IMPEL

BEST PRACTICE IN COMPLIANCE MONITORING

IMPEL
NETWORK

European Union Network for the Implementation
and Enforcement of Environmental Law
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IMPEL PROJECT ON BEST PRACTICE IN COMPLIANCE MONITORING

CONTENTS

Stage 6: Enforcement actions: *How best to respond to compliance findings ?*

- General aspects
- Responses to compliant situations
- Responses to borderline situations
- Responses to non-compliant situations
- Quality considerations

Stage 7: Reporting of monitoring: *How best to summarise and communicate ?*

- Audiences for reports
- Responsibility for reporting
- Scope of reports
- Categories of report
- Good reporting practices
- Self-incrimination aspects of reporting
- Quality considerations

Summary

Recommendations for further study

Annex 1: Glossary of terms

Annex 2 : Acronyms

Working Group Membership

FOREWORD

The European Union Network for the Implementation and Enforcement of Environmental Law is an informal network of the environmental authorities of EU Member States. The European Commission is also a member of IMPEL and shares the chairmanship of management meetings.

The network is commonly known as the IMPEL Network

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on certain of the technical and regulatory aspects of EU environmental legislation. 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. It promotes the exchange of information and experience and the development of greater consistency of approach in the implementation, application and enforcement of environmental legislation, with special emphasis on Community environmental legislation. It provides a framework for policy makers, environmental inspectors and enforcement officers to exchange ideas, and encourages the development of enforcement structures and best practices.

Information on the IMPEL Network is also available through its web site at http://europa.eu.int/comm/environment/impel.

This report on Best Practice in Compliance Monitoring is the result of a project within the IMPEL Network. The content does not necessarily represent the view of the national administrations or the Commission. The report was adopted during the IMPEL Meeting of 18 – 21 June 2001 at Falun in Sweden.

INTRODUCTION

1 IMPEL attaches great importance to environmental inspections and monitoring. It has published reports on Minimum Criteria for Inspections, Frequency of Inspections, Operator Self-Monitoring and Planning and Reporting of Inspections*. IMPEL recognised the need for a further exchange of information on monitoring issues and established a working group on Best Practice on Compliance Monitoring (BPCM). The membership of the working group is listed at the final page.

2 The objective of the project was to exchange information and develop best practice on compliance monitoring as it related to industrial installations (e.g. for the EC Directive on Integrated Pollution Prevention and Control) and sewage treatment works (e.g. for the EC Directive on Urban Waste Water Treatment).

3 Compliance monitoring is a fundamental activity within environmental protection and is one of the main ways by which adherence to limits and laws can be assessed for regulatory purposes. It can involve a range of inspection and reporting activities carried out to determine compliance with regulatory requirements (e.g. checking on progress with an improvement programme). The information provided by compliance monitoring is also valuable for other environmental and management activities (e.g. for optimising processes, protecting sensitive ecosystems, and informing the public of the effectiveness of environmental protection measures).

4 For the purpose of checking compliance with permitted limits for emissions and ambient pollutant loads compliance monitoring involves measuring pollutants and physical parameters (e.g. flow) in process emissions and receiving environments.

5 The term "monitoring" therefore has a broad range of meanings in its general regulatory usage. For the purposes of this project, "compliance monitoring" was taken to refer to measurements of process conditions, process emissions and levels in receiving environments; and reporting of the results of such measurements to demonstrate compliance with numerical limits specified in laws, regulations, permits or injunctions. It did not extend to the more qualitative aspects referred to at para.3.

6 This report builds on the earlier guidance published by IMPEL and summarises the main features of best practice at different stages in compliance monitoring. It recognises that Member States carry out compliance monitoring in different ways. It also identifies areas where further work is needed to clarify and harmonise particular aspects.

*see IMPEL Network web site : http://europa.eu.int/comm/environment/impel

BACKGROUND

7 The working group exchanged information at a managerial level. It did not consider detailed technical issues such as the merits of different sampling and analytical methods. The group focussed on developing common principles and practical advice on:

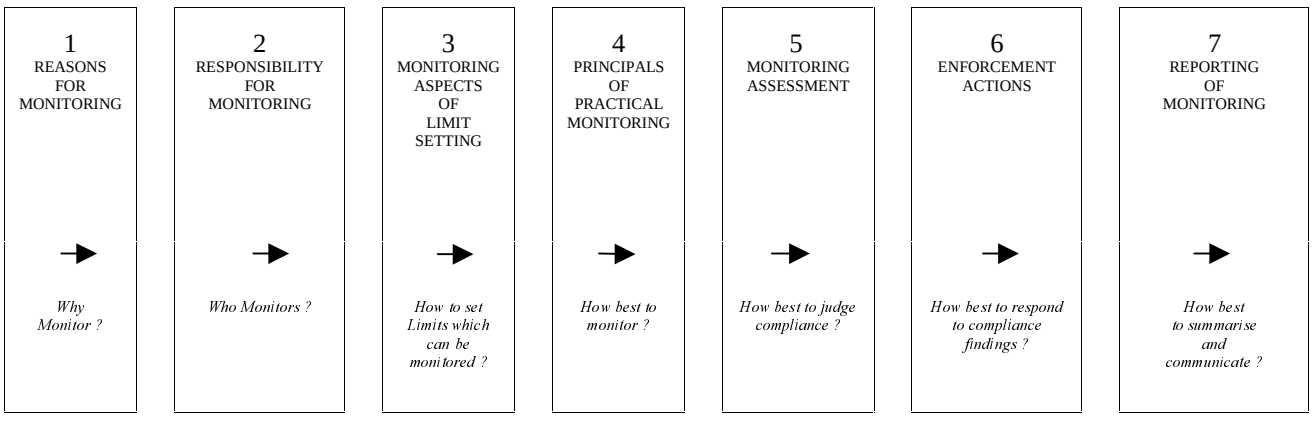
- the monitoring of pollutants in process emissions and receiving environments,
- the use of monitoring data to check compliance with numerical limits
- enforcement actions in response to compliance findings,
- reporting of monitoring results.

8 The general requirements for achieving best practice at the planning and implementation of compliance monitoring were considered. A logical sequence of seven key stages was identified. These stages are listed below and considered in greater detail in the following sections:

- stage 1: reasons for monitoring,
- stage 2: responsibility for monitoring,
- stage 3: monitoring aspects of limit setting,
- stage 4: principles of practical monitoring,
- stage 5: assessment of monitoring results,
- stage 6: enforcement actions,
- stage 7: reporting of monitoring.

9 These key stages are shown in Box 1. For each stage there is a title and question(s) expressing the practical issue(s) to be addressed. The stages are interdependent forming a "quality chain". The quality achieved at each stage affects what can be achieved at all later stages. Attention to quality is needed throughout the sequence so that there are no “weak links”. It is particularly important to take account of this quality chain when planning each stage. Otherwise any weaknesses at the early stages could have a major adverse effect on the quality and usefulness of the final results.

BOX 1: COMPLIANCE MONITORING: KEY STAGES IN BEST PRACTICE



Achievement of best practice in compliance monitoring requires careful consideration of 7 key stages. These are shown in sequence together with the question(s) to be answered at each stage.

STAGE 1: REASONS FOR MONITORING: *Why monitor ?*

10 Stage 1 of the quality chain is concerned with understanding why compliance monitoring should be required. This stage must take into account the main reasons for undertaking measurements which are to satisfy formal requirements including the provision of data to:

- judge whether emissions and impacts on receiving environments are compliant with numerical limits specified in permits, environmental quality standards or legislation,
- inform and/or support enforcement actions.

11 However, compliance monitoring can also have wider benefits in providing measurement data for many other uses.

12 Operators and authorities should have a clear understanding of objectives before monitoring begins. Best practice would be to document the objectives at the start and keep them under systematic review.

Formal requirements

13 In the case of self-monitoring, the requirements on the operator for making compliance measurements will be specified in permits or other legislation. These requirements can extend under some national arrangements to include the wider definition of monitoring referred to in the Introduction. In these cases self-monitoring can include operators checking and promoting compliance with formal requirements, and being responsible for taking action to correct non-compliances.

14 Requirements on the competent authority for making compliance measurements may be specified in legislation but more frequently the authorities are free to determine their own approaches, including consideration of how best to achieve effective and high quality measurements. Examples of the legally binding documents in which compliance monitoring requirements can be specified are listed in Box 2. These requirements may be specified so as to apply to all installations in an industrial sector, to all installations at a site, or to a single installation.

BOX 2: DOCUMENTS SETTING FORMAL REQUIREMENTS FOR COMPLIANCE MONITORING

Laws	Directives	Enforcement orders
Regulations	Prohibitions	Operator obligations and commitments
Permits	General binding rules	Monitoring & improvement programmes

Enforcement actions

15 The competent authorities may take a wide range of actions including formal enforcement actions in response to evidence of non-compliance, as revealed by monitoring. Examples of these actions, which are in addition to those which might be taken voluntarily or under self-correction duties by operators, are listed in Box 3.

Which authority will make use of the monitoring to take action depends on how responsibilities are allocated within a Member State. For example:

- inspection authorities may take actions involving inspecting improvement plans, issuing injunctions or prohibitions and imposing fees,
- permitting authorities may take actions involving issuing new permits or reviewing existing permits,
- criminal authorities may take actions involving criminal investigations and prosecutions.

BOX 3: ENFORCEMENT ACTIONS WHICH DEPEND ON EVIDENCE FROM COMPLIANCE MONITORING

Prohibitions	Orders	Permit reviews	Prosecutions
Injunctions	Requests for improvement	New permits	Court actions
Inspection plans	Fees, charges, fines, taxes	Judicial decisions	Enforcement notices

Wider benefits

16 Compliance monitoring is necessary for "policing" of emissions and their impacts on receiving environments. Wider benefits can be gained from the use of compliance monitoring data. These include a wide range of regulatory, industrial and environmental planning and performance reporting. Examples of wider benefits are given in Box 4. They show that compliance monitoring is a valuable source of information for understanding and managing the interactions of industrial processes with the environment and society. Compliance monitoring is therefore a useful investment with wide practical benefits.

BOX 4: WIDER BENEFITS OF COMPLIANCE MONITORING

Data for emissions inventories (e.g. local, national and European, EPER)
Data for assessing Best Available Techniques (e.g. at company, sector and EU levels)
Data for assessing environmental impacts e.g. for input to models, pollutant load maps
Data to inform the public, and to support public awareness and understanding
Data for use in negotiations e.g. of emission quotas, improvement programmes and emissions trading
Data for investigating possible surrogate parameters with practical and/or cost advantages
Information for decisions on feedstock and fuel, plant life and investment strategies
Information to assess the effectiveness of a permit and/or of a regulatory regime
Information for setting or levying environmental charges and/or taxes
Information to identify trends in plant performance including early warning of problems
Information for planning and managing increases in efficiency e.g. energy, feedstock
Information for appropriate targeting of inspections and corrective actions by authorities
Information for revising or updating permit conditions
Information for managing ambient pollutant loads in line with recognised standards
Information for improving the control and compliance of processes
Information for designing, improvement and/or updating of monitoring programmes

Systematic review

17 The objectives for requiring particular compliance monitoring programmes and associated reporting should be clear to operators, the competent authorities and other possible users of the measurement data. They should include consideration of the aims, obligations, uses and users of the data from a programme. These objectives should be documented and reported as discussed at Stage 7. The review process should also ensure that technical developments, which might improve the effectiveness of a programme, are taken into account. The data obtained must be compared regularly with the objectives over time to check that they are being met. The users of compliance monitoring data include primary users such as the competent authority and operator, and secondary users such as land-use planners, public interest groups and central government.

