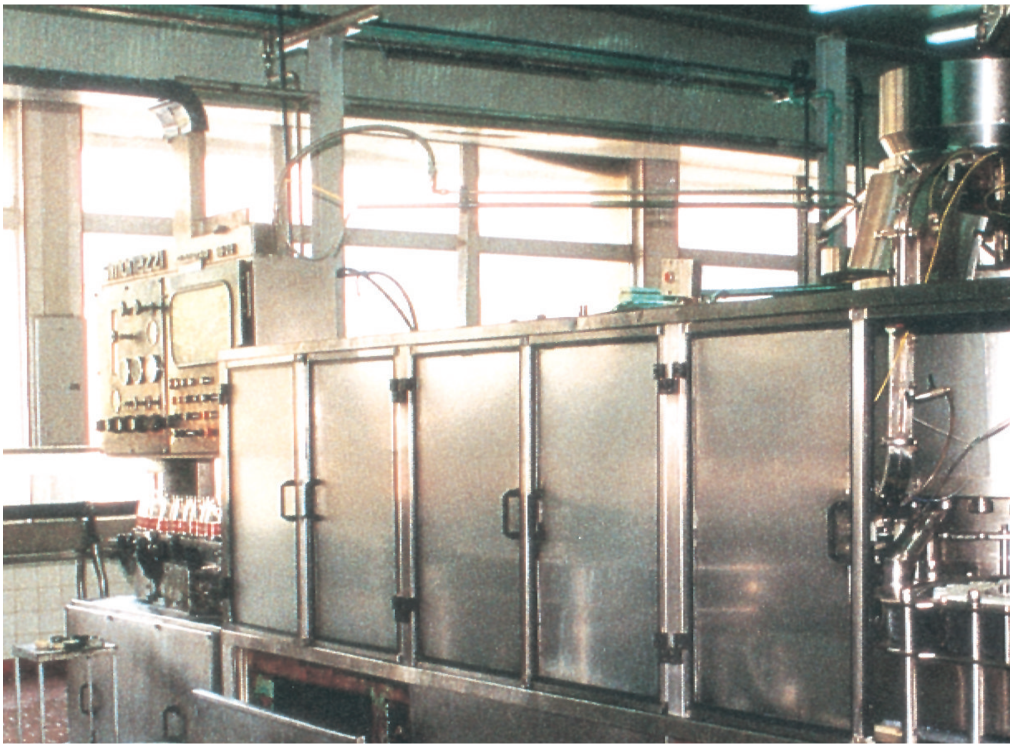
Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency (EEAA)
Egyptian Pollution Abatement Project (EPAP)

Self Monitoring Manual

Carbonated Beverages Industry



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Beverages Industry
Self-Monitoring Manual
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List of Acronyms

BOD	Biological Oxygen Demand
CAPMAS	Central Agency for Public Mobilization and Statistics
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
EMS	Environmental Management System
O&G	Oil and Grease
SIC	Standard Industrial Classification
SM	Self-Monitoring
SMS	Self-Monitoring system
SO_x	Sulfur Oxides
TDS	Total Dissolved Solids
UHT	Ultra High Temperature
WWTP	Wastewater Treatment Plant
µm	Micro meter 10^{-6} m
VOCs	Volatile Organic Compounds
NO_x	Nitogen Oxides
CFCs	Chloro-fluoro carbon
MHUUC	Ministry of Housing, utilities and urban Communities
CP	Cleaner Production
Eop	End-of-pipe
P2	Pollution Prevention
HACCP	Hazardous Analysis& Critical Control Point
CIP	Clean in Place

1. INTRODUCTION

The Egyptian Pollution Abatement Project (EPAP) sponsored by FINIDA has assigned Finish and Egyptian consultants for the task of developing sector-specific inspection and monitoring guidelines. This task is based on a previous collaboration between FINIDA and EPAP that resulted in the development of four Inspection Guidelines:

- Fundamentals and Background Manual that provides basic information about air pollution, wastewater characteristics, solid waste, hazardous materials and wastes and work environment.
- Guidelines for Inspectorate Management that discusses the strategy, objectives and tasks of the inspectorate management.
- Guidelines for Team Leaders that identifies the team leader resposibilities and tasks.
- Guidelines for Inspectors that presents a methodology for performing all types of inspection. Tasks during the various phases of planning, performing field inspection, report preparation and follow-up are discussed. Several checklists are included.

The three guidelines were later summarized into one that will be referred to as the General Inspection Manual (GIM EPAP, 2002), which was developed in order to cover aspects common to all sectors.

On the other hand, EPAP realized the need to introduce the concept of self-monitoring, as it provide useful information to the plant’s management on the production efficiency as well as the environmental status. Self-monitoring should cover, as a minimum, the monitoring of the releases to the environment including emissions to air, wastewater, solid waste and hazardous waste. A comprehensive self-monitoring plan may cover process parameters that would affect the environmental impacts. Such plan would assist the management to identify sources of waste, prevent pollution at the source, reduce emissions, and achieve economic benefits.

Therefore, a Self-Monitoring Guidebook was also developed to present the industrial community, the consultants, and government officials with the general principles and both managerial and technical aspects to be followed for self-monitoring. The textile industry was chosen as a case study for implementing and testing the manual and a self-monitoring manual for this industry was developed.

1.1 Preface

The developed manuals were tested through a number of training programs that targeted RBOs and EMUs. The inspectors involved in the training used these manuals to inspect a number of industrial facilities. Feedback from the concerned parties led to the improvement of these manuals and their continuous update. There was clearly a need for sector-specific guidelines, and EPAP took the initiative to develop such manuals. Five sectors were chosen:

- Food Industry with specific reference to the five sub-sectors of Dairy products, Vegetables and Fruit processing, Grain Milling, Carbonated Beverages and Confectionery.
- Pulp and Paper Industry
- Metallurgical Industry with specific reference to the two sub-sectors of Iron and Steel and Aluminum.
- Engineering Industry with specific reference to Motor Vehicles Assembly and Fabricated Metals industries.
- Textile Industry.

1.1.1. Project objectives

The project aims at the development of sector-specific guidelines for inspection and monitoring to be used by inspectors and plant personnel respectively. These manuals are meant to be simplified but without abstention of any information necessary to the targeted users. Flowcharts, tables and highlighted notes are used for easy representation of information.

With respect to the food industry, each sub-sector will have two distinct manuals one for inspection and the other for self-monitoring. Description of the industry, pollution aspects and relevant environmental laws will be similar for both manuals. Each manual will be, as much as possible a stand-alone with occasional cross-reference to the General Guidelines previously developed to avoid undue repetitions.

1.1.2 Organization of the manual

The self-monitoring manual for the beverages industry includes eleven chapters. The first chapter represents an introduction to the whole project and to the specific sub-sector of the industry. Chapters 2 to 5 deal with the beverages industry and its environmental impacts.

The description of the industry in Chapter two includes the inputs and outputs, a description of the different production lines with their specific inputs and outputs. In addition, it also includes a brief description of the service and auxiliary units that could be present at the industrial establishment with their potential sources of pollution and the various emissions, effluents and solid wastes generated from the different processes.

Chapter 3 describes the environmental and health impacts of the various pollutants whereas Chapter 4 gives a summary of the articles in the Egyptian environmental laws relevant to the beverages industry. Chapter 5 gives examples of pollution abatement techniques and measures applicable to the beverages industry.

The information and steps needed to establish of a self-monitoring system are detailed in chapter 6-11 inclusive. A reasonably detailed introduction to the definition, objectives, benefits of self-monitoring are presented in Chapter 6, in addition to the link between self-monitoring and each of environmental management system and cleaner production. Chapter 7 deals with the aspects of planning of self-monitoring. Monitoring of raw materials is discussed in Chapter 8, while operation control aspects are discussed in Chapter 9. Environmental monitoring is described in Chapter 10. Chapter 11 is dealing with data collection, data processing and data usage. It is worth mentioning that there will be a frequent need of referring to other sources of information in order to plan, implement, and operate an effective and sustainable self-monitoring system. Therefore, references pertinent to subject matter will be mentioned. In addition, need may arise, in some instances where plant personnel are advised to call for external consultation in order to establish a proper, effective, and sustainable self-monitoring system.

1.2 Introduction to the Carbonated Beverages Industry

The carbonated beverages industry is not a large enterprise in Egypt. This industry has been identified as a contributor to the pollution of waterways especially when large industrial establishments are involved. Major processes at this industry are automated and operated in the continuous mode. The production is subject to seasonal variation as production drops in winter. Wastewater is generated mainly from bottle washing and spills during filling operations as well as rejects.

1.2.1 Egyptian SIC code for the Carbonated Beverages Industry

The Standard Industrial Classification (SIC) code for the food industry is 15 and the carbonated beverages industries have a sub-sector code of 155. The CAPMAS (Central Agency for Public Mobilization and Statistics) 1997 data, which is based on the 1996 census, shows that the total number of carbonated beverages facilities is 136.

1.2.2 Industry Size Distribution

Table (1) presents a classification of the facilities by manpower for Egypt. Manpower is an indicator for the facility size, although modern facilities employ fewer workers for the same production rate. It is clear from that 45% of the facilities are operating with less than 4 workers and 26.5% have more than 40 employees.

Table (1) Size Distribution of Carbonated Beverages Industries

Manpower	1	2	3	4	5	6-10	11-15	16-20	21-25	26-30	31-40	41-50	51-100	101-500	501-1000
No of facilities	22	20	12	7	15	17	6	4	0	5	2	11	16	2	7

2. DESCRIPTION OF THE INDUSTRY

The carbonated beverages industry is characterized by the production of a number of products in the same production lines. Additives control the kind of beverage produced. The production process in these plants can be divided into two general production lines:

- Carbonated beverages production line.
- Carbon dioxide production line.

Usually part of the produced carbon dioxide is used in the production of the carbonated beverages produced in the facility and the rest is sold in cylinders to be used in other facilities.

Service and ancillary units provide water and energy requirements as well as maintenance, storage, packaging, testing and analysis needs. Because of the nature of carbonated beverages, which are susceptible to microbial spoilage, equipment is characterized by designs, which facilitate hygienic operation, easy cleaning and sterilization. Most of the processes are automated and operated in continuous modes throughout one or more shifts. Shut down for cleaning is generally required at least once per day.

2.1 Raw Materials, Products and Utilities.

Water, carbon dioxide and concentrates are the main raw materials used in this industry. Additives such as fructose, sucrose and flavors, are also used. Chemicals such as sodium chloride, ferrous sulfate, calcium hypochlorite, lime, potassium permanganate and sodium hydroxide are used for water treatment. Mono ethanol-amine and sodium carbonate are used in the carbon dioxide production process for purifying the gas.

Chemicals are also used in the lab for quality control and analysis. Detergents and antiseptics are used for cleaning and sterilization purposes (sodium hydroxide, nitric acid sodium hypochlorite). Lube oil is used for the garage and workshops.
Steam is generated in boilers that use either mazot (fuel oil), solar (gas oil) or natural gas as fuel. Steam is used for providing heat requirements and in some plants for electric power generations. Water is used for cleaning equipment and floor washing, as boiler feed water, as cooling water and for domestic purposes. Boiler grade water is pretreated in softeners to prevent scale formation.
Water sources may be supplied from public water lines, wells or canal water. The type of water will dictate the type of pretreatment.
Big facilities could include a housing complex generating domestic wastewater.

Note: Defining the inputs and outputs helps predict the expected pollutants

2.2 Production lines

Table (2) presents the various production lines and service units that could be present in a facility producing carbonated beverages.

> ***Note**: Knowledge of the processes involved in each production line and units allows the prediction of pollution hazards and expected violations and helps determine possibilities for implementing cleaner technology.*

Table (2) Production Lines and Service Units in Carbonated Beverages Industry

Production Lines	Service Units
Carbonated beverages production line. Carbon dioxide production line.	Boilers Cooling towers Refrigerators Laboratory Mechanical & electrical workshops Garage Storage facilities. Wastewater Treatment Plant Restaurant and Housing complex

2.2.1 Carbonated Beverages Production Line

Figure (1) presents the main units in this process, the inputs to the units and the pollution sources. These units are:

Bottle Washing

An automatic bottle washing machine is usually used for this purpose. Washing occurs in a closed loop (CIP) through the following steps:

- Primary rinsing using soft water at 25 ^{0}C to remove dust.
- Disinfecting using indirect-steam at 70 ^{0}C.
- NaOH (3% concentration) rinsing at 80 ^{0}C.
- Direct cooling at 50 ^{0}C using soft water.
- Final rinsing at 25 ^{0}C with soft watre.

The soft water from cooling and final rinsing steps is recycled and used in the primary rinsing step.
Large amounts of alkaline wastewater is generated from the unit and dumped at once at the end of the shift to the plant sewer system.

Water Treatment

In this unit water supplied from public water lines, wells or canals is treated as follows:

- Raw water is pumped to an agitated reaction tank where alum, lime, ferrous sulfate and calcium hypochlorite are added.

- Sludge precipitates at the bottom and is discharged as solid waste once a day. Some facilities discharge the sludge to the sewer, causing blockage of the lines.
- Water is then passed through a sand bed filter that removes suspended solids.
- An activated carbon filter is then used to remove odor and taste from water.
- To ensure high purification quality, water passed through micro filters.

This unit is back-washed using treated water. The backwash wastewater is high in dissolved solids.
Treated water from this unit is used in the preparation of the primary and final syrup and in soft water production.
Some facilities use reverse osmosis for water treatment instead of the lime process. In this case the only pollutant would be the backwash of the unit which is high in dissolved solids (TDS).

Soft Water Production

This includes softening of treated water obtained from the water treatment units.
Calcium and magnesium ions are removed from hard water by cation exchange for sodium ions. When the exchange resin has removed the ions to the limits of its capacity, it is regenerated to the sodium form with a salt solution (sodium chloride) in the pH range of 6-8. This performed by taking the softener out of service, back-washing with the salt solution, rinsing to eliminate excess salt, and then returning it to service. The treated water has a hardness level of less than 1 ppm expressed as calcium carbonate.
Soft water from this unit is used as make up in cooling water, in boilers, in bottle washing units and in carbon dioxide production process (if facility contains this process)
Wastewater from this unit contains soluble salts.

Syrup Preparation

Fructose (or sucrose) is mixed with treated water to prepare the primary syrup. Fructose is usually used in facilities situated in the Delta region, while sucrose is used in Upper Egypt.
The final syrup is prepared by mixing the primary syrup with concentrates (depending on the type of beverage).
The final syrup is then diluted with water (1:4.9) to adjust the Brix. This is performed in containers at 5 ^{0}C. The solution is then injected with carbon dioxide and fed to the bottle-filling machine.
Brix is a unit used to express sugar concentration. It indicates the percent sucrose in water solution by weight.

Bottle Filling

Washed glass bottles are moved on a belt conveyor in front of lighted screens. Reject bottles are discarded as solid waste. Accepted bottles move to the filling machine that fills and encapsulates them.

