Egyptian Environmental Affairs Agency (EEAA)

Egyptian Pollution Abatement Project (EPAP)

Inspection Manual

Paints Industry

June 2002

Table of Contents

			Page
1.	**Introduction**		**1**
	1.1	Preface	1
		1.1.1 Project Objectives	1
		1.1.2 Organization of the Manual	2
2.	**Description of the Industry**		**3**
	2.1	Raw Materials and Utilities	3
	2.1.1	Main Raw Materials	3
	2.1.2	Other raw Materials	6
	2.1.3	Utilities	6
	2.1.4	Equipment used in paint industry	6
	2.2	Production Lines	14
		2.2.1 Solvent-based Paint (household/ industrial) Production Line	17
		2.2.2 Water-based Paint Production Line	20
		2.2.3 Printing Inks Production Line	22
		2.2.4 Varnishes Production Line	24
		2.2.5 Alkyd Resin Production Line	26
	2.3	Service Units: Description and Potential Pollution Sources	29
		2.3.1 Boilers	29
		2.3.2 Water Treatment Units	29
		2.3.3 Cooling Towers	30
		2.3.4 Laboratories	30
		2.3.5 Workshops and Garage	31
		2.3.6 Storage Facilities	31
		2.3.7 Wastewater Treatment Plants	31
		2.3.8 Dow-therm Oil Heater	31
		2.3.9 Solvent Recovery Unit	31
		2.3.10 Restaurant and Housing Complex	32
	2.4	Emissions, Effluents and Solid Wastes	34
		2.4.1 Air Emissions	34
		2.4.2 Effluents	34
		2.4.3 Solid Wastes	38
		2.4.4 Work Environment	38
	2.5	Characteristics Specific to the Paint Industry	38
3.	**Environmental and Health Impacts of Pollutants**		**39**
	3.1	Impact of Air Emissions	39
	3.2	Impact of Effluents	45
	3.3	Environmental Impact of Solid Wastes	46
4.	**Egyptian Laws and Regulations**		**47**
	4.1	Concerning Air Emissions	47
	4.2	Concerning Effluents	48
	4.3	Concerning Solid Wastes	48
	4.4	Concerning Work Environment	49

	4.5	Concerning Hazardous Materials and Wastes	53
	4.6	The Environmental Register	54
5.	**Pollution Abatement Measures**		**55**
	5.1	Air Pollution	56
	5.2	Work Environment	56
	5.3	Water Pollution Abatement Measures	57
	5.4	Abatement Measures for Solid Wastes Pollution	61
	5.5	Water and Energy Conservation	62
6.	**Industrial Inspection**		**64**
7.	**Inspection Planning at the Inspectorate Level**		**64**
	7.1	Activities Characteristic to the Paint Industry	64
	7.2	Providing Information about the Facility	64
	7.3	Providing Resources	64
8.	**Preparation for Field Inspection (Inspection Team)**		**66**
	8.1	Gathering and Reviewing Information	66
	8.2	Preparation of the Inspection Plan	66
	8.3	Preparation of the Required Checklist	67
	8.4	Legal Aspects	67
9.	**Performing the Field Inspection**		**68**
	9.1	Starting the Field Visit	68
	9.2	Proceeding With the Field Visit	68
	9.3	Ending the Field Visit	74
10.	**Conclusion of the Field Inspection**		**75**
	10.1	Preparing the Inspection Report	75
	10.2	Supporting the Enforcement Case	75
	10.3	Following-Up Compliance Status of Violating Facility	75

Annex (1) Inspection Checklist for a Paint Production Facility

List of Acronyms

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
O&G	Oil and Grease
CO	Carbon Monoxide
CO_2	Carbon Dioxide
VOCs	Volatile Organic Compounds
MEK	Methyl ethyl Ketone
MIBK	Methyl Iso Butyl Ketone
SO_x	Sulfur Oxides
NO_x	Nitrogen Oxides
TDS	Total Dissolved Solids
EMS	Environmental Management System
EoP Treatment	End-of-Pipe Treatment
CP	Cleaner Production
P2	Pollution Prevention
SIC	Standard Industrial Classification
SM	Self-Monitoring
SMS	Self-Monitoring System
WWTP	Wastewater Treatment Plant
µm	Micro meter 10^{-6} m
MHUUC	Ministry of Housing, utilities and urban Communities

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.

A General Inspection Manual, GIM, has been developed covering inspection aspects common to all sectors. The manual :

- Discusses the strategy, objectives and tasks of the inspectorate management.
- Identifies the team leader responsibilities and tasks.
- 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.

Sector specific inspection manuals have been developed for the following industries:

- Textile industry
- Pulp and paper industry
- Food industry
  - Grain milling industry
  - Dairy industry
  - Carbonated beverages industry
  - Confectionery industry
  - Fruits and vegetables industry
- Metallurgical industry
- Fabricated metal industry
- Motor vehicle assembly

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.

1.1 Preface

As a continuation of the previous effort, the following manuals are developed

- Paint industry
- Detergent oil and soap industries
- Cement and ceramic industry
- Fertilizer industry

1.1.1 Project Objectives

The project aims at the development of sector-specific guidelines for inspection to be used by inspectors. 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.

1.1.2 Organization of the Inspection Manual

The inspection manual for the paints industry includes ten chapters. The first chapter represents an introduction to the whole project and to the specific sub-sector of the industry. Chapters two to five deal with the paints industry and its environmental impacts.

The description of the industry in chapter 2 includes the inputs and outputs, a description of the different production lines with their specific inputs and outputs, 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 three describes the environmental and health impacts of the various pollutants whereas chapter four gives a summary of the articles in the Egyptian environmental laws relevant to the paints industry. Chapter five gives examples of pollution abatement techniques and measures applicable to the paints industry.

The inspection procedures are described in chapters 6 to 10 starting with a brief description of the inspection process in chapter 6 then the planning aspects that should be considered at the inspectorate level are explained in chapter 7. The different tasks at the inspectors level specific to the paints industry, will be described in chapters 8 to 10. The tasks before field inspection are presented in chapter 8 whereas the inspection tasks for actually performing the field visit are defined in chapter 9. Chapter 10 is concerned with the conclusion of the field visit including inspection report writing, supporting the enforcement case and following-up the compliance status of the facility.

2. Description of the Industry

Products of the surface-coating (paints) are essential for the preservation of all types of architectural structures, including factories, from ordinary attacks of weather. Uncoated wood and metal are particularly susceptible to deterioration, especially in cities where soot and sulfur dioxide accelerate such action. Aside from their purely protective action, paints, varnishes, and lacquers increase the attractiveness of manufactured goods, as well as the aesthetic appeal of a community of homes and their interiors. Coatings that are used to cover building, furniture, and the like are referred to as trade sales or architecture coatings in contrast to industrial coatings which are used on materials being manufactured. Industrial finishes are applied to a wide variety of materials, such as metal, textiles, rubber, paper, and plastics, as well as wood. Architectural coatings are usually applied to wood, gypsum wall-board, or plaster surfaces.

The paints industry is a branch of the chemical industries sector. Surface coating (paints) have been divided into:

- Solvent-based paints
- Water-based paints
- Varnishes; clear coatings.
- Printing inks.
- Resins (for paints and varnishes manufacture).

Therefore, there are different production lines, plants can have as few as one or two production lines or all of them.

Service units (utilities) provide water and energy requirements as well as maintenance, storage, packaging, testing, and analysis needs.

The batch process is common in paints industry, old plants use open equipment, while modern plants use the closed one. Equipment cleaning is necessary, and required between batches.

2.1 Raw Materials and Utilities

2.1.1 Main Raw Materials

Liquid paints is a composite of a finely divided pigment dispersed in a liquid composed of a resin or binder and a volatile solvent. Therefore, paints are manufactured from three main constituents; pigments, binders, and solvents (thinners), in addition to many other additives to give the paints specific properties for specific purposes or applications.

The liquid portion of the paints is known as the vehicle. Vehicles are composed of nonvolatile and volatile parts:

- Nonvolatile;
  - Solvent-based paints: oils and/ or resins plus driers and additives.

- Lacquers: celluloses, resins, plasticizers, and additives.
- Water-based paints: styrene-butadiene, polyvinyl acetate, acrylic, other polymers and emulsions, copolymers plus additives.

* Volatile
  Ketones, esters, alcohol, aromatics, and aliphatics.

The pigment is one of the main and important constituent of the paint. In general, pigments should be opaque to ensure good covering power and chemically inert to secure stability, hence long life. Pigments should be nontoxic, or at least of very low toxicity, to both the painter and the inhabitants. Finally, pigments must be wet by the film-forming constituents and be of low cost. Different pigments possess different covering power per unit weight. Table (1) shows the different paints constituents.

Table (1) Paints Constituents

Constituent	Function
Main constituents	
Pigments are usually: • An inorganic substance, such as titanium dioxide, chrome pigment, earths, lead pigments, zinc pigments. • A pure, insoluble organic dye known as a toner. • An organic dye precipitated on an inorganic carrier such as aluminum hydroxide, barium sulfate or clay.	The function of pigments and fillers is to provide simply a colored surface, pleasing for its aesthetic appeal. The solid particles in paint reflect light rays, and thus help to prolong the life of the paints, and protect metals from corrosion.
Binders or vehicles. Those are resins or oils.	Its function is binding the pigment to the substrate.
Thinners and solvents; such as petroleum ether, toluene, xylene.	It is the volatile part of the vehicle. Its function is to dissolve the binders, adjust the paint viscosity, and give homogeneous, regular, and uniform thickness on the coated surface.
Fillers; such as clay, talc, gypsum, and calcium carbonate.	Pigment extender, or fillers, reduce the paint cost and control the rheorological properties (viscosity) of paints.

Table (1) Paints Constituents (continue)

Constituent	Function
Other additives	
Driers, as cobalt, lead, zinc, zirconium, manganese, calcium, barium.	To accelerate the drying of the paints.
Anti-skinning agents	It is added to the paints (unsaturated), to prevent the solidification of paints surface during storage.
Anti-settling agents	To improve the dispersion efficiency of the pigments into the vehicle, to prevent the settling of pigments during storage.
Plasticizers; These materials are special types of oils, phthalate esters or chlorinated paraffins.	To improve the elasticity of paint films, and to minimize the paint films tendency for cracking.
Dispersants, wetting agents, fire retarding, anti-floating, anti-foaming,…etc.	To give the paint specific property for specific purpose or application.

Paint Formulations

Proper paint formulations depend upon raw materials selection and accurate calculation of the amounts of its constituents. Generally, paint is a blend, in which pigments and fillers are suspended in a liquid. The paint formulations are related to their applications. Generally paints are used to hide the original surface, providing a certain color, resisting the weathering conditions, washability, gloss, and protecting surface from corrosion. The selection of pigments, fillers, and carrying liquids (vehicles) is necessary for a proper paint. In general, pigments should be opaque to ensure good covering power, and chemically inert to secure stability, and non toxicity. To predict some properties of paints such as ease of painting, gloss, washability for a certain formulation, the pigment volume concentration (PVC) in paint is used as indicator.

$$\text{Pigment volume concentration (PVC)} = \frac{\text{volume of pigment in paint}}{\text{Volume of pigment in paint} + \text{volume of nonvolatile vehicle constituents in paint}}$$

Indicator values for pigment volume concentration in paints, is shown in table (2).

Table (2) Pigments Volume Concentration (PVC)

Paints Type	Indicator Values
Matt paints	50-75%
Semigloss paints	35-45%
Gloss paints	25-35%
Exterior household paints	27-36%
Metal primers	25-40%
Wood primers	35-40%

2.1.2 Other Raw Materials

Chemicals; are consumed at the facility for different purposes:

- Chemicals used are organic solvents (ether, chloroform, ketones, esters, xylene, toluene, hexane, ethyl and methyl alcohol's), acids (acetic, boric, oxalic, benzoic, hydrochloric, sulfuric), alkalis (sodium, potassium and ammonium hydroxides), potassium chloride, sodium sulfate, sodium thiosulphate potassium iodide. These chemicals are used in the production processes, and in the quality control laboratories for raw materials and products.
- Biocides and antifouling agents are used in the manufacture of the antifouling and wood preservatives paints, and they are also used in the manufacture of water-based paints to prolong their life time.
- Water-alkali solutions, and solvents for equipment cleaning and washing, between batches.
- Detergents and antiseptics for floor cleaning.