STAGE 2: RESPONSIBILITY FOR MONITORING: *Who monitors ?*

18 Stage 2 in the quality chain is concerned with assigning responsibilities for carrying out compliance monitoring. This stage must take into account current practices and legal provisions. The responsibility for carrying out compliance monitoring in EU Member States is generally divided between the competent authorities and process operators. However, there is no EU-wide consistent division into "authority responsibilities" and "operator responsibilities". A few tasks are always done by the authorities (e.g. making regulations, studying operators' proposals) and a few tasks are always done by operators (e.g. self-monitoring). In general the answer to the question "who monitors ?" varies between Member States.

Assignment of responsibility

19 Historically, the competent authorities were mainly responsible for carrying out monitoring programmes to check on operators' compliance and performance. However, there is a trend now for the competent authorities to rely more on "self monitoring" by operators. The authorities then inspect the operators' arrangements and may carry out (or use contractors see para.20) more limited monitoring programmes themselves to provide independent checks. Self-monitoring has potential advantages because it can use operators' knowledge of their processes and can be relatively cost-efficient. It also encourages operators to take responsibility for their emissions.

20 Both the authorities and operators are also increasingly making use of external contractors to undertake monitoring work on their behalf. However, the responsibility for the monitoring and its quality remains with the relevant authority or operator and cannot be contracted out.

21 It is important that monitoring responsibilities are clearly assigned to relevant organisations (operators, authorities, contractors) so that all are aware of how the work is divided and what their own duties are. Details of such assignments and of the methods to be used may be specified in monitoring programmes, schemes, permits, legislation or other relevant documents (e.g. reports as discussed at Stage 7). For best practice, such specifications will cover:

- operator monitoring,
- monitoring by the competent authority,
- monitoring which may be assigned to external contractors by the operator or authority,
- methods and safeguards that are required in each case,
- reporting requirements.

22 The ways in which monitoring responsibilities may be divided between authorities and operators are illustrated in Box 5. However, the box is only an example and actual division of tasks depends on the legislation and regulatory arrangements in individual Member States. It identifies how tasks in the following three areas of responsibility may be subdivided:

- the design of monitoring programmes,
- the making of measurements,
- the evaluation, assessment and reporting of results.

BOX 5: POSSIBLE DIVISIONS OF MONITORING RESPONSIBILITIES	
OPERATOR	AUTHORITY
Design of monitoring programme	
To make proposals for the programme To explain and justify the programme To design and implement the programme To document the programme To evaluate the performance of the programme	To make regulations about the programme based on ordinances, directives or standards To develop technical or other guidance on the programme To assess the operators proposed programme To decide on the programme required in the permit
Making of measurements	
To give the authority's inspectors access to the plant for monitoring To perform / operate self-monitoring To commission monitoring by consultants approved by the authority To implement safeguards for quality and objectivity To ensure safety precautions are followed To ensure quality objectives are met	To make regulations about the measurements based on ordinances, directives or standards To develop technical or other guidance on the measurements To check that individual measurement systems are reliable and meet quality objectives To check that safeguards for quality and objectivity are implemented To use results from auditing schemes to ensure the quality of monitoring To examine measurements from operator self-monitoring To commission occasional check monitoring by consultants To check that safety precautions are implemented
Evaluation, assessment and reporting of results	
To evaluate results e.g. by calculating statistics To assess results by comparison with limits To report some results continuously To compile and report some results at regular intervals To report leaks, exceedences, environmental accidents, etc To explain results to the authority / public To take actions for improvement based on current results and past performance	To examine results To compare operator's results with check monitoring To identify exceedences of limits To report results in summary form To take enforcement actions based on current results and past performance To make results and findings public

23 There is no one division of responsibilities which represents best practice. Different divisions can all achieve best practice provided they ensure that:

- responsibilities are clearly assigned so as to avoid confusion,
- effective arrangements are in place to safeguard the quality of the monitoring.

Safeguarding quality

24 It is essential that the users of monitoring results are confident that the work has been done in an objective and rigorous manner and to a recognised standard. This means that whoever does the work must not only achieve a high level of quality, but also must demonstrate this to data users. Appropriate quality requirements are defined by law in some Member States, in others the competent authority may establish them. Best practice is to use third party certification and accreditation schemes. These can certify or accredit equipment, personnel and laboratories as conforming to relevant standards specified by the competent authority. Such schemes must be applied at each stage i.e. when designing the monitoring programme, taking samples, making measurements, analysing for chemical content, and interpreting and reporting the results.

25 In addition quality considerations, including for example a range of safeguards involving auditing and checking, are essential to achieve best practice and to ensure that the results of compliance monitoring can be relied on for decisions. Safeguards apply to operators and authorities and to any contractors appointed to do monitoring work. The following examples of safeguards cover the main on-site and laboratory activities within compliance monitoring:

- inspecting of the overall plan and system of monitoring,
- inspecting of the operator's management of the monitoring system,
- inspecting of particular detailed monitoring activities,
- inspecting of maintenance and calibration of monitoring instruments and equipment,
- inspecting that the process operating conditions at times of monitoring are known/relevant,
- occasional independent check monitoring by authorities or external contractors acting on their behalf,
- use of standard methods for testing, sampling and analysis,
- use of certified instruments and personnel and accredited laboratories.

26 As well as these safeguards for on-site and laboratory work, safeguards must be applied to the processing, evaluation and assessment of monitoring data, for example by checking that:

- appropriate statistical methods have been selected and correctly applied,
- uncertainties in sampling and analyses have been correctly assessed and included.

STAGE 3: MONITORING ASPECTS OF LIMIT SETTING: ***How to set limits which can be monitored ?***

27 Stage 3 in the quality chain is concerned with the process of limit setting. This stage must take into account the practical aspects of carrying out monitoring if the limits are to be enforceable. Monitoring requirements must be considered and specified alongside limits when they are set for process emissions or receiving environments so that the means of measuring compliance can be readily understood.

28 The types of limits where monitoring aspects must be considered as part of limit setting include:

- conditions within a process (e.g. temperature of combustion),
- equipment within a process (e.g. efficiency of abatement equipment),
- emissions from a process (e.g. pollutant release rates, fugitive releases),
- efflux conditions at a process (e.g. exit temperature, exit velocity or flow),
- impacts in receiving environments (e.g. ambient pollutant concentrations, noise, odour, light and vibration),
- resource usage (e.g. energy used or pollution emitted/unit of production),
- percentage capture of monitoring data.

29 It is essential that compliance with limits can be judged using appropriate measurement methods. These methods together with requirements with regard to sampling locations, timing, duration, quality and reporting requirements form a compliance monitoring programme. Best practice requires that the relationship between the limits and the monitoring programme are clear and unambiguous. It is important that the specified monitoring requirements cover all relevant aspects of the limit. For this purpose it is useful to consider the following aspects, which define the scope of the specified monitoring:

- the formal (e.g. regulatory) context of the limit, and hence of the monitoring
- the positions on a process plant or in the environment where samples and measurements are to be taken,
- the timing and time-scales of sampling and measurements,
- the feasibility of limits with regard to available measurement methods,
- the general types of measurement methods available for relevant scales/needs,
- the technical details of particular measurement methods, and how to specify them,
- the compliance assessment procedures,
- reporting requirements,
- quality considerations.

Formal context of monitoring

30 Monitoring is needed to show compliance with specific limits. The formal context and legal basis of monitoring are the same as for the limit itself, and examples are listed in Box 2.

31 When setting a limit its associated monitoring requirement must also be considered. Best practice is for the permit or other legislation to make clear that the monitoring is

an inherent and legally enforceable requirement. It is as necessary to comply with the monitoring obligation as with the limit value

Positions

32 An unambiguous monitoring programme must state clearly the positions (e.g. River "A" at map reference "xxx yyy" plus local descriptor) where samples and measurements are to be taken. These must match the positions where the limits are applied. The possibilities can be grouped into the following source, pathway and receptor positions:

- ***source positions***. These are positions within or at the exit from a process:
  - in a combustion chamber,
  - before and after abatement equipment,
  - within a flue or chimney stack for emissions to air,
  - at an outlet from an effluent pipe for waste water emissions.

- ***pathway positions*.** These are positions in the receiving environments (e.g. air, water), where the flow and dispersion require monitoring because they affect compliance with ambient limits:
  - in a river, for monitoring of river flow,
  - in the air, for monitoring of atmospheric dispersion conditions.

- ***receptor positions***. These are the sensitive positions in receiving environments where pollutants after emission or impacts (e.g. noise, odour) from sources and dispersion along pathways are:
  - at a point of maximum ground-level concentration or deposition,
  - at a position occupied by the most exposed person(s),
  - across a local ecosystem (e.g. a catchment, or an area of forest or farmland).

Timing and time-scales

33 The ***time*** at which samples and measurements are taken may be crucial to obtaining a result which is relevant to the limit. Any timing requirement of the limit and associated compliance monitoring must be defined so as to avoid ambiguity. The timing may depend on:

- ***plant processing conditions:***
  - when specified feedstock or fuels are being used**,**
  - when a process is operating at a specified load or utilisation,
  - when a process is operating in upset and abnormal conditions, any required monitoring method may differ because the pollutant concentrations may then exceed the scale of the method used in more normal conditions. (Upset and abnormal operations may include start-up, leaks, malfunctions, momentary stoppages and definitive cessations),

- ***ambient conditions:***
  - the dispersion situation in receiving environmental media such as in atmosphere, river, etc
  - the use of the receiving area at daytime, night-time for noise and light monitoring

- the temperature in the receiving environment, as relevant to condensation of wet plumes, evaporation of volatile substances, thermal plumes in rivers.

34 The ***time-scales*** are the frequency, duration, intermittency averaging time and time resolution over which monitoring must be carried out to match the time-scales of the relevant limits. The time-scales for limits and related monitoring must be chosen to take account of the following factors:

- the time during which harm may occur in the environment (e.g. 15-60 minutes for breathing of air pollutants; annual deposition for acid rain),
- the temporal variations of the process i.e. how long it runs in different modes,
- the time needed to obtain statistically representative information,
- the response time(s) of any instrument(s) involved.