The filled encapsulated bottles are tested again. Bottles are rejected when:

- effervescence is noticed
- liquid level is not as per specs (too high or too low)
- encapsulation was not performed
- bottle is fractured

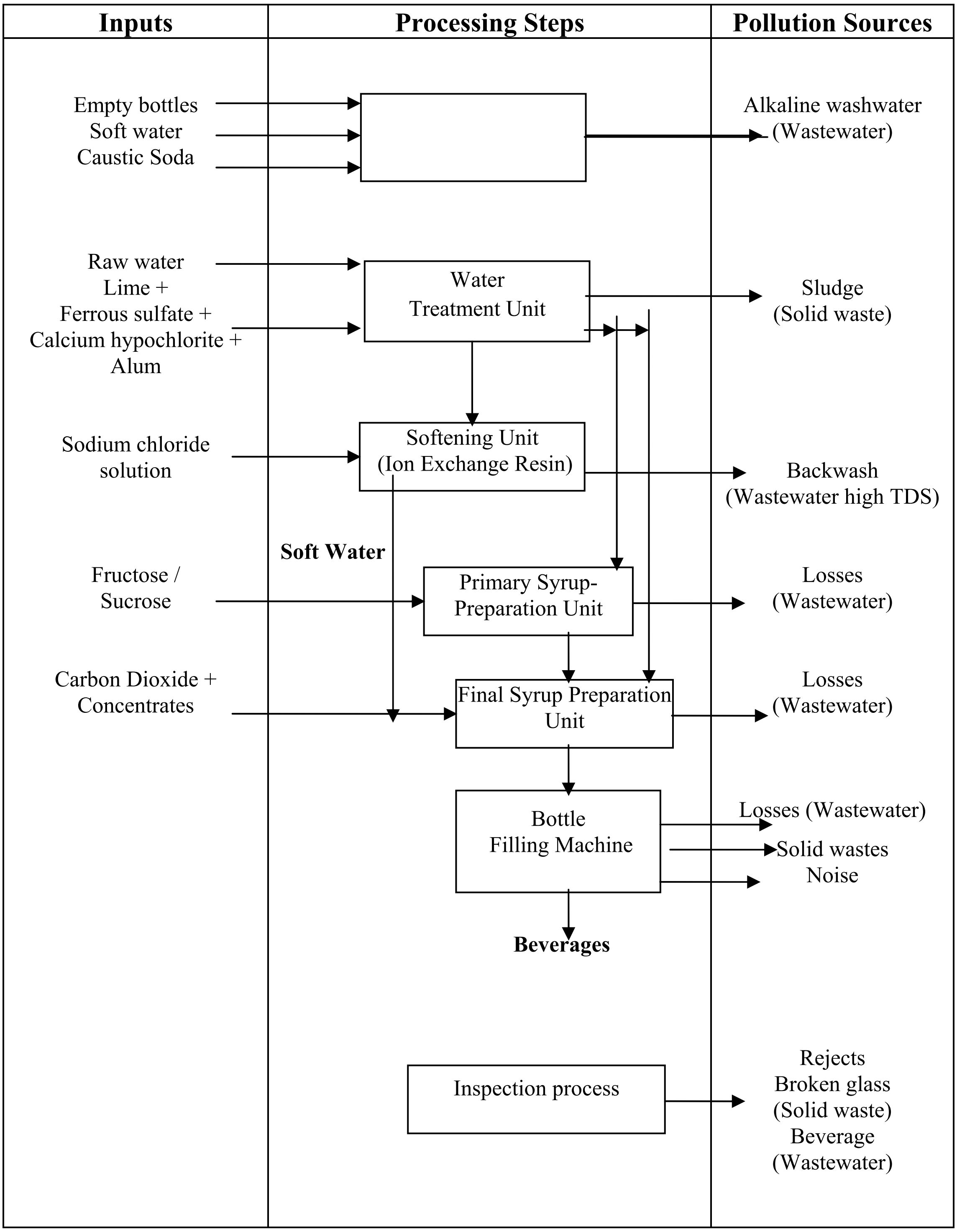
This is the most polluting step in the industry. The high BOD load in the wastewater is due to:

- Rejected bottles are emptied in the factory sewer system
- Losses of syrup during the filling operation
- Equipment wash when beverage type is changed.
- Losses during start-up and shut-down of machine.

Note: Find out:

- What happens to capsulated bottles rejected for out-of-spec liquid level?
- How and when does cleaning of equipment and floors occur?
- What type of detergent and/or antiseptic is used?
- What is the percentage loss of liquid during filling?
- What is the percentage of broken unfilled bottles?

Fig (1) Production Line for Carbonated Beverages and Related Pollution Sources



2.2.2 Carbon Dioxide Production Unit:

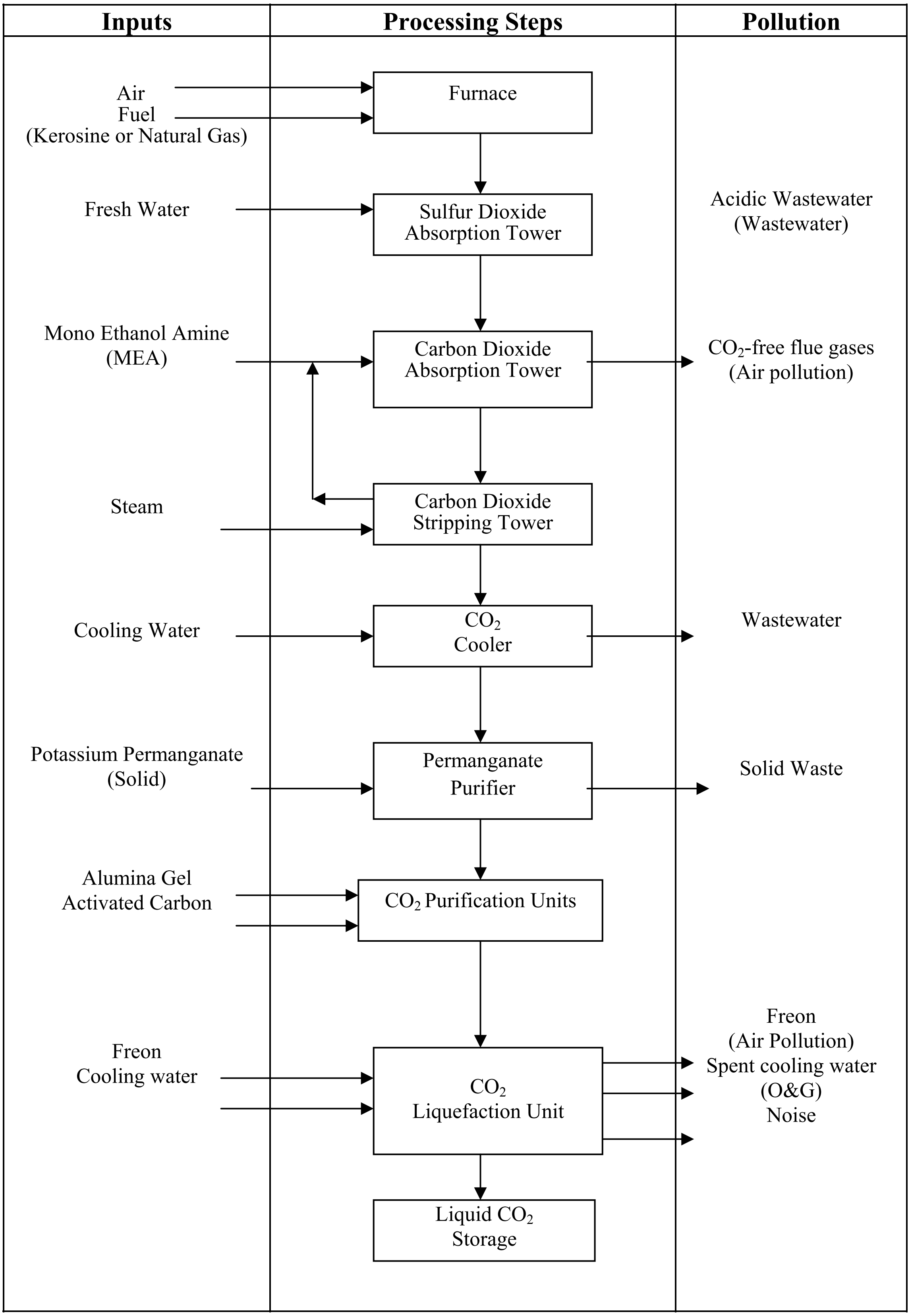
Figure (2) presents the processing steps for carbon dioxide production and its potential pollution sources. These steps involve the production of carbon dioxide by fuel combustion then its purification. The processes involved are:

Fuel Combustion	Combustion occurs in a furnace using kerosene or natural gas. If mazot (fuel oil) is used air pollution with sulfur oxides is expected.
Sulfur Dioxide Absorption	The resulting gases from fuel combustion unit are passed through an absorption tower where raw water is used to absorb sulfur dioxide (SO_2). The wastewater from this unit is acidic and is generated in large amounts.
Carbon Dioxide Extraction	The effluent gases from the absorption tower are introduced into a second absorption tower where Mono Ethanol Amine (MEA) is used to absorb and therefore extract carbon dioxide from the remaining gases which are discharged to the atmosphere. Carbon dioxide is de-sorbed by first pre-heating the solution then introducing it in a stripping tower using steam to heat and recover CO_2. The resulting regenerated MEA is recycled back to the carbon dioxide absorption tower. The heat generated in the furnace from the combustion reaction is used to supply the energy necessary for de-sorption. The extracted carbon dioxide needs to be purified from steam and traces of MEA vapors. The carbon dioxide stream is cooled by water in a heat exchanger to condense the steam. The gases are then passed through a scrubber consisting of a fixed bed of potassium permanganate that removes hydrogen sulfide and MEA. The remaining traces of MEA are removed by absorption in water or sodium carbonate solution. Potassium permanganate is being reduced during this operation and therefore looses its activity. It is replaced every two weeks and the spent permanganate is dumped as solid waste. Wastewater from the second scrubber is contaminated with traces of MEA.
Carbon Dioxide Purification	Carbon dioxide is passed through two columns containing alumina gel then a column filled with activated carbon. Carbon dioxide is then liquefied by a refrigeration cycle that uses Freon, which is an ozone depleting substance.

Note : There are two main sources of pollution :

- The CO_2 –free flue gases.
- The acidic wastewater from the sulfur dioxide absorption tower.

Fig (2) Carbon Dioxide Production Line and Related Pollution Sources



2.3 Service units: description and potential pollution sources

Medium and large size plants will have some/all of the following service and auxiliary units. These units can be pollution sources and therefore should be inspected and monitored. Figure (3) shows the various units with their corresponding raw materials and potential pollution sources.

2.3.1 Boilers

Boilers are used to produce steam for:

- heat supply to the processes
- electric power generation

Boiler grade water must be low in TDS to minimize scale formation. Therefore soft water is used as feed to the boilers. Conventional steam-producing thermal power plants generate electricity through a series of energy conversion stages. Fuel is burned in boilers to convert water to high-pressure steam, which is then used to drive the turbine to generate electricity.

The gaseous emissions generated by boilers are typical of those from combustion processes. The exhaust gases from burning fuel oil (Mazot) or gas oil (solar) contain primarily particulates (including heavy metals if they are present in significant concentrations in the fuel), sulfur and nitrogen oxides (SOx and NOx) and volatile organic compounds (VOCs). The concentration of these pollutants in the exhaust gases is a function of firing configuration (nozzle design, chimney height), operating practices and fuel composition. Gas-fired boilers generally produce negligible quantities of particulates and pollutants.

Wastewater is generated as blowdown purged from boilers to keep the concentration of dissolved salts at a level that prevents salt precipitation and consequently scale formation. The blowdown will be high in TDS. In the case of power plants, water is used for cooling the turbines and is also generated as steam condensate. The amount of wastewater generated depends on whether cooling is performed in open or closed cycle and on the recycling of steam condensate. Contamination may arise from lubricating and fuel oil

2.3.2 Cooling Towers

Cooling water is used extensively in industry. During the cooling process, water heats up and can only be reused if cooled. Cooling towers provide the means for recycling water and thus minimizing its consumption. The cooling effect is performed through partial evaporation. This causes an increase in the concentration of dissolved salts which is controlled by purifying some water (blowdown). The blowdown will be high in TDS.

2.3.3 Refrigeration Systems

The term refrigeration usually applies to cooling below ambient temperature. Refrigeration operations involve a change in phase of a substance (refrigerant) so that it will be capable of abstracting heat. The refrigerant absorbs heat at low temperature by vaporization and gives it up at the condenser. Compressors are used for increasing the pressure of the vaporized refrigerant. The increase in pressure is

accompanied by an increase in temperature that enables cooling water to condense the vapor, and the cycle is repeated.
The major pollutants can be:

- Noise from the compressors operation, which can be a violating parameter in the work and ambient environment.
- Waste cooling water, which could be contaminated with lube oil
- Hazardous materials, such as Chloro-Fluoro-Carbons (CFCs), if used as refrigerants. Freon is a CFC.

2.3.4 Laboratories

Laboratories have an important role in the food industry, as they are responsible for:

- Testing raw materials, chemicals, water, wastewater, packaging bottles, etc.
- Quality control of the different products and comparing the findings with the standard specifications for raw materials and final products
- The measured parameters are physical properties, chemical composition, and bacteriological counts.

Chemicals used for testing could be hazardous. Proper handling and storage are required for compliance with environmental law.

2.3.5 Workshops and Garage

Large facilities have electrical and mechanical workshops for maintenance and repair purposes. Environmental violations could be due to:

- Noise
- Rinse water contaminated with lube oil

Pollution in the garage area will depend upon the services offered. The presence of a gasoline or diesel station implies fuel storage in underground or over the ground tanks that require leak and spill control plans.
Replacing lube oil implies discharge of spent oil to the sewer lines or selling it to recycling stations.

2.3.6 Storage Facilities

The specifications for the storage facilities depend on the stored material.

- Water stored during beverage production.
- Bottles used in filling are stored in large shaded areas.
- Products are filled in bottles made of glass or plastic of predetermined weight.
- Chemicals are used as additives for the process, for washing and treatment processes. These chemicals require special handling, storage and management procedure as required by law.
- Fuel is used for the boilers, for the cars and delivery trucks. It is stored in underground or over ground tanks. The types of fuel usually used are fuel oil (Mazot), gas oil (solar), natural gas and gasoline.

2.3.7 Wastewater Treatment Plants

Although a WWTP is a pollution abatement measure, it has to be inspected and monitored for potential pollution. Pollution may be due to malfunctioning or improper management. A carbonated beverages facility discharges wastewater high in organic load. From time to time peak load will be discharged. They may be due to internal processes, to seasonal fluctuations, to lack of control or a “force majeur” situation such as power collapse.

The potential pollution sources are:

- Sludge which represents a solid waste problem
- Treated water, which could represent a water pollution problem if containing pollutants that exceed the limits set by relevant environmental laws.

2.3.8 Restaurants, Washrooms and Housing Complex

These facilities will generate domestic wastewater as well as domestic solid waste.

