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ENVIRONMENTAL MONITORING AND REPORTING BY ENTERPRISES

**FEASIBILITY OF DEVELOPING MONITORING GUIDELINES FOR CHEMICAL
INDUSTRY IN EASTERN EUROPE, CAUCASUS AND CENTRAL ASIA¹**

Introduction

Environmental monitoring by enterprises promotes environmentally-sound behaviour and creates a strong incentive to achieve compliance with environmental legislation. In addition, environmental self-monitoring is important to guarantee fair economic competition and the completeness of data for decision-making. Reliable data on emissions and their environmental impact can have high value from an economic viewpoint. Self-monitoring data can help identify and reduce environment-related costs which can form quite high share of operational costs of the plants. The proper organisation of self-monitoring can save costs and increase efficiency through reducing and managing resource use. Main areas where cost savings are apparent include the use of raw materials and supplies, reductions in waste, water and energy use, implementation of sustainable transport and packaging. By reducing environmental impacts, such as waste to landfill, companies can significantly reduce any associated taxes or charges, or avoid the cost of compliance altogether. Responsible management of risks and liabilities can lead to reduced insurance costs. A well-developed self-monitoring system ensures the earliest possible response to any environmental impact occurring due to malfunctions in production processes.

The purpose of the paper is to analyse the feasibility of developing self-monitoring guidelines for chemical industry in Eastern Europe, Caucasus and Central Asia (EECCA). The paper focuses on soda, chlorine and organic synthesis sector, covers the main requirements for self-monitoring at the international level and in the European Union (EU) and compares them with the ones in EECCA countries. The main advantage of developing detailed monitoring guidelines is to improve comparability and reliability of monitoring data, to achieve the

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harmonisation of self-monitoring requirements between different chemical companies and to raise the quality of data reported to public authorities. The guidelines would define the minimum requirements and additional voluntary or advisable parts of the self-monitoring programme to be established at chemical industry enterprises. The elaboration of guidelines for chemical industry can be a model for developing similar guidelines for other branches of industry.

Due to the resource-intensity of environmental self-monitoring, the public authorities should consider the costs of data production, analysis and reporting while imposing monitoring requirements. The preparation of the guidelines would provide an opportunity to study the cost issues as well. There is a need for a constructive dialogue to be established between the relevant public authorities and the operators of chemical enterprises in order to strengthen the motivation of industry to adequately perform environmental self-monitoring.

I. CURRENT SITUATION AND NEEDS FOR IMPROVEMENTS

A. Chemical industry developments in EECCA

In the 1990s the chemical and petrochemical industry in EECCA region passed a period of its recession. In many EECCA countries the industrial output of chemicals considerably decreased. The contribution of the chemical industry to GDP shrank to its minimum. Some chemical enterprises either were shut down or decreased their production by 50-70% of their planned capacities.

Such deep recession was caused by the following economic and technical factors:

- Severe economic situation as a whole in all countries;
- Interruption of vital trade and economic links between countries inside the EECCA subregion and with other countries that resulted in loss of markets;
- Lack of national and foreign investments in the chemical industry;
- Low level of research and development in the chemical industry;
- Use of outdated and worn-out equipment and technology, at many chemical companies (about 50-80% equipment needed to be replaced);
- Lack of experience, knowledge and training activities in industrial sustainable development in the transition conditions to the market economy.

Due to these reasons, the economic and technical levels of development in the chemical industry in EECCA are considerably lower than in developed market economy countries. In many cases, quality of chemicals produced does not meet international standards and they could not compete with the chemicals presented at the world market. The main concern of the chemical and petrochemical industry today is outdated and worn-out equipment and technologies which are used by many chemical companies. Modernization and renovation of technologies and equipment are vital tasks for the chemical industry in the near future in EECCA.

It should be mentioned as a general trend that from the year 2000 the chemical industry of EECCA countries started to recover and, in some countries, demonstrated growth in production of chemicals. For example, in the Russian Federation industrial output of the chemical and petrochemical industry increased by 1.43 times during 2000 - 2006. At present,

the share of the chemical and petrochemical industries is 10.4 % of total output of the manufacturing industries in the country. According to the Russian Federation Strategy on the Development of the Chemical and Petrochemical Industries up to 2015², it is envisaged to increase the output by 1.6 times in 2015 compare with 2005. Similar trends in the developments in the chemical and petrochemical industry are taking place in other EECCA countries, depending on their national and local conditions.

Expansion of the chemical products at world market is the main factor of future development of the chemical industry in EECCA countries. The introduction of chemical products to international market could be possible through improvement of present competitiveness of chemical products from EECCA countries in European and global markets. In many countries chemical export consists of raw materials instead of high value-added chemical products. Market and consumers require the information on the exposure to chemicals used (product assessment) and their toxicological properties. Self-monitoring systems could help in providing such information.

In order to speed up positive developments, modernization of technologies and introduction of new, less hazardous chemicals are needed. Advanced technological developments, innovations and introduction of new products in the chemical industry should be accompanied by the improvement of enterprises' environmental performance, which could be proved and demonstrated to the customers and the public by the data obtained from self-monitoring systems.

B. Environmental impact of chemical industry

The chemical industry is one of the major polluting sectors of the national economy. By the scale of danger it occupies the second place according the public opinion among the main environment polluting sectors. Its environmental effects comprises the following:

- Emission of air pollutants, mainly SO₂, NO_x, CO₂, CO, H₂S, hydrocarbons, including persistent organic pollutants (POPs) and other toxic substances into the atmosphere;
- Discharges of industrial waste-water containing all kinds of toxic substances (acids, alkalis, different cyanides etc.) and heavy metals (mercury, cadmium chromium, copper, cobalt and others) causing the deterioration of the quality of surface and groundwater;
- Solid waste and sludge, including sinters, ash, residues, arsenic and asbestos waste and active slimes from biological waste-water treatment leading, in conjunction with air emissions and water discharges, to soil contamination.

According to the above-mentioned Russian Federation Strategy, the chemical and petrochemical industries occupy the second place among industrial generators of industrial waste-water and the tenth place among air pollution contributors. Trends in air emissions, waste water discharges and waste generation by the chemical and petrochemical industries in the Russian Federation are presented in table 1. At present, only up to 20 –30 % of solid industrial waste and sludge are treated or recycled.

² www.minprom.gov.ru/activity/chem/strateg.

Table 1. Environmental pressures by chemical industry in the Russian Federation

Type of pressure	2000	2002	2003	2004
Air emissions (thousand tons)	428,0	428,0	403,3	407,6
Waste water discharges (million m ³)	1660	1302,6	1245,7	1126,1
Waste (million tons)		116,4	120,3	133,2

Source: State-of-the-environment reports of the Russian Federation. Moscow, 2001-2005.

One of the ways of human exposure to chemicals is via consumer chemicals, which includes food, commercial goods, construction materials, and house applications. There is a gap in knowledge of ecotoxicological effects of human and environmental exposure to commercial chemicals.

The chemical industry is the main generator of hazardous waste. Storage of hazardous waste either at industrial sites or at landfills creates problems by contaminating groundwater and soil in the vicinity of waste dumps.

C. Main legal and regulatory requirements for self-monitoring in EECCA

In EECCA countries environmental monitoring and reporting are carried out according to the requirements of basic laws and codes on environmental protection, decrees and directives of Presidents, resolutions of the Governments (Cabinet of Ministers) as well as different technical norms, standards and instructions. In addition, the provisions of some other basic laws are applied (Law on Health Protection, Water Code, Criminal Code, Labour Code, etc.).

For example, the legal and regulatory base for environmental self-monitoring and reporting in the Russian Federation includes Law on Environmental Protection Article 67 (No 7 FL, 10 January 2002); Resolution of the Government on the Approval of the Regulation on the Federal Service on Ecological, Technical and Atomic Inspection (No 401, 30 July, 2004); Resolution of the Government on Approval of the Regulation on the Organisation and Implementation of State Environmental Monitoring (No 177, 31 March 2003) and Resolution of the Government on Procedure of Development and Dissemination of the Annual Governmental State of Environment Report (No 53, 24 January 1993).

At present some EECCA countries are making progress in the development of environmental legal frameworks following international benchmarks. Many basic laws on environmental protection were developed and adopted and existing laws amended to adapt them to new conditions. However, the implementation and enforcement of basic environmental legislation are restrained by existing unrevised old secondary legislation (different technical regulations, norms and standards etc.), including the regulations on environmental self-monitoring. In some cases by-laws are not in consistency with the basic legislation.

According to the existing legislation local authorities keep the list of hazardous installations, issue environmental permits and undertake control and inspection of industrial installations on compliance with existing environmental norms and standards related to air, water and waste. Operator of the chemical installation is obliged to undertake all necessary measures in order to produce, transport and use of chemicals in environmentally friendly manner to avoid

adverse environmental effects. In some countries environmental legislation restricts production and use of those chemicals, toxicological properties of which are unknown.