Feasibility

35 The form of the limits must be set so that the monitoring required to determine compliance is within the capability of available measurement methods. For example, in order to obtain detectable quantities of dioxins from stack emissions it is usually necessary to sample over several hours. In this case the averaging period should correspond to this practical sampling time. The limit setting process must therefore take into account the technical and practical limitations of the relevant monitoring methods which in general will include consideration of:

- detection limits,
- response times,
- sampling times,
- possible interferents,
- general availability of the methods,
- possible use of surrogates.

Measurement methods: general descriptions

36 It is useful if the monitoring programme for a limit describes first the general type of measurement required, before giving details of specific methods. The general approach must suit the considerations of position, timing, time-scale and feasibility, and take into account the following options whose advantages and disadvantages are described:

- ***sampling and analysis.*** This involves taking a physical sample from an emission or environmental receptor and then analysing it in order to identify the species and amounts of pollutants present. Often spot samples are taken providing a snapshot of pollutant levels. However, cumulative information can be obtained by taking time-averaged or flow-proportional samples using automatic sampling equipment. The analyses are then done away from the sampling location under laboratory controlled conditions. The disadvantages include limited time resolution and the difficulty of maintaining the chemical stability of samples between the point of collection and the point of analysis.

- ***real-time instruments.*** This involves making direct measurements of pollutant concentrations in-situ with instruments that give immediate and continuous

readings. The main advantages of this approach are that it gives information with a high time resolution and virtually no time delay. The disadvantages include the difficulty and cost of calibrating and maintaining instruments under possibly difficult field conditions.

- ***surrogates.*** These are parameters which are closely related to direct pollutant values (e.g. concentrations) and may be measured as a convenient substitute for them. There are advantages and disadvantages with the use of surrogates. More information on surrogates is given at Stage 4.

- ***remote sensing*****.** This technique is usually used for measuring ambient pollutant concentrations from a distance by measuring the interaction of emitted electromagnetic radiation with particular pollutant molecules e.g. by LIDAR. The main advantage is that pollutant loads can be mapped over a wide area and at high time resolution. The main disadvantages are cost and the limited number of pollutants which can be detected.

- ***ecotoxicological surveys*****.** These are designed to check on the presence, trends or absence of effects in receiving environments around a process e.g. surveys of freshwater invertebrate populations near a sewage works as evidence of water quality. Their main advantage is that they give an integrated account of environmental impacts and the health of ecosystems. Their main disadvantage is that the results can be difficult to interpret e.g. because some effects may not be due to the process of concern but to other processes or to confounding factors such as climate change.

Measurement methods: detailed specifications

37 It is best practice when setting limits to ensure that they are unambiguous by specifying clearly the pollutant or parameter being limited, the associated standard (or alternative) measurement method within the compliance monitoring programme, and the units of measurement. Examples of the issues to be considered are:

- ***pollutant or parameter type:***
  if a volatile substance is to be monitored, it must be clear if this refers to the gaseous component and/or to the solid component as attached to particulates,
  - if oxygen in water is to be monitored, it must be clear which test is to be used e.g. Biochemical Oxygen Demand test; Total Oxidised Nitrogen test,
  - if particulates are to be monitored the size range should be specified e.g. total, <10µm.

- ***standard methods*****:**
  - if a CEN standard exists for the relevant pollutant or parameter, it is best practice to specify this method,
  - if the limit to be monitored is set under an EU Directive which requires the use of a particular standard method, this must be specified and will normally be a CEN standard,
  - if there is no standard method available from CEN, it is best practice to specify a relevant ISO or national standard (if one exists),

- if a standard method exists and an operator prefers to use an alternative method (or no standard method exists) then the alternative method must be approved by the competent authority or otherwise as determined by the Member States before it can be used. The competent authority may add extra requirements to the method.

- ***units:***
  - the units to be used for compliance monitoring purposes must be clearly stated,
  - internationally recognised units (e.g. based on the Systeme Internationale) should be used,
  - it is essential that the chosen units match the relevant parameter, application and context ,
  - examples are detailed in Box 6 of how different units suit different applications.

BOX 6: MONITORING ASPECTS OF LIMIT SETTING: MATCHING UNITS TO APPLICATIONS

PARA-METER	UNITS		EXAMPLES OF RELEVANT APPLICATION
	TYPE	EXAMPLE	
CONCEN-TRATION	Volume/Volume	Ppm % O_2	Process Control Reduction of data to standard condition
	Mass/Volume	mg/m^3	Process Control
FLOW OR DISCHARGE RATE	Velocity	m/s	Compliance with minimum stack gas efflux velocity
	Momentum	m^4/s^2	For assessment momentum available for stack plume rise
	Volume/Time	m^3/s	Discharge rate of effluent to receiving water
	Residence Time	s	For assessing completeness of combustion
	Mass/Time	g/s	Release inventories; Impact assessment
THERMAL EFFECTS	Temperature	^oC K	For assessing destruction performance of incinerator Reduction of data to standard conditions
	Heat / Time	W	Buoyant rise of stack plume Thermal impact on receiving waters
PROCESS EFFICIENCY	Emission Per Unit of Production	G SO_2/MJ	For assessing resource efficiency of power station
		Kg COD/tonne air dried pulp produced	For assessing resource efficiency of paper mill
	Mass Balance	G (out)/g (in)	For assessing efficiency of abatement equipment

Compliance assessment procedures

38 It is best practice for the permit to state clearly how the monitoring data will be interpreted to assess compliance with the relevant limit. Statements, which are open to wide interpretation (e.g. "as low as reasonably practicable"), should be avoided. Unambiguous statistical tests (e.g. based on relevant standards) should be used instead. If the programme uses examples to explain the assessment method, then it is important to explain that the examples are not meant to constrain the application of the method but only to illustrate it. Consideration should be given to the need to specify any statistical conditions relating to evaluation criteria e.g. for use with percentile type limits. These may determine the number of samples or measurements that need to be taken. For example:

- the number of samples that are required for a valid assessment of compliance,
- the fraction of samples, or the sampling statistic (e.g. percentile), that must be below the limit in order for the situation to be compliant.

Reporting

39 The legislation, permit etc must specify the reporting requirements, for example, what results and other information are to be reported, when, how, and to whom. Reporting aspects of compliance monitoring are considered further in Stage 7.

Quality considerations

40 It is best practice to include quality considerations in the monitoring requirement associated with the relevant limit, so that the measurements are reliable, consistent and auditable. The main quality considerations are:

- ***calibration, maintenance and certification.*** It is important that the monitoring system is regularly calibrated and maintained, and that relevant instruments, personnel and analytical laboratories are certified under recognised schemes.

- ***updating of monitoring requirements.*** It is important that the monitoring programme is regularly reviewed and updated to take account of :
  - changes in limits,
  - the latest compliance situation of the process,
  - new monitoring techniques.

- ***off-scale situations.*** Under some temporary process situations the monitoring equipment may go off-scale e.g. during abnormal conditions or during start-up or shut-down. In such cases it is important that the permit states how long the monitoring is allowed to be off-scale before emissions are judged to be non-compliant.

- ***availability and breakdown of monitoring equipment.*** It is important that the permit states if/how long a process is allowed to continue operating in the event of a breakdown of monitoring equipment. Consideration should be given to specifying requirements for data capture, off-line maintenance/calibration periods and back-up monitoring (e.g. taking of occasional spot samples while continuous monitors are unavailable).

STAGE 4: PRINCIPLES OF PRACTICAL MONITORING: *How best to monitor ?*

41 Stage 4 in the quality chain is concerned with the main principles of how best to plan and carry out monitoring. Best practice must be based on consideration of a range of practical issues relating to the monitoring of pollutants in process emissions and in receiving environments. Central to these considerations are:

- appropriate measurement methods,
- duration of the monitoring regime (e.g. year, operating life of process),
- frequency of sampling or measurements (e.g. one sample/day, measurements for one day/month; continuous measurements).
- temporal resolution to be achieved by the sampling or measurements (e.g. data resolved into average values for each minute, hour or day).
- records of relevant process and/or environmental information,
- possible use of surrogates,
- on-site safety precautions,
- quality.

42 Best practice requires:

- matching of the monitoring requirements, based on the considerations listed at para.41, to an understanding of the environmental risk an installation poses,
- specifying the level of statistical confidence required in compliance assessments in or alongside the limit value in permits or legislation.

Measurement methods

43 Monitoring must be based on recognised and validated methods, which are generally termed "standard" methods, where they are available. Standard methods are produced by CEN, ISO and the national standards organisations in Member States. Two key issues in relation to standard methods are:

- who chooses, proposes or specifies the standard method for use in a given situation,
- how is this method judged to be acceptable.

44 Standard methods may be chosen, proposed or specified for use in a compliance monitoring programme by:

- the competent authority - this is the usual procedure,
- the operator – this is usually a proposal which still needs approval by the authority,
- an expert – this is usually an independent consultant who may propose on behalf of the operator; this proposal still needs approval by the authority.

45 When deciding whether to approve the use of a method the competent authority is generally responsible for deciding if the method is acceptable, based on the following considerations:

- fitness for purpose - is the method suited to the original reason for monitoring as shown for example by the limits and performance criteria for an installation,
- legal requirements – is the method in line with EU or national law,
- facilities and expertise – are the facilities and expertise available for monitoring adequate for the proposed method e.g. technical equipment, staff experience.

46 The choice of measurement method may be constrained and/or informed if it is:

- defined in legislation (e.g. EC Directive 94/67/EC on the incineration of hazardous waste requires the use of relevant CEN standard methods),
- recommended in published technical guidance (e.g. on "State of the Art", "Best Available Techniques").

Duration of monitoring.

47 The total duration of a monitoring programme is often aligned to the operating life of a process, particularly when the timeframe(s) of any harmful effects are short compared to the operating life. However, monitoring may sometimes need to start before a process has begun operating (e.g. to establish baseline ambient concentrations before any extra impacts from the process). Similarly, monitoring may sometimes need to continue after a process has ceased operating if its harmful effects are more long-lived (e.g. monitoring of groundwater after closure of fuel depots, landfill sites or nuclear installations).

Frequency of monitoring

48 The frequency of monitoring refers to the time between individual measurements or groups of measurements at a process or in a receiving environment. It can vary widely between different situations (e.g. from one sample/year to on-line measurements covering 24-hours/day). Monitoring frequencies can be divided into two main categories:

- continuous,
- non-continuous.

49 Non-continuous monitoring can be further divided into four sub-categories:

- periodic,
- response,
- reactive,
- campaign.

50 Descriptions of the possible approaches, which should be considered, are noted below:

- ***continuous monitoring.*** This involves an ongoing series of measurements that provide data with a high time resolution (e.g. continual readings from rapid-response instruments). The data are often available in real time (e.g. as instrumental read-outs or electronic displays) and so are useful for short-term process control purposes. Continuous monitoring may be relatively expensive compared to non-continuous monitoring depending on the required frequency of periodic measurements. Also, it may not be an option for some pollutants/situations. This may be because appropriate continuous instruments have not yet been developed, or detection limits are too high to allow measurements without pre-concentration of samples, so that pollutant samples must be accumulated over a period in order to be detectable.