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Fig (3) Service Units and Their Related Pollution Sources

Inputs	Service Units	Pollution
Fuel + air Water	Boilers Steam	Boiler Blow Down (TDS) Flue Gases
Hot Water	Cooling Towers	Cooling Tower Blowdown (TDS)
Chemicals	Laboratory	Wastewater Hazardous Materials (handling)
Lube Oil Floor and equipment rinse water Cleaning Chemicals	Electrical & Mechanical Workshops	Oily Rinse Water Solid Wastes
Fuel Oil Rinse Water	Garage	Oily rinse water Solid wastes
Raw materials Fuel Chemicals Products	Storage	Spills Raw material & product rejects Hazardous material
Wastewater	Wastewater Treatment Units	Treated water Sludge
Water	**Restaurant and restrooms**	Sanitary Wastewater

2.4 Emissions, effluents and solid wastes

Table (3) summarizes the major polluting processes, their outputs and the violating parameters.

2.4.1 Air Emissions

There are two main sources of air emission in the carbonated beverages industry:

- Exhaust gases resulting from fuel consumption performed for:
  - producing carbon dioxide in facilities that have a carbon dioxide production line
  - generating steam from boilers for heat and/or electricity requirements.

The violating parameters would be: particulate matters, (PM10), sulfur oxides, nitrogen oxides, carbon monoxide.

- Freon resulting from leaks in refrigeration tubes of the carbon dioxide production line.

2.4.2 Effluents

The major pollution load of the carbonated beverages industry is generated from the following sources:

- Bottle washing unit (alkaline wastewater)
- Water treatment unit.
- Water softening unit (high TDS)
- Bottle filling unit as losses and out-of-spec product (BOD)
- Carbon dioxide production units (acidic wastewater form the sulfur dioxide absorption unit)
- Syrup preparation units as losses during change of beverage type.
- Blow down from cooling towers and boilers (high in TDS and TSS).
- Spent lube oil from garage and workshops if discharged to sewer will give oily wastewater (O&G).
- Floor and equipment washing and sanitation produces a wastewater containing organic matter, oil and grease, and traces of the chemicals used for neutralization and sanitation.

Typical effluent characteristics of the Egyptian carbonated beverages industry are shown in table (4). Typical pollution loads per ton of production are given in table (5).

Table (3) Pollutants Per Process

MAJOR POLLUTING PROCESS	PROCESS INPUTS	PROCESS OUTPUTS	POLLUTANTS	IMPACT
Bottle washing	Soft water NaOH	Alkaline wastewater	pH	Water
Testing	Empty and filled bottles	Accepted and rejected products	Rejected beverages (BOD) broken glass (solid waste)	Water Soil
Fuel combustion	Air Fuel	Flue gases (carbon dioxide)	Sulfur dioxide, carbon monoxide	Air
Sulfur dioxide absorption	Flue gases, Water	Acidic wastewater	pH	Water
Refrigeration with Freon	Carbon Dioxide	Cold carbon dioxide		
	Freon	Freon leaks	Freon (hazardous)	Air
Bottle filling	Carbonated beverages	Losses in wastewater	Wastewater of Relatively high values of BOD and COD. Noise Solid wastes from brocken bottles	Water
Water treatment	Raw water	Treated water	Sludge	Soil
Softeners	Treated water	Soft Water		
		Backwash	TDS, TSS	Water
Boilers	Soft Water + Condensate recycle	Blowdown	TDS, TSS	Water
	Fuel	Flue Gasses	CO, SO_x	Air
Cooling Towers	Water	Blowdown	TDS, TSS	Water
WWTP	Process WW	Treated effluent	BOD, COD, TSS, Color	Water
		Sludge	TSS	Soil

Table (4) Typical Chemical Analysis of Effluents from a Carbonated Beverages Plant.

Parameters	pH	BOD mg/1	COD mg/1	T.S.S mg/1	Oil& Grease mg/1
Final effluent	8	1150	1800	600	Nil

Table (5) Typical Organic Pollution Loads for a Production of 470 Cubic Meters Per Day

Parameters	Effluent flow rate, m^3/d	BOD, kg/d	COD, kg/d
Final effluent	800	920	1440

2.4.3 Solid Wastes

The main sources of solid wastes are broken bottles during handling, transportation and filling processes and from the workshops and garage. The water treatment and the biological wastewater treatment plant also generate sludge. There are no hazardous wastes discharged from the plants.

2.4.4 Hazardous Wastes

The beverages production facilities consume some hazardous substances including caustic soda, ammonia and ferion. Caustic soda is used in bottle washing operation, which results in an alkalie wastewater. On the other hand

2.5 Characteristics of the Carbonated Beverages Industry

Proper inspection and monitoring of the carbonated beverages industry should take into consideration the following aspects:

- Production lines are operated on a continuous basis. However, due to the special nature of food processes, washing and sanitation are performed at least once a day for both operating modes.
- Shock loads are expected and are caused by emptying reject bottles to sewer. Although the wash water for the empty bottles is recycled (a clean in place, CIP system is usually applied), it is discharged to the sewer at the end of the shift.
- Carbonated beverages production rate is seasonal since it decreases in winter.
- Pollution loads are expected to be higher during start-up and shutdown.
- Wastewater is characterized by high BOD and COD.

3. IMPACT OF POLLUTANTS ON HEALTH AND ENVIRONMENT

3.1 Impact of Air Emissions

Particulate matters Recent epidemiological evidence suggests that much of the health damage caused by exposure to particulates is associated with particulate matters smaller than 10μm (PM_{10}). These particles penetrate most deeply into the lungs, causing a large spectrum of illnesses (e.g. asthma attack, cough, and bronchitis). Emissions of particulates include ash, soot and carbon compounds, which are often the result of incomplete combustion. Acid condensate, sulphates and nitrates as well as lead, cadmium, and other metals can also be detected.

Sulfur Oxides Air pollution by sulfur oxides is a major environmental problem. This compound is harmful to plant and animal life, as well as many building materials. Another problem of great concern is acid rain, which is caused by the dissolution of sulfur oxides in atmospheric water droplets to form acidic solutions that can be very damaging when distributed in the form of rain. Acid rain is corrosive to metals, limestone, and other materials.

Nitrogen Oxides Nitrogen oxides also dissolve in atmospheric water droplets to form acid rain.

Carbon dioxide Combustion of fossil fuels to produce electricity and heat contribute to the green house effect caused by the formation of carbon dioxide. The greenhouse phenomenon occurs when heat radiation from earth is absorbed by the gases causing a surface temperature increase.

Freon Freon is a trade name for Chloro-Fluoro-Carbons (CFCs) which are considered to be Ozone Destroying Substances (ODSs). The Ozone Depleting Potential (ODP) for these substances reflects the ability to destroy the ozone layer (Table 6).

Water Vapor (humidity) Humidity in workplace is regulated by law 4/1994 due to its effect on the respiratory system especially for people suffering from asthma.

Table (6) Ozone Depletion Potential (ODP) of the Principal Ozone Depleting Substances (ODSs)

ODS	ODP
CFC-11,-12,-13	1.0
CFC-113	0.8
CFC-115	0.6
CFC-111,-112,-114	1.0
CFC-211,-212,-213,-214,-215,-216,-217	1.0

3.2 Impact of Effluents

It is clear that the main impact will be due to high organic loads. The effluent is violating Egyptian environmental laws as presented in section 4.2.
Spent lube oil from garage and workshops could be a cause for concern if discharged into the sewer system.
The organic material in wastewater stimulates the growth of bacteria and fungi naturally present in water, which then consume dissolved oxygen.
The environmental impact of the wastewater depends on the receiving water body.
The Ministry of Irrigation has set limits for the pollutants in the wastewater discharged into agriculture canals and drains as well as the Nile river for their detrimental effect on agriculture (Decree 8/1983). The parameters of relevance to the carbonated beverages industry are BOD, COD.
Discharge of polluted wastewater high in BOD into lakes and sea can cause eutrification and impact bio-diversity.

Sudden discharge of high BOD loads to the public sewer system will have an indirect environmental impact. Shock loads can cause malfunction of the domestic wastewater treatment plant.

3.3 Environmental Impact of Solid Wastes

Solid waste is mainly scrap that is collected and sold. Broken glass is sold to recycling plants. Sludge from the water treatment unit can cause blockage of the sewer lines if discharged to sewer. No major impacts are expected.

4. EGYPTIAN LAWS AND REGULATIONS

There are a number of laws and regulations that address the different environmental violations. The following are the laws applicable to the carbonated beverages industry.

4.1 Concerning air emissions

Article 40 of Law 4/1994, article 42 of the executive regulations and annex 6 deal with gaseous emissions from combustion of fuel. The statutes relevant to the fuel combustion are:

- The use of fuel oil (mazot) and other heavy oil products, as well crude oil shall be prohibited in dwelling zones.
- The sulfur percentage in fuel used in urban zones and near the dwelling zones shall not exceed 1.5%.
- The design of the burner and fire-house shall allow for complete mixing of fuel with the required amount of air, and for the uniform temperature distribution that ensure complete combustion and minimize gas emissions caused by incomplete combustion..
- Gases containing carbon dioxide shall be emitted through chimneys rising sufficiently high in order that these gases become lighter before reaching the ground surface, or using fuel that contains high proportions of sulfur in power generating stations, as well as in industry and other regions lying away from inhabited urban areas, providing that atmospheric factors and adequate distances to prevent these gases from reaching the dwelling and agricultural zones and regions, as well as the water courses shall be observed.
- Chimneys from which a total emission of wastes reaches 7000 – 15000 kg/hr, shall have heights ranging between 18 – 36 meters.
- Chimneys from which a total emission of gaseous wastes reaches more than 15000 kg/hour, shall have heights exceeding at least two and a half times the height of surrounding buildings, including the building served by the chimney.
- The permissible limits of emissions from sources of fuel combustion are given in table (7).

Table (7) Maximum Limits of Emissions from Sources of Fuel Combustion

parameters	Maximum limit, mg/m^3 of exhaust
Sulfur Dioxide.	3400
Carbon Monoxide.	250
Volatized ashes in urban regions.	250
Volatized ashes in remote regions.	500
Smoke.	50

4.2 Concerning efluents

Limits for pollutants in wastewater vary depending on the type of receiving water body. The parameters that should be monitored and/or inspected are BOD, COD, pH, temperature, residual chlorine, TSS, TDS, Oil and Grease.

Table (8) presents the permissible limits for discharges to the different recipients (sea, Nile, canals, agricultural drains, public sewer) according to the different relevant laws.

Spent lube oil has a negative impact on water and soil and therefore its disposal should be monitored/inspected. A record should be kept for this purpose.

Table (8) Egyptian Environmental Legal Requirements for Industrial Wastewater

Parameter (mg/1 unless otherwise noted)	Law 4/94: Discharge Coastal Environment	Law 93/62 Discharge to Sewer System (as Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
					Municipal	Industrial
BOD (5day,20 deg.)	60	<600	20	30	60	60
COD	100	<1100	30	40	80	100
pH (Grease)	6-9	6-9.5	6-9	6-9	6-9	6-9
Oil & Grease	15	<100	5	5	10	10
Temperature (deg.)	10C>avg. temp of receiving body	<43	35	35	35	35
Total Suspended Solids	60	<800	30	30	50	50
Settable Solids	__	<10	__	20	__	__
Total Dissolved Solids	2000	__	800	1200	2000	2000
Chlorine	__	<10	1	1	__	__

4.3 Concerning Solid Wastes

A number of laws address solid waste management. The following laws apply to scrap and sludge from the WWTP:

- Law 38/1967 which addresses public cleanliness, regulates the collection and disposal of solid wastes from houses, public places, commercial and industrial establishments.
- Ministry of Housing, Utilities and Urban Communities (MHUUC) decree No. 134 of 1968, which provides guidelines from domestic and industrial sources, including specifications for collection, transportation, composting, incineration and land disposal.
- Law 31/1976, which amended law 38/1967
- Law 43/1979, the Law of Local administration, which provided that city councils are responsible for “physical and social infrastructure”, effectively delegating responsibility for infrastructure functions.
- Law 4/1994 regulates incineration of solid waste

4.4 Concerning Work Environment

Violations of work environment could be encountered:

- In the boiler house: gas emissions, regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex 8.
- Wherever heating is performed: temperature and humidity are regulated by article 44 of Law 4/1994, article 46 of the executive regulations and annex 9.
- In refrigeration rooms: ammonia leaks are regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex 8.
- Near heavy machinery: noise is regulated by article 42 of Law 4/1994, article 44 of the executive regulations and table 1, annex 7.
- Ventilation is regulated by article 45 of Law 4/1994 and article 47 of the executive regulations.
- Smoking is regulated by article 46 of Law 4/1994 and article 48 of the executive regulations, and Law 52/1981.
- Work environment conditions are addressed in Law 137/1981 for Labor, Minister of Housing Decree 380/1983, Minister of Industry Decree 380/1982

The limits for the relevant pollutants are presented in Table (9)

Table (9) Permissible Limits as Time Average and for Short Periods

Material	Limits			
	Time average		Exposure limits for short periods	
	ppm	mg/m^3	ppm	mg/m^3
Ammonia	25	18	35	27
Carbon dioxide	5000	9000	15000	27000
Carbon monoxide	50	55	400	440
Sulfur dioxide	2	5	5	10

4.5 Concerning Hhazardous Material and Wastes

Law 4/1994 introduced the control of hazardous materials and wastes. The carbonated beverages industry does not generate any hazardous wastes. The hazardous chemicals used in the lab and the fuel for the boilers, fall under the provisions of Law 4/1994. Articles 29 and 33 of the law makes it mandatory for those who produce or handle dangerous materials in gaseous, liquid or solid form, to take precautions to ensure that no environmental damage shall occur. Articles 25, 31 and 32 of the executive regulations (decree 338/1995) specify the necessary precautions for handling hazardous materials. Storing of fuel for the boilers is covered by the Law 4 as hazardous material There is no explicit articles in Law 4/1994 or in decree 338/1995 (executive regulations), regarding holding a register for the hazardous materials; article 33 is concerned with hazardous wastes. However, keeping the register for the hazardous materials is implicit in article 25 of the executive regulations regarding the application for a license.

4.6 The Environmental Register

Article 22 of Law 4/1994 states that the owner of the establishment shall keep a register showing the impact of the establishment activity on the environment. Article 17 and Annex 3 of the executive regulations specify the type of data recorded in the register.

The emergency response plan and the hazardous materials register will also be part of the environmental register as stated in part 4.5.

5 POLLUTION ABATEMENT MEASURES

This section deals with pollution abatement in the three media air, water and soil. Three types of interventions will be considered:

- In-plant modifications, which are changes that are performed in the plant to reduce pollutant concentrations in streams through recovery of materials, segregation and/or integration of streams, reducing the flow rate of the wastewater streams that need further treatment to reduce the hold-up of the required WWTP.
- In-Process modifications, which are changes performed on the process such as the introduction of newer technology, substitution of a hazardous raw material, performing process optimization and control.
- End-of-pipe (EoP) measures, which involve treatment of the pollutant or its separation for further disposal. Whereas in-plant and in-process modifications usually have an economic return on investment, end-of-pipe measures will be performed for the sole purpose of compliance with the laws without economic

Egyptian Environmental Laws do not require water and energy conservation measures. These measures have been considered in this manual since resource depletion and hence conservation is a worldwide-recognized environmental issue that could be implemented in Egypt in the near future. Water conservation measures can lead to higher concentrations of pollutants in the effluent streams. Both energy and water conservation measures will provide both financial and economic benefits.