Environmental quality norms and standards, including maximum allowable concentrations (MAC), used in EECCA countries include hundreds of parameters and substances. MACs are very low for many environmental pollutants because they were developed taking into account only zero impact on human health, without any assessment of economic consequences to comply with them. The compliance with existing strict MACs of pollutants in emissions and discharges impose high costs on industry in EECCA countries. At the same time in EECCA countries the assessment of the technical and economic consequences of emission limit values set for enterprises are not carried out.

Depending on the governmental structure in EECCA countries, enterprise self-monitoring data is reported to local environmental and statistic authorities (environmental and statistical departments of rayon and/or Oblast); central environmental and statistical bodies (Ministries of Environmental Protection, Environmental State Agencies; Ministries of Health, Statistical Committees or Agencies). Information on air protection and environmental expenditures is reported to central statistic bodies; schedule of analytical measurements, data on air emissions, information on generation, treatment and disposal of waste are reported to local and central statistical and/or environmental authorities; data on use and discharge of water is reported to local water bodies; information on quality of drinking water, sanitary conditions at the sites, state of sanitary protected zone, as well as information on effects of the pollution on staff's health is provided to central and local health authorities.

Enterprises use different kind of forms for environmental reporting to various authorities. Reporting frequency depends on the data and the receiving body (annually, quarterly, monthly or daily). Enterprises also submit environmental data upon requests from public authorities.

Main shortcomings of self-monitoring systems at chemical installations in EECCA may be explained by:

- Gaps or contradictions in the legislation. The definition of the scope of self-monitoring is not based on legally binding documents and self-monitoring programmes are not part of the environmental permit;
- Lack of coordination and communication between different environmental and health authorities at different levels when setting the environmental permit conditions;
- Non-compliance with quality assurance and quality control requirements for self-monitoring;
- Low technical and instrumental base of both industries and public authorities.

D. Organization of environmental monitoring at EECCA enterprises

Basic structure of the self-monitoring system in EECCA countries includes directors and chief engineer of enterprise, chief of analytical control accredited laboratory, laboratory's department on monitoring air, water and waste as well as department of industrial sanitary. Large analytical laboratories on monitoring emissions, discharges and deposition of waste, including accredited laboratories have been established at large enterprises. If a chemical enterprise does not have an accredited laboratory it has to conclude an agreement on carrying out sampling and analysis with an accredited one. Use of mobile laboratories for purpose of self-monitoring at enterprises is also coming to practice.

As usual the system of environmental self-monitoring consists of “Production Ecological Control” (PEC) and “Production Ecological Monitoring” (PEM) or just PEC. The system includes, inter alia, control of concentrations of pollutants in air and water, including groundwater at the sites and their vicinities; noise and vibration measurements at the industrial site; collection and processing of analytical information, assessment of life cycle of chemicals and environmental impact assessment of industrial sites and their vicinities. Some chemical companies introduced automatic control environmental system for measurement of pollutants.

A number of chemical enterprises in EECCA countries have received certificates corresponding to international standards ISO 14000 and 14001 regulating environmental management systems.

II. INTERNATIONAL REQUIREMENTS FOR SELF-MONITORING BY CHEMICAL INDUSTRY AND EU PRACTICES

A. International environmental agreements

Stockholm Convention on Persistent Organic Pollutants. Parties in EECCA: Armenia, Azerbaijan, Belarus, Georgia, Kyrgyzstan, Moldova, Ukraine and Tajikistan.

The Convention prohibits the production and use of POPs according to the list, set out in the Convention. Nine out of twelve prohibited POPs are pesticides. In addition to this list the Convention stipulates that other hazardous substances, which possess properties of high toxicity, persistency and effect of bioaccumulation can be covered by the Convention. Chemical companies should reduce or stop production of such products and undertake measures to treat and dispose of POPs stored. The Convention also requires the substitution of hazardous chemicals produced by alternative ones which are less- or non-hazardous.

Under the Convention national implementation plans were developed in EECCA countries. It is planned to carry out of national inventories of existing POPs and eliminate them by environmentally sound methods. Certainly, the data of national environmental monitoring systems, including self monitoring at the industrial chemical sites would be needed to implement measures under the Convention.

Convention on Long-range Transboundary Air Pollution and its 8 protocols. Parties to the Convention in EECCA: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation and Ukraine.

Parties to the Convention should report on, inter alia, emissions and their sources, abatement technologies and their costs, depositions and concentration of air pollutants, critical load of air pollutants and their impact on human health and the environment as well as on the national strategies and policy on air pollution abatement. Air emissions includes SO₂, NO_x, NH₃, CH₄, CO₂, CO, NMVOCs, heavy metals (Cd, Hg, Pb) and selected POPs.

National reporting obligations could not be fulfilled without active participation of industry, in particular, without data on emissions and their sources, technologies and environmental effects. Submitted data is used for the preparation of strategies and policies for air pollution

abatement in the ECE region. These data is also base for the modelling transboundary movement and depositions of air pollutants.

Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (The Aarhus Convention). Parties in EECCA: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan and Ukraine and. The Protocol on Pollutant Release and Transfer Registers (PRTRs) was developed and signed by 36 ECE countries, including 5 EECCA countries: Armenia, Georgia, Moldova, Tajikistan and Ukraine.

Parties to the Convention are obliged to:

- Establish mandatory systems containing the information concerning proposed and existing activities, which may significantly effect the environment to be provided to public authorities;
- Encourage operators whose activities have a significant impact on the environment to inform the public regularly of the environmental impact of their activities and products, where appropriate within the framework of voluntary eco-labelling or eco-auditing schemes or by other means;
- Develop mechanism to ensure that sufficient product information is made available to the public in a manner, which enable consumers to make informed environmental choices;
- Take steps to established nationwide system of pollution inventory or registers.

Parties to the Protocol are obliged to establish national PRTRs and provide public access to its data. Large industrial companies should report on the emissions of 86 pollutants. Chemical enterprises, waste water treatment installations and waste management facilities are listed under the Protocol. Development and implementation of Pollutant Release Registers at chemical enterprises, which is used as source of information for establishment of national PRTRs should be mandatory under the national legislation.

Convention on the Transboundary Effects of Industrial Accidents. Parties in EECCA: Armenia, Azerbaijan, Belarus, Kazakhstan, and the Russian Federation.

Parties to the Convention should undertake all necessary measures for the prevention of, preparedness for and response to, industrial accident and its transboundary effects. Large chemical hazardous installations should prepare and implement on-site and off-site contingency plans to be activated in the case of industrial accident. Preparation of such plans required a lot of environmental data, in particular, information on human and environmental effects of all chemical products used and produced at companies. Self-monitoring data are indispensable source of information for the preparation of contingency plans.

Convention on the Protection of the Marine Environment of the Baltic Sea Area. Party in EECCA: the Russian Federation.

A monitoring programme is implemented under the Convention to collect data on emissions of hazardous substances from industrial activities into the Baltic Sea. Data of self-monitoring by industrial enterprises are used in this programme.

Basel Convention on the Control of Transboundary Movements of Hazardous Waste their Disposal. Parties in EECCA: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, the Russian Federation, Turkmenistan, Ukraine and Uzbekistan.

Parties should report on the generation, movements, treatment, disposal and transition of hazardous waste. Reduction of waste generation at source is a priority for the implementation of the Convention. Consequently, data on of waste generation at source should be one of main objectives of self-monitoring systems in the Parties. According to the Convention the import of hazardous waste is prohibited.

The International Conference on Chemicals Management (ICCM) adopted a new international voluntary agreement on **the Strategic Approach to International Chemicals Management (SAICM)** in February 2006. The agreement was developed and adopted as achievement of the goal of the 2002 Johannesburg World Summit on Sustainable Development of ensuring that, by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health. The agreement contains a global plan of action on management of chemicals and hazardous waste and new policy on regulation of hazards of chemicals and industrial waste. It includes hazard and risk assessment of chemicals through the use of a life cycle or “cradle-to-grave” approach and the harmonization of the chemical labelling systems at the international levels.

B. UNECE Enterprise Monitoring Guidelines

The *Guidelines for Strengthening Environmental Monitoring and Reporting by Enterprises* prepared by the UNECE Working Group on Environmental Monitoring and Assessment (<http://www.unece.org/env/documents/2007/ece/cep/ece.cep.2007.9.e.pdf>) offer general rules for establishing and improving environmental monitoring and reporting system at the enterprises, in particular in EECCA countries.

The Guidelines prescribe monitoring and reporting requirements for enterprises, including chemical enterprises. The Guidelines is important tool for the governmental authorities to introduce a framework for environmental monitoring and reporting requirements at the enterprises, aiming at the improvement of environmental management as a whole. They are also useful instrument for the operators of enterprises to develop or revise and implement effective enterprise environmental monitoring programme.

The Guidelines recommend to cover by self-monitoring programmes operation monitoring, emission monitoring and monitoring of environmental quality. Programmes should address operational conditions, monitoring parameters, frequency of measurements, responsibilities, technical details of sampling and monitoring methods used.