- ***non-continuous periodic monitoring.*** This involves measurements made at regular intervals in order to cover a defined part of the operating time of a process.

It may involve spot measurements made at regular intervals, analysis of samples accumulated over regular periods, or instrumental data obtained at regular intervals during operation of the process. The periods of monitoring should be specified in advance (e.g. in a permit or legislation) and designed to be representative of the total operation.

- ***non-continuous response monitoring*.** This involves measurements made in response to special events which are foreseeable but cannot be precisely scheduled (e.g. start-up and shut-down conditions, low and high utilisation conditions). The monitoring is done at irregular intervals. It is "routine" because the events to be measured can be anticipated but not their timing.

- ***non-continuous reactive monitoring.*** This involves measurements made in reaction to special events such as exceedances of limits, which cannot be foreseen. The work is therefore devised on an ad-hoc basis rather then being specified in advance, and is done at irregular intervals. Because of the nature of this monitoring it may not be possible to specify the measurement methods in advance.

- ***non-continuous campaign monitoring*.** This involves measurements made in response to a need or interest in obtaining more fundamental information than routine, day-by-day monitoring normally provides. The types of events which may trigger campaigns include evidence of epidemiological effects, and permit applications for new processes where baseline monitoring is needed to aid assessments. Campaign monitoring usually involves measurements that are relatively detailed, extensive and expensive, so that they cannot be justified on a regular basis. Examples are: sampling of dioxins in soil around incinerators; detailed speciation of volatile organic compounds for odour or other investigations, studies to verify more conventional measurements and estimate uncertainties, ecotoxicological surveys, and fundamental research studies.

Temporal resolution

51 Best practice entails matching the temporal resolution of monitoring to the timeframe(s) over which harmful effects or trends may occur. For example, if harmful effects may occur due to short-term pollutant impacts, then it is best to design the monitoring to give a high temporal resolution (and conversely if they are due to long-term exposure). The resolution of the monitoring should be reviewed and if necessary revised as more information becomes available (e.g. on the timeframe(s) of harmful effects).

Process and environmental information

52 When measurements are being made it is essential to collect information on concurrent conditions in the process and/or the environment. This information is needed so that the results can be put into context for purposes of interpretation and process management. This type of monitoring can also be used to show that a process is operating in normal stable mode between measurements of emissions. Examples of the types of information needed are presented in Box 7.

BOX 7: INFORMATION REQUIRED ON PROCESS AND ENVIRONMENTAL CONDITIONS	
Type of Information	Description /example
Feedstock	Type, rate and condition of input raw materials
Fuel	Type and rate of fuelling
Abatement	Type, status (e.g. on/off) and efficiency of equipment
Plant utilisation	Load factor, or percentage of plant capacity used
Residence time	Calculated time of gas in combustion chamber
Temperature	Temperature in combustion chamber or condenser of temperature releases
Flow	Flow of discharge gases; flow of intermediate products
Production	Rate of generation of useful product(s)
Ambient conditions	Meteorology or hydrology for dispersion
Normalisation Data	As needed to convert measured data to prescribed standard and conditions e.g. oxygen, carbon dioxide, humidity, pressure, temperature

53 It is best practice to record process and environmental information in a detailed archive or database. The information can then be related easily to the monitoring results and used to evaluate, compare and manage aspects of process performance such as:

- the rate of release of pollutants compared to production,
- the rate of generation of waste compared to production,
- the rate of consumption of energy and/or materials compared to production,
- the impacts on environmental receptors compared to production or to their sensitivity,
- the overall resource efficiency of the process i.e. production compared to inputs of raw materials and energy, and outputs of pollutants and waste,
- the rate of use of raw materials, for integration over time for assessment and reporting purposes.

Surrogate parameters

54 Surrogate parameters are variables which can be closely related to conventional direct measurements of pollutant releases or impacts, and which may therefore be monitored and used instead of direct values for some practical purposes. A surrogate is likely to be useful for compliance monitoring purposes if it is:

- closely and consistently related to a required direct value (e.g. relationships between opacity and particulate concentrations; condenser temperatures and VOC emissions, dust and associated metals, estimation of NO_X emissions using Predictive Emission Monitoring Systems),
- cheaper, easier or quicker to monitor than a direct value, or giving more frequent information,

- capable of being related to specified limits,
- approved for use (e.g. in permit or by competent authority); this implies that any extra uncertainty due to the surrogate must be insignificant for regulatory decisions.

55 The general requirements which must be met before surrogates can be used for compliance monitoring, and their advantages and disadvantages are summarised in Box 8.

56 Key disadvantages are that some surrogates may be more uncertain that direct measurements and may be less effective for legal purposes.

BOX 8:USE OF SURROGATES
GENERAL REQUIREMENTS, ADVANTAGES AND DISADVANTAGES

General requirements	Advantages	Disadvantages
Consistent relationship is required between surrogate direct value. Monitoring surrogate should be cheaper than monitoring direct value. It must be possible to relate surrogates values to specified limits. The use of surrogate for monitoring must be approved and must prescribe the type/form of surrogate. Process conditions when surrogates are available match conditions when direct measurements are required. The uncertainty due to use of surrogate should be determined and taken into account in deciding its significance for regulatory decisions or process management. Characterisation of surrogate is necessary including periodic evaluation and follow-up.	Cost savings; greater cost effectiveness More continuous information than possible with direct measurement e.g. continuous opacity vs. periodic dust sampling. Allows more discharge positions to be monitored for same or less resources. Sometimes more accurate than direct value e.g. fuel oil sulphur vs. directly monitored SO_2. Gives early warning of possible upset conditions or abnormal emissions e.g. combustion temperature warns of possible increase in dioxin emissions. May cause less disruption to process operation than direct measurements. May combine information from several direct measurements, so as to give a more complete and useful account of process performance e.g. temperature may be useful for energy efficiency, pollutant emissions, process control and feedstock blending. Allows recovery of corrupted monitoring data	Needs resources for calibration against direct value. Surrogate may provide a relative measurement rather than an absolute value. Surrogate may only be valid for a restricted range of process conditions. Surrogate may not command as much public confidence as direct value. Sometimes less accurate than actual measurements. Sometimes may not be acceptable for legal purposes.

Risk Assessment

57 It is best practice to assess the overall risk posed by emissions from an installation to the environment and to match the frequency and scope of the monitoring programme to this risk. These aspects of the monitoring programme may be determined by considering and combining several individual risk factors. These may be assessed, for example, as "trivial", "significant" or "critical". Monitoring requirements may then be judged to range from "minimal" for trivial cases to "continuous and comprehensive" for critical cases. Examples of the risk factors to be considered include:

- the size of the installation, which may determine its environmental impact,
- the complexity of the process, which may increase the number of potential malfunctions,
- the frequency of process switching, particularly at multi-purpose chemical plants,

- possible hazards posed by the type and amount of input feedstock and fuel materials,
- possible environmental harm resulting from emissions taking into account the pollutant types and their rates of release,
- the uncertainty in the amounts being emitted, their rate of release and their possible environmental harm,
- the possible environmental harm arising from unabated emissions if abatement equipment fails,
- the risk of emission limits and/or ambient quality standards being exceeded,
- the proximity of the environmental impacts of emissions to sensitive environmental receptors,
- the presence of natural hazards, such as geological, hydrological, meteorological or marine factors,
- past performance of the installation and its management,
- the level of technical and toxicological complexity of the installation which may increase uncertainties with regard to its operation and environmental impact,
- the degree of public concern, particularly with regard to contentious installations.

Safety precautions

58 Safety must be carefully considered before monitoring begins (either at a process or in a receiving environment) and then appropriate precautions followed. Every monitoring programme must include a requirement for a risk assessment based on a safety audit to develop a safe-working plan covering the following points:

- confirmation that the equipment and facilities which will be used are safe and adequate (e.g. electrical and sampling equipment, gas cylinders, walkways, ladders),
- guidance or briefing on how safely to access locations where monitoring is to be done,
- availability of appropriate number of qualified personnel,
- reminders concerning risks and precautions in relation to physical and toxic hazards,
- safety training of staff, including training in emergency and evacuation procedures (e.g. by means of site induction and safety courses).

Quality considerations

59 The quality requirements for practical monitoring must be set out in the monitoring programme in line with the permit conditions and/or other relevant legislation. It is best practice to include monitoring activities within an overall Quality Management System (e.g. for an installation).

60 The operators of an installation may set policies which commit the company to using recognised quality systems to manage its process operations and environmental impacts. Such policies and systems can include procedures to ensure the quality of monitoring and to help the company to develop a best practice monitoring scheme.

61 These quality policies and systems can be used to define general objectives for a best practice monitoring scheme including:

- reliability (e.g. low risk of breakdown),
- compatibility (e.g. with process conditions and operations),
- uncertainty and repeatability (e.g. of measurements),
- availability of relevant technical skills (e.g. qualified staff),
- transparency and public accessibility.

62 These quality policies and systems can also be used to define specific targets for a best practice monitoring scheme. For instrumental measurements this means having equipment which is:

- "fit for purpose" (e.g. has appropriate range and response) ,
- appropriately sited (e.g. in a process stream or a receiving environment),
- measuring at appropriate times (e.g. during relevant process operating conditions),
- subject to appropriate checks (e.g. is calibrated and maintained),
- meets availability requirements for data capture.

63 Once a best practice monitoring scheme has been defined, the quality of the scheme may be established and maintained by applying a recognised quality assurance system (e.g. one based on international standards). Best practice involves applying procedures to assure quality before, during and after monitoring so that:

- before the measurements start, all necessary steps have been taken to design and construct a robust and representative monitoring regime,
- having spare equipment available to take over if there is a breakdown,
- application of proper safeguards during the measurements, e.g. checks are made to ensure that appropriate conditions of process operation are maintained,
- after the measurements, the methods used to analyse samples or to infer results are checked e.g. checking of methods used to infer direct values from surrogate data.

64 Best practice also involves having formal procedures within the quality assurance system for certification, accreditation and calibration, as explained below:

- ***certification*****.** This is used to judge if the monitoring facilities and activities at an installation conform with a specific standard. It is done by an organisation which is formally accredited as competent to do it, and which is independent of the operator and authority. Certification involves systematically comparing different aspects of monitoring, such as equipment, quality management systems and personnel with documented criteria and procedures. National certification schemes exist in some EU member states. For best practice, the quality management system of an installation will explain: (i) which facilities and activities are certified (ii) to what standards they are certified, and (iii) what requirements this satisfies (e.g. legal requirements, permit conditions, company policy).

- ***accreditation.*** This is used formally to show that an organisation is competent to do a specific task, or that a method is fit for a particular purpose. An analytical laboratory is accredited to do one or more specific analyses. For best practice, the quality management system of an installation and/or its permit will require that accredited organisations and methods are used for monitoring work. National accreditation bodies exist in all Member States.