The term Cleaner Production (CP) refers to the same concepts of pollution reduction through in-process, in-plant and resource conservation, in contradistinction to end-of-pipe treatment. In many cases, the adoption of CP can eliminate the need for (EoP) treatment.

The following CP and EoP measures have been identified for the carbonated beverages industry.

5.1 Air Pollution

Flue gases *Particulate matter* in flue (exhaust) gases are due the ash and heavy metal content of the fuel, low combustion temperature, low excess oxygen level, high flow rate of flue gases. *Sulfur dioxide* is due to the sulfur content of the fuel. *Nitrogen oxides* are formed when maximum combustion temperature and high excess oxygen. *Carbon monoxide* is formed when incomplete combustion occurs at low air to fuel ratio.
The following measures can be adopted to minimize air pollution from flue (exhaust) gases:

- Replace Mazot by solar or natural gas. Mazot is high in sulfur content.

- Regulate the fuel to air ratio for an optimum excess air that ensures complete combustion of carbon monoxide to dioxide.
- Keep the combustion temperature at a moderate value to minimize particulate matter and nitrogen oxides.

Gas leaks Freon and steam leaks are minimized through maintenance and repair. Freon should be replaced by another non-hazardous refrigerant.

5.2 Water Pollution Abatement Measures

In-plant modifications

- The installation of product-capture systems for filling machines can reduce product losses.
- Spent caustic soda wash stream from the bottle washing unit can be collected in a tank and slowly discharged over the 8 hour shift instead of suddenly discharging it to the sewer at the end of the shift.
- Implementation of a quality control system such as HACCP (Hazard Analysis & Critical Control Point) is recommended to minimize waste.
- Proper storage of the product as well good distribution networks minimizes product spoilage and hence rejects.`
- Integration and segregation of sewer lines to minimize treatment needs and ensure compliance with the environmental laws, can be an option for many factories. In some cases where there are several discharge points from the factory, mixing of the streams could lead to compliance. In other cases where treatment is imperative some streams could be segregated and discharged without violation. The remaining streams will require a smaller treatment unit.

In-process modifications

- Implementation of a control system involving pressure regulators on the steam lines, temperature controllers, flow controllers…
- Control carbon dioxide concentrations in order to prevent spillage and bottle bursts.
- Replace batch processes with continuous ones.
- Modernize the equipment.

End-of-pipe treatment Because of the typically high, COD and BOD in the carbonated beverages industry waste-streams, end-of-pipe treatment frequently involves biological treatment. Pretreatment of effluents consists of flow equalization, neutralization followed by biological treatment.

Some of the waste streams are alkaline (bottle washing unit) and can be used to neutralize the acidic waste streams from other units (syrup preparation, bottle filling, ..).

If space is available pond systems are potential treatment methods. Other possible biological treatment methods include trickling filters, rotating biological contactors and activated sludge treatment.

5.3 Abatement Measures for Solid Waste Pollution

Scrap Scrap is collected and sold.

Sludge

- Effluent treatment processes generate solids. On average 70-80% of the original carbon is converted to solids. This sludge is subject to putrefaction, is malodorous and offensive. It can also be hazardous to health by absorbing pathogens that multiply in this favorable medium and toxins. Raw sludge is saturated with bound water, should be de-watered and disposed of in sanitary landfills.
- Sludge is also be generated from water treatment when lime and chemicals are used. It should be dried and dumped in waste disposal sites.

5.4 Water and Energy Conservation

Water and sewer service costs have been rising, and these increases can cut into profits. Using water more efficiently can help counter these increases.

Water Conservation

- Install water meters and monitor water use
- Use automatic shut-off nozzles and mark hand-operated valves so that open, close and directed-flow positions are easily identified.
- Use high-pressure, low-volume cleaning systems, such as CIP (clean in place) for washing equipment.
- Install liquid level controls with automatic pump stops where overflow is likely to occur.
- Recycle cooling water through cooling towers.
- Minimize spills on the floor minimizes floor washing.
- Repair leaks.
- Handle solid waste dry.
- Recycle steam condensate whenever economically viable.

Energy conservation measures

- Insulation of steam lines.
- Installation of steam traps.
- Repair or replace steam valves.
- Maximize boiler efficiency.
- Install pressure regulators on steam lines.

6. ENVIRONMENTAL SELF-MONITORING

Self-Monitoring (SM) is a process that primarily relates to measurements of process inputs, releases and environmental pollution levels, as well as process conditions (operation controls) that are directly related to the monitored emissions. Self – monitoring is necessary for the plant to improve its economic performance by identifying the sources of wastes in raw materials, water, and energy that represent the main sources of pollution. Thus, the plant would be able to implement pollution prevention techniques that could reduce production costs and minimize compliance costs, which should lead to improved economic and environmental performance of the plant.

In addition, self-monitoring may include reporting of the results to the pertinent authorities. Monitoring can be carried out by the industrial establishment, or on its behalf, and paid for by the industrial establishment. The information obtained from the sampling component of the monitoring system must be recorded and the results reported to the appropriate internal and external decision-makers.

6.1 Benefits of SM

In general, the benefits of self-monitoring results to the operators include:

- Raising their awareness about the process performance and efficiency
- Having them ready for inspection by authorities.
- Providing inspectors with more reliable data to verify the single unrepresentative samples and/or measurements
- Raising their awareness about impact of pollutants
- Implementing corrective actions if non-compliance occurs.
- Deciding on raw materials, additives, fuels, and investment strategies.
- Identifying trends in plant performance and setting alarms.
- Improving process efficiency.

These benefits are generated through implementing an integrated environmental self-monitoring plan that comprises:

- Emission monitoring, which covers releases to air, wastewater, and solid and hazardous waste as well as regulated working conditions
- Monitoring of process parameters (operation controls) that are directly related to the releases; such as temperature, pressure, and humidity. In addition, process conditions such as shutdowns, maintenance operations, and spills need to be also monitored, linked to emissions, and reported.

6.2 Scope and Objectives of SM

As previously indicated, environmental self-monitoring comprises the monitoring of environmental releases (emissions) as well as the monitoring of process parameters (operation controls) that affect the environmental impact of the facility. The objectives of each type are separately detailed as follows:

a) Emissions self-monitoring

The basic objective of self-monitoring is to monitor compliance with environmental regulations. As the inventory for hazardous materials and wastes is mandatory with procedures for handling and storage as regulated by law 4/1994, self-monitoring should assist in covering this area. The objectives of emission monitoring may go beyond monitoring compliance; i.e. to assist improving environmental performance. In other words, monitoring of emissions at the process level is necessary to minimize emissions at the source through pollution abatement and prevention measures. While Egyptian regulations consider only concentration of the pollutants, self-monitoring may include pollution loads as well as the environmental impact on the receiving media. These data are required to assess the improvement of the environmental performance.

b) Process self-monitoring (operation control)

In most industrial facilities monitoring of process operations already exists. Some process operation controls should be monitored for improved environmental benefits. The main objectives of process self-monitoring (operation control) is:

- Optimization of process operation by controlling the operating conditions
- Minimization of losses
- Planned maintenance and repair as opposed to emergency maintenance and shutdown
- Minimization of cost through conservation of energy and water

6.3 SM and Environmental Management Systems (EMS)

Aside from the regulatory aspects, SM has shown to be a necessary tool for the plant to manage its releases, control its environmental impacts and improve its environmental performance. Such achievements represent the main objectives of the Environmental Management Systems (EMS), which in turn constitute a requirement for internal monitoring, checking and implementing the corrective actions. In addition, EMS encourages the industrial plants to adopt Cleaner Production, (CP), and Pollution Prevention, (P2), measures as the main tools for continual improvement. This can be achieved only by implementing a comprehensive and effective SM plan.

The following sections highlight the concept of EMS, link to SM and link between SM and cleaner production.

6.3.1 Environmental Management Systems (EMS)

An Environmental Management System (EMS) is a framework that helps a company achieve its environmental goals through consistent control of its operations. The EMS itself does not dictate a level of environmental performance of the company; each company tailors its EMS to its specific business goals. Compliance with environmental laws and regulations has become a major goal that has to be attained with minimum cost. This is the minimum level for environmental performance to be achieved through the EMS. In general, an EMS comprises five phases leading to continual improvement; commitment and policy, planning, implementation, evaluation and review. These phases will be herein explained within the context of the standard system “ISO 14000”, which is internationally recognized. With regard to Egypt, this system is being gradually implemented by the Egyptian Industry. The different stages of the EMS form a cycle (Figure 4) that allows feedback of information and continuous improvement. This system includes the following elements:

1. ***Environmental policy.*** Top management commits to an environmental policy that comprises, as a minimum, compliance with laws and regulations, pollution prevention and continual improvement. The policy is the foundation of the EMS
2. ***Planning***: The company first identifies environmental aspects of its activities. Environmental aspects are those items such as air pollutants or hazardous wastes that can have negative impacts on people and/or the environment. Once the pertinent laws and regulations are identified, the company sets objectives and targets. An objective is an overall environmental goal (e.g. minimize use of chemical x). A target is a detailed, quantified requirement that arises from the objective (e.g. reduce use of chemical ***x*** by 25% by September 2003). The final part of the planning stage is developing an action plan for meeting the targets, including schedule, resources, and the clearly defined steps to meet the targets.
3. ***Implementation.*** This phase comprises the establishment of the structure, assignments and responsibilities of the designated personnel. An important component is personnel training and awareness for all employees. Other steps in the implementation stage include documentation, document control, implementing operation procedure, and setting up internal and external communication lines. In addition, an emergency and preparedness plan has to be developed.
4. ***Checking and Corrective Action***. The company monitors its operations and activities to ensure that targets are being met. If not, the company takes corrective action and keeps records for the emissions and environmental performance. Internal audit is a key element to improve the system.
5. ***Management Review.*** Top management regularly reviews the results of the evaluation to see if the EMS is efficient and effective. Management determines whether the original environmental policy is consistent with company values. The plan is then revised to optimize the effectiveness of the EMS. The review stage creates a feedback of information necessary for continuous improvement.

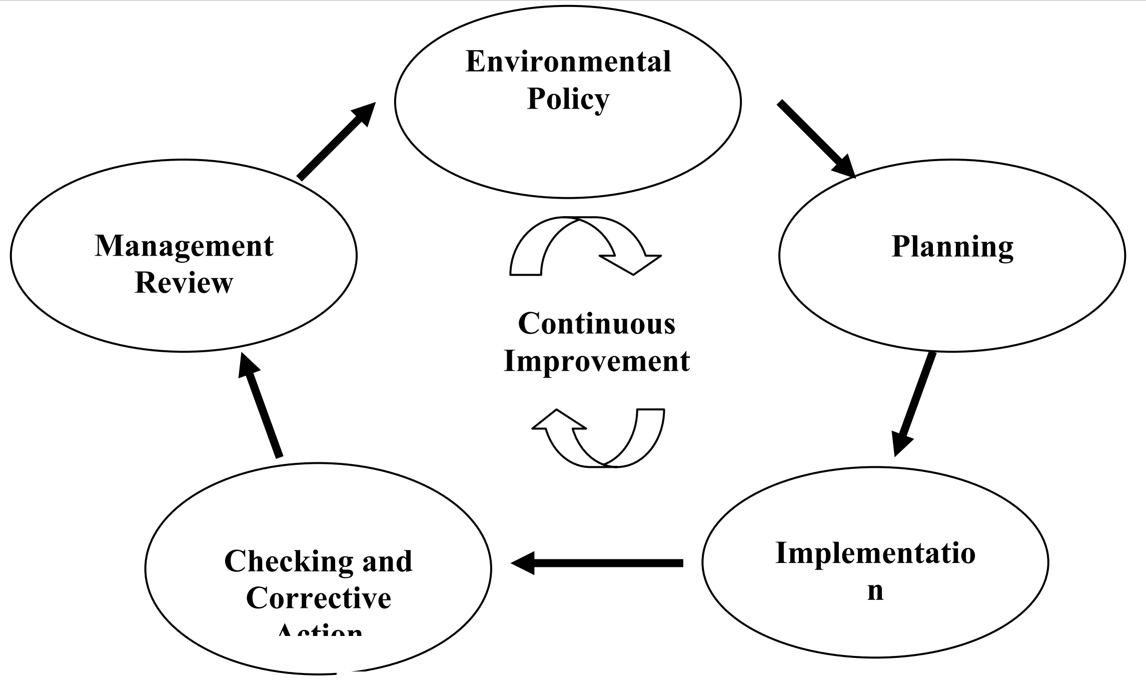


Figure (4) Phases of EMS cycle (ISO 14000)

6.3.2 Link between self-monitoring and (EMS)

As previously explained, an EMS e.g. ISO 14000, comprises 5 stages: environmental policy, planning, implementation, checking and corrective actions. By analogy, the self-monitoring system (SMS) can be looked at using the same concept. Taking into consideration the definition, concept and principles of self-monitoring, as stated in the "Guide Book on Self Monitoring", the elements of SMS can be rearranged as follows:

Commitment: In general, an effective self-monitoring requires that the management of the plant be committed to environmental compliance, as a minimum. However, this commitment will be an integrated part of the environmental policy in the EMS, if exists.

Planning: The planning of the SM is mainly based on objective (s) that have been set. For a basic SMS, the objective would be monitoring of regulated parameters to assist in achieving regulatory compliance; e.g. end-of-pipe emissions and discharges. In an advanced SMS, the objectives may include monitoring of operation controls as well as emissions and wastes at the source, to help in implementing pollution prevention and cleaner production measures. In all cases, the objectives of self-monitoring should be in line with the objectives of EMS, if exists. In such case, the self-monitoring plan can be part of the EMS plan and includes:

- Description of the regulatory limits for compliance
- Brief description of the actual situation (existing monitoring activities, devices, equipment, resources,..).
- Objectives and targets with time frame for implementation.

- Identification of parameters monitored, location of monitoring points and preparation of a self-monitoring schedule.
- Description of methods and procedures used for sampling, analyses, measurements, calculations, recording and data manipulation.
- Description of tasks
- Training program

***Implementation*:** The implementation of SM means that the tools and mechanisms for collecting the relevant data are functioning. On the other hand, the implementation phase in EMS means that the environmental performance of the plant is improving.

The implementation of SM results in large amount of data that need representation, interpretation and reporting in order to be useful as tools for decision making for corrective actions. The decision making requires knowledge about the status of:

- Emissions as compared to limits set by law.
- Toxic and hazardous releases: concentration, handling procedures and transfers.
- Maintenance and repair.
- Percentage losses of raw materials, products and utilities.
- Process operating parameters.

***Evaluation*:** Evaluation of the self-monitoring plan through regular auditing will allow its continuous improvement. Evaluation should include all aspects of the plan (training, meeting targets, reliability of data, efficiency of devices,…etc). On the other hand, the evaluation of the EMS involves checking and taking corrective actions of all system components, including the monitoring activities.

***Review*:** On the basis of the evaluation of the monitoring plan, a review can be made of the monitoring objectives and targets. In case of EMS, the management review covers all the involved procedures, including monitoring activities.

It is clear from the above explanation that self-monitoring is an integral part of any EMS. More specifically, self-monitoring is the tool for the evaluation function of an EMS. Figure (5) illustrates relationship and interaction among the main elements of EMS and SMS.