C. Main requirements for self-monitoring in chemical industry in EU

According to EU Chemical Policy Review, published by the European Chemical Industry Council (CEFIC) (www.cefic.org), existing EU legislation on chemicals includes about 500 Directives, Regulations, Decisions and Recommendations. The main objectives of this legal framework are: protection of health and the environment at high level and prevention of barriers to free trade within a single chemical market. It includes substantial management of chemicals, environmental protection, occupational health, chemicals and consumer protection, technology and transport safety (chemical safety).

The main reasons why self-monitoring is required in EU are the following:

- For compliance assessment purposes, i.e. self-monitoring is needed to identify and quantify the plant performance, thereby allowing the authorities to check compliance with the conditions in the permit;
- For the purposes of reporting of industrial emissions, i.e. self-monitoring is needed to generate information for reports on environmental performance of industries, among them to meet the reporting obligation under the various legislative acts;
- In some cases this information is also applicable for the assessment of financial charges, taxation or emission trading;
- For the purposes of informing the public and various stakeholders.

Environmental self-monitoring requirements are established in EU at different legislative levels. General self-monitoring requirements are set at the level of Directive on Integrated Pollution Prevention and Control (IPPC, 96/61/EC), Regulation on Eco-Management and Audit Scheme (EMAS, 761/2001/EC), Regulation on Pollutant Release and Transfer Registers (PRTR, 166/2006/EC). More specific and sectoral requirements are set by the Large Combustion Plants Directive (2001/80/EC), Incineration of Waste Directive (2000/76/EC), The Directive on Waste (2006/12/EC), Water Framework Directive (2000/60/EC), Urban Waste Water Directive (91/271/EEC, as amended by Directive 98/15/EC), Air Quality Framework Directive (96/62/EC) together with relevant Daughter Directives.

The next level for setting environmental self-monitoring requirements for chemical industry derives from the IPPC Directive and is stated in Best Available Technique Reference documents (BREFs). Many of the BREFs include a chapter on self-monitoring which contains the lists of pollutants to be monitored and other relevant requirements including, for instance, measurement frequency and other timing considerations.

The purpose of the **IPPC Directive** is to achieve an integrated system of pollution prevention and control for a range of specified industrial activities including measures concerning waste. The aim of the integrated system is to prevent or reduce emissions to air, water and land (including waste) and to achieve a high level of protection of the environment as a whole. The Directive requires Member States to establish an integrated system of permits that contain specific conditions, including emission limit values and the application of Best Available Techniques.

The Directive requires applicants for authorizations to supply details of the installation and its activities, materials and energy used on the site, the sources of emissions, conditions on the site, likely emissions to the environment and their possible effects, techniques to prevent or reduce emissions, measures for the prevention and recovery of waste, operational parameters of the site, and monitoring proposals.

Member States should establish a procedure for the inspection and monitoring of facilities to ensure compliance with permit conditions. The monitoring procedure may involve both the competent authority in inspecting and taking samples, and a degree of self-monitoring undertaken by the operator. The competent authority should decide on the scope of self-monitoring which is appropriate for particular installations and it should specify the conditions to be upheld by the operator in carrying out self-monitoring. An audit procedure should be applied to such results. A procedure should be established such that the competent

authority is regularly informed by the operator of the results of monitoring or of any incident affecting the environment.

In some EU Member States self-monitoring programmes must be inspected regularly at the operator's expense by an external consultant. The costs of the permitting system, including monitoring and inspections, are met by industry, with the regulatory bodies determining the nature and timing of the inspections. The competent authority needs to ensure that monitoring is undertaken to verify compliance with the permit conditions. The permit contains conditions specifying self-monitoring to be performed by the plant operator, including the parameters to be monitored, analytical techniques to be used, frequency and recording format. The competent authority should undertake periodic inspections to ensure that the permit conditions are complied with and that monitoring is undertaken correctly. At least a proportion of these inspections is made unannounced. A public register needs to be established containing details of permits granted and monitoring results.

The overview of different pieces of EU legislation setting the monitoring and reporting requirements is presented in Table 2.

Table 2. Overview of the EU legislation setting the monitoring and reporting requirements

Legislative Act	Requirements
<i>Directive on Integrated Pollution Prevention and Control (IPPC, 96/61/EC)</i>	The Directive requires applicants for authorizations to supply details of the installation and its activities, materials and energy used on the site, the sources of emissions, conditions on the site, likely emissions to the environment and their possible effects, techniques to prevent or reduce emissions, measures for the prevention and recovery of waste, operational parameters of the site and monitoring proposals.
<i>Regulation on Eco-Management and Audit Scheme (EMAS, 761/2001/EC)</i>	The adoption of an environmental management scheme under the EMAS Regulation within a company helps it to, inter alia, comply with regulatory instruments and provides organizational guarantees that the company is capable of identifying, monitoring and acting upon the environmental impacts of its activities on a continuous basis. Both the IPPC Directive and the EMAS Regulation stress the importance of monitoring environmental effects, reducing environmental impacts and using an integrated approach to seeking solutions for different environmental problems.
<i>Regulation on Pollutant Release and Transfer Registers (PRTR, 166/2006/EC)</i>	Regulation sets up a Pollutant Release and Transfer Register at EU level in the form of a publicly accessible electronic database. The register contains information on releases of pollutants to air, water and land, as well as transfers of waste and pollutants, where emissions

	<p>exceed certain threshold values and result from specific activities. Operators carrying out the activities listed in Annex I of the Directive will submit information to the competent national authority if their activities involve releases or transfers of pollutants exceeding certain threshold values. The public is able to access this register free of charge on the internet and will be able to find information using various search criteria.</p>
<i>Large Combustion Plants Directive (2001/80/EC)</i>	<p>The Directive contains various requirements for self-monitoring. The requirements of the Directive are applicable to the chemical companies who operate a combustion plant with the capacity equal or higher than 50 MW.</p>
<i>Incineration of Waste Directive (2000/76/EC)</i>	<p>The Directive regulates the permitting, design, equipment, and operation of waste incineration plants in order to control air pollution. It lays down extensive requirements for monitoring, inspection and reporting by the operators of such plants and establish different emission limit values depending on the nominal capacity of the plant.</p>
<i>The Landfill Directive (99/31/EC)</i>	<p>The Directive sets standards for the operation of landfills. Its provisions cover the opening, management, closure and monitoring of sites and the acceptability of the waste for landfill.</p>
<i>The Directive on Waste(2006/12/EC)</i>	<p>The Directive defines the general waste issues including categories of waste, disposal operations and recovery operations. It lays down general monitoring and reporting requirements in this field.</p>
<i>Water Framework Directive (2000/60/EC)</i>	<p>According to the Directive self-monitoring must be established for:</p> <ul style="list-style-type: none"> • Surface waters, for ecological, physical and chemical and morphological parameters; • Groundwater, for physical and chemical parameters at the industrial sites and in the vicinity of enterprises; • Discharges of waste water, parameters depending on the particular case. <p>The Directive uses combined approach addressing concurrently the measures achievable at source through the application of technology and the needs of the receiving environment in the form of quality objectives.</p>
<i>Air Quality Framework Directive (96/62/EC)</i>	<p>The Directive requires the introduction of statutory ambient air quality standards and alert thresholds in Member States. It also requires the establishment and co-ordination of an ambient air quality monitoring and assessment programme</p>

	<p>and reporting the results of monitoring annually to the European Commission and the public. The system to ensure that the public is notified when alert thresholds are exceeded should be put in place.</p> <p>Public authorities should prepare plans to improve air quality in areas where it does not meet the ambient air quality standards. Operators and local authorities will need to be consulted, to determine technically and financially realistic approaches to reducing emissions to prescribed standards. Implementing plans for improving air quality require co-operation between the competent authorities and operators in the private sector.</p>
<i>Directive on Public Access to Environmental Information (2003/4/EC)</i>	The purpose of the Directive is to guarantee the right of access to environmental information held by or for public authorities and to set out the basic terms and conditions of and practical arrangements for its exercise and to ensure that environmental information is progressively made available and disseminated to the public in order to achieve the widest possible systematic availability and dissemination to the public of environmental information. The use in particular of computer telecommunication and/or electronic technology, where available is promoted.
<i>Regulation on the Application of the Provisions of the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters to Community Institutions and Bodies (1367/2006/EC)</i>	The objective of the Regulation is to contribute to the implementation of the obligations arising under the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters by laying down rules to apply the provisions of the Convention to EU institutions and bodies.
<i>The Seveso II Directive (96/82/EC)</i>	The Directive aims to ensure high levels of protection against accidents involving dangerous substances. Operators of establishments where certain quantities of dangerous substances are present are requested to notify the competent authorities and to establish and implement a major accident prevention policy.
<i>Directive on Dangerous Substances (67/548/EEC)</i>	The Directive introduces common provisions on the classification of dangerous substances as placing a substance into one or several defined classes of danger characterizes the type and severity of the adverse effects that the substance can cause; packaging of dangerous substances as adequate packaging protects from the known dangers of a substance; labelling of dangerous

	substances as the label on the packaging informs about the nature of the dangers of the substance inside and about the safety measures to apply during handling and use. The notification system of new substances of the Directive will be substituted by REACH Regulation.
<i>The Forthcoming Directive on Soil Protection</i>	The Directive would establish a common framework to protect soil on the basis of the principles of preservation of soil functions, prevention of soil degradation, mitigation of its effects, restoration of degraded soils and integration in other sectoral policies. It contains the requirement to identify, describe and assess the impact of some sectoral policies on soil degradation processes with a view to protect soil functions and the requirement for land users to take precautionary measures when their use of the soil can be expected to significantly hamper soil functions. Measures to limit the introduction of dangerous substances into the soil, to avoid accumulation in soil that would hamper soil functions and create a risk to human health and the environment and the definition of contaminated sites and a list of potentially soil polluting activities would be established.