Lube oil; is used in the garage and workshops.

Packaging materials; different types of packaging materials are used (aluminum foil, metallic and plastic containers, tin sheets, and cartons).

2.1.3 Utilities

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 large facilities for electric power generations.

Water; is used as process water, as rinse water for equipment and floor, as boiler feed water, as cooling water and for domestic purposes. Boiler feed water is pretreated in softeners to prevent scale formation. Water may be supplied from public water lines, wells or canals. The type of water supply will dictate the type of pretreatment.

> *Note: Defining the inputs and outputs helps to predict the expected pollutants.*

2.1.4 Equipment Used in Paints Industry

1. ***Mixers***

Mixers are used to achieve homogeneity between different components, specially in the production of varnishes or water-based paints. Mixers are used in the following operations:

- Mixing oils or resins.
- Mixing pigments and fillers with coating materials.
- Decreasing the viscosity of resins, and varnishes.

- Mixing additives with paints or varnishes.
- Adding solvents or diluting agents (thinner) to paints, to adjust the viscosity.
- Preparing emulsion (water-based) paints.

There are many types of mixers used in paint industry, they differ in their suitability for different applications. Choice of mixer type depends on the following:

- Viscosity: mixers types used in preparing pastes differ from those used in the production of low viscosity paints.
- Density difference between components: achieving the desired homogeneity depends on the type of impeller, blades design, mixing speed, and inclination of impeller axis with respect to mixing tank axis.
- Solid particle size: Some components, such as pigments agglomerates, have relatively large particle size compared to other components. Also volatility of solvents affects the design of mixers and the need for cooling.

The following are different types of mixers:

- Manual mixers.
- Automatic mixers.
- Kneaders.
- Colloid mills.
- Rotary churns.
- Mixing by air streams.

Figures (1-14) shows the types of impellers or mixers used in paints industry.

The mixers usually consists of mixing tank, usually vertical, and one or more impeller(s) driven by electrical motor, the mixing tank may also have vertical baffles. The impeller consists of a shaft assembled with one or more mixing blades propellers. Propellers can be divided into two main types, axial and radial flow propellers.

Figures (1-6) show axial flow propellers, the type shown in Figure (1) is considered the most common type in paints industry. The impeller in figure (4) is fixed in the wall of mixing tank with suitable inclination, it can be also fixed vertically at the axis of mixing tank using vertical baffles. Such impellers rotate at speeds between 1150-1750 rpm. The vertical type shown in Figure (5) usually rotate at speeds between 350-420 rpm via gearbox and it is used in preparing colloids. The inclined high-speed type is used for the preparation of emulsions. The type shown in Figure (6), which fixed in the side of mixing tank, is used in mixing solid particles free liquids.

Figures (7- 10) show radial flow propellers, which have blades parallel to propeller shaft axis. Turbine propellers in figures (7, 8) rotate the mixing tank contents in circular motion in both vertical and axial directions. The diameter of paddle propellers shown in Figure (9), reaches 60% of mixing tank diameter and rotates with relatively low speeds.

Figures (11 and 12) show paddle stirrers, which are used in mixing high viscosity liquids or pastes, whereas Figure (13) shows anchor stirrers which are used for very high viscosity liquids or pastes. This type has a small clearance between the mixing propeller and mixing tank walls. Figure (14) shows the multiple vane stirrer, and figures (15 and 16) the motion of the inclined propellers.

Figures (17) shows kneaders used in the production of putties. The kneader consists of a separate tank which can be fixed in the mixer or transferred with its contents to the packing unit. This system helps in weighing the tank content before mixing and to clean the mixing vessel in the cleaning unit. In this system the mixers can be elevated vertically or laterally as shown in Figure (18).

Figure (19) shows a horizontal kneader consisting of a U-shaped vessel in which two mixers with special shape rotate in different directions with small clearance between them. There are other types of kneaders which can be heated by steam or cooled by water in order to control the viscosity of the mixture.

2. *Mills*

Paints industry uses different types of mills such as roller mills or ball mills, etc.. Figure (20) shows three-roller mills in which each roller rotates in the opposite direction of the others and with different speeds with ratio 1:3:9. The clearance between each two rollers must be controlled accurately to maintain the desired finesse of dyes. This type of mills leads to the desired homogeneity as the dye is dispersed into its particles. This type of mills is open and therefore cannot be used in grinding of paints which contain high volatility solvents as solvent emissions to the atmosphere could occur.

Another type of mills is the ball mills. This type consists of a cylinder rotating about its horizontal axis and containing the grinding balls which may be made of steel or pebbles. If steel balls are used the cylinder lining will be also made of steel and is used only with dark color paints. But if the balls are made of pebbles or ceramics the cylinder lining will be made of ceramic or silica and can be used with white or light color. The grinding efficiency and fineness of particle depend on the dimensions of the cylinder, speed of rotation, balls size and balls density. In some mills the length of the cylinder is equal to its diameter, but to maintain higher degree of fineness mills with a length larger than diameter are used. There are other types in which the grinding operation is made in steps inside the mill, as the cylinder is separated into sections with screens with suitable sizes separating the sections. The initial grinding is done in the first section and the final grinding is done in the final section. In some types of theses mills bars are used instead of balls in order to obtain particles with slightly different sizes. This type of mills is suitable for dry grinding or grinding of colloidal particles.

The roller mill and ball mill are used in small factories. Presently, the most common used mills, in large modern factories, are sand mills (vertical or horizontal) and dyno mills.

The relations between the internal diameter of ball mills and the diameter of balls are shown in table (3).

Table (3) Relations between the internal diameter of ball mills and the ball diameter

Internal diameter	Ball diameter (cm) & their percentage
30 - 60	1.5 (70%), 2.5 (30%)
90 - 120	1.5 (30%), 2.5 - 4 (60%), 4 - 5 (10%)
120 - 150	2 – 2.5 (85%), 5 – 6.5 (15%)

3. *Filters*

During the manufacturing steps in paints or varnishes industry or during the oil heating process the liquids are contaminated by foreign matters that fall into them. Moreover the paint may contain particles that were not ground to the required size or some polymers that didn't dissolve. Some surface hardness may also exist. For all the previous reasons, paints and varnished liquids must be purified by one of the following methods:

- Single cylinder mill: It can work as a screen as all large pigments particles and foreign particles will be separated in the mill hopper.
- Fine screens.
- Filter press.
- Centrifugal separator for varnishes purification.
- Settling for varnishes purification.

4. *Packing machines*

The packing may be manual, semi-automatic, or automatic according to the size of production. There is a number of packing machines differing in speed and packs handling.

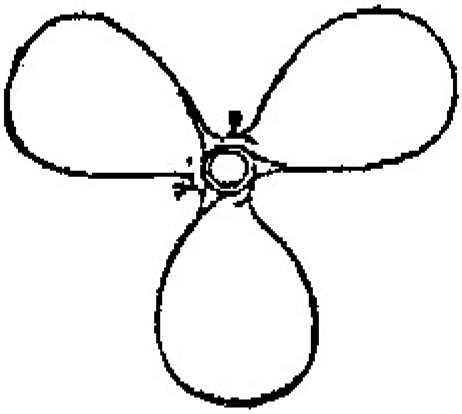


Fig. (1)

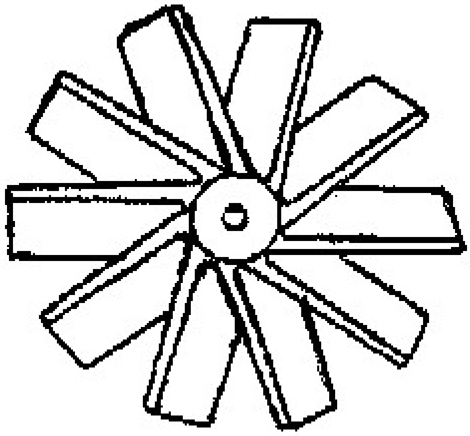


Fig. (2)

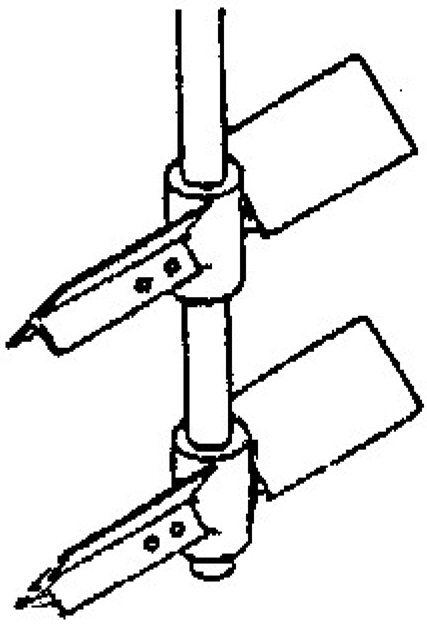


Fig. (3)

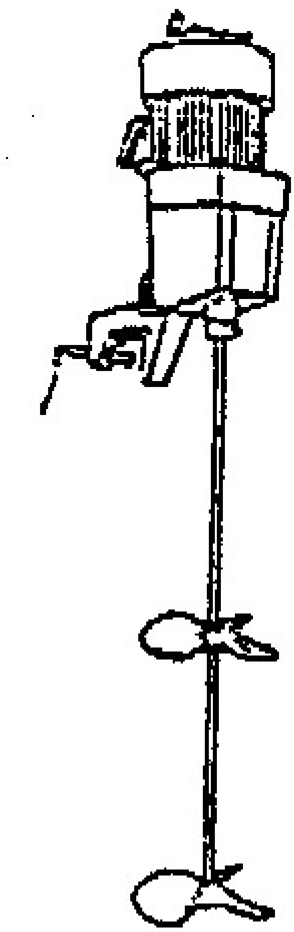


Fig. (4)

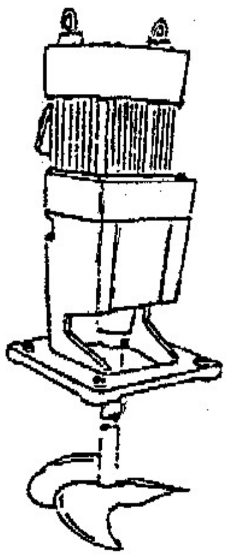


Fig. (5)

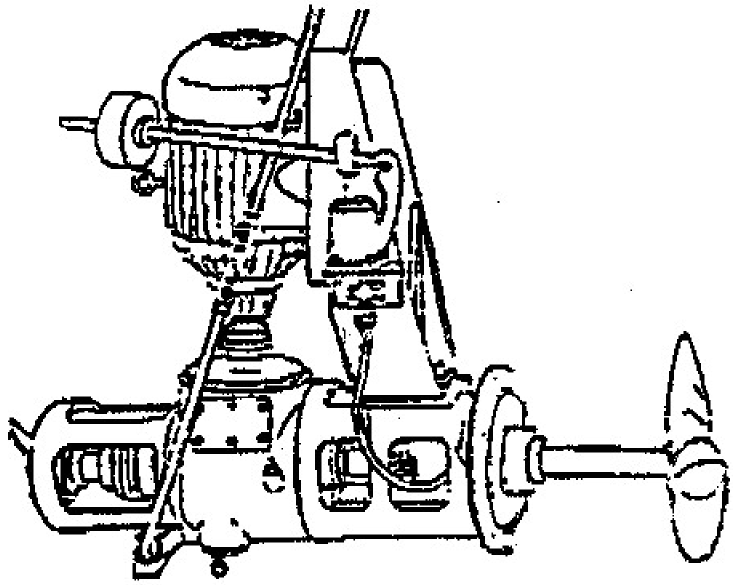


Fig. (6)