6.3.3 SM Link to Pollution Prevention and cleaner production

Growing understanding that escaping raw materials, chemicals and products constitute major pollution sources, industry has opted to implement pollution prevention measures at the source. These measures include in-plant and in-process modifications as well as resource conservation (minimization of water and energy consumption). The implementation of these measures will decrease the end-of-pipe treatment cost. However, plant management will have to undertake a cost-benefit analysis to determine which measures are economically viable.

Self-monitoring is the tool that helps undertake these analyses by providing the necessary data and information about process inputs and outputs as well as the framework for performing the required tasks.

The introduction of emission monitoring for the purpose of improved environmental performance through the application of cleaner technology widens the objectives of the plant EMS beyond compliance with relevant laws and should be met with economic incentives from the part of the competent authorities.

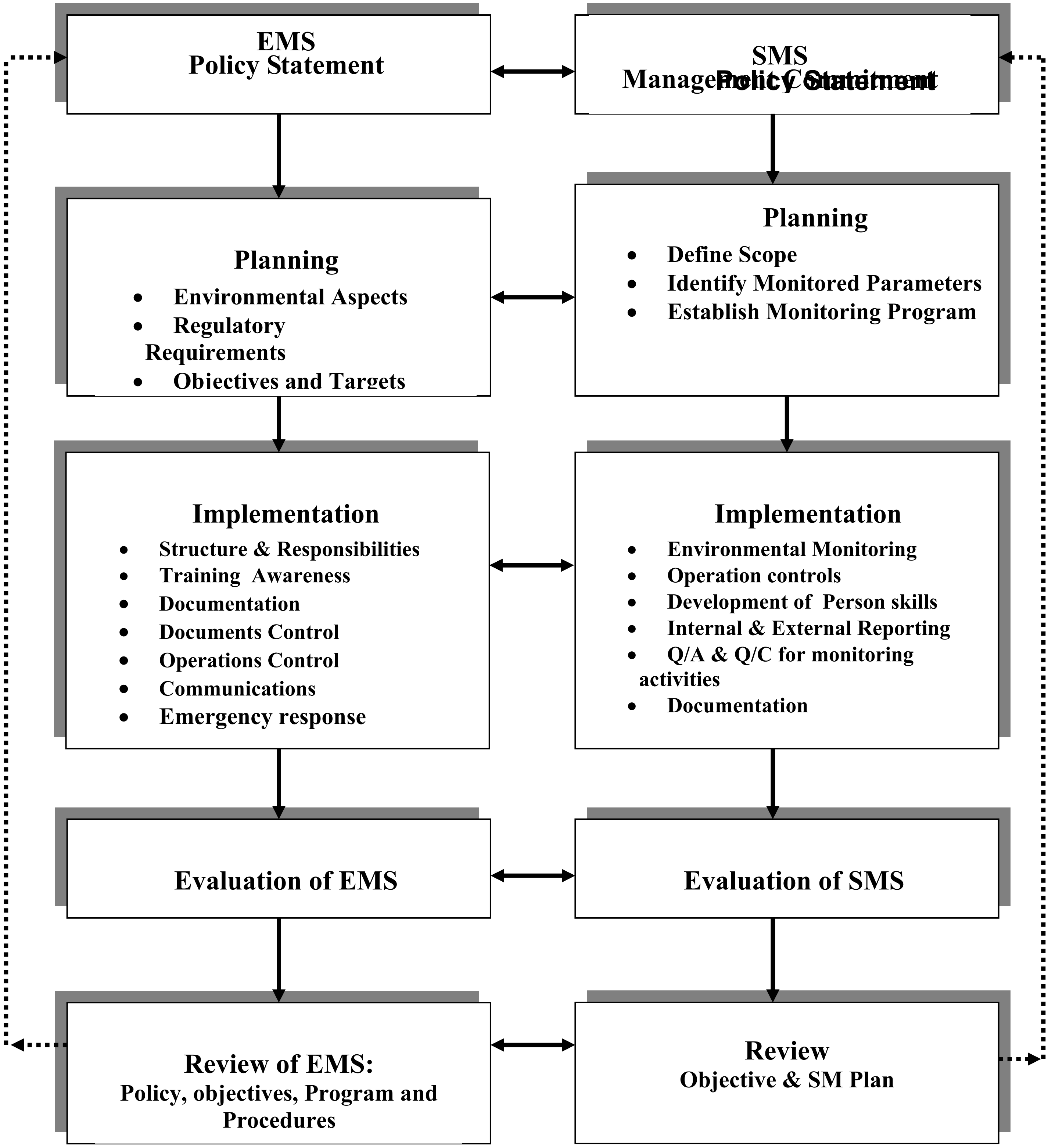


Figure (5) Relationship between EMS and SMS

6.4 Regulatory Aspects

In developed industrial countries, e.g. in Europe, the competent authorities must approve the monitoring program, specify the standards and quality requirements for self-monitoring that are to be achieved by the operator, and ensure those possibilities for cheating and fraud are minimized. The competent authorities will receive self-monitoring reports periodically from the operator. These should provide summary information, following data reduction, in a format facilitating easy comparison with permit limits. Additionally, the competent authorities would inspect the operator's self-monitoring records, including log sheets covering sampling, analyses, instrumental monitoring, and data-reduction calculations.

6.4.1 SM and Environmental Register

According to Law 4/1994, industrial facilities (operators) are required to keep a record of their inputs, outputs and releases in the environmental register as stated by which implicitly requires some sort of self-monitoring. The Egyptian Environmental Affairs Agency (EEAA) is mandated to check the validity of the data in the Environmental Register. The responsibilities of the operator and the competent authority are not affected by who carries out the monitoring. It is the responsibility of the operator to comply with laws and regulations. On the other hand, the competent authorities (inspectors) are responsible for assessing and ensuring the operator's compliance.

When combined with Self-monitoring, the Environmental Register can offer benefits to the competent authorities through:

- Utilizing the operator's knowledge and experience of his process in planning and carrying out a monitoring program that can lead to improved control over releases to the environment.

- Self-monitoring will normally provide more information than may be obtained by periodic inspection by the competent authorities.

- Providing a mechanism for educating the operator about the requirements for complying with relevant laws, regulations and permits and for increasing of management responsibility for compliance and the impact of process releases on the environment.

6.4.2 SM and Inspection

Self-monitoring does not constitute self-regulation. SM provides additional information on which the competent authorities can judge whether an operator is complying with relevant legislation and conditions of permits. It does not change the duty of the competent authority to assess compliance by means of inspection and by performing its own monitoring or choose to rely on the operator's monitoring data or a combination of both. The competent authority continues to be responsible for enforcement.

As mentioned above, SM provides a wealth of information that can be utilized by the competent authority in reviewing standards and developing applicable environmental policies. However, the competent authority will have to check the reliability of the SM data. Thus, inspectors may be required to check the SMS plan, QA/QC procedures, data handling and documentation. In this context, it is expected that inspectors may perform the following tasks:

- Check the SM program
- Check and verify the specified measurement standards
- Check the reliability of the data (by carrying out independent monitoring).
- Inspect SM arrangements such as:
  - The positioning and serviceability of fixed instrumentation.
  - Records confirming the maintenance and calibration of instrumentation and sampling equipment.
  - Manual sampling and analytical procedures.

This expected interaction would help both partners, i.e. the operator and the competent authority, in achieving their objectives in terms of reliability of emission data and environmental performance.

7. PLANNING OF SM

Planning for SM starts by setting the objectives. It should be clear that a number of process control parameters needs to be monitored, along with environmental monitoring. For the purpose of this manual environmental self-monitoring will be considered in addition to monitoring of process parameters that are related to emissions (operation controls).

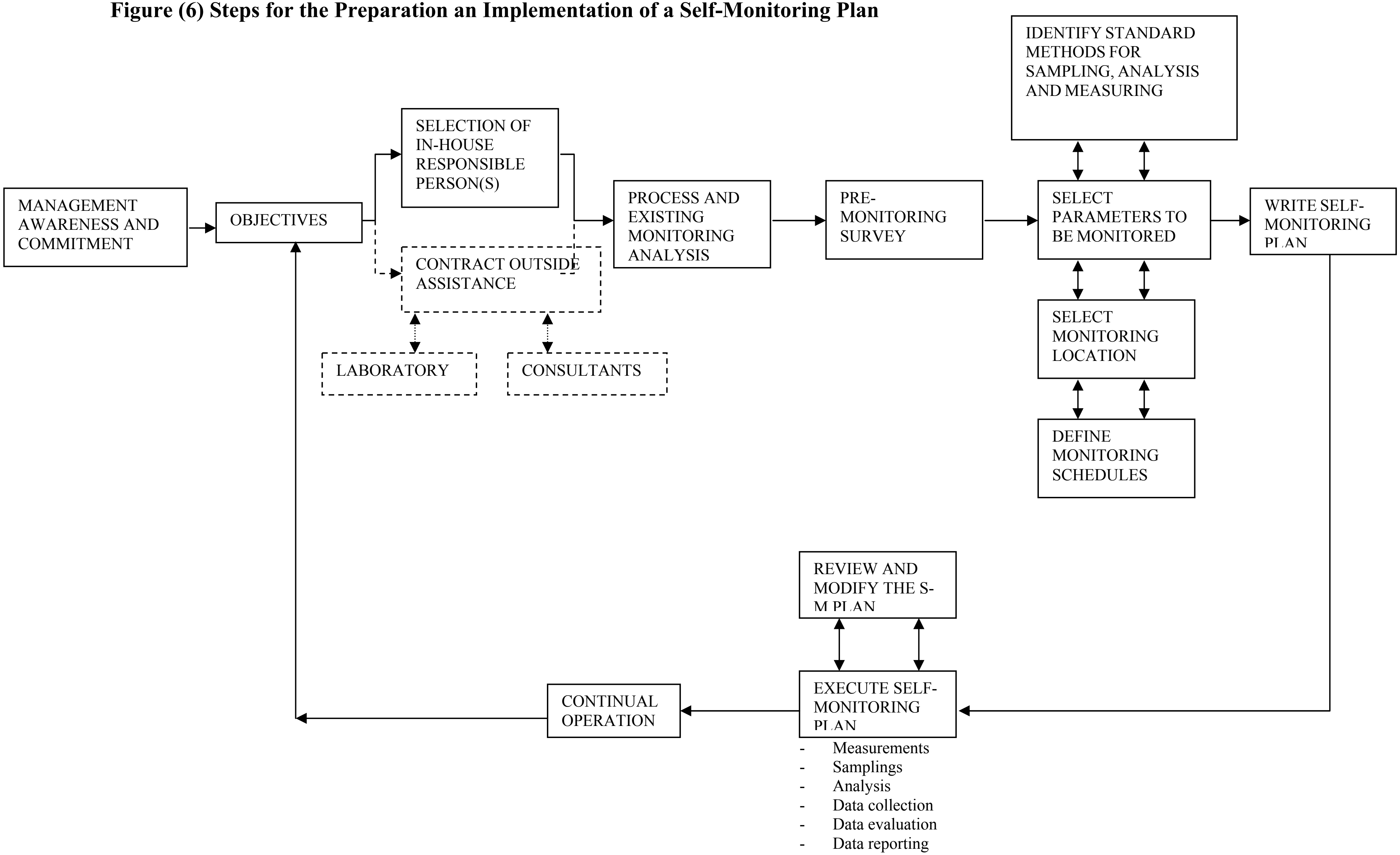
Compliance monitoring requires measurements, analysis and data on end-of-pipe releases, whereas operation controls target the production units that offer pollution prevention opportunities. The environmental manager with the help of various sector managers should carry out the planning activities.
With reference to ”Guidebook for Industrial Self-Monitoring”, the main elements of the Self-Monitoring Plan, that describes the SMS, include:

- Objectives and results required from the self-monitoring system
- Organization and share of responsibilities and tasks
- Planning activities and design of an implementation schedule
- Definition of the parameters and relevant monitored indicators to reach the objectives
- Design of an appropriate measurement and sampling program
- Data processing and reporting procedures
- System for follow-up of decisions, actions and monitoring development
- Quality assurance and control

With reference to the Guidebook for Industrial Self-Monitoring the objective of the SMS can be limited to provide the data required for the Environmental Register which is mandated by the Environmental Law, e.g. total inputs, outputs and emissions on the plant level. This objective ”compliance with regulations” requires the ”Basic Self-Monitoring System” which comprises the minimum requirements. In these cases where self-monitoring is not mandatory, operator can build a ”basic” self-monitoring system that focuses on the regulated emissions, as a minimum. Then, the system can be gradually upgraded, ”continual improvement” through internal auditing of all system components. Other objectives, e.g. waste minimization, pollution prevention and improved environmental performance require upgraded SMS that includes monitoring of inputs, outputs and releases on the level of operations and detailed processes. In all cases, the established SMS should be gradually improved and upgraded, considering the plant financial and economic constrains.

The following sections are detailing the stepwise activities that are needed to develop a viable, realistic, and applicable plan for a self-monitoring system. Figure (6) presents the various steps for the preparation and implementation of a self-monitoring plan.

Figure (6) Steps for the Preparation an Implementation of a Self-Monitoring Plan



7.1 Assessment of existing monitoring capacity

Assessment of existing monitoring capacity includes the following aspects:

- Management system: presence of an EMS, existing system for data collection and reporting.
- Human resources: available personnel, level of training; motivation.
- Technical resources: monitoring equipment and laboratory, status of equipment
- Financial resources: available budget for self-monitoring activities.
- Table (10) presents an example of a checklist for existing self-monitoring activities.

Table 10. Example for assessing the status of existing monitoring activity.

Monitored activity	Location	Parameter	Associated tasks	Person in charge	Frequency
Wastewater	Final discharge	Flow rate	Recording flow on flow meter Inspect meter Calibrate Data analysis, representation	Operator X Supplier Operator Y Lab staff	Daily
		BOD, COD..	Grab sample Sample preservation Analysis Review results and reporting	Lab technician Lab staff Lab staff Chief of Lab	Once a week

7.2 Identification of key parameters

The identification of key monitoring parameters requires an understanding of the manufacturing processes and the operation of the various units. The brief description provided in section 2 and the relevant tables can help identify some of these parameters. However, a pre-monitoring audit is necessary to determine sampling and measurement locations and schedules needed to design the self-monitoring plan. Priority should be given to parameters that determine compliance with environmental laws. A table describing the monitoring activities can be prepared for process and compliance monitoring.

The exact positions of the monitoring points within the production line have to be determined on a case by case basis by production experts, according to the following criteria (SM Guidebook, EPAP 1999):

- Representativeness of the monitoring point.
- Criticality of the monitoring point
- Accessibility of the monitoring points

The choice of the parameters is determined by the type of production, the legal requirements, the nature of the pollutant and its load, and the importance of the parameter for decision making. For each of the proposed parameters the trends and variations should be monitored in addition to the value of the parameter at a given time.