III. ADVANTAGES OF MODERNIZING/UPGRADING AND STRENGTHENING ENVIRONMENTAL MONITORING PROGRAMMES AT CHEMICAL INSTALLATIONS IN EECCA

Self-monitoring regulations and systems in EECCA countries are being affected by the modernization and strengthening environmental legislation in individual countries, the implementation of international obligations of EECCA countries resulting from their membership in multilateral environmental agreements, political decisions taken in EECCA countries to harmonize national legislation or make it compatible with that of the EU requirements, interests of companies and enterprises themselves including the need to upgrade environmental management systems to penetrate European and world markets, and, last, but not least, the pressure from the public.

At present harmonization of national environmental legislation, including norms and standards with EU is a policy priority in some EECCA countries. Irrespective of the fact whether such political decision has been taken or not, several EECCA countries have started to revise old standards and norms to more realistic MACs and introduce new environmental permitting reforms taking into account the provisions IPPC Directive 96/61/EC. New regulations stimulate integrated environmental permits based on best available techniques (BAT) for enterprises and replace environmental quality-based permit requirements with technology-based emission limit values. The requirements for enterprise's self-monitoring system are being included in environmental integrated permits.

The application of international chemical regulations containing requirements for certification is essential task, especially for those EECCA countries, which joined or are in the process of joining World Trade Organisation (WTO). The access to international chemical markets, to great extent, depends on how effectively and properly chemical enterprises will implement requirements according to existing and new EU new legislation on chemicals. The recently adopted EU system on Registration, Evaluation and Authorization of Chemicals (REACH) requires the chemical industry in EECCA countries to harmonize and adapt its classification and labelling systems in order to maintain the competitiveness on the European chemical market. From 1st June 2007 the import of chemicals from EECCA countries to EU countries will be under the REACH procedure through the new European Chemicals Agency. This will require the improvement of overall chemical safety at chemical facilities and, especially, the knowledge of toxicity of produced chemicals and their adverse impact on human beings and the environment during their life cycle (from production to disposal).

The success of environmental protection depends, to great extent, on whether environmental issues are considered by the companies as one of important factors of their competitive market for credits, investments and products. High environmental performance of chemical companies is also important base for their financial achievements. Those companies which invest in environmental monitoring and reporting not only improve their image and reduce input costs but create also favourable conditions for foreign credits, trade and participation in stock markets.

The development of internationally-agreed guidelines on environmental monitoring programmes in EECCA chemical industry focusing on chlorine, soda and organic synthesis sectors would help companies and enterprises to address their most significant environmental impacts and report on these impacts in a way that meets the needs of various stakeholders. They will also help to demonstrate how chemical companies can address environmental impacts in their supply chains and products and demonstrate their environmental performance to their customers. Companies can demonstrate to other stakeholders its progress towards sustainable development through the use of recognised guidelines and frameworks with appropriate performance indicators. Reporting on relevant environmental issues in a clear and transparent way improves the trust among the customers and increases the confidence into the chemical company's products.

A. Advantages for chemical companies

As environmental costs form quite high share of operational costs of the chemical plants the accurate self-monitoring data can be extremely valuable from the economical point of view. The reduction of operational costs can be obtained through reduction and managing of resource, including energy and water use. Reductions in emissions, discharges and waste lead to the reduction of any associated taxes and charges.

The implementation of Guidelines for self-monitoring by chemical companies would allow to reach the following outcomes:

- Improvement of overall chemical safety in the area where a company is situated and image of chemical companies by providing reliable environmental information and data to the public in the vicinity of plants and surrounding residential areas;
- Investigations in the toxicity of all chemicals used and produced in the technological processes at an enterprise;

- Special attention addressed to persistent organic pollutants (POPs) and other persistent chemicals, research and development in their lifecycle and investigation in the alternative technologies for their substitution by less hazardous products;
- Development and implementation of the precautionary and warning systems at the chemical enterprises in the case of industrial accidents, including the measures for the first medical aid;
- Use of mass balances as a monitoring method for definition of quantities of polluters in air emissions, water discharges, generated waste and their uncontrolled losses, for example, mercury losses in chlor-alkali production;
- Methodological guidance to enterprises on such issues as monitoring of groundwaters, monitoring of chemical waste storage, and ecotoxicological evaluations;
- Development of measures, based on monitoring data, to reduce the generation of hazardous industrial waste and their toxicity in order to decrease the cost of their treatment and disposal at landfills, including storage of low hazardous waste with municipal waste, and elimination of non-authorized dumps;
- Use of modern equipment and methods for sampling and analysis of air, water and soil quality, including new methods for underground water and soil analysis at the sites and in the vicinity of enterprises;
- Facilitating the implementation of automatic control systems to define and minimize the release of hazardous substances and generation of waste in technological units;
- Adequate balance between self-monitoring requirements and expenditures needed, including mandatory monitoring system and voluntary self-monitoring data;
- Adaptation of environmental management systems at chemical industry enterprises to international requirements and good practices;
- Contribution to comply with existing and upcoming national and international environmental regulations, norms and standards, which facilitates exports of chemicals to world markets;
- Contribution to the improvement of chemical products quality;
- Improvement of links between chemical companies by means of the exchange of environmental monitoring data and experiences;
- Facilitating the cooperation of chemical companies on waste reduction, treatment and disposal, including the use of joint facilities for waste treatment, which would result in the reduction of payment for waste disposal.

B. Advantages for central environmental and health authorities

The guidelines would help to harmonize self-monitoring principles within the chemical industry across all EECCA countries and avoid the possibility that the authorities require industries to monitor the maximum possible number of parameters without balancing the scope of self-monitoring with reasonable costs. This would also avoid the possibility that authorities themselves do not have sufficient resources to analyze data and information they receive from industry.

Effective environmental self-monitoring programmes by chemical enterprises would considerably contribute to:

- Preparation of national and local state-of-environment assessment reports;

- Assessment of adverse effects of the chemical industry on human beings and the environment followed by the development and implementation of measures to reduce such effects;
- Development, updating and implementation of environmental policy at governmental, local and enterprise levels, including national environmental action plans;
- Improvement of sustainable use of raw materials and energy at the national and local levels;
- Provision of environmental information to international bodies to fulfil national obligations under multilateral environmental agreements and programmes.

C. Advantages for local authorities and the general public

First of all, local authorities and the public would profit in the improvement of environmental and living conditions in the area. Organisation of self-monitoring reduces public expenditure on governmental compliance monitoring. The public would have a better access to the information on the air, water and soil quality, including concentrations of harmful substances at the industrial sites and surroundings through database in Internet.

Better quality environmental self-monitoring data would help in the preparation of on-site and off-site contingency plans activated in the case of industrial accident. These plans contain information on how the public and staff of enterprises should act in the event of industrial accident and what is the first medical aid to be provided to people exposed to the hazardous chemicals.

IV. POSSIBLE ELEMENTS FOR UNECE GUIDELINES FOR ENVIRONMENTAL SELF-MONITORING PROGRAMMES FOR CHEMICAL INDUSTRY IN EECCA

A. General principles of environmental management systems for chemical industry

Effective and efficient management systems are very important in the attainment of high environmental performance. The best practice is the combination or selection of the following techniques:

- Organizational structures to integrate environmental issues into decision-making;
- An environmental strategy and a commitment to follow the strategy;
- Written procedures or practices for all environmentally important aspects of plant design, operation, maintenance, commissioning and decommissioning;
- Internal audit systems to review the implementation of environmental policies and to verify compliance with procedures, standards and legal requirements;
- Accounting practices that internalize the full costs of raw materials and wastes;
- Long-term financial and technical planning for environmental investments;
- Control systems (hardware and software) for the core process and pollution control equipment to ensure stable operation, high yield and good environmental performance under all operational modes;
- Systems to ensure operator environmental awareness and training;
- Inspection and maintenance strategies to optimise process performance;
- Defined response procedures to abnormal events;
- Ongoing waste minimisation exercises.

Management systems are identified as having a central role in minimising the environmental impact of organic chemical production processes. The best environmental performance is usually achieved by the installation of the best technology and its operation in the most effective and efficient manner. Environmental management system typically addresses the organisational structure, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and monitoring the environmental policy.