- ***calibration.*** This is used to test the performance of monitoring equipment against standard samples (e.g. of gases) under controlled conditions, in order to check that the equipment is giving results which are accurate to within required limits. Calibrations may be done at an installation or in an off-site laboratory, and must be repeated at regular intervals to ensure that the required performance is maintained. Particular quality considerations include:
  - calibrations must be done by personnel who are suitably qualified,
  - calibration procedures vary between different equipment and types of monitoring,
  - the intervals between calibrations vary between different equipment and situations,
  - calibration records must be kept and archived for inspection e.g. by the authority.

STAGE 5: ASSESSMENT OF MONITORING RESULTS: ***How best to judge compliance?***

65 Stage 5 in the quality chain is concerned with how best to assess the compliance of monitoring data with formal requirements. There are two aspects of compliance to be considered:

- **evidential compliance**. This means compliance with requirements to provide adequate monitoring evidence.
- **compliance with limit values**. This means compliance on the basis of monitoring results with requirements for emissions not to exceed numerical limits in permits, or for ambient impacts not to exceed quality standards in receiving environments.

66 These assessments generally involve numerical and statistical comparisons between monitoring results, taking into account the associated uncertainties in the results, and limit values.

67 It is best practice to ensure that the available monitoring results provide evidence which is adequate (i.e. is evidentially compliant) before using it to determine compliance with emission limits and environmental quality standards. This is essential because if the evidence is inadequate then any determination of compliance based on it will be invalid. Although inadequate evidence cannot be used to determine compliance, it may be used as a basis for negotiating and discussing improvements (e.g. in monitoring). The results of the assessments of compliance with evidential requirements and limit values are linked to enforcement actions for each type of compliance, as discussed in Stage 6.

Assessment of evidential compliance

68 There are two aspects of evidential compliance to be considered:

- **the adequacy of the measurements made.** This requires information on all contributions to the uncertainty in measurements including contributions due to sampling, analysis, the basic method under ideal experimental conditions, field conditions which may introduce additional uncertainty.
- **the adequacy of the available contextual information** concerning the situation in which the measurements were made. This information is needed to confirm that the measurements were made in a situation where the limit value applies (e.g. in normal operating conditions; start-up or shut-down conditions).

69 In order to assess evidential compliance it is necessary to have information on:

- **the method of measurement** including information, for example, on the standard method, any approved changes or approved alternative methods,
- **the number and/or continuity of measurements available** including, for example, information on the frequency of measurements and the percentage data capture,
- **the minimum number or continuity of measurements required** to keep uncertainties within acceptable levels, for example, the minimum required percentage data capture,
- **the uncertainty in the measurements made** for the purpose of assessing evidential compliance, this is the uncertainty prevailing in the measured value at the level of concentration (or other parameter) being measured. This uncertainty

may be expressed as a percentage or as an absolute amount, and is made up of contributions from different factors. It may be estimated from:
  - the number of measurements,
  - the method used,
  - the practical (on-site) measurement situation,
  - field calibrations made in this situation,
  - special campaigns (e.g. studies of the representativeness of sampling),
  - calibration data for surrogate parameters, where surrogates are used.
- **the maximum uncertainty expected or allowed in the measurements** estimated from the uncertainty in the method under laboratory conditions, together with the additional uncertainty expected when the method is used under well-managed field conditions,
- **the measurement context** including information on the operating situation when the measurements were made, and particularly on factors affecting the applicable limit value, for example, installation type, operating mode, utilisation, feedstock,
- **the minimum amount of contextual information required,** this is the minimum required to identify or confirm the applicable limit value.

70 Measurements can be accepted as evidentially compliant if they meet the above requirements for method, number, continuity, uncertainty and contextual information. However, they must be rejected as evidentially non-compliant if they fail to meet these requirements. In particular, measurements must be rejected if they are:
- of inadequate quality (e.g. have too much uncertainty, or systematic biases which cannot be corrected)
- of adequate quality but made in the wrong context, so that they are not relevant to the limit
- not accompanied by enough information to determine quality/context.

71 It is best practice to have a monitoring programme which delivers measurements and contextual information which have been systematically checked so that they are of known quality and quantity, and of known uncertainty.

Assessment of compliance with limit values

72 In order to assess compliance with limit values it is necessary to have four items of information:
- **the limit value for the relevant operating condition.** This is typically a pollutant emission value (e.g. mass release rate or discharge concentration) or an ambient pollutant loading (e.g. concentration or deposition on an environmental receptor). However, it may be a surrogate parameter value (e.g. opacity in place of particulate concentration), or an efficiency value (e.g. efficiency of effluent treatment).
- **the relevant measured pollutant/parameter value.** This must be based on the same operating situation and units as referred to in the limit value. It may be a single result, or based on several results (e.g. an average or percentile). The measured value is typically expressed as an absolute amount (e.g. see Box 6)
- **an estimate of the uncertainty in measurements made at the limit value.** This is the overall uncertainty in measurements when they are made in situations where an installation is operating at the emission value limit or ambient values are at the environmental quality standard. The overall uncertainty is typically composed of

contributions from different factors as listed in paragraph 69. Any systematic biases should be eliminated from the measurements, so that the estimated uncertainty is only due to random effects. This uncertainty is typically given as a statistical estimate (e.g. standard deviation) and may be expressed as a percentage or as an absolute amount.

- **a level of statistical probability or confidence** above which measurements are deemed to be not compliant (e.g. as specified in the limit or quality standard). In practice, this probability level is applied by comparing the differences between measurements and the limit with the uncertainty in the measurements. The probability level may typically be 1 in 20, which corresponds to a 95% level of confidence.

73 Before assessing compliance, all of the values should be converted into absolute amounts. For example, this means that if the uncertainty in a measured value of 10 mg/m^3 or kg/d is given as 20%, then this uncertainty is re-expressed as $\pm$ 2 mg/m^3 or kg/d.

74 The measured value can now be compared with the limit, taking account of the overall uncertainty in measurements made at the level of the limit. This comparison is illustrated below with a simple example detailed at Box 9. In the example the limit value is 10 mg/m^3, and measurements are made to within 1 mg/m^3 with an uncertainty range of $\pm$ 2 mg/m^3 at the required level of statistical confidence. The uncertainty range summarises a statistical distribution according to which there is a defined probability of the true measurement being within the range, and a defined probability of it being outside the range. There are three possible categories of outcome from the comparison as detailed in Box 9.

Box 9: Outcome categories arising from comparison of measurements with limit value

Limit value (mg/m^3)	Measurement (mg/m^3)	Uncertainty (mg/m^3)	Comparison (mg/m^3)	Outcome category
10	7 <7	$\pm$ 2	7 $\pm$ 2 v. 10 <7 $\pm$ 2 v. 10	Compliant
10	9 11	$\pm$ 2	9 $\pm$ 2 v. 10 11 $\pm$ 2 v. 10	Within uncertainty consideration
10	13 >13	$\pm$ 2	13 $\pm$ 2 v. 10 >13 $\pm$ 2 v. 10	Non-compliant

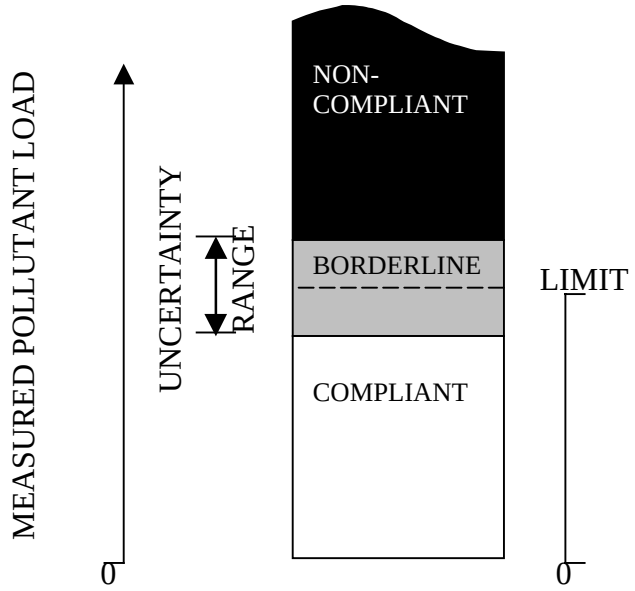
75 "Within uncertainty consideration" means that the measurements have not been able to demonstrate beyond reasonable doubt that the amount of the release is out of conformity with the limit at the required level of confidence. This outcome category is termed "borderline".

76 The three outcome categories can be used to define three compliance zones, as shown schematically in Figure 1:

- ***compliant zone***: the measured value is less than the limit, even if the value is increased by uncertainty,

- ***borderline zone***: the magnitude of difference between the measured value and the limit is less than uncertainty,
- ***non-compliant zone***: the measured value is more than the limit, even if the value is decreased by the magnitude of the uncertainty.

FIGURE 1: DETERMINATION OF COMPLIANCE ZONES (schematic)



77 As shown in the example, measurements of pollutants are compared with the limit and the uncertainty by placing them as appropriate in one of 3 zones: Compliant, Borderline, or Non-compliant.

78 In some simple cases it may be sufficient to include the uncertainty range within the limit. In practice this would mean setting the limit at the upper-bound of the borderline zone shown in Figure 1. The determination of compliance would then be based on just 2 zones i.e. compliant and non-compliant.

Quality considerations

79 For quality purposes, it is best practice to check that:

- the personnel doing the interpretation are professionally competent in statistics, uncertainty analysis and environmental law, and have a sound understanding of practical monitoring methods.
- information is interpreted within the context of the prevailing process conditions and is not extrapolated to dissimilar conditions,
- authorities and operators are aware of the quality of evidence needed to mount successful prosecutions/appeals using compliance monitoring data (e.g. as shown by recent EU/national case law).

STAGE 6: ENFORCEMENT ACTIONS: *How best to respond to compliance findings?*

80 Stage 6 in the quality chain is concerned with how the competent authorities can best respond to compliance findings based on monitoring results. This involves using the assessment of the results from Stage 5 in conjunction with other information, such as operator performance, to identify the most appropriate enforcement actions.

General aspects

81 It is best practice for the competent authority's response to an assessed situation to be in proportion to the degree of compliance or non-compliance. This means that the responses of the authority will graduate from:

- simple routine reviews in compliant situations, where the general approach is to confirm and accept a satisfactory performance,
- seeking improvements in the monitoring arrangements where the quality of results does not provide adequate evidence,
- precautionary advice and negotiation of voluntary improvements in borderline situations, where the general approach is to influence the operator towards reducing the risk of a definite non-compliance occurring,
- checking that an operator has carried out appropriate actions under self-correction arrangements,
- revision of a permit limit where a non-compliance has an acceptable environmental impact, within the provisions of the relevant legislation and taking into account the costs and benefits and the principles of precaution and prevention (e.g. when determining BAT under IPPC),
- enforcement actions in non-compliant situations (including both lack of quality monitoring for adequate evidence and exceedance of limit values), where the general approach is to ensure compliance by imposing mandatory corrective actions e.g. a formal warning, on the operator,
- prosecution/court action where a Member State's legislation requires legal action for all non-compliances or where the non-compliance is great and has a significant environmental impact and/or the process operator has a history of non-compliances and may have an impact on human health.

