Geological and hydrogeological studies
	* Control points
	* Frequency and parameters to determine
4. Noise
	* Mapping
	* Control
5. Quality assurance and preventive/corrective maintenance of the pollution control instrumentation
	* Emissions Tasks of quality according to standard UNE EN 14181 assurance. Measurement of fuel flow.
	* Air quality stations
	* Water discharges monitoring
	* VOCs
	* Noise
	* Operational control
6. Environmental emergencies plan:
	* Performance during exceptional conditions
	* Procedures in case of emergency
	* Mechanisms of information to authorities and environmental information to transmit

# Key points to assess in a self-monitoring report

## Take always into account uncertainty

**Uncertainty in the measurements**: when comparing the result of a measurement with an ELV set in a permit, it is absolutely essential to know what is the uncertainty linked to that measurement, because it may be the case that the value obtained is higher than the ELV, but if one considers the uncertainty of the measurement, the range includes the ELV, so it is compatible with the permit conditions. E.g., if for pollutant X the ELV is 20 mg/m3, and the result of the measurement is 23 ± 4 mg/m3, this result respects the ELV of 20 mg/m3.

##  Some measurements may surpass the ELV, but that does not necessarily mean that there is a breach in permit conditions!

**What happens if a given measurement, even after taking into account the confidence intervals, surpasses the ELV set in the permit?** Can that be considered a breach of the permit conditions? The answer can be **sometimes NO**, so one must be very careful and take into account the following considerations **for air emissions**:

Manual and semiautomatic controls:

* From the values ​​obtained, it shall be deemed to comply with the applicable limit value when all valid values ​​within each hour, (minimum of three) measured for at least six hours do not exceed the established ELV.
* Also, if <33% of the measurements surpass the ELV, and none of them exceeds the ELV by more than 40%, it is considered that the ELV has not been surpassed.
* If <33% of the measures exceeds the ELV, but some of them surpass by >40%, the measurement period must be increased for three consecutive days, at least three measurements being made ​​every day. In this second round of measurements, <11% of the validated values surpasses the ELV, and none of them surpasses >25% the ELV, it is considered to be not exceeded the ELV.
* If none of the previous 3 points is met, then it is considered that the ELV is exceeded.

Automatic measurement systems:

* First one has to **distinguish between raw data, valid data and validated data:**
	+ Raw Data: Obtained by applying the characteristic function of the analyzer to the output. Correction must be carried out in moisture and oxygen in relation to the reference value, using the corresponding equations, for comparison with the limit value.
	+ Valid data: normalized data in humidity and temperature, once the wrong values are discarded.
	+ Validated data: valid data discounting the confidence interval, as follows:
		- If normalized valid data ≥ ELV: Validated data = valid Data - (X% x ELV).
		- If normalized valid data <ELV: Validated data = valid data - (X% x normalized valid data)

Where X is defined in the corresponding legislation (e.g. Directive 2010/75/EU)

* **Data Validation:**
	+ Only valid data must be used. Periods of maintenance, calibration or any other incident periods have to be excluded.
	+ Values ​​will be used on dry basis and, if necessary, corrected to the reference oxygen percentage.
	+ For values ​​below the detection limit of the equipment, the detection limit of the equipment will be recorded. This value is considered valid data.
	+ A minimum percentage of 75% of valid data from one period is required to calculate the average time data.

* **Valid data and confidence interval** **(X%):**

The values ​​of the confidence intervals of 95% of any measurement, established in daily ELVs, shall not exceed the following percentages of the ELVs:

* + Carbon monoxide: 10%.
	+ Sulphur dioxide: 20%.
	+ Nitrogen dioxide: 20%.
	+ Total dust: 30%.

* **Validated data:**

Validated hourly and daily mean values ​​are determined from the measured valid hourly average values, once the value of the confidence interval specified is subtracted

* + Days in which more than three hourly average values ​​are invalid due to malfunction or maintenance of automatic measuring system will be invalidated.
	+ If following this criteria are invalidated more than ten days a year, the competent authority shall require the operator to take the necessary measures to improve the reliability of the automated measuring system.

* **Assessment of compliance with the ELVs for** **Automated Measurement Systems in** **installations under the scope of Directive 2010/75/EU**
	+ No validated monthly average value exceeds the emission limit values; validated monthly average values ​​are determined from validated daily average values, taking into account a calendar month.
	+ No validated daily average value exceeds 110% of the relevant ELVs.
	+ In the case of combustion installations composed only by boilers using coal with a total rated thermal input below 50 MW, no validated daily average value exceeds 150% of the emission limit values.
	+ 95% of all the validated hourly average values ​​of the year do not exceed 200% of the ELVs .

# Annex 1: Useful links & documents

|  |  |
| --- | --- |
| **Document / information** | **Link** |
| Website of the State Environmental Inspectorate, with useful materials, including inspection manual, factsheets and checklists | [www.sei.gov.mk](http://www.sei.gov.mk) |
| Handbook for Emission Measurements for Macedonia (Macedonian version) | http://airquality.moepp.gov.mk/airquality/wp-content/uploads/2012/05/Upatstvo\_za\_merenje\_na\_emisii.pdf |
| Handbook for Emission Measurements for Macedonia (English version) | <http://airquality.moepp.gov.mk/airquality/wp-content/uploads/2013/01/Handbook-EM-FINAL-ENG.pdf>  |
| Monitoring of emissions from IED-installations | <http://eippcb.jrc.ec.europa.eu/reference/mon.html> |
| [Waste Treatment - The European IPPC Bureau](http://eippcb.jrc.ec.europa.eu/reference/wt.html) | <http://eippcb.jrc.ec.europa.eu/reference/wt.html> |
| EPA: Waste Sampling Draft Technical Guidance Planning, Implementation, and Assessment | <https://www.epa.gov/sites/production/files/2015-10/documents/rwsdtg_0.pdf> |

1. A hazardous waste is defined as a solid waste, or a combination of solid wastes which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may cause, or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed, or otherwise managed. [↑](#footnote-ref-1)