B. The division into sub-sectors in organic synthesis sector on the basis of generic product groups and the description of key processes in different sub-sectors

Organic synthesis sector encompasses a large range of chemicals and processes. In very simplified terms it can be described as taking refinery products and transforming them, by a complex combination of physical and chemical operations, into a variety of commodity or bulk chemicals in continuously operated plants. Although processes for the production of organic chemicals are extremely diverse and complex, they are typically composed of a combination of simpler activities and equipment that are based on similar scientific and engineering principles.

Most organic chemicals production processes can be described in terms of five distinct steps, namely: raw material supply/work-up, synthesis, product separation/refining, product handling/storage, and emission abatement.

The most important causes of process emissions are:

- Contaminants in raw materials may pass through the process unchanged and exit as wastes;
- The process may use air as an oxidant and this creates a waste gas that requires venting;
- Process reactions may yield water/other by-products requiring separation from the product;
- Auxiliary agents may be introduced into the process and not fully recovered;
- There may be unreacted feedstock which cannot be economically recovered or re-used.

The exact character and scale of emissions will depend on such factors as: plant age; raw material composition; product range; nature of intermediates; use of auxiliary materials; process conditions; extent of in-process emission prevention; end-of-pipe treatment technique.

The main air pollutants from organic chemical production processes are volatile organic compounds (VOCs) but emissions of combustion gases, acid gases and particulate matter may also be significant. VOCs typically arise from process vents, the storage, transfer of liquids and gases, fugitive sources and intermittent vents. VOCs from fugitive emissions are caused by vapour leaks from equipment as a result of gradual loss of the intended tightness. Combustion units (process furnaces, steam boilers and gas turbines) give rise to emissions of carbon dioxide, nitrogen oxides, sulphur dioxide and particulates.

The main water pollutants from organic chemical production processes are mixtures of oil and organics, biodegradable organics, recalcitrant organics, volatile organics, heavy metals, acid and alkaline effluents, suspended solids and heat. Most wastewater components of organic chemical production processes are biodegradable and are often biologically treated at

centralised wastewater treatment plants.

Wastes are very process-specific but the key pollutants can be derived from knowledge of: the process, construction materials, corrosion and erosion mechanisms and maintenance materials. Catalysts are often based on expensive metals and are regenerated. At the end of their life the metals are recovered and the inert support is landfilled. The heavy organic residues from distillation columns and vessel sludge etc. may be used as feedstock for other processes, or as a fuel (to capture the calorific value) or incinerated (under appropriate conditions). Spent reagents (e.g. organic solvents), that cannot be recovered or used as a fuel, are normally incinerated (under appropriate conditions).

C. Key elements for an environmental self-monitoring programme

1. The generic origins of air, water and waste emissions and their benchmark values

Chlor-alkali industry

The chlor-alkali industry is the industry that produces chlorine (Cl_2) and alkali, sodium hydroxide (NaOH) or potassium hydroxide (KOH), by electrolysis of a salt solution. The main technologies applied for chlor-alkali production are mercury, diaphragm and membrane cell electrolysis, mainly using sodium chloride (NaCl) as feed or to a lesser extent using potassium chloride (KCl) for the production of potassium hydroxide. Nowadays 95% of world chlorine production is obtained by the chlor-alkali process.

Some inputs and pollutant outputs from the chlor-alkali industry are common to all processes. Others are specific to the cell technology used, the purity of the incoming salt and the specifications of the products.

The inputs are primarily salt and water as feedstock; acids and chemical precipitants used to remove impurities in the input brine or output chlorine/caustic soda; cooling agents (CFCs, HCFCs, HFCs, ammonia etc.) for liquefying and purifying the chlorine gas produced. The chlor-alkali process needs huge amounts of electricity and electrical energy is a major input.

The main pollutant outputs which are common to all three electrolytic processes are chlorine gas emissions to air, free oxidants to water, spent acids, cooling agents, and impurities removed from the input salt or brine. The pollutant of most concern from the chlor-alkali industry is mercury, which is specific to the mercury cell technology. Due to the process characteristics, mercury can be emitted from the process through air, water, wastes and in the products. Air emissions consist of mercury and, in small quantities, chlorine gas from the cells. Other fugitive emissions are described in the paragraphs concerning outputs from the auxiliary processes.

Releases of mercury are specific to the amalgam technology. Air emissions consist of mercury vapour coming from:

- Cell-room ventilation
- Process exhausts
- Brine purification
- Stack of caustic evaporators
- Hydrogen burnt or vented to atmosphere

- Mercury retorting
- Maintenance outside cell room.

With good mercury housekeeping the ventilation air contain mercury levels of 2-20 $\mu\text{g}/\text{Nm}^3$. Another source of emissions into air is the evaporation of mercury deposited in the equipment and in the building, for instance in cracks in the floor and in porous concrete and bricks. Storage and handling of mercury-contaminated material may lead to diffuse emissions of mercury from the store houses. Emissions depend mainly on the type of storage (open/closed), the storage temperature and the amount of mercury-contaminated material in storage.

The fugitive emission of carbon dioxide is also possible. Carbon dioxide is emitted from the brine acidification tanks due to the decomposition of carbonate and bicarbonate ions into water and carbon dioxide. The carbonate and bicarbonate ions are from the auxiliary chemicals used in the purification step. The carbon dioxide either escapes from the brine and is emitted to the atmosphere or is led to the chlorine destruction unit, depending on the presence of chlorine in the brine. Other air emissions include chlorine and carbon tetrachloride. The latter has a potential to destroy ozone.

Wastewater emissions consist of mercury and other substances in wastewater streams (sulphites, chlorides, chlorates, metals, chlorinated hydrocarbons). The releases of mercury are specific to the amalgam technology. Mercury emitted from mercury cell facilities mainly arises from:

- The process: bleed from brine purification, condensate from hydrogen drying, condensate from caustic soda concentration units, brine leakage, ion-exchange eluate from process-water treatment;
- The washwater from the cell cleaning operations: inlet and outlet boxes;
- The rinsing water from the electrolysis hall: cleaning of the floors, tanks, pipes and dismantled apparatus;
- The rinsing water from maintenance areas outside the electrolysis hall, if they are cleaned with water.

The mercury concentration in wastewater can be taken down to 30 $\mu\text{g}/\text{l}$ with purification process.

Wastes containing mercury include: sludge from wastewater treatment, solids generated during brine purification (filter residue), spent graphite from decomposer cells, sludge from caustic filters (spent caustic filters from the filtration of caustic solution such as graphite candles), etc.

Soda

Dust is emitted from soda ash production in limited quantities, arising from the following steps:

- Handling of mineral raw materials (coke, limestone) as diffuse sources;
- Limestone burning in kilns;
- Handling of soda ash and densification of light soda ash to produce dense soda ash;
- During the handling of these products.

The composition of dust relates to the material handled, namely:

- C from coke;
- CaCO_3 , Al_2O_3 and SiO_2 from limestone (and sand and clays present in limestone);
- CaO from burned lime;
- Na_2CO_3 and NaHCO_3 from the production and transport of soda ash and sodium bicarbonate.

For dry gas streams, such as those encountered in product handling (conveying) and the storage section of a soda ash plant, dust abatement techniques normally achieve figures below 50 mg/Nm^3 , and with modern equipment (e.g. bag filters) below 20 mg/Nm^3 . For wet streams, dust abatement techniques normally achieve figures below 200 mg/Nm^3 and with modern equipment (e.g. wet scrubber) may be expected to achieve figures below 50 mg/Nm^3 .

During CaCO_3 burning to CaO in the lime kilns, CO and CO_2 are produced from the combustion of coke and decomposition of limestone. The amount of CO_2 vented to the atmosphere from a standalone soda ash process is in the range of 200 to 300 kgCO_2/t soda ash. The split of losses to the atmosphere depends on the detailed plant configuration. CO gas is virtually inert throughout the process. All CO produced must therefore be vented to the atmosphere either at the kilns or through the carbonation tower at the outlet of gas scrubbers. CO generation is in the range of 4 to 20 $\text{kg CO}/\text{t}$ soda ash, depending on the conversion of CO to CO_2 during the limestone calcination step.

NO_x are produced inside the kiln by the oxidation of nitrogen contained in the air used in the combustion process. Since the temperature inside the kiln is moderate (up to 1100°C), the formation of NO_x is rather limited. Specific emission value of 0.193 $\text{kg NO}_2/\text{t}$ soda ash has been estimated. Measurements in some plants indicate concentration after gas washing of less than $500 \text{ mg NO}_x/\text{Nm}^3$ of the outlet gas. Concentrations in the range of 240 – 290 $\text{mg NO}_2/\text{m}^3$ at the outlet of gas scrubbing section, and below 300 $\text{mg NO}_2/\text{m}^3$ of the outlet gas from the lime kiln.