82 The main consideration for the competent authority to take into account when deciding on an appropriate response is the compliance zone to which a particular situation belongs. However, the authority may also take a precautionary approach particularly when other considerations give further information on the risk of non-compliances occurring in future. These extra considerations are often qualitative and may include:

- the competence of the operator,
- the reliability of the process equipment, procedures and management control,
- the previous compliance performance of the installation and/or operator,
- the sensitivity of the receiving environment,
- the possible risk of harm to the receiving environment and human health.

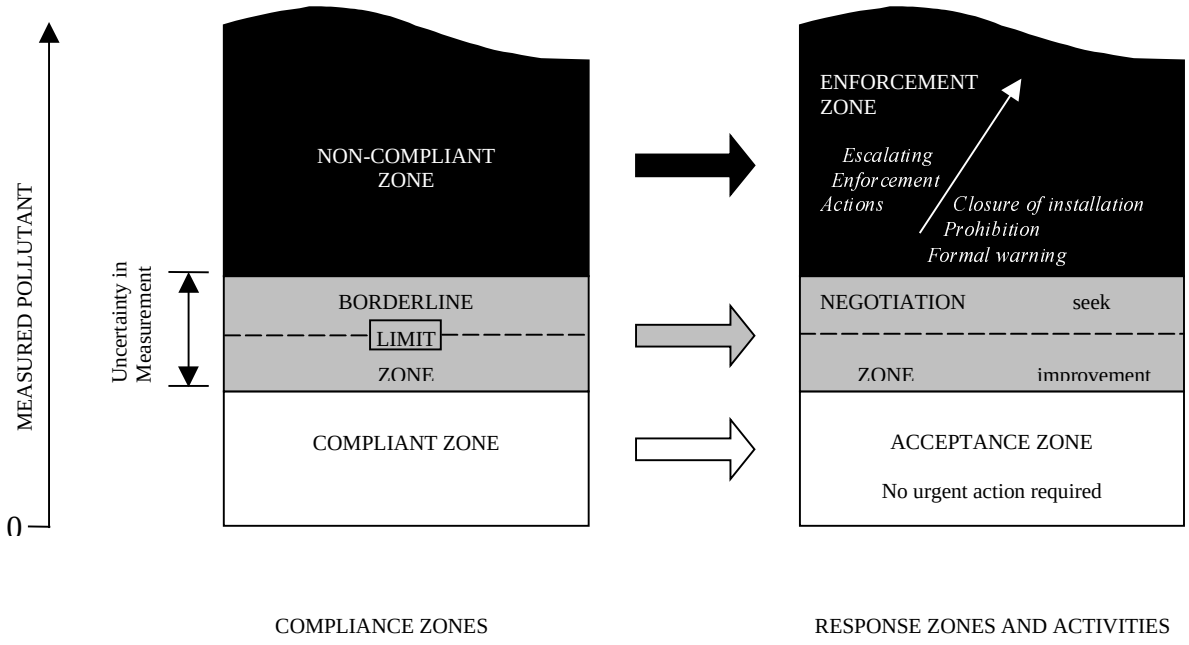
83 These qualitative considerations may lead the competent authority to adjust the thresholds at which the three forms of response (i.e. acceptance, negotiation or enforcement) may be adopted for a particular situation. For example:

- if the previous performance and competence of the operator are poor, the authority may start negotiating for improvements when the measured results are still below the threshold between the compliant and borderline zones,
- if the previous performance and competence of the operator are good, the authority may not start negotiating for improvements until the measured results are consistently above the compliant/borderline threshold.

84 The appropriate response for each type of compliance situation is summarised schematically at Figure 2 using the same system of zones. For response purposes, the original "compliant", "borderline" and "non-compliant" zones (in the compliance diagram) are re-labelled as the "acceptance", "negotiation" and "enforcement " zones, respectively (in the response diagram). The response diagram summarises the appropriate types of activity for each response situation.

85 It should be noted, that in the particular case of the simplified assessment as described in para 78 the types of responses available would be limited to compliant and non-compliant situations.

FIGURE 2 : RESPONSES TO DIFFERENT COMPLIANCE SITUATIONS



86 The results of compliance assessments should be fed back promptly to all the organisations who were involved with the original monitoring of the process. The feedback should be documented and used to ensure that monitoring effort is kept in balance with the compliance situation and is directed to the most critical or sensitive

parts of the process or of the receiving environment. This is an important aspect of the competent authority's actions when responding to the compliance findings.

Responses to compliant situations

87 In compliant situations there is no need for urgent enforcement action to protect the environment from harm. It is best practice to respond by accepting the compliant performance and by conducting a routine review of the performance of the process and the continuing requirements of the monitoring programme. The review should consider the following points:

- continuation of the monitoring programme in order to detect any possible future deterioration,
- reductions in the frequency and/or scope of the monitoring programme in order to switch effort onto higher priority situations e.g. onto borderline and non-compliant situations,
- switching from monitoring of direct values to surrogate parameters in order to save costs where the generally greater uncertainty of surrogates is acceptable in such compliant situations,
- identifying trends towards increased emissions.

Responses to borderline situations

88 Responses are needed in borderline situations in order to reduce the probability of exceeding the limit. Best practice is for the authority to negotiate with the operator and encourage the operator to make voluntary improvements. (This approach may be constrained by legal requirements in some Member States). The authority's negotiating position is likely to be stronger in situations near the top of the "borderline" zone and weaker in situations near the bottom of the zone. For statistical reasons, most situations in the zone entail an appreciable risk of non-compliance (particularly if they are towards the top zone) and, therefore, it is best practice in such situations to agree actions which will ensure that emissions do not remain in the borderline zone indefinitely.

89 Best practice is to consider requiring the process operator to:

- carry-out a detailed investigation of the individual process activities in order to establish why a borderline situation has arisen,
- develop a time-tabled plan, based on the investigation, for specific actions and improvements which can be undertaken to re-establish or achieve compliance,
- carry-out additional monitoring and reporting while the plan is being implemented, in order to demonstrate that progress is satisfactory.

90 Consultation and collaboration between the operator and the authority is important during all stages of investigation, plan development and implementation, and any necessary changes. In borderline situations, it is usually possible for responses to be made with less urgency and with less disruption or cost to the process operator than in non-compliant situations. For example, improvements may be scheduled during maintenance periods or timed to coincide with refurbishment or updating of the process.

91 If an approach based on negotiation is not successful, then the authority may intensify the monitoring, for example, by increasing the number of positions measured and the frequency of measurements. (For statistical reasons, the latter will increase the probability of measuring a definite non-compliance). The authority may then be able to respond using enforcement rather than negotiation.

Responses to non-compliant situations

92 There are variations in the responses of Member States to non-compliant situations, because of the differences allowed in national legal systems. Examples of responses are listed below:

- ***initial responses.*** After confirmation of a non-compliant situation the following initial responses should take place:
  - the operator should take action to minimise and mitigate any adverse impact to the environment, and should inform the competent authority,
  - the competent authority should take action to check that any adverse impact is minimised and mitigated, and should require the operator to investigate and report on the reasons for the non-compliance, the authority should also consider carrying out its own investigation.

- ***assessment of severity.*** Once any adverse impact to the environment has been minimised and mitigated and the results of the investigation(s) are available, the authority should decide on further actions based on an assessment of the severity of the non-compliance on the basis of:
  - its duration, frequency and foreseeability,
  - the number of limits exceeded, e.g. for different substances
  - the magnitude of the exceedence(s),
  - the reactions of the operator to minimising and mitigating adverse impacts to the environment.

93 The severity of the non-compliance should be taken into account by the competent authority when deciding on further enforcement action. These possible actions form a sequence of responses which can be escalated to match the severity of the non-compliance. In order of increasing stringency, these actions may include:

- ***issuing a warning note.*** A warning note is issued whenever a non-compliance is found. In some Member States this may not be practice when the legislation already requires an operator to take action following discovery of a non-compliance. The note may explain :
  - the nature of the non-compliance and the objective of the enforcement action,
  - the sanctions which will be applied if the enforcement action is violated
  - any criminal consequences which may follow from violation.

- ***issuing a prohibition notice.*** The authority can prohibit any operation (or part of an operation) which poses an unacceptable risk to the environment and/or cannot comply with a permit or other legal requirement e.g. enforcement actions, statutes, ordinances, or formal conditions set by the authority. The prohibition order may explain:
  - which operation is prohibited and the reasons for prohibiting it,

- what conditions the operator must satisfy so as to have the prohibition lifted,
- what sanctions will be applied if the prohibition is violated,
- any criminal consequences which may follow from violation.

- ***closure of an installation.*** The authority can give orders to close down an installation which has been built, operated or modified without having an appropriate permit. The closure order may explain:
  - the reasons for closure,
  - how and by what date the installation is to be closed down,
  - what sanctions will be applied if the closure order is violated,
  - any criminal consequences which may follow violation.

94 Fines may be imposed through legal actions taken in the courts or under administrative powers provided for by the legislation in some Member States.

95 The operator may be entitled to appeal against any of the actions and to seek compensation if the appeal is upheld.

STAGE 7: REPORTING OF MONITORING: How best to communicate monitoring results and compliance findings?

96 Stage 7 in the quality chain is primarily concerned with the reporting of compliance monitoring results. This involves effectively summarising and presenting monitoring results, related information and compliance findings. Best practice will be 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,
- quality considerations.

97 However, some other aspects of compliance monitoring, such as the agreed objectives as referred to at para.17, assignment of responsibilities, should be reported before monitoring starts.

Requirements and audiences

98 Compliance monitoring reports are required for a range of uses. Primary uses include:

- ***legislation :*** to comply with national and European law; also with legally-enforceable permit conditions and relevant legislation.
- ***evidence:*** to provide data which operators and authorities can use as evidence of compliance or non-compliance in judicial situations (e.g. prosecutions; appeals).
- ***public interest:*** to inform residents and public groups e.g. under the Aarhus "Freedom of Information" convention which gives right of access to all environmental information.

99 Secondary uses include:

- ***environmental performance:*** to show processes are employing Best Available Techniques, using resources efficiently and contributing to sustainable development.
- ***inventories:*** to provide basic information for use in release inventories.
- ***emissions trading:*** to provide data on pollutant emissions for negotiation and trading of permitted emission quotas (e.g. between installations, industry sectors, member states).
- ***charging:*** to provide data for allocating regulatory charges and environmental taxes.

100 Corresponding to this list is a range of users or "audiences" for compliance monitoring reports. These include: legislators, competent authorities, operators, prosecutors, inventory specialists, certification and accreditation bodies, charging and taxation authorities, permit traders and the public. It is best practice for organisations with responsibility for preparing reports to know how and by whom the information will be used, so they can design their reports to help these applications and users.