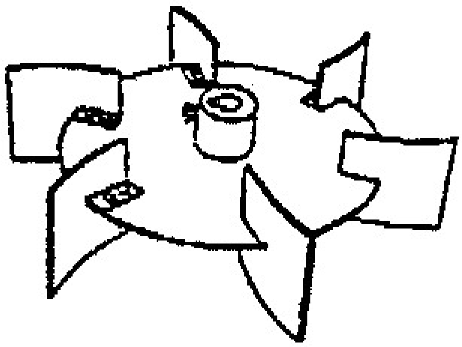


Fig. (7)

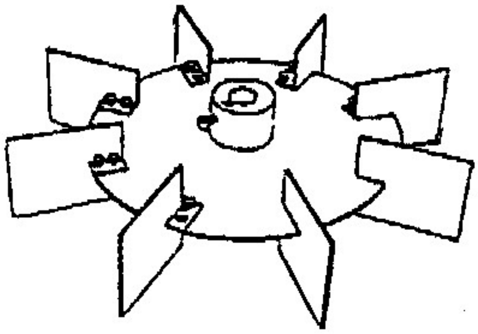


Fig. (8)

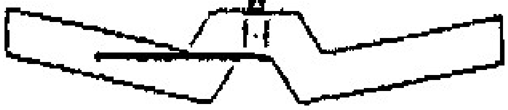


Fig. (9)

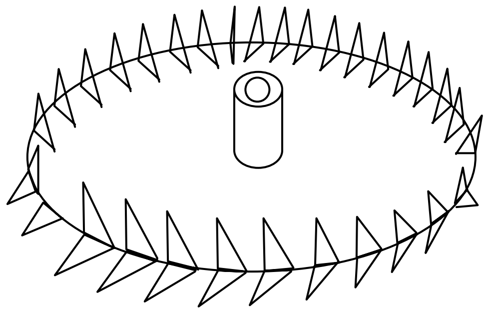


Fig. (10)

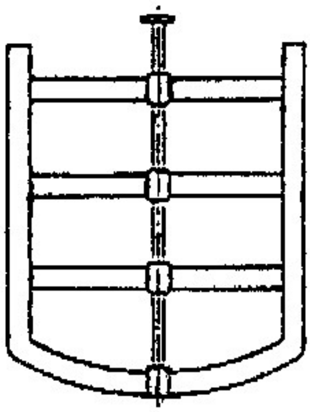


Fig. (11)

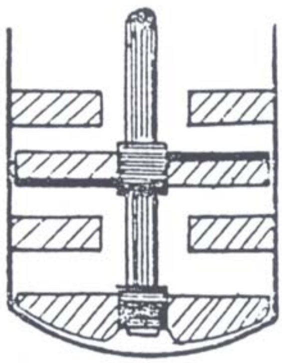


Fig. (12)

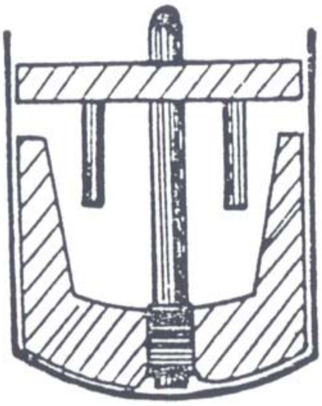


Fig. (13)

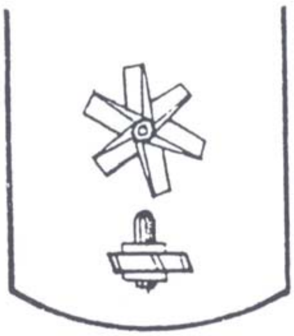


Fig. (14)

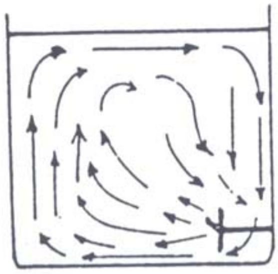


Fig. (15)

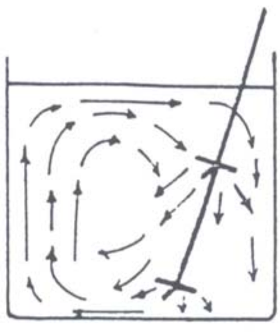


Fig. (16)

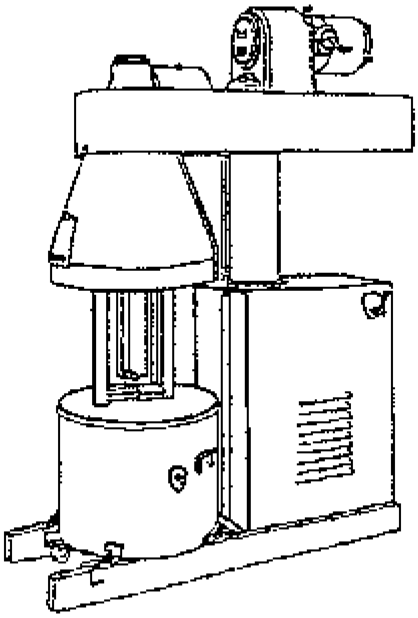


Fig. (17)

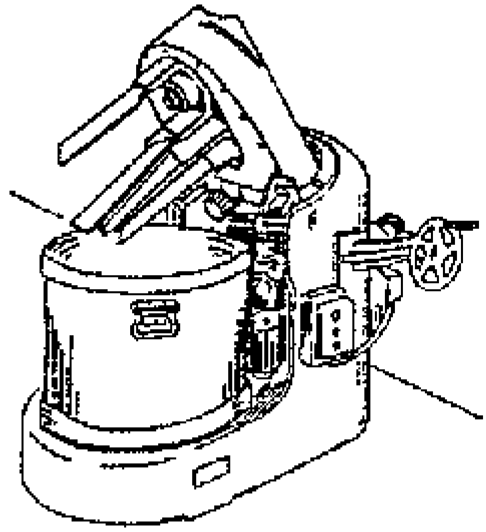


Fig. (18)

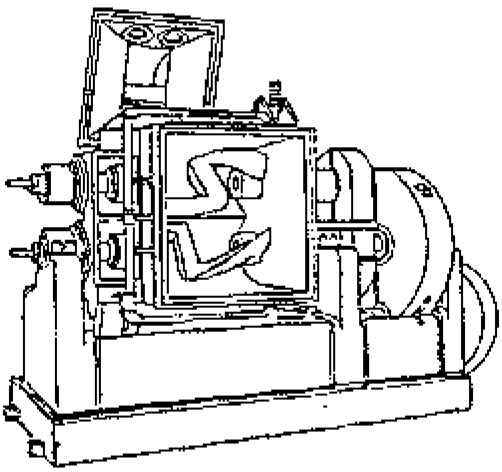


Fig. (19)

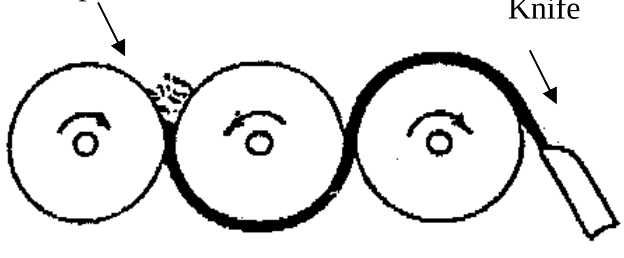


Fig. (20)

2.2 Production Lines

Table (4) presents the various production lines and service units that could be present in a facility.

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

Table (4) Production lines and service units in paints industry

Production Lines	Service Units
Water-based paints Solvent-based (household) paints Solvent-based (industrial) paints Printing inks production line Varnishes production line Resins production line	Heating furnaces (Dow-therm oil heater) Cooling towers Solvent recovery unit Compressors Boilers Generators Laboratories Mechanical & electrical workshops Garage Storage facilities Wastewater Treatment Plant Restaurant and Housing complex

Large plants use huge number of raw materials and chemicals, and produce a multitude products for different applications. Paints industry is characterized by batch processing, which helps adjust the color and properties of paints.

The unit operations used for paints manufacture are shown in Figure (21). These unit operations are mainly physical (mixing, grinding, filtration and packaging).

Chemical conversions are involved in the manufacture of the constituents of paints as well as in the drying of the film on the substrate. These constituents are either exported or purchased from another chemicals production plant, therefore, the chemical processes involved in the production of these constituents will not be addressed in this manual.

The manufacture procedures illustrated in Fig. (21) are for a mass-production of paints. The weighing, assembling, and mixing of the pigments and vehicles take place on the top floor. The mixer may be similar to a large dough kneader with sigma blades. The batch masses are conveyed to the next operation, where grinding and further mixing take place. A variety of grinding mills may be used. One of the oldest methods is grinding, or dispersion, between two buhrstones; however, ball-and-pebble mills and steel roller mills were the principal grinding mills used until recently. Sand mills, high-speed agitators, and high-speed stone mills are being used increasingly to grind paints and enamels.

The types of pigments and vehicles are dominant factors in the choice of the equipment used. The mixing and grinding of pigments in oil require skill and experience to secure a smooth product.

After mixing, the paint is transferred to the next operation, where it is thinned and tinted in agitated tanks, which may hold batches of several thousand liters. The liquid paint is strained into a transfer tank or directly into the hopper of the filling machine. Centrifuges, screens, or pressure filters are used to remove nondispersed pigments. The paint is poured into cans or drums, labeled, packed, and moved to storage, each step being completely automatic