7.3 General data required

When assessing the performance of the operation and its impacts on the environment, some basic information is needed to put the monitoring data into the context of interpretation. Such information is about:

- Identification: Name, address, plant location, name of owner, manager and head of environmental department.
- Inputs name, type and amount: Raw materials, chemicals, fuels, water, steam, electricity.
- Technology: Description of process, applied technology, operating conditions (temperature, pressure), maximum capacity, operating capacity during monitoring.
- Outputs name, type and rate: Products, by-products
- Abatement techniques: Air pollution prevention, wastewater treatment, solid waste management, noise abatement
- Emissions and their sources: receiving media, pollutant type, concentration and load, pollutant impact.
- Existing EMS system, analyses and measurement results, relevant environmental laws and allowable pollutant levels.
- Assessment of legislative and regulatory requirements.

7.4 Data collection, manipulation and reporting

Data collection and analysis should be carefully planned according to the following principles:

- Base the analysis on trends over a long period to take into consideration the shock loads that characterize the beverages industry.
- Determine the causes and degree of variability of a parameter. A dramatic change of a low-variability parameter may be interpreted as a sign of anomaly of the process. This will require an investigation to find the potential source of the problem and take the right corrective action.
- Study the correlation between different parameters. The cause of variation for a highly variable parameter may be correlated to another parameter.

A considerable amount of data may be generated by the operator carrying out self-monitoring especially when continuous monitoring instrumentation are used. Data reduction is necessary to calculate time-averaged means, percentile values and the like. When compliance data are recorded in the environmental register the relevant calculations for data reduction should be specified.

Measured values are used to form half-hourly mean values for each successive half-hour to generate frequency distribution. For each calendar day a daily mean value, related to the daily operating time, is calculated from the half-hourly mean values and kept on file. Measurement results should be kept in the environmental register for at least 10 years (Article 22 of law 4/1994 and 17 of its executive regulations). An annual report is prepared on the outcome of the measurements including information on:

- Measurement planning
- The outcome of each individual measure
- Measurement methods used

- Operating conditions that are important for the assessment of individual data and measurement results.

7.5 Criteria for selecting monitoring method.

The choice of monitoring method used to determine the value of the parameter depends on the specific features of the process, the emission sources, the physical state and properties of the sample and the nature of emissions from the operation. The latter can be classified as:

Normal emissions	Occur during normal operation and normal process and abatement technique conditions .
Diffused and fugitive emissions	These are emissions from a certain process but from scattered points such as emissions from ventilation ducts, barrels, and scattered small stores. The diffuse emissions are calculated/estimated by monitoring the source periodically and assessing the long-term emission from the measurement results or by mass balance calculations.
Exceptional emissions	Exceptional emissions refer to varying input or process conditions, start-ups, shutdowns, by-pass of a process for malfunctioning and accidental causes. The emissions can differ from those of normal operation in their volume and/or concentration. These emissions can be multiple compared to normal emissions. It can be impossible to measure the concentration or volume of the exceptional emissions as the measuring device is calibrated according to the normal operating conditions. Estimation techniques should then be performed.

There are four basic methods that may be used to develop estimates:

- Direct or indirect measurement
- Mass balance
- Emission factors
- Engineering calculations

7.5.1. Direct or indirect measurement

a) Direct measurements: Using monitoring data or direct measurements is usually the best method for developing chemical release and/or other waste-management activity quality estimates. Data may have also been collected for the facility through an occupational health and safety assessment. If only a small number of direct measurement data is available or if the monitoring data are not based on a representative sample, another estimation method should be used to give a more accurate result.

Note : Treatment Efficiencies
Supplier data on treatment efficiencies often represent ideal operating conditions, should be adjusted to account for downtime and process upsets during the year that would result in lower efficiencies. Efficiencies reported by supplier are often general and may not apply to specific chemicals. For example, an incinerator or flare may be 99.99% efficient in destroying organic chemicals, but will have a 0% efficiency in destroying metals.

For successful measurements the following considerations should be satisfied:

- The frequency of measurement and sampling must cover temporal variations of the process and specifically the period during which harm occurs.
- Continuous monitoring is suitable for large emission sources, such as stacks and wastewater canals except in cases where high temperature or corrosive substances are involved. At smaller sites the cost of continuous monitoring is weighed against the value of the monitoring results and the possibility of obtaining representative results from periodic measurements.
- Utilization rate (percentage of continuous monitoring time to total operation time) should be known when performing continuous monitoring.
- The process conditions must be specified when monitoring takes place (e.g. start-up, shutdown, production rate, operating production lines, and failure of abatement equipment).

b) Indirect measurements: These are performed through surrogate parameters. Surrogate parameters are variables that can be closely related to conventional direct measurements of pollutant releases or impacts and which may therefore be monitored and used instead of direct values for some practical purposes. Surrogates are commonly used in operation control as they give an early warning of possible abnormal conditions or emissions. Surrogates may provide a relative measurement rather than an absolute value and may only be valid for a restricted range of process conditions. On the other hand, surrogates can provide more continuous information than direct measurements. It is also often cost-effective as it allows more discharge positions to be monitored for the same resources. The advantages and disadvantages of surrogate parameters are summarized in Table (11).

A surrogate can be used for compliance monitoring purposes if all the following conditions are met:

- It is closely and consistently related to a required direct value (e.g. fuel sulfur vs. directly measured SO_2, relationship between opacity and particulate concentration, condenser temperature and VOC emissions).
- It is regularly calibrated against the direct value.
- It is cheaper or easier to monitor than the direct value, or gives more frequent information
- Its value can be related to specific limits
- The process conditions where it is measured matches the conditions where direct measurements are required.
- Any extra uncertainty due to use of surrogate is not significant for regulatory decisions or process management.

Table (11) Advantages and disadvantages of surrogate parameters

Advantages	Disadvantages
• Cost savings	• Need cost for calibration against direct values.
• More continuous information e.g. continuous opacity vs. periodic dust sampling	
• Allow more positions form discharge monitoring Sometimes more accurate e.g. fuel sulfur vs. SO_2	• May provide relative measurement rather than an absolute value
• Give early warning of possible abnormal emissions e.g. combustion temperature warns for increase in dioxin emissions.	• May not valid only for a restricted range of process conditions.
• Causes disruption to process operation. • May combine information from several direct measurements e.g. temperature indicates energy efficiency, emissions and process control.	• May not command as much public confidence as direct values. • Sometimes less accurate.

7.5.2. Mass balance

A mass balance involves determining the amount of chemical entering and leaving an operation. The mass balance is written as follows:

$$\text{Input} + \text{Generation} = \text{Output} + \text{Consumption}$$

- **Input** refers to the materials (chemicals) entering an operation. For example, chlorine added to process water as a disinfectant would be considered an input to the water treatment operation.
- **Generation** identifies those chemicals that are created during an operation. For example, when nitrogen sources are used in biological wastewater treatment systems, additional ammonia may be produced (generated).
- **Output** means any stream by which the chemical leaves the operation. Output may include on-site releases and other waste management activities to the environment, storage, or disposal; or the amount of chemical that leaves with the final products. In a can coating operation, for example, pigments in the paint may leave the operation as part of the product (the coating on the can) and on paint spray booth filters sent for disposal.
- **Consumption** refers to the amount of chemical that is converted to another substance during the operation (i.e., reacted). For example, phosphoric acid would be consumed by neutralization during wastewater treatment.

The mass balance technique may be used for manufactured, processed, or otherwise used substances. It is typically most useful for chemical that do not become part of the final product, such as catalysts, solvents, acids, and bases. For large inputs and outputs, a mass balance may not be the best estimation method, because slight uncertainties in mass calculations can yield significant errors in the release and other waste management estimates.

Material balance calculations are also used to examine the effects of emission reduction on the material balances of the plant. A material balance calculation gives an impression of the magnitude of the emission of a specific substance but can not show neither accurate emission amounts, nor their division between emissions into the air, water discharges or solid wastes. Material balance calculations are often based on evaluated process flows and concentrations. Calculating a reliable average emission level for a factory means long term monitoring of the processes and statistical examination.

7.5.3. Emission factors

An emission factor is a representative value that attempts to relate the quantity of an emission released with an associated activity. These factors are usually expressed as the weight of emission released divided by a unit weight, volume, distance, or duration of the activity (e.g. kg of emission released per kg of product). Emission factors have been developed for many different industries and activities. Emission factors depend on the technology used, raw materials and pollution control devices. Emission factors can be obtained from industrial database e.g. DSS (available at EEAA).

> ***Note***
> *Sources of information on emission factors should be carefully evaluated and the conditions for using the factors reviewed to determine if it is applicable to the situation at the facility.*

7.5.4. Engineering calculations.

Engineering calculations are assumptions and/or judgements used to estimate quantities of listed chemicals released or managed. The quantities are estimated by using physical and chemical properties and relationships (e.g. Raoult’s law, Ideal gas law) or by modifying an emission factor to reflect the chemical properties of the toxic chemical in question. Engineering calculations rely on the process parameters; thorough knowledge of the operation is required to complete these calculations.

Engineering calculations can also include computer models. Several computer models are available for estimating emissions from landfills, wastewater treatment, water treatment and other processes.

8. MONITORING OF RAW MATERIALS, UTILITIES AND PRODUCTS

Inputs and outputs data is needed for estimating the nature and amount of the releases when assessing the reliability of the monitoring results. The input data includes the quantity and quality of raw materials, chemicals, fuel and water used

8.1 Raw materials and chemicals

The amount of raw milk received per day and cost/kg are important monitoring parameters. The quality of raw milk is assessed by bacteriological and chemical tests before acceptance. Some factories use storage tanks for rejected raw milk and discharge it with a specified flow rate to the sewer, see Table (12). The flow rate should be monitored to make sure that it does not cause an increase in pollutant concentrations in the final discharge beyond limits set by law.

Table (12) Monitoring of Raw Materials and Chemicals

Parameter	Monitoring Method	Indication
Amount of raw materials (milk) and chemicals (salt, preservatives,….etc) necessary to produce 1 ton of product	Weighting, measuring, book keeping and recording	Rationality in the use of raw materials
Quantity of rejected raw material (milk) per unit of product	Weighting, measuring, book keeping and recording	Losses, process efficiency, storing or handling problems
Quality of raw material	Specific criteria (density, fat content, etc)	Avoiding possible production problems due to bad quality Identifying raw materials(milk) harmful for the environment if discharges to the sewer it will lead to BOD increase
Cost of the raw material necessary to produce 1 ton of product	Book keeping	Assess economical burden due to non rational use of raw material and possible avoidable extra costs
Proportion of the cost of raw material in the cost of product & its variation	Book keeping	Assess economical burden due to non rational use of raw material

8.2 Utilities

Monitoring of energy consumption takes into account the different forms of energy. It is important to note that heat and electricity cannot be summed up, as they are not commensurate. The energy efficiencies of heat and electricity should therefore be dealt with separately, Table (13).

Table (13) Monitoring of Utilities

Parameters	Monitoring Method	Indication
Energy consumption per ton produced • Electricity • Fuel	Consumption measurements and book keeping Fuel flow accumulator	Energy use efficiency
Repartition between the different types of energy used	Recording and book keeping	Energy use efficiency
Water consumption per ton of product produced per ton of production & and its variability	Flow measurements, book keeping and recording	Water use efficiency, most of the discharge related parameters are calculated
Quality of the utilities	According to the specific criteria	Impact on the smooth running and efficiency of processes
Steam : Pressure level Degree of saturation		
Process water : Pressure, temperature, quality		
Boiler water : Chemical quality		
Electric power : Voltage level		

8.3 Products

The most important parameters that need monitoring are presented in Table (14)

Table (14) Monitoring of products

Parameters	Monitoring Method	Indication
Amount produced - Final product (packed milk, white cheese, roquefort cheese,…..etc) - By- product (cheese whey)	Recording and book keeping	Production statistics
Rejects as a percentage of the total production, per unit of time - Final product (out of specification, expired date) - In- line rejects	Recording (quality control)	Production quality, avoidable expenses

9. OPERATION CONTROL

Processes should be operated at the optimum operating conditions to ensure the highest yield and productivity as well as product quality. Operation control deals with the control and monitoring of key parameters that affect environmental performance. These key parameters are monitored to minimize losses and therefore pollution.
Planned maintenance is also important to minimize pollution and improve environmental performance.

9.1 Monitoring process parameters

Table (15) presents the major processes in each production line and the parameters that should be monitored to minimize losses, maximizing productivity and predict maintenance needs.

Table (15) Operation Control

Major Pollution Process	Cause of pollution	Affected media	Parameter monitored	Method used	Indication
Beverages Production Line					
Softening unit	Back wash	water	TDS	Washing solution flow rate	Softening effic
Primary Syrup preparation	Syrup losses	water	Spills amount	Collect spills an measure amount	End-of- pipe ef characteristics
Final syrup preparation	Syrup losses	water	Spills amount	Collect spills an measure amount	End-of- pipe ef characteristics
Bottle filling machine	Syrup losses	water	Spills amount	Collect spills an measure amount	End-of- pipe ef characteristics
Bottle inspection	Broken glass	Land	Amount	No. of bottles	Lower product
Carbon Dioxide Production Line					
Carbon dioxide absorption tower	Acidic wastewater	water	Dissolved CO2	Analysis	CO2 productiv
Carbon dioxide absorption tower	Temperature	Air (increase fuel consumption)	Air pollution	Flue gases	
Permanganate purifier	Solid waste	Land			
CO2 liquefaction unit	Freon	Air	Temperature	Thermometer	Efficiency

Table 15. Operation control (cont)

Service units	Cause of pollution	Affected media	Parameter monitored	Indication	Method used	Person Responsible	Frequency /Duration
Boilers							
	Steam	Air	Pressure level Degree of saturation	Steam leaks Steam quality	Pressure controller		On-line
	Boiler flue gas	Air	Fuel to air ratio	Incomplete combustion (CO)	Gas analyzer		Every 6 months
	Boiler fuel (mazout)	Air	Sulfur content	SO_x in flue gas	Gas analyzer		
	Boiler Feed Water	Water	Chemical quality	Scale formation	Analysis		Once a month
	Softener back wash	Water	Flow rate	Zeolite regeneration	Flow meter on wash water		
Refrigeration system							
	Freon or ammonia leaks	Workplace	Refrigerant pressure Pipe condition	Cooling temperature Product quality	Thermometer		On-line
	Cooling of compressors	Water	Oil in spent cooling water	Oily wastewater	Visual observation		Once a day
Cooling tower							
	Input water quality	Water	Temperature, dissolved solid	Scale formation	Analysis		Twice a month
	Output water		Temperature	Higher temperature	Temperature		
	Blowdown		Flowrate	Scale formation	Flow rate measurement		
Wastewater Treatment Plant							
	- Flowrate higher than design value - Pollutants concentration higher than design value	Receiving water body	Input flowrate and characteristics	Low efficiency	Analysis and measurements		Once a month

9.2 Planned maintenance

Maintenance can be classified broadly into planned and emergency maintenance. Various types of planned activities (preventive, predictive) are undertaken with the basic objective of avoiding the need for emergency (breakdown) maintenance and the corresponding loss of plant profitability. The cost of an unscheduled breakdown resulting in loss of production can be substantial, and the cost of repairs may also be considerably higher than the cost of routine, planned maintenance of the equipment. A preventive maintenance program must include the following basic elements:

- Inventory of equipment with detailed design and operating parameters. The operating parameters are monitored as indicators for predictive maintenance.
- A record of failure rate and causes
- Evaluation of condition of equipment using the following criteria:
  - Maintenance cost per unit of product
  - Downtime due to maintenance
  - Percent of planned maintenance hours as compared with emergency maintenance
- Determination of corrective actions.