SO_x are produced by the oxidation of compounds containing sulphur in the limestone and coke. The formation of SO_x is limited both due to the low sulphur content in fuels used in limestone burning and some autopurification reactions in the lime kilns. A specific emission value of 0.0003 $\text{kg SO}_2/\text{t}$ soda ash and the concentration of 2.5 $\text{mg SO}_2/\text{m}^3$ of the outlet gas has been reported.

The main atmospheric emissions containing ammonia originate from the bicarbonate precipitation and the filtration stages of the process:

- From the precipitation of bicarbonate in carbonation towers after cleaning in tower washers;
- From the filtration of bicarbonate, after cleaning in filter washers;
- There are a number of diffuse losses of ammonia from filters, bicarbonate conveyors and from the handling and processing of the distillation effluent.

The typical concentration of ammonia emissions is around 30 – 40 mg/Nm^3 , but much higher values can be encountered ($>100 \text{ mg/Nm}^3$). Considering the high turnover in the process (550 $\text{kg NH}_3/\text{t}$ soda ash), the loss rate of ammonia in the process is, therefore, very low (generally much less than 0.5 %). In some plants H_2S may be added as a corrosion inhibitor, in the form

of sodium hydrogen sulphide. Emission sources are from the tower gas washers and H₂S is typically controlled at maximum emission levels of 5 to 15 mg/Nm³ of the outlet gas.

The main sources of liquid effluent from the soda ash process are typically:

- Waste water from the distillation (after treatment);
- Waste water from the brine purification.

Cooling waters from lime kiln gas washers, cooling in the CO₂ compression loop, cooling of the absorption and distillation towers, and calcination (once through or closed circuits) may be carriers of traces of pollutants, and although their volumes may be very large, they normally only have very minor environmental impact. Of major concern is, in particular, the load of suspended solids discharged with wastewater (annual average 90 – 700 kg/t soda ash) with an average value estimated at 240 kg/t soda ash. Wastewater from brine purification is basically brine with suspended precipitated CaCO₃ and Mg(OH)₂ in variable proportions according to the nature of the salt deposits (calcium and magnesium ions coming naturally from the original seawater). These solids (10 – 70 kg/t soda ash) can be treated separately or can be disposed of together with liquid effluent from the distillation unit for solid removal and treatment.

Typical waste streams from soda production are:

- Fines of raw limestone from screening which consist of 85 to 97 % CaCO₃ with impurities of sand and clays (as SiO₂, Al₂O₃) depending on the limestone composition in the deposit;
- Some unburned stone, due to imperfect conversion reaction inside the kiln, is drawn with the lime to the slaker.

2. Cross-media issues

Under the term “cross-media effects” it is meant to describe the environmental effects of the options under consideration. Choosing between alternative options might require a choice to be made between releasing different pollutants in the same environmental medium (e.g. different technology options might release different air pollutants). In other cases, the choice might be between releasing to different media (e.g. using water to scrub an air emission thereby producing waste water or filtering a water discharge to produce a solid waste). The purpose of the cross-media methodology is to provide guidance on how to choose which option is best for the environment in more complex cases.

The first stage in the cross-media methodology is the definition of the alternative proposals to be considered. It is important that the alternatives are described in sufficient detail to prevent any ambiguity or misunderstanding, either in the scope of the technique or the boundaries of the assessment. The significant environmental releases and the resources consumed by each of the alternative techniques under consideration need to be listed and quantified. This list should cover the pollutants released, the raw materials consumed (including water), the energy used and the wastes produced.

Sources of information that might provide data on releases and resources consumed include:

- Monitoring information from existing installations of a similar type or configuration;

- Research reports;
- Data from pilot plant studies;
- Calculated data, such as mass balance information, stoichiometric calculations, theoretical;
- Efficiencies, or scaled-up laboratory data;
- Information from the information exchange process.

The data should be as complete as possible, so that all the emissions, raw material inputs, energy used and waste produced are accounted for. Both point source and fugitive emissions need to be assessed. Ideally, the mass of emissions released and the mass of resources consumed should be used (for example, kg emitted/year or kg emitted/kg of product). Information might also be available as a release rate (for example, reported as mg/m³ or mg/l), which might be particularly important for batch techniques or for techniques that follow a cycle where concentrations may be particularly high at certain stages in the process.

In the cross-media methodology the following themes are used:

- Human toxicity
- Global warming
- Aquatic toxicity
- Acidification
- Eutrophication
- Ozone depletion
- Photochemical ozone creation
- Abiotic depletion.

3. Selection of measurement and sampling points and their preparation, safety aspects

It is the general practice that the sampling location points should be:

- Representative
- Clearly marked
- Having a disturbance-free flow in the measurement section
- Having monitoring points that can be closed
- Having the required energy supplies
- Meeting the requirements for health and safety at work.

When defining the sampling plan and interpreting the results, the following issues will have to be considered:

- The location at which the samples are taken are chosen so that the material is well mixed and sufficiently far away from the mixing points to be representative of the overall release. It is recommendable to select a sampling point that is practical to reach and where the flow can also be measured or is already known;
- The frequency at which the samples are taken and other timing considerations including the averaging time and the duration of sampling;
- The sampling method and/or equipment;
- The type of sampling, e.g. automatic (time or flow proportional) or manual spot sampling;

- The type of sample, e.g. a sample for analysing of single or multiple parameters;
- The size of individual samples and bulking arrangements when taking composite samples;
- The qualification of the personnel in charge of taking the samples.

Safety will have to be carefully considered before monitoring begins (either at a process or in a receiving environment) and then appropriate precautions followed. Every monitoring programme should 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;
- 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.

4. The selection of monitoring equipment and measurement techniques

The selection of monitoring equipment has an influence on the manner in which data can be used and on the credibility of the data. Taking into account that increased costs are directly connected with increased accuracy there will be a need to decide how much accuracy is necessary to achieve the objectives of self-monitoring. The estimation of releases and transfers is based on the fundamentals of science. Each of the techniques is valid under certain conditions. If there is more than one option, one of the methods becomes the preferred option and the others are considered alternative. There are several factors influencing what is determined to be the optimal approach. These factors include time and cost constraints, available data, required data quality and the ability of the estimation technique to best represent the release. Also the significance of the individual source in relation to other sources influence the selection of the monitoring equipment.

Pollution Prevention and Abatement Handbook of World Bank gives the examples of ambient and emission measurement techniques together with relevant methodologies and standards. Reference Document on the General Principles of Monitoring of the European Integrated Pollution Prevention and Control Bureau gives the full list of CEN standards available for air and water emission and solid residues measurements.

5. Environmental quality monitoring programmes

Environmental quality monitoring is the monitoring of the environment influenced by the operators. It is carried out in order to make sure that the state of the environment as well as harmful impacts caused by the emission will stay on acceptable level. In general monitoring programmes include impacts of gaseous emissions to air quality and deposit. The second field is monitoring of effects of waste water on water quality and biota. In certain cases monitoring of the quality of soil and ground water in vicinity of industries and dumping sites and monitoring of the effects of the air emissions and deposit on terrestrial flora and fauna is performed.

In some cases the effects of wastewater on fish stocks and fishing as well as the efficiency of fishery management measures is monitored. The industries participate in the ambient air

monitoring program of the surrounding human settlements. The costs of the ambient air monitoring are divided between industries that affect the air quality in the area. The division of the costs is usually based on the pollution load of the industries affecting the environment. Those industries with higher emissions will pay proportionally more than those with lower emissions.

Ambient monitoring is carried out for a variety of reasons, including assessment of environmental problems and evaluation of interventions. The initial design of a program is usually based on the available data on existing conditions or sometimes on simple models based on emissions estimates.

The choice of parameters is based on the sources in the area and on the receptors and impacts of concern. In practice the choice of parameters depends on the local conditions, purpose of the impact monitoring and available financial resources. Table 3 gives the approximate cost estimates for ambient air measurement methods and can be used when setting up the monitoring plan in the negotiation process between permitting authority and operators. The similar cost estimations would be presented in the guidelines for other parts of self-monitoring programme.

Table 3. Air Sampling Methods

Method	Advantages	Disadvantages	Cost (U.S.dollars)
Passive samplers	Very low cost; very simple; useful for baseline and screening studies	Unproven for some pollutants; in general, provides only weekly or monthly averages	2-4 per sample
Active samplers	Low cost; easy to operate; reliable operation and performance; yields historical data sequence	Daily averages; labour-intensive; laboratory analysis required	2,000-4,000 per unit
Automatic analyzers	Proven; high performance; hourly data; on-line information and low direct costs	Complex; expensive; high skill required; high recurrent costs	10,000-20,000 per sensor
Remote sensors	Path or range resolved data; useful near sources and for measurements taken vertically through the atmosphere; multicomponent measurements	Very complex and expensive; difficult to support, operate, calibrate and validate; not always comparable with conventional analyzers	>200,000 per sensor

Environmental quality monitoring programmes include in general the following parameters:

- In water bodies pH (indicating acidity or alkalinity), dissolved oxygen, biological oxygen demand (BOD) and suspended solids are measured;

- Other indices measured in water include coliform bacteria, ammonia, nitrogen, phosphorus, nitrates, various toxic substances and metals;
- In ambient air suspended particulate matter (in addition fine particulate matter - PM10 or PM2.5), sulphur dioxide, nitrogen oxides, lead, ozone, POPs and VOCs are monitored.