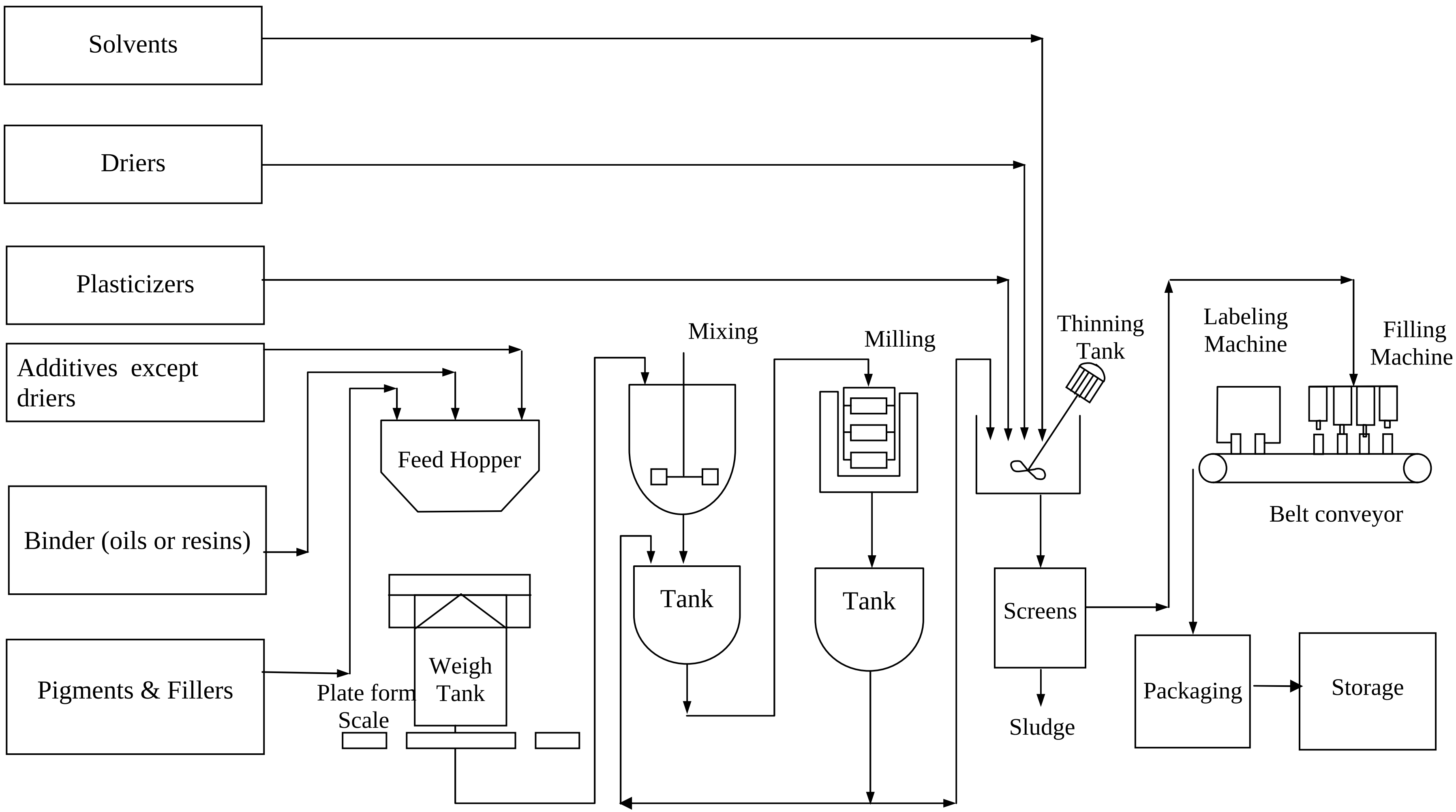


Fig. (21) Flowchart of Paints Manufacturing Steps

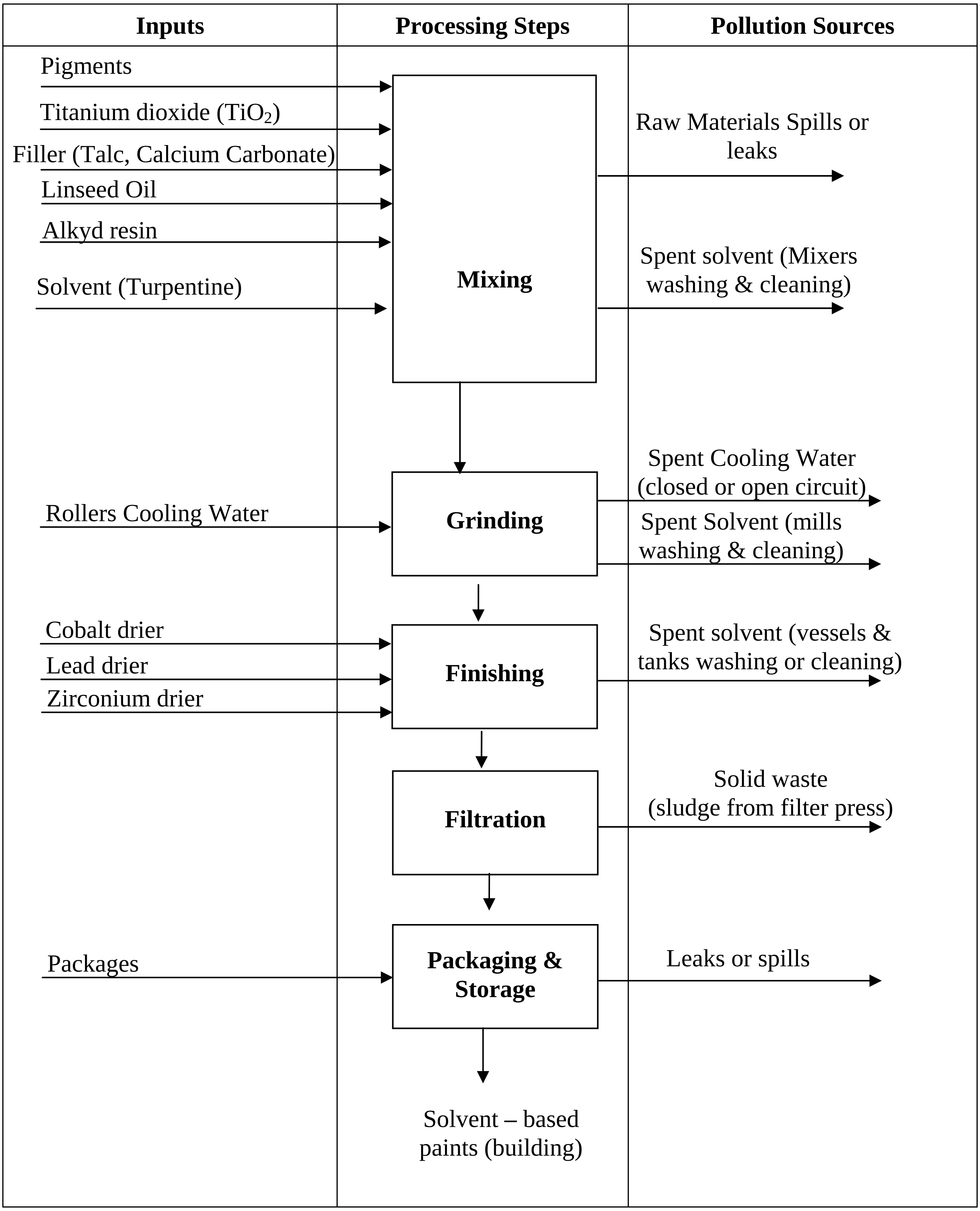
2.2.1 Production of solvent-based (household/ industrial) Paints

The solvent-based paints differ according to their applications and therefore the raw materials and additives (adhesives, driers, heat resisting agents, …) used in their production. They include industrial and household paints. The industrial paints are used for industrial purposes such as motor vehicle, washing machine, and pipelines painting operations. The household paints are used to cover buildings and furniture.

Figures (22, 23) present the main operations in the solvent-based household/ industrial paints production lines, the input to the units and the pollution sources.

Mixing	Alkyd resins or vegetable oils (boiled linseed oil), fatty acids, pigments (titanium dioxide), fillers (talc, and calcium carbonate), and plasticizers are weighed, and fed automatically to the mechanical mixers.
Grinding	After mixing, the mixture (batch) is transferred to the mills for further mixing, grinding, and homogenizing. The type of used mill is related to the type of pigments, vehicles, and fillers.
Intermediate storage	In some plants, after grinding, the batch is transferred to an intermediate storage tank, because the batch may need further grinding to obtain the required degree of homogeneity.
Thinning/ dilution	The batch is then transferred from the intermediate storage tank to a mixer for thinning and dilution, where solvents, and other additives are added.
Filtration and finishing	After thinning, the batch is filtered in a filter, to remove nondispersed pigments and any entrained solids. Metal salts are added to enhance drying (cobalt, lead, zirconium).
Packaging and storage	The paint is poured into cans or drums, labeled, packed, and moved to storage, each step being completely automatic.

Figure (22) Solvent-based (household) Paints Production Line

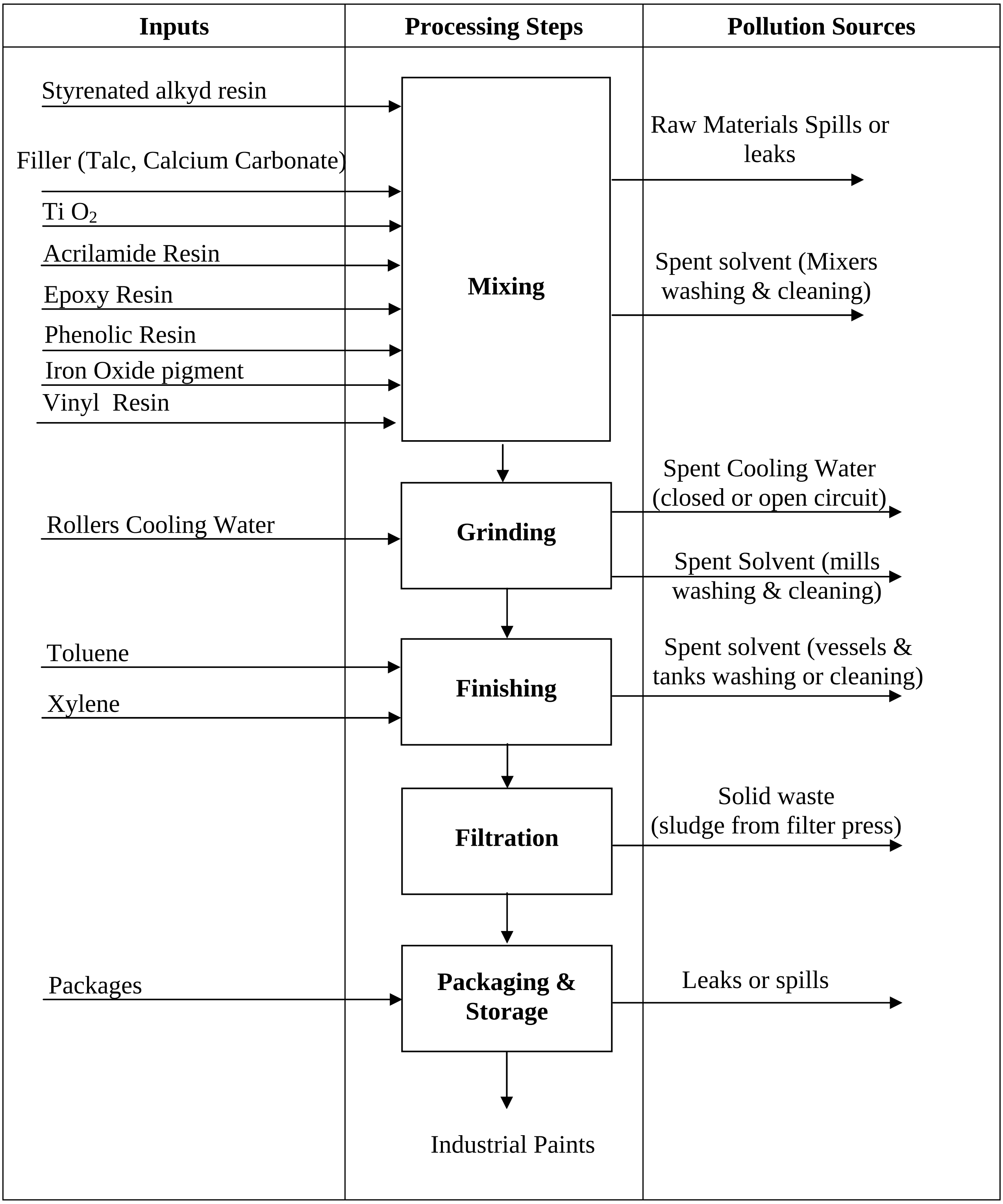


* Work place pollution parameters are VOCs, particulates, and noise.

** Spills or leaks could occur through the whole process, and may contaminate the water if discharged to the sewer.

*** Chemicals empty containers are generated, and considered hazardous. Those hazardous solid waste should be safely disposed into a landfill.

Figure (23) Solvent-based (Industrial) Paints Production Line



* Work place pollution parameters are VOCS, particulates, and noise.

** Spills or leaks could occur through the whole process, and may contaminate the water if discharged to the sewer.

*** Chemicals empty containers are generated, and considered hazardous. Those hazardous solid waste should be safely disposed into a landfill.

2.2.2 Production of Water-based Paints

Figure (24) presents the main operations in the water-based production line, the input to the units and the pollution sources. The water-based paints manufacturing steps are similar to those of the solvent-based paints production, except that the raw materials are added to the mixture in different order, and water is used instead of solvent as thinner.

Mixing and thinning/ dilution

Mixing in water-based occurs in two steps. In the first step (very high speed mixing) all inorganic materials dispersing agents, and wetting agents are mixed thoroughly. In the second one, polymer, glycol, freeze thaw agent, etc… are added and mixed at low speed.

The pigments, acrylic resins, and extenders most used are water-dispersible grades of titanium dioxide, zinc sulfide, lithophone, and regular grades of barium sulfate, mica, diatomaceous silica, clay, and magnesium silicate.