It is clear from the above paragraph that maintenance is a pollution prevention measure as it increases the efficiency of the unit, minimizes water consumption by preventing leaks, helps conserve energy through proper maintenance of electric and mechanical equipment as well as insulation of steam pipes. Table (16) includes examples of the parameters that can be monitored. The following are examples of typical maintenance procedures for some service units operated in chemical plants:

Compressors and refrigeration systems	Routine checking should include: • Testing for leaks • Checking refrigerant charge • Checking oil level and lubrication
Boilers, steam lines, heaters and dryers	There are many items to be checked to prevent explosion, such as checking operating procedures, detection of flame failure, detection of unburned combustibles. With respect to energy conservation, the maintenance of steam traps, steam valves and insulation of steam lines is important. The following parameters should be monitored: • Water level in the boiler • Water quality to prevent the build up of scales that reduce heat transfer rates • Temperature of metal, gas and water • Pressure • Fuel to air ratio • Check the fuel supply for leaks • Check air supply for leaks • Check the flue gas temperature.

Table (16) Monitoring and preventive maintenance

Parameters	Monitoring method	Indication
Total number of shut downs and production interruptions	Recording	Overall assessment of the process reliability and avoided environmental loads
Number of equipment failures resulting in production shut down per type of process and type of equipment	Recording	Critical equipment
Process performance monitoring	Methods depending on the performance criteria	Process performance/ efficiency of equipment
Process equipment condition monitoring	Numerous methods, inspection, testing	Prevention of failures

10. ENVIRONMENTAL MONITORING

Environmental monitoring covers emissions to air, effluent and solid and hazardous waste. Section 4 presents the various law and regulations that apply to emissions, effluents and wastes from the beverages industry. Expected pollutants and hazardous releases from the industry are specified in section 2.4, Table (3). For each production line related pollution aspects are identified in section 2.2, Figures 1 -3. The pollution aspects of service units are presented in section 2.3. The output from the measurements and analysis of the parameters are recorded in the environmental register of the facility. Table (17) presents the compliance monitoring activities for the different aspects of pollution as per environmental laws.

Monitoring of pollutants and releases requires careful consideration of the techniques being used because of the expected effect on the interpretation and hence, the reliability of the collected data. The common techniques used in environmental monitoring will be explained in next section.

10.1 Emission to air

Air emissions can be measured either on periodical or continuous basis.

Periodical measurements: Periodical measurements give the state of emissions over the chosen sampling time. Quantities needed in every emission calculation, such as volume flow, oxygen content and humidity of the fume, are determined by periodical measurements. Periodical measurement results are also used as a support for converting the continuous concentration measurement results into annual emissions. Periodical measurements are carried out as manual single measurements or as short period continuous measurements by the plant itself or by an exterior measurer. Periodical emission measurements are carried out annually for the following emission components: NOx,SO2, CO,CO2, Cl and particles. In all cases, it should be noted that regular maintenance, control and calibration are needed to obtain an acceptable measurement accuracy level.

Continuous measurements: The continuous measurements describe the temporal variation of the concentrations of the emission components during the operation. General requirements for continuous monitoring systems are that the sampling locations should be representative and that the monitoring equipment should be suitable for the concentrations to be monitored in the prevailing circumstances. The emission control data system should preferably be part of the process control system Sulfur dioxide, TRS, particles, carbon oxide are generally measured continuously.

Emission calculation: Differences between the different calculation methods can cause mistakes when comparing the environmental loads of different plants. Material balance calculations are used to complete emission measurements in order to get an impression of the reliability of the measurement results as well as to create a general view of the total emission level of each component. The amount of diffuse emissions that can not be recorded by emission measurements can be substantial.

10.2 Effluents (wastewater)

The regulations set the limits for the concentrations of specific pollutants of in wastewater when discharged to a recipient body. For monitoring purposes, the discharge values for specific substances or parameters are mostly expressed as total amounts per unit time. In some cases these values are given as specific amounts per ton of product or as purification efficiencies. Limit values are set for a large number of parameters such as COD/BOD5, TSS, phosphorus and nitrogen.

Monitored control parameters: Typical wastewater control parameters include the following:

- Wastewater flow (Q), m^3/d
- Total suspended solids (TSS), mg/l
- Temperature, ˚C
- Chemical oxygen demand (CODCr)
- Biological oxygen demand (BOD_5)
- Total nitrogen (N), mg/l
- pH
- Conductivity, mS/m

Flow measurement: Measuring of the total wastewater flow is required for the operation of the wastewater treatment plant. There have been no provisions on the procedures or the accuracy of a flow measurement, but installation of automatic composite samplers (preferable flow dependent) can be used. Wastewater flow is usually measured with venture measurement equipment, but also magnetic and ultrasonic methods are used. Measurement equipment is maintained several times a year and the measurement system is calibrated regularly.

Regular maintenance, control and calibration are needed to obtain an acceptable measurement accuracy level. The structure of the measurement system, a possible mounting fault or a false choice for measurement area can cause errors. Other sources of error or factors disturbing the measurement are dirt deposition and temperature variations. Evaluation of the total error is extremely difficult, as it must include all these factors.

Sampling: Well realized sampling is essential for determining of wastewater discharges. There are general instructions for wastewater sampling. However, industry-specific problems such as variation of the wastewater quality or flow rate have to be solved on case-by-case basis.

Table 17a. Compliance monitoring for air pollution, workplace and wastewater

Major pollution sources	Impact	Parameter monitored	Method used	Source type		Operating		Person responsible	Frequency
				Point	Diffuse	Normal	Exceptional		
Boilers									
Flue gases	Air	Particulate matters Sulfur oxides Nitrogen oxides Carbon dioxides	Gas analyzer						Depends on needs
Fans	Work environment	Noise	Noise meter						Depends on needs
Beverages Production Line									
Bottle filling machine	Work environment	Noise	Noise meter						Depends on needs
CO2 Production Line									
Liquefaction of CO_2	Ambient air	Freon	Ambient air analyzer						Depends on needs
	Work place	Noise	Noise meter						
End-of-pipe									
Wastewater effluent	Receiving water body	BOD, COD and TSS	Analysis						Depends on needs

Table 17 b. Compliance monitoring plan for solid waste

Process Unit	**Type of waste**	**Tons/year**	**Tons /ton production**	**Internal Utilization**		**Discharged**	**Frequency**
				Reused	**Recovered**		
Filling processes	Broken bottles						Depends on needs
Workshops	Scrap						Depends on needs
Garage	Scrap						Depends on needs
Water treatment	Sludge						Depends on needs
Wastewater Treatment Plant	Sludge						Depends on needs

Samples are either single grab samples, composite samples, or composite samples in proportion to the flow. A single grab sample reveals the composition of the wastewater at the sampling time. With several single samples it is possible to follow the wastewater load peaks, quality variation and the variation range of the significant parameters. A composite sample reveals the average composition over a chosen period. A 24-hour composite sample is normally taken in proportion to the flow so that the sampler is controlled by flow meter. Sampling period and sample size should be considered on case-by-case basis depending on the analyses used and on the issues affecting the reliability of sampling and analyses. Samples for wastewater analysis are mostly taken over 24 hours, 5-7 days a week. In some cases samples are frozen and combined to cover a longer period. Samples for COD and suspended solid determination are taken daily or continuously and analyzed daily. Samples for BOD and nutrient determination are usually taken weekly. pH and conductivity are usually measured continuously.

Analyses: A specific analysis program may be needed for each plant. The program usually covers a wide range of measurements and analyses, as predetermined in the self-monitoring plan. The measurements and analyses should be carried out according to the standards recommended by the authorities.

It is important to mention that in year 2000, EEAA/Central Laboratories developed a document detailing all the standard sampling and analysis techniques for wastewater.

Calculations: Wastewater discharges are calculated and reported as specified in the monitoring plan. Discharges are often calculated as below:

Discharge per day	The arithmetic mean value of the daily samples taken during one month divided by the number of sampling days
Discharge per month	Daily discharge multiplied by calendar days
Discharge per year	Sum of the values of monthly discharges

The efficiency of biological wastewater treatment is also controlled by calculating the reduction of organic matter (BOD, COD) between untreated wastewater before primary sedimentation and treated wastewater after secondary clarification. A typical wastewater discharge monitoring report includes e.g. monthly mean values and variations for discharges at the monitoring points before and after the treatment, applicable limit values and also some production information.

10.3 Monitoring of solid waste

The properties of solid wastes that are generated, especially when they are utilized or taken to a landfill, have to be investigated. The general principles in landfill operation are that the composition, leachability, long term behavior and the properties of the waste. The approval for using a landfill for a specific waste is based on the origin and the properties of the waste. The evaluation of the waste is based on the following:

- The composition of the waste
- The organic content and degradation properties of the waste,
- The content and leachability of harmful compounds, and
- The ecotoxicological effects of the waste and the landfill waters

11. DATA COLLECTION, PROCESSING AND USAGE

The general objective for the self-monitoring system is to produce data that is representative, repeatable, reliable, compatible and comparable. These characteristics are dependent on the applied measures for quality control and quality assurance throughout the data production chain i.e. volume determination, sampling, sample pretreatment, treatment and analysis, data processing and reporting.

11.1 Data collection and processing

The different parts of the monitoring system of a plant include diverse factors affecting the reliability and comparability of the emission data. These factors have to be taken into consideration in sampling, sample treatment and analysis as well as in processing and reporting of the data. Requirements for the whole data production chain should be set in the monitoring program. In addition, implementation of the relevant measures for quality control and quality assurance is extremely important in obtaining maximum reliability, repeatability and comparability.

The aspects and parameters that are involved in data collection and processing are explained in the Annex A. Figure (7) shows the main aspects and parameters that affect the effectiveness of SM in terms of reliability, repeatability and comparability.

11.2 Using SM outputs

The implementation of the self-monitoring plan will basically result in three outputs:

- Data and information about the facility
- Preparing the environmental register as required by law.
- Reports describing results of the self-monitoring and problems faced during implementation
- Feed back and decision making

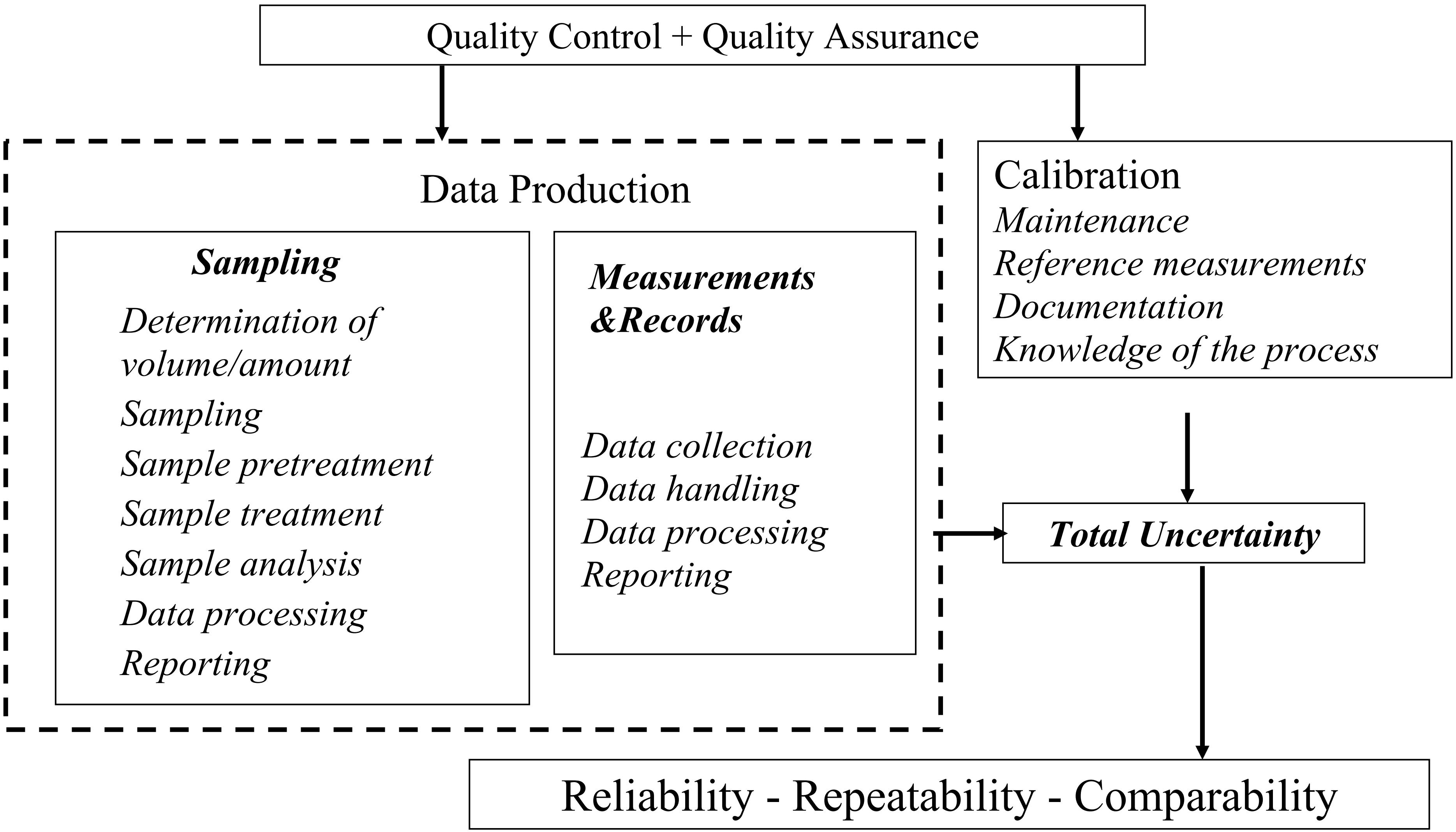
11.2.1 Techniques for summarizing and illustrating data

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

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

There are many techniques used in the interpretation of results (e.g. statistical analysis of the measurement results, reduction of operating conditions to normal conditions when monitoring gaseous emissions).

Figure (7) Parameters Affecting SM Reliability



11.2.2. Environmental register

Only monitoring data related to compliance will be included in the environmental register. Description of the measuring and/or analytical techniques used should be reported as well as the location of sampling and measuring. EEAA/EPAP prepared a detailed description of the environmental register, based on the requirements of law 4/1994, see Annex B. The competent authorities could request the inspection of the measuring devices to check their operability and the maintenance record for these devices. The procedures for taking samples could also be checked by the inspector. The inspectors check whether the facility has provided information that is relevant and of sufficient quality. To assess compliance, a simple numerical or statistical comparison between the measurements, their uncertainty and the limit value is performed.

According to Law 4/1994, compliance self-monitoring data should be recorded and kept for a minimum of 10 years.