Pollutants of concern for the environment are monitored to obtain reliable information on the quality of ambient air and media. Such information is a necessary part of any environmental management system. It provides a basis for informed decision-making and the development of environmental management strategies. Monitoring plans are designed and implemented for collecting data on ambient air and water quality. Ambient levels of pollutants such as heavy metals should be measured in air, water and soil along with other parameters at specified locations and frequencies using specified equipment and methods. The objective is to collect and analyze representative samples to produce data for use in the environmental management system.

To ensure acceptable ambient levels concentrations of pollutants in the environment are predicted using models and information on emissions from major pollution sources and then verified by actual observation. The results of modelling give information on the areas of highest concentration. This will help to select the sites for setting up the measuring stations.

Locations of monitoring stations are determined on the basis of the receptors in the airshed. A network of monitoring stations is usually established to estimate exposure levels. A monitoring station is also set up to measure background concentrations in cases where the resultant ambient levels of a particular source or sources are to be computed. Monitoring may be continuous or be done for short durations of 1 hour, 8 hours or 24 hours to determine the maximum and average for the set period.

6. Possibilities for using surrogates, mass-balances and emission factors as monitors

Direct measurements may not be appropriate when it implies a very high cost. Therefore in addition to direct measurement of emissions, several other approaches to monitoring can be used: surrogate parameters, mass-balances and emission factors.

Surrogate parameters are measurable or calculable quantities which can be closely related, directly or indirectly, to conventional direct measurements of pollutants, and which may therefore be monitored and used instead of the direct pollutant values for some practical purposes. The use of surrogates, used either individually or in combination with other surrogates, may provide a sufficiently reliable picture of the nature and proportions of the emission. For example in chemical industry it is often the case when polluting substances in waste gas are in a constant relation to each other then continuous measurement of the leading component can be used as a surrogate for the rest of the pollutant substances.

The three categories of surrogates can be distinguished based on the strength of the relation between the releases and surrogate:

- **Quantitative surrogates** give a straightforward quantitative projection of the releases and can become a substitution for the direct measurements. The examples to that in chemical industry is the measurement of total amount of volatile organic compounds instead of measuring the individual components provided that their percentage in the flue gas is constant

or the calculation of the pollutant concentrations based on the measured throughput of fuel or other raw materials;

- **Qualitative surrogates** give credible qualitative information on the composition of the releases to air or water. These may be the measurement of temperature in the combustion unit or of the catalyst in a catalytic incinerator. The measurement of conductivity can also be used instead of knowing the exact content of individual components in precipitation;
- **Indicative surrogates** give information about the operation of a facility or technological process and therefore give indication to the content of pollutants in the releases. Examples of indicative surrogates can be a measurement of temperature of the gas flow from a condenser.

Mass balance usage is a monitoring method that includes accountancy of inputs, accumulations, outputs and the generation or destruction of the substances in question. The releases to the environment are then calculated based on the difference in balance. Mass balances can be used for an estimation of the emissions from a facility, process or technological unit. For determination of diffuse emissions in organic synthesis sector it may sometimes be the only applicable method. Mass balances are only usable in practice when exact input, output and uncertainties quantities can be determined.

Emission factors are values that can be used to estimate the releases when multiplying these factors by a capacity of the installation or by throughput data from a facility such as the production output, water consumption. The emission factors are in general expressed as the amount of a pollutant released divided by the unit of throughput (weight, volume etc.) of the facility emitting the substance, for instance kilogram of pollutant emitted per m³ of gas combusted. Examples of using emission factors for air emissions for chlorine, soda and organic synthesis sector can be found at US EPA website (AP-42 methodology). Empirical relationships or emission factors do not always exist for all sources. In these cases direct measurements of releases are the only way to obtain an estimate of amounts of pollutants.

7. Specific conditions and timing considerations

Various timing considerations should be taken into account when setting monitoring requirements in permits. The exact time when samples or measurements are taken will have to be established by self-monitoring programme. Another relevant factors are the averaging time of the measurement result and frequency of sampling.

The monitoring timing requirements established in the permit mainly would depend on the type of process. The basic types of the process are the following:

- In case of a very stable process the time when samples are taken is not important since the results are very similar notwithstanding of choosing of the sampling and the averaging time. The measurements can therefore be discontinuous because the results would be very similar, independent of the frequency of sampling.
- In case of a cyclic or a batch process the time when samples are taken and the averaging time can be limited to the periods when the batch process is in operation.
- In case of a relatively stable process which has incidental short-time but high peaks frequency of sampling depends fully on the potential hazard of the releases. If harmful effects can occur due to short-term pollutant impacts then it is important to control the peaks rather than the cumulative load. A very short averaging time is used for controlling the peaks, and a

longer averaging time for controlling the total amount. A high frequency or continuous monitoring is more suitable for controlling peaks.

- In case of a highly variable process the time when samples are taken is very important due to the variability of the process and the samples taken at different times can give totally different results. A very short averaging time is used for controlling the peaks, and a longer averaging time is used for controlling the total amount.

When the release is subject to random or systematic variations, statistical parameters including means, standard deviations, maximum and minimum provide only rough approximation of the true values. In general, the uncertainty decreases as the number of samples increases. The level and duration of variations would determine the monitoring timing requirements.

Monitoring of exceptional releases is complicated in case of liquid or gaseous emissions. It is performable if the source can be monitored continuously and the release concentration stays in the measurement range of the equipment used. In practice the exceptional emission concentrations often exceed the measurement range of the equipment.

D. Possible actions to optimize costs

The guidelines would improve the cost-effectiveness of self-monitoring if the following issues are addressed:

- Selection of the appropriate quality performance requirements;
- Optimization of the monitoring frequency;
- Optimization of the number of parameters to be monitored and only considering those that are strictly necessary;
- Use of continuous monitoring for cases where it provides the requested information at a lower overall monitoring cost than discontinuous monitoring;
- Consideration of the possibilities to replace expensive parameters with surrogates;
- Standardization of data collection techniques;
- Complementing routine monitoring by special studies and campaigns.

Consideration of the following overlaps may be needed when assessing environmental self-monitoring costs:

- Safety inspections of materials, process conditions, incidents – this could involve information about accidental releases or leaks (usually estimated or calculated by indirect parameters) that could also be useful for emission monitoring purposes;
- Monitoring of the workplace environment - this could involve information about, e.g. concentration levels within the workplace (typically inside buildings) or flow-rates for ventilation. In many cases, the same or similar equipment, methods and parameters used in monitoring of the workplace environment could also be used for emission monitoring purposes;
- Other work programmes, such as those intended for preventive maintenance or operational checks (visual and checking rounds, mechanical examination, etc.) can also be used for self-monitoring purposes.

E. Record keeping, data management and reporting within companies and outside

The guidelines would give basic recommendations for record keeping, data management and reporting within chemical companies and outside. After the production of measurements' results, the data generated always needs to be processed and evaluated. Data processing includes signal processing, statistical treatment of the data, interpretation of the measurement results and their validity, calculation of the results and uncertainty analysis. The validation of emission data is usually done by skilled personnel in the laboratory who check that all the procedures have been properly followed. Validation may include the use of a thorough knowledge of monitoring methods and national and international (CEN, ISO) standardization procedures. An effective system of controls and supervision, in which calibration of equipment and intra- or inter-laboratory checks are involved, may also be a standard requirement in the validation process. Data reduction is often needed in order to produce the information in a format suitable for reporting. Statistical reductions may include calculations of means, maximum, minimum and standard deviations over appropriate intervals.

From the large amount of data generated when a parameter is monitored, a summary of the results over a certain period of time is usually generated and presented to the relevant stakeholders (public authorities, operators, public, etc.). Standardization of reporting formats facilitates the electronic transfer and subsequent use of data and reports. Depending on the medium and the monitoring method, the report may include averages (e.g. hourly, calendar day, monthly or annual averages), peaks or values at a specific time or at times when the ELVs are exceeded.

In the framework of self-monitoring programmes the operators are recording all sampling, analyses, measurements, examinations, calibrations and maintenance carried out in accordance with the environmental permit. The information on all incidents which affect the normal operation of the activity and which may create an environmental risk is also recorded. Data management includes the organisation of data and its conversion into information. The following items are considered in data management:

- How and when data are transferred - it may be sent in line with agreed criteria and schedules or in response to requests;
- Data processing (collation, analysis and condensation) - processing is carried out in stages so that recent data are available in a detailed form and earlier data in a more summarised form;
- Details of any software packages and statistical methods used to analyse or summarise the data;
- Archiving issues – data can be systematically archived in a secure store, so that records of past performance are readily available. In general operator maintains the archives not the authority.