Grinding

After mixing, the batch is transferred to the mills for further mixing, grinding, and homogenizing. The type of used mill is related to the type of pigments, vehicles, and fillers.

Mixing of additives

The batch is then transferred to a mixer, where ammonia and dispersants are added to water, followed by pigments (premixed and ground in a mill). plastisizers, anti-foaming agents, preservative solution (usually chlorinated phenols) and polyvinyl acetate to give the required characteristics. Other additives are needed for specific purposes.

Intermediate storage

In some plants, after that, the batch is transferred to an intermediate storage tank, because the batch may need further grinding to obtain the required degree of homogeneity.

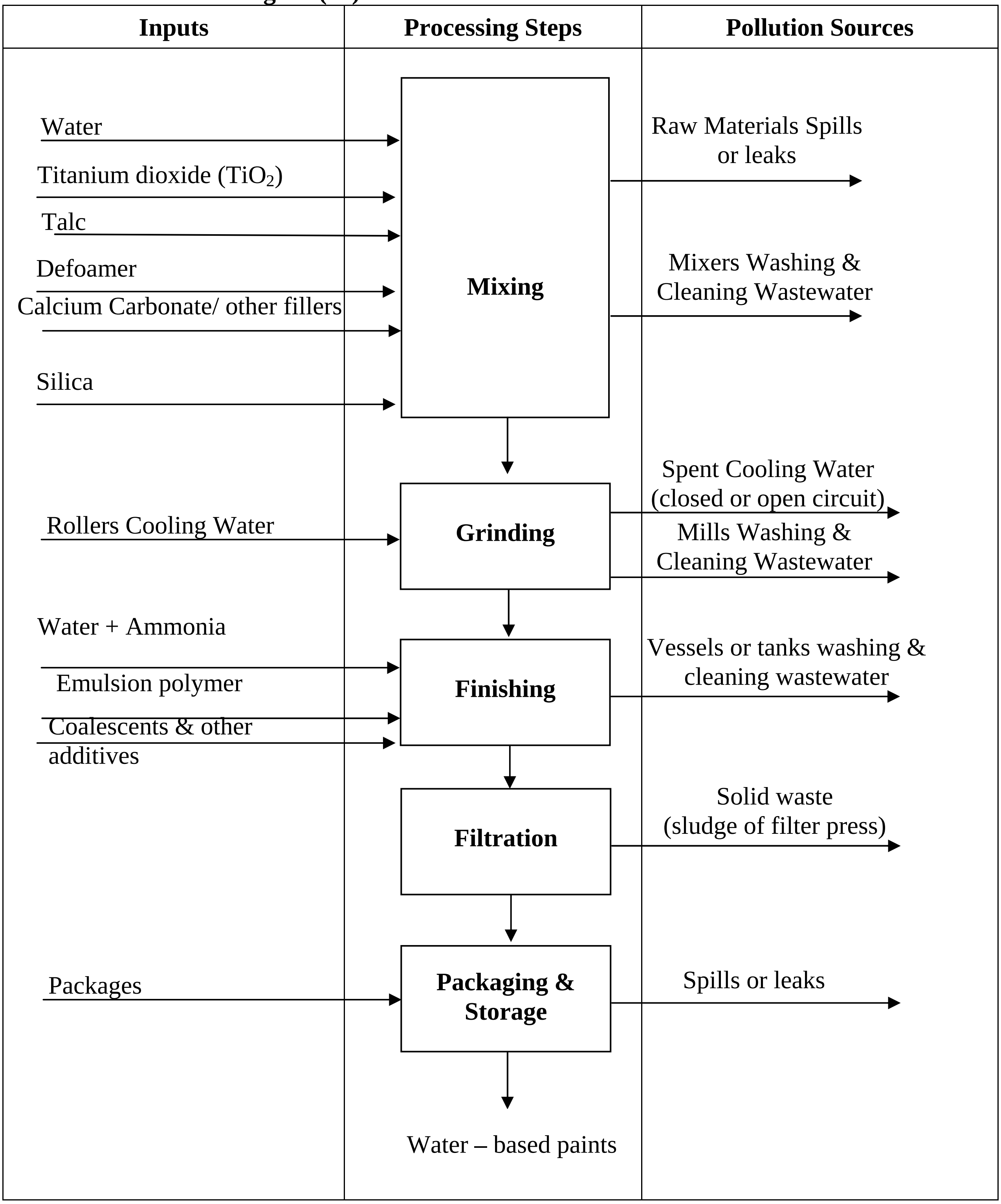
Filtration and finishing

The batch is then filtered in a filter to remove nondispersed pigments and any entrained solids.

Packaging and storage

The paint is poured into cans or drums, labeled, packed, and moved to storage, each step being completely automatic.

Figure (24) Water-based Paints Production Line



* Work place pollution parameters are ammonia, particulates, and noise.

** Spills or leaks could occur through the whole process, and may contaminate the water if discharged to the sewer.

*** Chemicals empty containers are generated, and considered hazardous. Those hazardous solid waste should be safely disposed into a landfill.

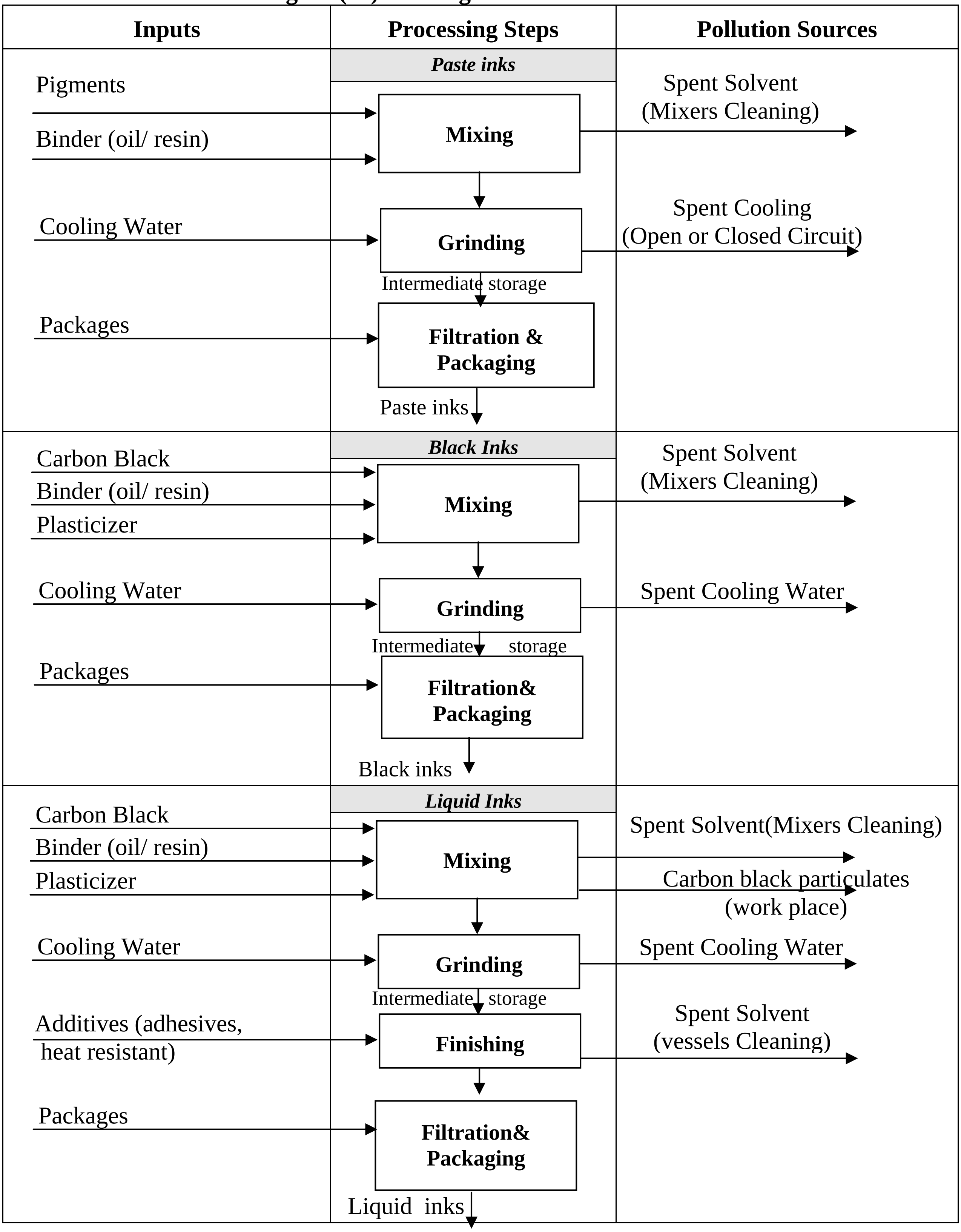
2.2.3 Production of Printing Inks

Figure (25) presents the main operations in the printing inks production line, the input to the units and the pollution sources. The printing inks manufacturing steps are similar to those of the paints production.

Printing inks consist of a fine dispersion of pigments or dyes in a vehicle which may be a drying oil with or without natural or synthetic resins. Drying oils or petroleum oils and resins are used, although the newer synthetic resin systems are finding great favor because they are quick-drying and their working properties are excellent. There are three main types of printing inks; black inks, paste inks, and liquid inks. The paste inks are used in manufacturing of pens, and the black inks in newspaper print, and the liquid inks for printing on metals, plastics, carton.

Mixing	Binder (resins/ oils), pigments (in paste, and liquid inks) or carbon black (in black inks), and solvent or water are used according to the type of ink manufactured. These raw materials are fed automatically to the mechanical mixers.
Grinding	After mixing, the batch is transferred to the mills for further mixing, grinding, and homogenizing. The type of used mill is related to the type of pigments, vehicles, and fillers.
Intermediate storage	In some plants, after grinding, the batch is transferred to an intermediate storage tank, because the batch may need further grinding to obtain the required degree of fineness.
Filtration and finishing	After thinning, the batch is filtered in a filter (usually filter press) to remove nondispersed pigments and any entrained solids. Other additives are added to the batch for special purposes.
Packaging and storage	The paint is poured into cans or drums, labeled, packed, and moved to storage, each step being completely automatic.