11.2.3. Reporting

Description of the reporting scheme, its content, recipient and purpose should be included in the self-monitoring plan. A monitoring report is a uniform presentation of data over a fixed period. An annual monitoring report that provides information of the past calendar year is always required. Shorter period reports are required for significant polluters. The conditions of the process and equipment as well as location of monitoring points should be specified. Reporting can be:

- **Internal** to inform management and raise the environmental awareness of the facility personnel. It should include problems met during the implementation of the SM plan to be used in decision making.
- **External** for the competent authority based on the environmental register, establishments are required to report on environmental violations.

11.2.4. Internal auditing and conclusions on results

The data obtained must be compared regularly with the objectives written down in the monitoring program to check that they are being met.

11.2.5. Feedback and decision making

Feedback on the assessment of compliance based on the monitoring results should include all parties involved with the monitoring activities. The participants should make the necessary improvements and corrections to the next monitoring program.

In those parts of the monitoring program where compliance is met, possible reduction in frequency of monitoring can be considered and instead move resources to parts that need more accurate monitoring, e.g. borderline or non-compliance situations.

Feedback should include all parts of the monitoring program, process, product control, maintenance, environmental management and occupational safety. Detailed requirements should be set for the improvements needed and a date fixed for their implementation.

11.2.6. Using outputs in public relations

The monitoring data is refined and distributed to the end users such as national and international reporting, research and statistical purposes, citizens, and the media.

The citizens have the right to present complaints about the health or environmental impacts caused by the operation these complaints are directed to the permitting and supervising authority.

Monitoring data is needed e.g. in national research and statistics, for planning and evaluation purposes, by national group organizations and the media.

Annex A

DATA COLLECTION AND PROCESSING

The general objective for the self-monitoring system is to produce data that is representative, repeatable, reliable, compatible and comparable. These characteristics is dependent on the applied measures for quality control and quality assurance throughout the data production chain i.e. volume determination, sampling, sample pretreatment, treatment and analysis, data processing and reporting. Data production chain is explained in Section 3.

1 Reliability

The realism and correctness of the measurement results should be assessed against the knowledge of the processes and inputs, e.g. by using mass balance calculations.

Good knowledge of the process: This is essential for achieving reliable emission data. Process input variations can include varying properties of the raw material, chemicals or fuel used in the processes, and the size of the input. The interdependency between the inputs, processes and outputs (products and environmental load) should be known to be able to assess the correctness of the monitoring results.

Total uncertainty: The results obtained from any measurement have a specific uncertainty. It is important that the uncertainty is estimated and taken into account when the results are used in process management or for regulatory purposes. For example, the measurement result 10 g/t ± 2 g/t indicates that the uncertainty for this specific measurement is 20 % of the measured value.

Each step of the data production chain has an uncertainty and the total uncertainty of the measurement is the sum of these partial uncertainties. Uncertainty of each step of the data production chain must be known in order to be able to give the uncertainty of the final results, i.e. the uncertainty of the whole data production chain. When assessing the measurement uncertainty it is good to keep in mind that the factors causing measurement error can also affect each other.

Calibration and maintenance have to be carried out according to the relevant instructions and the management of them must be documented.

Reference measurements are carried out to certify the reliability of the measurements in practice. Results of an independent and neutral measurement laboratory are compared with the operator or consultant monitoring results. Reference measurements should be carried out regularly.

2 Comparability

Monitoring systems at the individual plants differ according to the scale, production, capacity or economic aspects of the operation. Data on necessary auxiliary measures and good documentation of the measurement procedure improves both the comparability and reliability of the results. All reference data, i.e. auxiliary measures and reference data (inputs and outputs) should be clearly defined in the monitoring program or permit according to the nationally and internationally used standards and guidelines.

3 Data Production Chain

The different parts of the monitoring system of a plant include diverse factors affecting the reliability and comparability of the emission data. These factors have to be taken into consideration in sampling, sample treatment and analysis as well as in processing and reporting of the data. Requirements for the whole data production chain should be set in the monitoring program.

Data Production Chain: The data production chain includes the following phases:

- *Determination of volume/amount*
- *Sampling*
- *Sample pretreatment*
- *Sample treatment*
- *Sample analysis*
- *Data processing*
- *Reporting*

***Determination of volume/amount*:** The accuracy of determination of the volume of the release has a substantial impact on magnitude of the total emissions. Variations in the volume measurement results can be caused either by variations in the flow of the emission or in the accuracy of the measurement. Measurement of volume flow or amount of the emission can be continuous, periodic or single.

Sampling: Continuous emission analysis includes sampling, sample pretreatment, sample treatment and analysis. Variations in the process or emission treatment affect also the quantity and quality of the sample. Both sampling conditions and the sampling point must be representative. Measurement of emission concentration can be continuous, periodic or single. The sample must be representative in relation to the measurement point, emission flow/amount, sampling period and time period.

***Sample pretreatment*:** Sample pretreatment includes all treatment of the sample before it is taken to the laboratory. The need for sample pretreatment is determined by the needs to protect the substance to be determined from any changes before analysis. Usually the appropriate pretreatment method is presented in the standards.

Sample treatment: Sample treatment includes operations in the laboratory before analysis, such as dilution, concentration, pH adjustment, adding of reagents. Sample treatment is usually carried out according to standards or specific method instructions. The treatment methods used should be documented.

Sample analysis: Sample analysis includes physical, chemical or biological determination of the parameter. Figures presented in emission reporting are not always comparable, without describing the analysis methods used.

Data processing: The calculation methods for the emission data are process specific and their function is to give as true load data for the specific process as possible. The correspondences of the equations to the reality must be checked from time to time and automatically in cases of any changes having an impact on them. The following general rules for emission calculation need to be determined and used nationally to harmonize the methods:

- calculation methods for the peak of an hour, calendar day, monthly/annual means
- amount of emission data needed for calculation of the annual mean of the emission
- exceeding times, i.e. percentage of time of the exceptional emissions of the total operation time
- utilization rate for the continuous measurements, i.e. percentage of time during which the measurement system has not been available of the total operation time
- calculation formulas used for data conversion into reference conditions
- conversion factors used for data conversion between different units
- calculation methods for total emissions over a certain period

Reporting: Data reporting should include sufficient data on the parameters, pollutants and other measures that are defined in the monitoring plan. The data to be reported should be presented in the form required with all the additional information and documentation.

A ***monitoring report*** is a uniform presentation of the emission data over a fixed period. An annual monitoring report-providing information of the past calendar year is always required. In case of large industrial sites, shorter period reports are demanded (a monthly report or a report over 3, 4 or 6 months). Emission data must be presented in a form easy to compare with the given emission limits. The following data is needed for reporting:

- *The emission parameters and pollutants* are reported with all the relevant the reference parameters, auxiliary measures and uncertainties expressed as required in the monitoring program in one or more of the following forms:

    - Specific emissions (ton / ton of production): used for assessing performance or efficiency
    - Total emissions (t/ year) : used for assessing the environmental load
    - Concentration (mg / m^3, PPM, % O_2): used for e.g. operation control
    - Flow rate (m/s): used for e.g. velocity/rate for flue gas/effluent
    - Residence time (s): used e.g. for assessing completeness of combustion
    - Temperature (^{0}C): requirements for controlling certain exhaust pollutants.
    - Heat (W): thermal stress in the recipient
    - The *exceptional and diffuse emissions* are included in the total emissions of the period.

- *Operation control data should be available to the authority.*
- *Utilization rate of the measurement system is expressed e.g. as percentage of the process operation time.*
- *Documentation of the reference measurements.*

4 Quality control and quality assurance

Quality control is a system of routine technical activities to measure and control the quality of monitoring data as it is being produced. QC includes e.g. checking of equipment, methods and procedures, and that the monitoring system is regularly calibrated and maintained. The relevant instruments personnel and analytical laboratories should be certified under recognized schemes.

Quality assurance includes a system of reviewing the implementation of the quality system by personnel not directly involved in the monitoring process. QA reviews verify that the quality objectives are met and ensures that the monitoring carried out represents the best available results.

Guidelines for the below listed factors help to harmonize the practical factors at site level. The monitoring plan can determine the listed factors even in details. If the plant or the laboratory uses a sub-supplier in any step of the data production chain, the competence of the sub-supplier has to be checked, too. Quality system work involves the following processes:

Data production chain
Maintenance and calibration
Certification and Accreditation

Annex B

REGISTER FOR ENVIRONMENTAL CONDITIONS

General Information:

- Name:
- Address:
- Contact Person:
- Position:
- Time Period covered by the current data:

General Description of the facility:

- Industrial Sector:
- Actual Production:
- Production Capacity:
- Products:
- Capital Investment:
- Annual Turnover:
- Number of Employees:
- Year of Start of Operations:
- Major Renovations:

Location:

- The location of the plant shown on a map describing also neighboring areas.
- Layout describing the location of the building, unit processes, storage areas and other parts of the plants of wastewater and air emission points to be shown on the layout.
- The maps should also show types of the surrounding and sensitive areas (Hospitals, Schools, Settlements, Parks).

Raw Materials:

- Use of raw materials & auxiliary materials (ton/year)
- Opening times for processes shall be reported as follows:
    1. Annual average operating time (days/year or hour/year)
    2. Weekly operating time and operating days per week
    3. Daily operating time and shifts per day
    4. Possible daily or seasonal variations
- Maximum amounts of each kept in storage
- Describe storage area
- Danger substance:

List of danger substance used

Name of substance	Annual consumption	Environmental properties (flammability,……)

- Describe storage areas (capacities, preventive emergency, constructions, ventilation,………..).
- The method for circulation of the danger substance by (hand, windlass,……).

Raw Water:

- Sources of raw water.
- Amounts of raw water taken per source and year.
- Use of water:
  1. For processes
  2. For lighting
  3. For other purposes

Laws and Legislation:

- State laws & regulations pertinent to the establishment. Attach copies of possible decisions and permits:
  1. Law no. 4/94 (yes or no)
  2. Law no. 93/62 (yes or no)
  3. Law no. 48/82 (yes or no)
  4. Law no. 137/81 (yes or no)
- Attach copies of the correspondence with EEAA & other environmental authorities.

Process Description:

- Attach copies from schematic diagrams for each unit processes.
- Describe the utilities (e.g. boilers).
- Using of raw water for each unit:

Name of Unit	Water consume

- Using of energy & fuels for each unit:

Name of Unit	Fuels consume

Gaseous Emissions:

- Describe the gaseous emissions (for each stack).
- Name of each unit giving rise to air pollution.
- Rate of gas emission (m^3/year):

Pollutants	Concentration of Pollutants mg/m^3	Limits of Law 4/94 for Combustion of Fuels mg/m^3	Limits of Law 4/94 for Emission of production processes mg/m^3	Loads of Pollutants ton/year

- This table for each stack.
- Measure the conc. of pollutants according to Annex no. 6 in the Executive Regulations of Law 4/94 if this emission generated from unit processes but if this emission generated from combustion of fuels so the measurement of the conc. of pollutants according to Article no. 42 in the Executive Regulations of Law 4/94.
- Describe all treatment facilities for gaseous emissions (estimate, material balance, individual measurement, continuous monitoring of process parameter, continuous monitoring of emissions).
- Treatment processes for gaseous emissions:
  1. Name of unit linked by the equipment of treatment
  2. Type of the equipment
  3. Describe the equipment
  4. Design efficiency %
  5. Actual efficiency %
- Pollution before & after treatment:

Conc. of the pollutants before treatment mg/m^3	Conc. of the pollutants after treatment mg/m^3	Loads of the pollutants before treatment ton/year	Loads of the pollutants after treatment ton/year

- This table for each treatment unit.

- Describe treatment, transport, and disposal of sludge from air pollution control

Wastewater Emissions:

- Attach copy show discharge points of industrial sewerage and domestic sewerage on the maps.

Wastewater Treatment Plant:

Describe wastewater treatment facilities with layouts and drawing. The following information shall be given:

- Processes flow diagram
- Machinery
- Design parameter
- The unit linked by the equipment of treatment.
- Type of treatment (initial, secondary, advanced).
- Capacity of the plant (m^3/hour).
- Type of equipment.
- Describe the treatment of sludge.
- Describe the way used for disposal of sludge.
- Loads of pollutants:

Pollutants	Loads of pollutants for income water	Loads of pollutants for outcome water

- The design efficiency (%) & actual efficiency.
- Monitoring of efficiency

Discharge sewerage:

Table for pollutants according to discharge points and discharge points after the treatment.

Pollutants	Conc. of Pollutants (mg/l)	Limits of Law	Loads ton/year

- The concentration of pollutants measure according to the annex no. 1 of the Executive Regulations of Law 4/94 if the wastewater discharge into the sea.
- The concentration of pollutants measure according to modify by Decree 9 for 1989 if the wastewater discharge into Municipal Sewerage.
- The concentration of pollutants measure according to the Article no. 61, 62, 66 of Law no. 48/82 if the wastewater discharge into Fresh water or Non fresh water.

Solid Waste Loads:

- Solid waste for each unit
- Name of each unit

Kind of Solid Waste	The Quantity of Solid Waste ton/year	Volume of Solid Waste m^3/year	Notes
• Paper • Plastics • Glasses • Organic Compound • Metals • Anther Materials			

- This table for each unit.

- Describe the waste disposal areas (total solid waste)

Kind of Solid Waste	The Quantity of Solid Waste ton/year	Volume of Solid Waste m3/year	Notes
• Paper • Plastics • Glasses • Organic Compound • Metals • Anther Materials			

Hazardous Wastes (Article no. 28 of Law no. 4/94):

- Hazardous waste for each unit (Name of units):

Kind of Hazardous Waste	The Quantity of Hazardous Waste ton/year	Volume of Hazardous Waste m3/year	Notes

Working Environment:

- According to Annex no. 7,8,9 of Law no. 4/94
- Name of each unit

Pollutants	Conc. of Pollutants (mg/m3)	Limits of Law no. 4/94	Loads ton/year
• Temperature • Humidity • Noise • Heat • Vibrations • Bacteria & Viruses • Odors • Other Emissions			

Self Monitoring of Emissions

Article no. 17 of Law no. 4/94:

- **Wastewater:**
- Parameters monitored (BOD, COD, TDS, TSS, Heavy metals, ……etc.)
- Sampling Location, Sampling Frequency and Time Table.

Sampling Location	Time between Samples

- Analytical Procedures:
- The person who responsible for monitoring and reporting

- **Gaseous Emission from Stacks:**
- Parameters monitored (NOx, Sox, COx, CO, ………. Etc.)
- Sampling Location, Sampling Frequency and Time Table.

Sampling Location	Time between Samples

- Analytical Procedures
- The person who responsible for monitoring and reporting

- **Working Environment:**
- Parameters monitored (dust emissions, odors, noise, ………….. etc.)
- Sampling Location, Sampling Frequency and Time Table.

Sampling Location	Time between Samples

- Analytical Procedures
- The person who responsible for monitoring and reporting

Annex C

REFERENCES

- ***"Monitoring and Control Practices of Emissions in Pulp and Paper Industry in Finland", 1998, Saarinen K., Jouttijarvi T. and Forsius K.,*** Saarinen K***. Finnish Environment Institute***

- ***"Data Production Chain in Monitoring of Emissions", 1999,*** Saarinen K, ***Finnish Environment Institute.***

- ***Draft Document "Self-Monitoring Manual for Beverages Industry", August 2002, prepared by Dr. Shadia El Shishini, ENVIRONICS.***