Responsibility for reporting

101 Responsibility for reporting compliance monitoring results is assigned to different organisations, depending on whether the results are being applied to an individual process, a group of processes, or a wider strategic review. Best practice means assigning reporting responsibilities to the appropriate level and organisation. There is a general trend in Member States towards putting more responsibility onto operators.

102 There are three main levels of information and responsibility:

- ***responsibility for individual installations.*** The operator is generally responsible for reporting compliance monitoring results for his installation to the competent authority. The authority may also produce reports on individual installations (e.g. to report the results of independent check monitoring). These may be of interest to the operator, the competent authority itself, government departments, pressure groups and the public. Best practice means ensuring that the operator's duty to report results from their own process is stated unambiguously in the relevant permit or legislation, including specifying the scope and timing of the reports.

- ***responsibility for groups of installations.*** Covering various collections of results (e.g. for installations in a particular area or industry sector). In certain cases the installation operator can be responsible for collecting and reporting the information (e.g. through local industry committees). However, the competent authority is more often responsible for collating and reporting operators' results and any authority results where the requirements transcend industrial sectors or geographical areas. Best practice means ensuring that the relative responsibilities and requirements in terms of timing, scope and format are understood and, where appropriate, defined in permits or legislation.

- ***responsibility for strategic reporting.*** This covers data relevant to wider environmental policies (e.g. national policies). The information is usually collated and reported by the competent authority or a relevant government department. Operators may have a responsibility to supply results in a form that can be used for strategic reports, and it is best practice to state this, where appropriate, in the relevant permits or legislation.

Initial planning of reports

103 There are three main aspects to consider when planning the scope of a compliance monitoring report:

- ***type of situation.*** Best practice involves defining and addressing the situation(s) which led to the requirement for compliance monitoring. Examples will include:
  - a permit condition which requires regular reporting of releases,
  - a qualification condition for an environmental certification scheme,
  - an audit to check on the accuracy of routine monitoring,
  - part of a general analysis of plant performance (e.g. life-cycle or cost-benefit analysis).
  - international reporting requirements (e.g. for EU Directives, EU Recommendations, climate protocol),
  - complaints or evidence of harmful effects,
  - exceedences of permitted limits for emissions or ambient impacts,

- commissioning trials for a new process,
- changes to an existing process and/or abatement techniques e.g. to fuel, feedstock or abatement equipment,

- ***time-scale.*** Best practice involves defining and addressing the time-scales specified in the permit or relevant legislation and those needed to assess compliance and/or environmental impacts. This includes such aspects as:
  - period: i.e. total period covered and advice on and how representative it is,
  - frequency: i.e. how often samples or readings were taken during the period,
  - response times: i.e. the response times of the instruments used,
  - averaging times: i.e. the time(s) over which data are averaged or accumulated,
  - percentiles: i.e. the type of percentile and the method of computation.

- ***location.*** Reports should cover locations of interest for judging compliance with limits on emissions and levels in receiving environments. These can range widely (e.g. from one sampling point at a single process, to ambient monitoring sites covering a region impacted by many processes). Best practice includes reporting details of:
  - monitoring positions: i.e. description and explanation of why/how they were chosen,
  - point and area sources: i.e. type, height and/or area of the emission,
  - grid reference: i.e. definition of the position of each emission,
  - receiving environments: i.e. details of local receiving environments,
  - groups: i.e. say how groups are defined .

Categories of report

104 For practical purposes it is useful to categorise compliance monitoring reports as follows:

- ***local or basic reports***. These reports are usually prepared by operators (e.g. as part of self-monitoring). They must be of a standard suitable for inputting into national and strategic reports and where appropriate must meet any permit requirements. These are relatively simple, concise and immediate reports of emissions and/or levels in receiving environments concerning:
  - compliance with a specific quantitative limit, rather than with a strategic aim or policy,
  - an individual site, installation or discrete source, or a particular location in the environment,
  - a recent campaign or an occurrence which covers a short period of time and needs to be reported promptly e.g. an exceedence report, a monthly emissions report,
  - basic or partial results (e.g. for a sub-period) which are not yet fully collated or analysed,
  - information for use in relatively short-term responses or process management,
  - local audiences e.g. the site regulator or local residents.

- ***national or strategic reports***. These reports will generally be prepared by the competent authorities or government departments but operators may also do so for example for an industry sector. These are more synoptic and infrequent reports concerning:

- several sites or installations, or a broad sector of activity e.g. the energy supply sector,
- longer periods (e.g. several years) in order to show trends,
- more complete and sophisticated analyses e.g. full statistical analyses of annual data,
- a range of environmental receptors covering a wide geographical area,
- a particular category or group of pollutants (e.g. volatile organic compounds),
- compliance with a range of limits or with a strategic aim e.g. energy efficiency,
- information for longer-term process management e.g. for planning capital investment,
- national or international audiences e.g. policy departments, national and international decision making bodies.

- ***specialised reports.*** These reports are on relatively complex or novel techniques which are generally prepared by the competent authority and used to supplement the more routine monitoring methods. Examples are reports relating to:
  - the electronic transfer of monitoring data (e.g. by telemetry) to users in real time e.g. to a regulator's computer, to residents via an electronic display at a works entrance,
  - neural networks using a computer to develop correlations between process conditions and measured emissions, which can then be used for emission control,
  - deposition surveys involving the sampling of pollutant deposits around a process (e.g. dioxins in soil around an incinerator, metals in river sediment near a sewage works).

Good reporting practices

105 There are three stages in the reporting of information on compliance monitoring:

- ***data collection.*** This involves the acquisition of basic measurements and facts. Best practice in data collection for reporting purposes should consider the following points:
  - each permit should contain a schedule which states how, when, by whom and to whom the data are to be reported, and what types of data are acceptable (e.g. calculated, measured, estimated). The schedule should cover the time-scales and locations of interest, and the format of the data. It should also gives details of relevant limits, the units to be used and any normalisation required (e.g. to standard conditions of temperature and pressure).
  - standard forms should be used for collecting data so that it is easy to compare values and to identify gaps and anomalies; these forms may be paper or electronic files.
  - the forms should record if the values are based on measurement, calculation or estimation, and identify the methods used for monitoring, sampling and analysis.
  - details of uncertainties and limitations should be collected and reported alongside the monitoring data (e.g. details of detection limits, and numbers of samples available).
  - the collected data should include full details of the prevailing process operations and/or environmental conditions (e.g. of fuel, feedstock, utilisation,

process temperature, abatement equipment, weather conditions, river level, use of receiving environments etc.) in order to set them in an operational context.

- ***data management.*** This involves the organisation of data and its conversion into information. Best practice in data management for reporting purposes should consider the following points:
  - processing: arrangements should be specified for the collation, analysis and condensation of data. Processing should be in stages so that recent data are available in a detailed form and earlier data in a more summarised form. The diagram at Figure 3 shows this staged approach. By this means data can be converted regularly into useful information and not form unmanageable "data mountains". Each operator is principally responsible for condensing the data for his installation and for preparing reports at each stage.
  - arrangements should be specified for how data are to be transferred and define the structure of any databases to be used. It is not necessarily desirable for all data are sent from an operator to the authority, or that all necessary data should be sent immediately, as this will create handling and storage problems for the authority. Instead, data can be sent in line with agreed criteria and schedules, or in response to requests.
  - the approach to estimating results below detection levels should be explained.
  - the reporting system should provide details of any software packages and statistical methods used to analyse or summarise the data.
  - data should be archived systematically so records of past performance are available. It is usually more practical for the operator to maintain this archive than the authority.

- ***presentation of results.*** This involves the delivery of information to uses in clear and usable form. Best practice in the presentation of results for reporting purposes should consider the following points:
  - programme: arrangements should identify the users of reports and define a programme of presentations using different occasions and media as appropriate (e.g. public registers, publications, meetings, Internet). Each presentation includes opportunities for feedback.
  - trends and comparisons: presentations should set results in context by showing trends over time and comparisons with other sites and standards; full use should be made of graphs and other forms of pictorial representation..
  - statistical significance: reports should indicate if exceedences or changes are significant when compared with the uncertainties in measurements and process parameters.
  - interim performance: interim reports should give performance statistics for the year to date.
  - strategic results: national and strategic reports should detail levels of compliance for different policies, activities, technologies, environmental receptors and geographical areas.
  - non-technical summaries: reports should be prepared for the public using non-technical language which can be readily understood by non-specialists.
  - distribution: arrangements should state who is responsible for distributing reports, who must receive them and when, and the number of copies required. Recipients may include the EU IPPC Bureau for use in BREF notes, and the European Environment Agency for use in emissions inventories.