Figure (25) Printing Inks Production Line



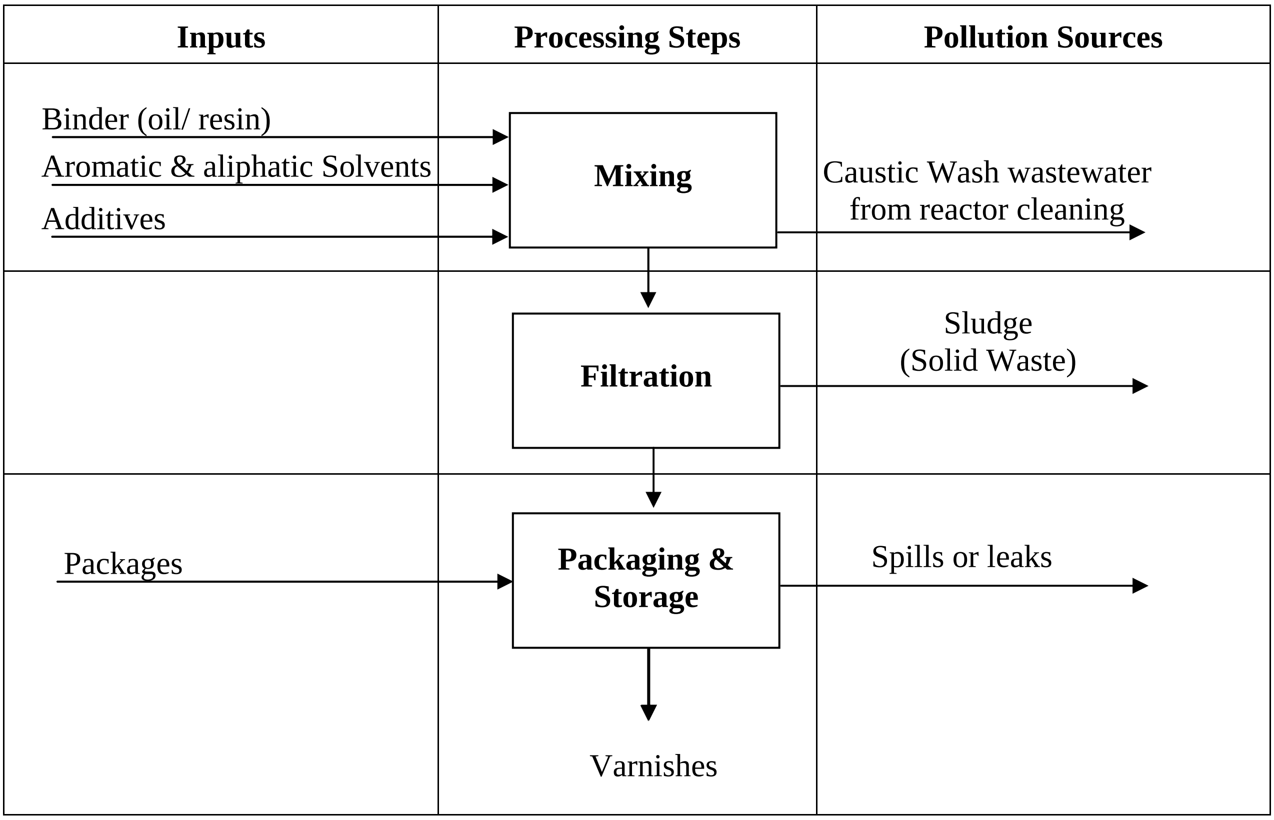
* Work place pollution parameters are VOCS, particulates, and noise.
** Spills or leaks could occur through the whole process, and may contaminate the water if discharged to the sewer.
*** Chemicals empty containers are generated, and considered hazardous. Those hazardous solid waste should be safely disposed into a special landfill.

2.2.4 Production of Varnishes

Figure (26) presents the main operations in the varnishes production line, the input to the units and the pollution sources. A varnish is an unpigmented colloidal dispersion or solution of synthetic and/or natural resins in oils or urethenated oils dissolved in true solvents. These are used as protective or decorative coating for various surfaces specially wood.

Mixing	Only one production step occurs, in which the binders (natural resin + oil, nitro cellulose + short alkyd resin, urethenated oil, synthetic resins,…etc.) are thoroughly mixed with true solvents. After thorough mixing, the required additives are added. These raw materials are fed automatically to a mixing container.
Filtration and finishing	After mixing has been finished, the batch is filtered in a filter, to remove any entrained solids.
Packaging and storage	The varnish is poured into cans or drums, labeled, packed, and moved to storage, each step being completely automatic.

Figure (26) Varnishes Production Line



* Work place pollution parameters are VOCS, and particulate.
** Spills or leaks could occur through the whole process, and may contaminate the water if discharged to the sewer.
*** Chemicals empty containers are generated, and considered hazardous. Those hazardous solid waste should be safely disposed into a landfill.

2.2.5 Production of Alkyd Resins

Figure (27) presents the main operations in the resins production line, the input to the units and the pollution sources.

Reaction

Any resin that is a polymer of an ester type monomer is a polyester resin. In this broad sense alkyds are polyesters, however, general usage restricts the term alkyd to polyesters that are modified with a triglyceride oil or the acids of such an oil.

Generally alkyd resin means the reaction product of a polybasic acid, a polyhydric alcohol, and a monobasic fatty acid or oil. Alkyds differ according to the type of oil which depends on whethere it is oxidized or nonoxidized, and on the length of the chain short, medium, or long. The reaction basic to all polyester resins, including alkyds, is a condensation reaction of carboxyl groups with hydroxyl groups, splitting out water and forming an ester.

In this process raw oils (linseed, soybean, safflower, sunflower, dehydrated castor), glycerol (or penta erythretol), phthalic anhydride (or maleic anhydride), and solvents are fed to a catalytic reactor using heavy metal oxides (lead oxides) as catalyst. The acids typified by phthalic anhydride, contain two carboxylic acid groups, this gives them a reactive capacity or potential functionality of two glycerols.

The reaction conditions (temperature and pressure) depend on the specifications of the final product as short, medium, or long alkyd resin. Since the reaction is reversible, its completion requires removal of water. The addition of solvents (e.g. xylene) facilitates the removal of water by forming an azytropic vapors mixture.

Xylene Recovery (Xylene/ water Separation)

Xylene recovery can be performed by one of the following operations:

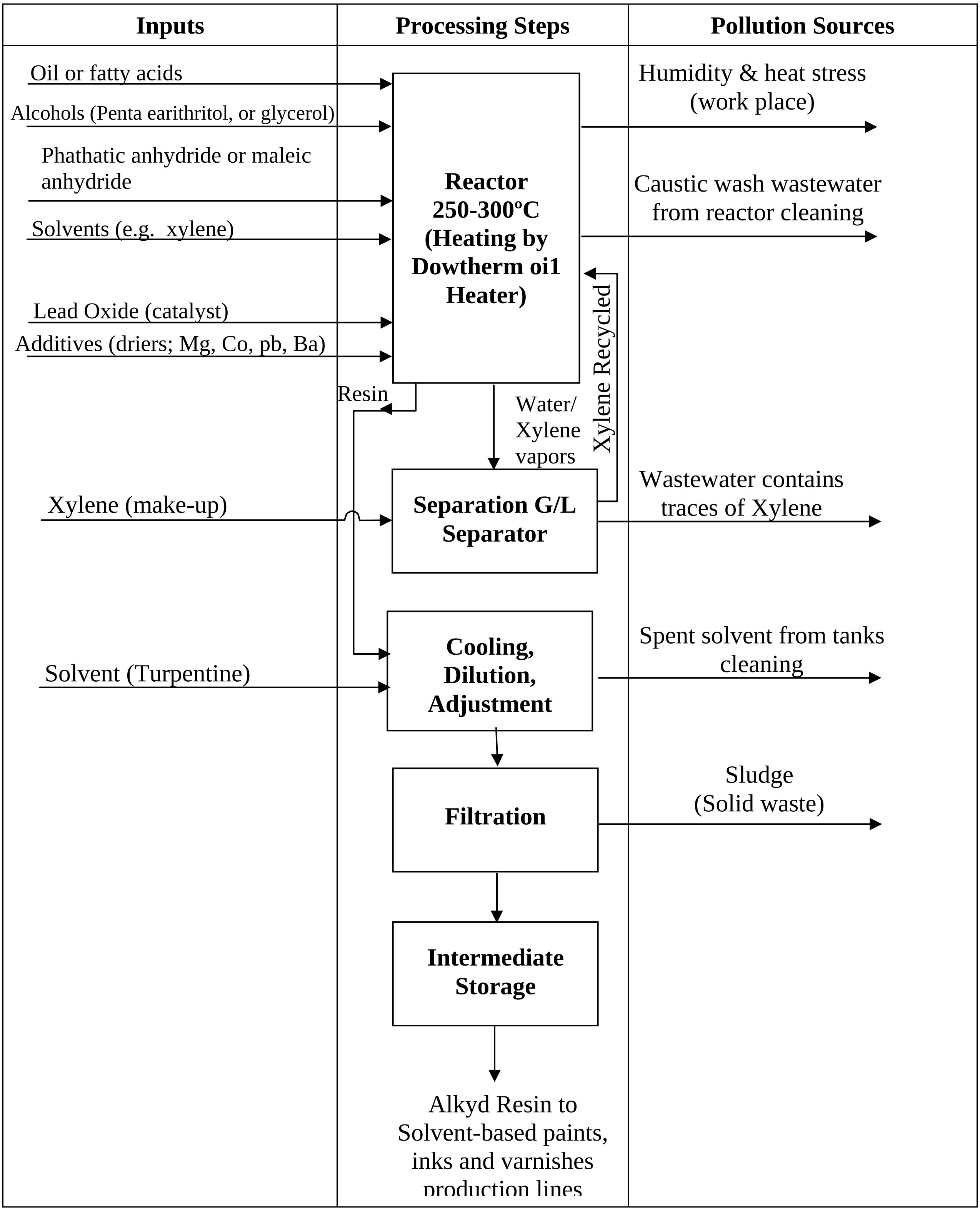
<u>Condenser/ decanter</u>, where the xylene/ water vapors are first cooled in a condenser and the resulting liquid allowed to separate in a decanter into a water rich layer and a xylene rich layer. The latter is recycled to the reactor.

<u>Gas/ liquid separator,</u> where the water/ xylene vapors mixture is introduced to a gas-liquid separator, which is fed with make-up xylene. Cooling to the dew point of the vapors allows the separation of the xylene rich

vapor from the water solution. The Xylene rich vapor is recycled to the reactor, and the contaminated water is discharged to the internal sewer system of the plant.

Cooling	The produced resin is cooled to about 200^{o}C, by cooling water circuit.
Dilution	The batch is transferred to tanks, where it is diluted with suitable solvent.
Filtration	After dilution, the batch is filtered in a filter (usually plate and frame filter press), to remove any entrained solids.
Properties adjustment	After filtration, additives are added to adjust the properties of the resin.
Packaging and storage	The produced resin is then stored in barrels (for sale) or in tanks to be used in the solvent-based paints manufacturing.

Figure (27) Alkyd Resins Production Line



* Work place pollution parameters are VOCS, and particulates.

** Spills or leaks could occur through the whole process, and may contaminate the water if discharged to the sewer.

*** Chemicals empty containers are generated, and considered hazardous. Those hazardous solid waste should be safely disposed into a landfill.

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 (28) shows the various service units with their corresponding raw materials and potential pollution sources.

2.3.1 Boilers

Boilers are used to produce steam which is used to supply heat to the processes. Although, processes in the production lines do not require steam, some paints facilities have boilers to supply heat to the solvent recovery unit.

The gaseous emissions, due to fuel (Mazot or solar) burning, contain primarily particulates (including heavy metals if they are present in significant concentrations in the fuel), sulfur and nitrogen oxides (SOx, and NOx), carbon oxides (CO, and CO_2), and volatile organic compounds (VOCs). The concentration of these pollutants in the exhaust gases depends on firing configuration (nozzle design, chimney height), operating practices and fuel composition.

Wastewater is generated as blow-down purged from boilers to keep the concentration of dissolved salts at a level that prevents salt precipitation and consequently scale formation. The blow-down will be high in (TDS)

Also large quantities of water is used for cooling the turbines, therefore, spent cooling water is generated. Also steam condensate is generated as wastewater. The amount of wastewater generated depends on whether cooling is performed in open or closed cycle, and on the recycling of steam condensate (may return to the boiler). Wastewater contamination may arise from lubricating and fuel oil.

The heat stress may be high, in work place, in case of absence of thermal insulation for boilers and steam pipelines.

2.3.2 Water Treatment Units

There are different treatment processes, depending on the water source and the application in the industry.

i) Water softening for medium hardness water
calcium and magnesium ions are removed from hard water by using cation exchange resin (sodium form). When the exchange resin has been loaded with Ca and Mg ions, it is regenerated to the sodium form by using a salt solution (sodium chloride) in the pH range of 6-8. This is performed by backwashing with the salt solution. The treated water has a hardness level of less than 1 ppm expressed as calcium carbonate.

ii) Water softening for very high bicarbonate hardness

Water from wells and canals is pre-treated before softening. Water is treated first by the lime process, then by cation exchange resin. The lime process reduces dissolved solids by precipitating calcium carbonate and magnesium hydroxide from the water. It can reduce calcium hardness to 35 ppm if proper opportunity is given for precipitation. A coagulant such as aluminum sulfate (alum) or ferric sulfate is added to aid magnesium hydroxide precipitation. Calcium hypochlorite is added in some cases.