V. PROPOSED METHOD OF WORK

To develop the proposed guidelines, it is proposed to set up a **Task force on Environmental Monitoring in Chemical Industry in EECCA Countries** under the WGEMA. Participants would be:

- (a) Environmental experts from industry (big chemical companies) and representatives of national environmental authorities from the EECCA countries concerned;

- (b) Experts from other interested UNECE countries;
- (c) Representatives of the European Chemical Agency, the secretariat of the REACH (Registration, Evaluation, and Authorisation of Chemicals), the European Chemical Industry Council (CEFIC) and interested national chemical associations;
- (d) Interested competent NGOs from EECCA.

The schedule of activities would be as follows:

- (a) Setting up the Task force on Environmental Monitoring in Chemical Industry in EECCA Countries by WGEMA: mid-June 2007
- (b) Meeting of the Task Force to develop a detail work plan for the preparation of draft guidelines and making work-sharing arrangements: early September 2007
- (c) Preparation of draft guidelines for environmental self-monitoring by chemical enterprises in EECCA countries: September-December 2007
- (d) Preparation of case studies by interested chemical companies in EECCA on specific sections of the guidelines: September-December 2007
- (e) Meeting of the consultants to consolidate the text of the draft guidelines: December 2007
- (f) Editing and translation of the draft guidelines: January- February 2008
- (g) Meeting of the Task Force to discuss the draft guidelines: March 2008
- (h) Finalization of the guidelines including additional editing and translation: April 2008
- (i) Publication and dissemination of the guidelines: September 2008.

Requirements in extrabudgetary support for carrying out the proposed activities are presented in table 2.

Table 2. Requirements in extrabudgetary support for carrying out the activities³

Activity	US \$
1. Preparation of individual sections of draft guidelines (consultancy fees)	50,000
2. Meeting of the consultants involved in the preparation of the guidelines (travel and per diem)	10,000
3. Two meetings of the Task Force (travel and per diem for EECCA governmental experts and NGOs, and consultants)	50,000
3. Editing and translation of the guidelines	10,000
5. Publication and dissemination of the guidelines	10,000
6. Coordination by the UNECE secretariat (consultant for 8 months and 8 missions)	60,000
Total	190,000

³ Including UNECE administrative support costs.

Annex

LIST AND BRIEF DESCRIPTION OF RELEVANT AVAILABLE INTERNATIONAL AND NATIONAL GUIDELINES

1. DEFRA (Department for Environment, Food and Rural Affairs). Environmental Key Performance Indicators. Reporting Guidelines for UK Businesses. 2005.
<http://www.defra.gov.uk/environment/business/envrp/envkpi-guidelines.pdf>
Gives guidance to companies on how to report on their environmental performance using environmental key performance indicators and defines which ones of them are most relevant to most sectors.
2. Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants EU Official Journal L 309, 27/11/2001 P. 0001 – 0021. http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/l_309/l_30920011127en00010021.pdf
The Directive is an example of establishing self-monitoring requirements directly by legal act and also shows the importance of direct connection between limit values and the relevant monitoring requirements.
3. Environment Agency. PI reporting forms, guidance and tools for activities regulated under PPC, IPC and WML. <http://www.environment-agency.gov.uk/business/444255/446867/255244/255276/858947/859031/?version=1&lang=e>
An example from UK to establish electronic reporting system to submit data. The system has a number of automatic checks to help the validation of data and it also allows you to compare it to that submitted in previous years.
4. EUREXEMP. Case Study Finland. Does e-government pay off? October 2004.
<http://europa.eu.int/idabc/servlets/Doc?id=19136>
An analysis of advantages of using environmental reporting system in Finland.
5. European Commission. Guidance Document for the implementation of European PRTR. December 2005. http://eper.eea.eu.int/eper/documents/E-PRTR_GD-02062006_FIN.pdf
The document provides guidance on the various reporting processes as set out in the European PRTR (E-PRTR) Regulation. E-PRTR implements at EU level the UNECE PRTR Protocol.
6. European Integrated Pollution Prevention and Control Bureau. Reference Document on the General Principles of Monitoring. July 2003, <http://eippcb.jrc.es/pages/FActivities.htm>
The document provides information to guide IPPC permit writers and operators of IPPC installations in meeting their obligations under the IPPC Directive with regard to monitoring requirements of industrial emissions at source.
7. Galloway, Carol R. Information Systems to Support Compliance and Enforcement. Fourth International Conference on Environmental Compliance and Enforcement.
www.inece.org/4thvol1/galloway.pdf
A general overview of the types of information and information systems that support the United States' compliance assurance and enforcement programs at the national, regional and

state levels including the need for national information and national systems, typical data, evolution of enforcement systems and public access to the data.

8. Hietamäki, M. (2002), Self-monitoring (of air emissions, discharges to water and waste) in Finland. Proceedings of the Sixth International Conference on Environmental Compliance and Enforcement. www.inece.org/conf/proceedings2/53-Self-Monitoring%20Finland.pdf

The paper discusses compliance monitoring based on self-monitoring. Self-monitoring is understood in quite different ways by the environmental protection community. The paper explains how this procedure is implemented in Finland.

9. IMPEL (1999). Operator Self-Monitoring. Impel Network (1999).

<http://ec.europa.eu/environment/impel/pdf/selfmon.pdf>

The paper aims to promote common principles for operator self-monitoring at industrial installations, arising from the obligations on industry to respect the implementation of environmental law and to protect the environment. The paper provides guidance on formulating conditions for self-monitoring in permits, or in other statutory requirements appropriate to the systems in place in EU Member States and the role of the competent authorities under self-monitoring regimes.

10. INECE (International Network for Environmental Compliance and Enforcement), Compliance monitoring: discussion summary. <http://www.inece.org/4thvol1/4toc.htm>

Proceedings of the Fourth International Conference on Environmental Compliance and Enforcement.

11. INTEGRATED POLLUTION PREVENTION AND CONTROL: A Practical Guide to Health Authorities www.pcpoh.bham.ac.uk/publichealth/publications/ippc.pdf

A Guide for implementation of IPPC Directive.

12. Ireland's Environmental Protection Agency. IPPC Licensing. <http://www.epa.ie>

A practical example of establishing IPPC licensing system in one EU Member State (Ireland).

13. OECD. Framework for Selecting and Applying PRTR Release Estimation Techniques. 2005.

http://www.oecd.org/LongAbstract/0,2546,en_33873108_33844430_35639967_1_1_1_37407_00.html

Document provides general principles to be applied in producing comparable and representative PRTR data and in the selection and application of estimation techniques. Three case studies provide detailed information on practical applications.

14. OECD. Uses of Pollutant Release and Transfer Register Data and Tools for their Presentation. 2005.

[http://www.oelis.oecd.org/olis/2005doc.nsf/43bb6130e5e86e5fc12569fa005d004c/546a5d6d751bc761c1256f95005512b8/\\$FILE/JT00177567.PDF](http://www.oelis.oecd.org/olis/2005doc.nsf/43bb6130e5e86e5fc12569fa005d004c/546a5d6d751bc761c1256f95005512b8/$FILE/JT00177567.PDF)

This report presents numerous examples of the variety of tools for presenting and illustrating PRTR data and the types of uses of PRTR data in OECD member countries. It presents examples of uses for the purposes of the public, community groups, industry, the government, and academic and independent research institutions. The intent of this report is not to describe all of the many programmes, activities, and tools that use PRTR data, but to present examples in each category to illustrate the wide variety of current and evolving uses of such data.

15. OECD. Resource Compendium of PRTR Release Estimation Techniques. 2002.
[http://www.oelis.oecd.org/olis/2002doc.nsf/43bb6130e5e86e5fc12569fa005d004c/b3697d5137c6db14c1256c07003623a8/\\$FILE/JT00130099.PDF](http://www.oelis.oecd.org/olis/2002doc.nsf/43bb6130e5e86e5fc12569fa005d004c/b3697d5137c6db14c1256c07003623a8/$FILE/JT00130099.PDF)

The technical document to provide governments and industry - as well as others who are interested in this issue - with information and practical guidance for identifying, selecting and applying different techniques for estimating pollutant releases from point and diffuse sources and from transfers.

16. Province of British Columbia. Ambient Fresh Water and Effluent Sampling Manual. 1997. <http://ilmbwww.gov.bc.ca/risc/pubs/aquatic/ambient/index.htm>

The manual covers the minimum requirements to ensure quality and consistency of the field aspects of ambient water and effluent data collection.

17. US Environmental Protection Agency. Sector Notebooks.

www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/index.html

The Sector Notebook is set of profiles containing information for specific industries and governments. Unlike other resource materials, which are organized by air, water and land pollutants, the Notebooks provide a holistic approach by integrating processes, applicable regulations and other relevant environment information.

18. USEPA (1997), Release Factor Documentation for AP-42, United States Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC, USA.

<http://www.epa.gov/ttn/chief/ap42/index.html>

A comprehensive overview of air emission factors elaborated in United States.

19. World Bank Group. Pollution Prevention and Abatement Handbook 1998. Towards Cleaner Production. Washington, D.C.

Gives the examples of ambient and emission measurement techniques together with relevant methodologies and standards.