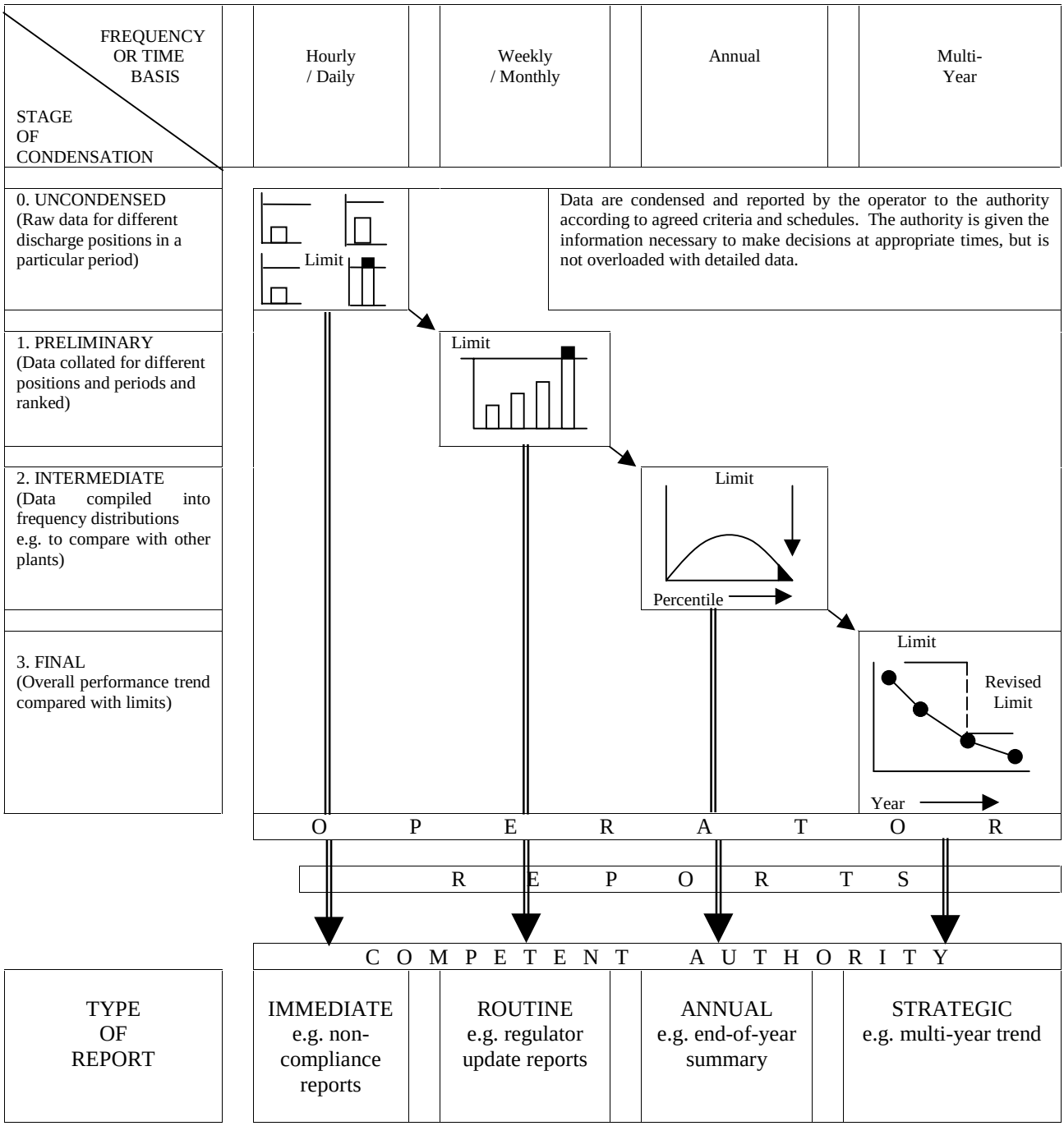
Quality considerations

106 The users of reports must have confidence that reports will be readily available and reliable (to within stated uncertainties), so that they can be used for decisions. Data-providers and authors will achieve best practice if they check the accessibility and quality of their reports as follows:

- ***quality objectives and checks***: Quality objectives for the technical standard and availability of reports should be set. Checks should be carried out to test how well these are being met. This may involve checks by both internal and external experts, and certification under a formal quality management system.
- ***competence:*** Reports should be prepared by competent and experienced teams, who maintain their skills by participating in relevant technical groups and quality initiatives e.g. in workshops and certification schemes.
- ***contingency arrangements:*** Special contingency arrangements should be in place for rapid reporting of abnormal and upset events, including off-scale conditions and breakdowns of monitoring equipment.
- ***sign-off systems:*** A nominated person should be responsible for the authenticity and quality of the information in each report using a "sign-off" system, which may be manual or electronic.
- ***retention of data:*** The operator should retain basic monitoring data and reports for periods to be agreed with the authority and makes them available to the authority on request. In particular, information which may be needed for prosecution purposes must be kept in enough detail and for long enough to be usable: i.e. it is not to be discarded or condensed so that it cannot be used as evidence in a prosecution.
- ***falsification:*** Regulators should define procedures for dealing with any falsification of reported monitoring results. These should include unannounced audits and effective legal sanctions.

FIGURE 3: STAGES IN CONDENSATION & REPORTING OF COMPLIANCE MONITORING DATA

(schematic example for a process plant)



SUMMARY

107 Compliance monitoring results, arising from measurements of emissions, environmental levels and associated parameters, are used for regulating and managing industrial installations and sewage treatment works, and for protecting the environment from emissions. High standards of compliance monitoring are therefore an important objective for competent authorities, process operators, and public groups. The main aspects of best practice involve adopting a staged approach.

Staged approach

108 The quality and usefulness of compliance monitoring results depend on how well the monitoring has been conceived, assigned, specified, executed, assessed and reported. The stages form a quality link because the quality achieved at one stage affects what is achievable at all subsequent stages. The best results are obtained by considering and optimising each stage in turn, and by applying appropriate quality systems and safeguards.

Reasons for monitoring

109 The formal or legal basis for compliance monitoring must be clearly understood by the authority, operator and other users of the monitoring results. Users will find wider benefits from the results, apart from the specific purpose of monitoring compliance with permit conditions and limits e.g. for process management, public information and sustainable development.

Responsibility for monitoring

110 Responsibility for compliance monitoring in Member States is generally divided between authorities and operators. There is no consistent division into "authority responsibilities" and "operator responsibilities". A few tasks are always done by one or other group. This variable division of responsibilities is compatible with best practice provided that safeguards are applied, irrespective of whom does the work, to ensure that monitoring is done competently and objectively, using formally-recognised equipment, personnel, procedures and laboratories.

Monitoring aspects of limit setting

111 Limits must be set in such a way that they can be monitored for compliance assessment purposes. Monitoring requirements are an integral part of limits and should be linked to each limit (e.g. when it is set in a permit). Limits and their monitoring requirements can cover a wide range of parameters including conditions within a process, emissions and impacts on receiving environments. To satisfy best practice, the monitoring aspects of limits must comply with any formal requirements, cover relevant positions and time-scales, use reference methods which are available and appropriate, be specified clearly and in detail, and include quality safeguards.

Principles of practical monitoring

112 These principles cover practical issues, such as choice of methods, timing, frequency of measurements, and requiring information on prevailing process conditions. For best practice, monitoring is usually based on measurements of direct parameters using standard methods, although sometimes it may be advantageous to use surrogate parameters if these are appropriate and well-calibrated. The frequency of monitoring work may involve continuous or non-continuous measurements. The time resolution and duration of monitoring must match those of possible adverse impacts on the environment and human health. Information on conditions in the process and in the environment must be collected at the same time as monitoring data, and safety precautions must be considered and followed. The uncertainties in monitoring results must be assessed, and the quality of practical work must be assured by appropriate calibration, maintenance, certification, and accreditation.

Assessment of monitoring results

113 The competent authority and/or the operator must confirm the quality of the measurements and other information before starting to assess compliance. This is necessary to ensure that adequate monitoring evidence is being provided. If the results are acceptable then they may be used to assess the compliance situation. This involves comparing measurements and their uncertainties with limits, and then determining if the situation is compliant, borderline, or non-compliant.

Enforcement actions

114 Appropriate enforcement actions should be identified which are consistent with the compliance situation. These should also reflect qualitative considerations such as the competence and track record of the operator. It is best practice to have a system of graduated responses, which range from routine reviews (if compliant), through voluntary improvements (if borderline) to enforcement and legal actions (if non-compliant). It is also best if the actions include feedback to optimise the monitoring work.

Reporting of monitoring

115 The authors of reports must take account of how and by whom the information will be used and should plan their reports accordingly. For best practice, the permit or relevant legislation for a process needs to explain who is responsible for reporting. It is expected that operators will be responsible for reporting on individual installations or collectively on groups of installations. The authorities may take the lead on more strategic reports covering industry sectors or national policies. All reports must explain the circumstances which led to the report and the time-scales and locations involved. Reports should achieve best practice in relation to data collection, data management and the presentation of results. Authorities must ensure that routine reports from operators are adequate for prosecution purposes. Checks must be made on the quality and availability of reports, including checks on the competence of authors, retention of past data, and falsification.

RECOMMENDATIONS FOR FURTHER STUDY

116 The Working Group recognised that compliance monitoring, as it relates to measurements of emissions and levels in receiving environments, is a complex issue. It had not been possible to address all relevant aspects in the BPCM study. The Group therefore recommended the following issues for further study:

- **an assessment of the comparability of compliance monitoring methods in Member States.** Consideration should be given to achieving a reduction in the number of technical options by harmonising measurement methods. The comparison should be supported by parallel measurements made using different methods, in order to expose areas of greater/lesser consistency. These inter-comparisons should cover methods of laboratory analysis as well as methods of sampling. A well-designed set of tests for comparing monitoring methods in different situations would be required. This study could underpin the establishment of an EU-wide quality measurement infrastructure to mee the competent authorities requirements.
- **the treatment of uncertainties in compliance monitoring data.** Consideration should be given to how uncertainties should be calculated and treated when processing compliance monitoring data and using it for regulatory responses, decisions and legal actions. For some (e.g. Hazardous Waste Incineration Directive) the treatment of uncertainties is specified; however in other cases the treatment of uncertainty is left open to interpretation. There are also seemingly differences between the approaches adopted by Member States.
- **the electronic handling of compliance monitoring data.** There are increasing opportunities to use electronic methods for transferring storing, retrieving and distributing data e.g. via E-commerce. These methods also present risks e.g. authorities may be swamped with data, data may not be ratified, the context of the data may be lost or not explained. All of these risks could mean that data could be incorrectly interpreted, or not interpreted at all. Consideration should be given to reviewing existing approaches in Member States and developing standard schemes for data condensation and standard conventions for the transmittal of data (e.g. from operator to authority).

ANNEX 1: GLOSSARY OF TERMS

In order to ensure a common understanding between Working Group members and for reporting purposes the following definitions and descriptions of terms used in this report apply:

Aarhus Convention: EU convention concerning the public's "Right to Know" about emissions from potentially polluting installations and their impacts on the environment.

Ambient limit: Limit on the amount of a substance or an effect (e.g. noise) allowed at a position in the environment.

Competent authority: National or local organisation with legal duty and relevant technical knowledge to check on the environmental performance of a process or installation.

Compliance monitoring: Measurements of pollutants and physical parameters (e.g. flow) in emissions and receiving environments, for the purpose of checking compliance with permitted limits for emissions and ambient pollutant loads.

Emission limit (value): Limit on the amount of a substance or an effect (e.g. noise) which may be emitted from a process.

Installation: The site, equipment and activities of a process permitted under the IPPC or UWWT Directives, or other national legislation.

Monitoring programme: a documented account of the facilities, activities and timetables for measurement work which is needed for compliance monitoring purposes.

Monitoring methods: The range of activities needed to measure process releases and impacts for purposes of compliance assessment and environmental protection, including the taking and analysis of samples, flow measurements, and the use of continuous monitors.

Operator: Person or organisation who is legally responsible for the environmental performance of a process or installation

Operator self-monitoring: Monitoring undertaken by the operator in accordance with a requirement of permit or relevant legislation. It may include monitoring of emissions and of impacts on receiving environments.

Predictive Emission Monitoring Systems: a method of estimating emissions using a range of related process operating data e.g. temperature, pressure, flow, residence time, excess oxygen in combustion processes.

Request for improvement: Instruction from a competent authority to an operator which asks the operator to propose a programme and timetable for improvements, which the authority can then consider accepting.

Surrogate parameter: A measured or calculated variable which is closely and consistently related to a required direct parameter; so that it may be used as a substitute for the direct parameter for compliance assessment purposes.

ANNEX 2: ACRONYMS

BPCM: Best Practice in Compliance Monitoring

BREF: Best Available Technique Reference Document

CEN: Comité Européen de Normalisation

COD: Chemical Oxygen Demand

EPER: European Pollutant Emission Register

EU: European Union

IMPEL: The European Union Network for the Implementation and Enforcement of Environmental Law.

IPPC: Integrated Pollution Prevention and Control

ISO: International Standards Organisation

LIDAR: Light Detection and Ranging

UWWT: Urban Waste Water Treatment

VOC: Volatile Organic Compound

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