Currently the use of organic polyelectrolytes is replacing many of the traditional inorganic coagulant aid. Sludge precipitates and is discharged to disposal sites whereas the overflowing water is fed to a sand filter followed by an activated carbon filter that removes any substances causing odor and taste. A micro filter can then be used to remove remaining traces.

A successful method to accelerate precipitation is contacting previously precipitated sludge with the raw water and chemicals. The sludge particles act as seeds for further precipitation. The result is a more rapid and more complete reaction with larger and more easily settled particles.

iii) Desalination (Reverse Osmosis/ Electro-dialysis)

Desalination can also be performed by reverse osmosis. In this process water is forced through a semi-permeable membrane by applying pressure.

2.3.3 Cooling Towers

Moderate quantities of cooling water is used for cooling furnaces and the formation equipment in this industry. 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 (blow-down). The blow-down will be high in TDS and will represent a source of pollution to the wastewater to which it is discharged.

2.3.4 Laboratories

Laboratories, in paint industry, are responsible for:

- Testing raw materials for compliance with required standards.
- Quality control of products to check agreement with standard specifications.
- Check the physical, chemical, and mechanical properties of final products.

Chemicals, including hazardous materials, are used in laboratories. Storage and handling should be checked by the inspectors, in addition to the disposal of chemicals empty containers, which is considered as hazardous waste.

2.3.5 Workshops and Garage

Workshops are very important in the paint industry, where they are divided into mechanical and electrical workshops. They are responsible for repairing and maintenance of the equipment. Environmental violation could be due to:

- Noise
- Rinse water contaminated with solvents and lube oil

Pollution in the garage 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 system or selling it to recycling facility.

2.3.6 Storage Facilities

The specifications for the storage facilities depend on the nature and properties of the stored material:

- Environmental laws stipulate that special system should be applied for handling and storing hazardous chemicals.
- Fuel is kept in under/or above ground tanks. Storage requires proper preventive plans for spills and leaks.

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 paints production facility discharges wastewater, high in organic load. From time to time, due to batch processing, 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 could represent a water pollution problem if not complying with relevant environmental laws.

2.3.8 Dow-therm Oil Heater

Heating oil is heated in a furnace, where fuel is burned to produce the necessary energy. The pollution is expected to be generated from oil leaks or spills, which may contaminate the wastewater, if discharged to the sewer system. The gaseous emissions generated from stacks, due to fuel (Mazot or solar) burning in the heater.

2.3.9 Solvent Recovery Unit

The spent solvent generated from equipment cleaning, in the solvent-based production line, could be recovered by vacuum distillation of the spent solvent, then condensation of solvent vapors. Spent solvent could be recovered through distillation process, with about 90% solvent yield achievable from the still, and 10% sludge (removed paints). The solvent can be recycled for reuse in dilution or cleaning.

The sludge (precipitates) generated from the solvent recovery process could be dried and safely disposed into a landfill, or used in the production of a new paint product (a primer).

2.3.10 Restaurants, Washrooms and Housing Complex

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

Figure (28) Service Units and their Related Pollution Sources

Inputs	Service Units	Pollution
Water Lime + chemicals	**Treatment**	Sludge
	Softening Units	Back- wash w.w
Fuel	**Boilers** Steam	Boiler Blow Down (TDS) Flue Gases
Hot Water	**Cooling Towers**	Cooling Tower Blow-down (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 Hazardous material
Wastewater	**WWTP**	Treated wastewater Sludge

Figure (28) Service Units and their Related Pollution Sources (continue)

Inputs	Service Units	Pollution
Fuel →	Dow-therm oil heater →	Flue Gases
Spent cleaning solvens →	Solvent Recovery Unit →	Sludge (removed paints)

2.4 Emissions, Effluents and Solid Wastes

Table (5) summarizes the major polluting processes, process inputs, their outputs, the pollution parameters and corresponding impact.

2.4.1 Air emissions

There are two sources of air emission in the paints industry.

- Exhaust gases, resulting from fuel consumption used to generate steam from boilers, and to heat oil in the heater (Dow-therm oil heater).

  The violating parameters would be; particulate matters (PM_{10}), sulfur oxides, nitrogen oxides, carbon monoxide.

- Fugitive emissions; volatile organic compounds (VOCs) as solvents and other low molecular weight compound (in solvent-based paints, inks, alkyd resins and varnishes), ammonia (in water based paints), solvents, particulate matters (PM_{10}), these emissions resulting from the operation processes (mixing, grinding, packaging,…) in the workplace.

2.4.2 Effluents

The major pollution load of the paints industry is the wastewater from the various sources. Liquid effluent is generated from equipment, vessels, tanks, mixers, mills, and packages, cleaning or washing process, between batches.

The cleaning process is performed using water (in water-based paints), or using solvent (in solvent-based paints). This effluent contains oil& grease, BOD, COD, ammonia, solvents, and heavy metals (lead, chromium, and mercury), and is considered hazardous waste.

Specific effluents are:

- Caustic wash wastewater generated from vessels and reactors cleaning. This effluent contains caustic soda, BOD, COD, heavy metals, and oil& grease. It is usually pretreated (precipitation and pH adjustment), and recycled for reuse. The pretreatment process generates sludge, which is considered hazardous waste.

- Equipment (mixers, mills, tanks, and vessels) and filling machines are responsible for raw materials and products spills, these leaks could contaminate the wastewater if discharged to the internal sewer system. (BOD, COD, oil& grease, and heavy metals).
- Spent solvents used for equipment cleaning in the solvent-based paints production line. The solvent is recovered by distillation and recycled back. The nonvolatile materials, sludge (containing paints, solvents, and heavy metals) is disposed as solid waste, and considered hazardous.
- Blow-downs from the cooling tower and boilers as well as back-wash of softeners are high in TDS and TSS.
- Spent lube oil from garage and workshops if discharged to sewer will give oily wastewater (O&G).
- Floor washing and sanitation produces a wastewater containing organic matter, oil and grease, and traces of the chemicals used for sanitation.
- Out-dated, off-spec, and refused or rejected products.

Typical effluent characteristics of the Egyptian paints industry are shown in table (6) Typical pollution loads per ton of production are given in table (7).

Table (5) Pollutants Per Process

MAJOR POLLUTING PROCESS	PROCESS INPUTS	PROCESS OUTPUTS	POLLUTION PARAMETERS	IMPACT
Solvent-based paints	Pigments Resins Fillers Binding agents Solvents Additives	Accepted product		
		Fugitive emissions	VOCs, particulates	Work Environment
		Solid waste	Chemicals empty containers, paints filters sludge	Land
		Spent cooling water	Contaminated with traces of chemicals (O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals)	Water
		Spent solvent from equipment cleaning	Contaminated with paints	Water, if discharged to sewer
		Losses or leaks to Sewer	O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals	Water
ater-based paints	Pigments Fillers	Accepted product		
		Fugitive emissions	particulates, ammonia	Work Environment

	Binders (resins/ oils) Water Ammonia	Solid waste	Chemicals empty containers, paints filters sludge	Land
		Spent cooling water	Contaminated with traces of chemicals (O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals)	Water
		Wastewater from equipment wash	O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals	Water
		Losses or leaks to Sewer	O&G, BOD, COD, color, pH, TDS, TSS, S.S, heavy metals	Water
Printing inks	Pigments Binder (resins/ oils) Solvents	Accepted product		
		Fugitive emissions	VOCs, particulates	Work Environment
		Spent cooling water	Contaminated with traces of chemicals (O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals)	Water
		Spent solvent from equipment cleaning	Contaminated with paints	Water, if discharged to sewer
		Losses or leaks to Sewer	O&G, BOD, COD, color, pH, TDS, TSS, S.S, heavy metals	Water
		Solid waste	Chemicals empty containers, paints filters sludge	Land
Resins	Vegetable oils Binders (resins/ oils) Solvents	Accepted product		
		Fugitive emissions	VOCs, particulates	Work Environment
		Spent cooling water	Contaminated with traces of chemicals (O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals)	Water
		Spent solvent from equipment cleaning	Contaminated with paints	Water, if discharged to sewer
		Losses or leaks to Sewer	O&G, BOD, COD, color, pH, TDS, TSS, S.S, heavy metals	Water
		Solid waste	Chemicals empty containers, filters sludge	Land
	Vegetable oils Oil free Fatty acids	Accepted product		
		Fugitive emissions	VOCs, particulates, acids vapor	Work Environment

	Alcohols/ Glycero Penta erythrito Solvents (Xylene) Phthalic anhydride Maleic anhydride Metal oxides	Wastewater from the reaction	Contaminated with xylene	Water, if discharged to sewer
		Caustic wash wastewater from equipment cleaning	O&G, BOD, COD, color, pH, TDS, TSS, S.S, heavy metals	Water
		Losses or leaks to Sewer	O&G, BOD, COD, color, pH, TDS, TSS, S.S, heavy metals	Water
		Spent cooling water	Contaminated with traces of chemicals (O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals)	Water
		Solid waste	Chemicals empty containers, filters sludge	Land
Packaging	Paints products	Losses in wastewater	O&G, BOD, COD, color, pH, heavy metals	Water
Softeners	Raw Water	Treated Water		
		Back-wash	TDS, TSS	Water
Boilers	Treated Water + Condensate recycle	Blow-down	TDS, TSS	Water
	Fuel	Flue Gasses	PM_{10}, CO_2, CO, NO_x, SO_x	Air
Cooling Towers	Water	Blow-down	TDS, TSS	Water
Dow-therm oil heater	Fuel	Flue Gasses	PM_{10}, CO_2, CO, NO_x, SO_x	Air
Solvent Recovery Unit	Spent solvents	Sludge	Solvents and heavy metals	Land
		Air emissions (VOCS)	solvents	Air
WWTP	Process W.W	Treated effluent	O&G, BOD, COD, TDS, TSS, S.S, color, pH, heavy metals	Water
		Sludge	O&G, heavy metals, TSS	Soil

Table (6) Typical chemical analysis of paints factory waste effluents

Parameter	pH	BOD mg/1	COD mg/1	TSS mg/1	TDS mg/1	S.S mg/1	Color Pt/CO	Oil& Grease mg/1
Solvent-based paints line	7.7	66	221	39	353	-	15	28
Water-based paints line	7.7	3000	5930	1485	1659	-	Out-of-range	402
Printing inks	7.1	220	680	123	403	0.5	40	168
Resins	7.4	615	1344	218	790	3	55	89

Table (7) Typical organic pollution loads in Egyptian paints industry per ton of production

Plants	Effluent flow rate m^3/d	BOD kg/d	COD kg/d	TSS Kg/d	TDS Kg/d	S.S Kg/d	Oil& Grease Kg/d
Solvent-based paints line	150	9.9	33.15	5.85	53	-	4.2
Water-based paints line	2.5	7.5	14.83	3.7	4.15	-	1
Printing inks	2	0.44	1.4	0.25	0.81	0.001	0.34
Resins	90	55.4	121	19.6	71	0.27	8

2.4.3 Solid and Hazardous Wastes

The main sources of hazardous and solid wastes are:

- Empty containers of raw materials and chemicals, contaminated with traces of chemicals, are considered as hazardous waste.
- Spent bags of the Bag-Filters, contain pigments particulates. This solid waste is considered as hazardous waste.
- Sludge generated from the solvent recovery unit, and filter press, containing paints, solvents, and heavy metals, are considered as hazardous waste.
- Outdated, rejected, and off-spec. products. These solid wastes are considered hazardous wastes.
- Sludge generated from the biological wastewater treatment plant, may contain heavy metals, and could be considered hazardous.
- Oil separators could be used as a pretreatment before the WWTP or in the garage, workshops, and storage area. Sludge is generated from the oil separators and considered hazardous waste.
- Scrap metals generated from workshops and garage.
- Packaging wastes, paper, plastic,…

2.4.4 Work Environment

There are many sources of air emission in the paints industry. These emissions resulting from the operation processes (mixing, grinding, packaging,…) in the workplace.

Fugitive emissions; volatile organic compounds (VOC) as solvents and other low molecular weight compound (in solvent-based paints), ammonia (in water based paints), particulate matters (PM_{10}) of pigments during unpacking and mixing.

Noise could occur during grinding (near mills).

2.5 Characteristics Specific to the Paints Industry

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

- Production lines operate on batch mode, therefore, equipment cleaning and washing are performed between batches.
- Shock loads are expected and are caused by discharging equipment wash wastewater, in water-based paints production lines.
- Paints products production rate is seasonal, it increases in summer and decreases in winter.
- Pollution loads are expected to be higher during start-up and shut-down.

3. Environmental and Health Impacts of Pollutants

3.1 Impact of Air Emissions

Particulates

Particulate matters from fuel combustion and other manufacturing processes

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, bronchitis).

Emissions of particulates include ash, soot and carbon compounds, which are often the result of incomplete combustion.

Lead, cadmium, Chromium, and other metals of pigments, can also be detected in the production processes.

Chromium pigments

Chromium is steel-gray, lustrous metal; body-centered cubic structure, gray crystals and blue-white hard metal. It is also an odorless element, insoluble in water. Under strongly oxidizing conditions, may be converted to hexavalent state & occur as chromate anions. Chromium is soluble in acids (except nitric) and strong alkalies.

Chromium is causing irritation to the upper respiratory tract, severe nasal irritation. Chromium (III), the naturally occurring form, has low toxicity due to poor membrane permeability and non-corrosivity, while Cr (VI), from industrial emissions, is highly toxic due to strong oxidation characteristics and ready membrane permeability.

Occupational exposure to trivalent chromium and other chromium compounds by inhalation has been studied in the chromate manufacturing and ferrochromium industries; however, exposures all include mixed exposures to both Cr (III) and Cr (VI). Cr (VI) species is the likely etiological agent in reports of excess cancer risk in chromium workers. Data addressing exposures to Cr (III) alone are not available and data are inadequate for an evaluation of human carcinogenic potential. Hexavalent chromium is known to be carcinogenic in humans by the inhalation route of exposure. Hexavalent chromium compounds are carcinogenic in animal bioassays. There is sufficient evidence for increased incidence of lung cancer among workers.

Chromium occurs in nature mostly as chrome iron ore (feo.cr 203). Chromium is present in small quantities in all soils & plants. Movement from the soil surface to a depth of 10 cm was observed for all of the seven metals; cadmium, chromium, copper, molybdenum, nickel, lead and zinc, but most of the metal (60%-100%, mean 87%) remained in the upper 5 cm of soil.

Although most of the soluble chromium in surface waters may be present as Cr (VI), a small amount may be present as Cr (III) organic complexes. Hexavalent chromium is the major stable form of chromium in seawater; however, Cr (VI) may be reduced to Cr (III) by organic matter present in water, and may eventually deposit in sediments.

Nickel pigments

Nickel is a silvery metal, odorless, Excellent resistance to corrosion and insoluble in water, ammonia; soluble in diluted nitric acid; slightly soluble in hydrochloric acid and sulfuric acid.

Nickel metal is well known cause of contact dermatitis in sensitized individuals. Instances of dermatitis in region of eyes has resulted from contact with nickel spectacle frames, but eye itself has not been involved. Histological changes in nasal mucosa of nickel workers were studied. Nickel is considered toxic as dust or powder. Nickel is the most frequent metal, which induces allergic contact sensitization. Nickel hypersensitivity dermatitis may be initiated by contact with nickel on the skin. Exposure to industrial nickel dust causes nickel dermatitis. Sensitivity to nickel may be exhibited from skin contact … divalent nickel ions can penetrate skin at sweat-duct & hair follicle ostia, & bind with keratin.

There is sufficient evidence in humans for the carcinogenicity of nickel sulfate, and of the combinations of nickel sulfides and oxides. There is inadequate evidence in humans for the carcinogenicity of metallic nickel and nickel alloys. There is sufficient evidence in experimental animals for the carcinogenicity of metallic nickel, nickel monoxides, nickel hydroxides and crystalline nickel sulfides.

No data was found to suggest that nickel is involved in any biological transformation in the aquatic environment.

Lead pigments

Chronic exposure to lead has been found to produce infertility, germinal epitheleium damage, oligospermia and testicular degeneration, decreased sperm motility, and prostatic hyperplasia. The subjective symptoms of lead poisoning in working adults are diffuse and include weariness at the end of the day. The patient is moody and irritable and may fall asleep watching T.V. Often he loses his interest in leisure- time activities. Lead poisoning is due to inhalation of lead dust, upon inhalation, absorption takes place easily from the respiratory system tract and symptoms develop relatively quickly than oral ingestion.

Cadmium	Cadmium and cadmium compounds are carcinogenic to humans. They are highly toxic, inhalation (dust or fumes), and cause throat dryness, cough, headache, vomiting, chest pain, extreme restlessness and irritability, penumonitis, possibly bronchopneumonia, and it is irritating to nose and throat. Inhalation of cadmium dust, fumes, or salts over a number of years result ion chronic cadmium poisoning, a disease characterized by distinctive, non-hypertrophic emphysema with or without renal tubular injury, in which urinary execration of a protein occurs. Other toxic effects include anemia, eosinophilia, anosmia, chronic rhinitis, yellow discoloration of teeth, and bone changes.
Gases	
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, also deteriorates the agriculture land.
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.
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.

Vapors

Ammonia

Ammonia is a corrosive and severely irritating gas with a pungent odor.

Anhydrous ammonia is irritating to the skin, eyes, nose, throat, and upper respiratory system. Ecologically, ammonia is a source of nitrogen (an essential element for aquatic plant growth), and may therefore contribute to eutrophication of standing or slow-moving surface water, particularly in nitrogen-limited waters such as the Chesapeake Bay. In addition, aqueous ammonia is moderately toxic to aquatic organisms.

There is currently no evidence to suggest that this chemical is carcinogenic.

Ammonia combines with sulfate ions in the atmosphere and is washed out by rainfall, resulting in rapid return of ammonia to the soil and surface waters. Ammonia is a central compound in the environmental cycling of nitrogen. Ammonia in lakes, rivers, and streams is converted to nitrate.

Toluene

Toluene is a volatile organic chemical.

Inhalation or ingestion of toluene can cause headaches, confusion, weakness, and memory loss. Toluene may also affect the way the kidneys and liver function. Reactions of toluene in the atmosphere contribute to the formation of ozone in the lower atmosphere. Ozone can affect the respiratory system, especially in sensitive individuals such as asthma or allergy sufferers. Some studies have shown that unborn animals were harmed when high levels of toluene were inhaled by their mothers, although the same effects were not seen when the mothers were fed large quantities of toluene. Note that these results may reflect similar difficulties in humans.
There is currently no evidence to suggest that this chemical is carcinogenic. A portion of releases of toluene to land and water will evaporate. Microorganisms may also degrade toluene. Once volatilized, toluene in the lower atmosphere will react with other atmospheric components contributing to the formation of ground-level ozone and other air pollutants.

Xylene

Xylene are rapidly absorbed into the body after inhalation, ingestion, or skin contact. Short-term exposure of humans to high levels of xylene can cause irritation of the skin, eyes, nose, and throat, difficulty in breathing, impaired lung function, impaired memory, and possible changes in the liver and kidneys. Both short- and long-terms exposure to high concentrations can cause effects such as headaches, dizziness, confusion, and lack of muscle coordination. Reactions of xylene in the atmosphere contribute to the formation of ozone in the lower atmosphere. Ozone can affect the respiratory system, especially in sensitive individuals such as asthma or allergy sufferers.

There is currently no evidence to suggest that this chemical is carcinogenic.A portion of releases to land and water will quickly evaporate, although some degradation by microorganisms will occur. Xylene are moderately mobile in soils and may leach into groundwater, where they may persist for several years. Xylenes are volatile organic chemicals. As such, xylene in the lower atmosphere will react with other atmospheric components, contributing to the formation of ground-level ozone and other air pollutants.

Methyl Ethyl Ketone (MEK)

Methyl ethyl ketone is a flammable liquid. Methyl ethyl ketone (MEK) is used as a solvent. Its extremely volatile characteristic makes fugitive emissions its primary source of releases to the environment.

Breathing moderate amounts of methyl ethyl ketone (MEK) for short periods of time can cause adverse effects on the nervous system ranging from headaches, dizziness, nausea, and numbness in the fingers and toes to unconsciousness. Its vapors are irritating to the skin, eyes, nose, and throat and can damage the eyes. Repeated exposure to moderate to high amounts may cause liver and kidney effects.

No agreement exists over the carcinogenicity of MEK. One source believes MEK is a possible carcinogen in humans based on limited animal evidence. Other sources believe that there is insufficient evidence to make any statements about possible carcinogenicity.

Most of the MEK released to the environment will end up in the atmosphere. MEK can contribute to the formation of air pollutants in the lower atmosphere. It can be degraded by microorganisms living in water and soil.

Methyl Isobutyl Ketone (MIBK)

Acute inhalation can cause nose, eye, and throat irritation, nausea headatche, vertigo, incoordination,…

Methanol

Methanol is highly flammable. Methanol is readily absorbed from the gastrointestinal tract and the respiratory tract, and is toxic to humans in moderate to high doses. In the body, methanol is converted into formaldehyde and formic acid. Methanol is excreted as formic acid. Observed toxic effects at high dose levels generally include central nervous system damage and blindness. Long-term exposure to high levels of methanol via inhalation cause liver and blood damage in

Acetone is highly volatile, and once it reaches the troposphere (lower atmosphere), it will react with other gases, contributing to the formation of ground-level ozone and other air pollutants.

Petroleum Ether

Petroleum ether is a mixture of hydrocarbons having carbon numbers in the range of C5 through C6, it is used as solvent. Petroleum ether is classified as reactive and volatile, and it participate in smog formation. Occupational exposure to petroleum ether can occur through inhalation, dermal contact, and ingestion. Petroleum ether applied to the skin may induce severe irritation, its vapor is an irritant of the mucous membranes and respiratory tract. It also affect the central nervous system, and may cause headache, fatigue, poor concentration, emotional instability, and impaired memory.

Chloroform

Chloroform is an irritant, its main effect is as a central nervous system and cardiac depressant. Delayed renal and hepatic toxicity may also occurs. It can be a poison by ingestion and inhalation. General symptoms of exposure include nausea, vomiting, anorexia, salivation, a sensation of bodily warmth, headache, chest pain, fatigue, giddiness, drowsiness, and disorientation.

Butyl Acetate

Butyl acetate vapors can affect central nervous system and cause headache, muscle weakness, giddiness, ataxia, confusion, delirium, coma. It also has and irritating effect to skin, eyes, throat. It causes cough and dyspnea. It may result to death by respiratory failure.

Butyl acetate has moderate mobility is soil, ans its volatilization is expected from moist and dry soil, and water surfaces.

Ethyl Acetate

The inhalation of ethyl acetate may be damaging to lung, liver, kidney, and heart. It is also toxic by ingestion. It may cause irritation of the eyes, nose, and throat. It is expected to have high mobility in soil and it is volatile from moist soil and water surfaces, its biodegradation in soil is also expected.

Cellosolve

Cellosolve can affect the central nervous system causing headache, drowsiness, and weakness. Long term exposure may affect semen quality. Cellosolve has a very high mobility in soil, and its biodegradation may occur rapidly in water.

Butyl Cellosolve

Butyl cellosolve can affect the central nervous system causing headache, drowsiness, and weakness. It penetrates skin easily and has toxic action by excessive skin exposure. It is also irritating to eyes, nose, and throat. It is expected to have high mobility in soil and to biodegrade rapidly in soil.

animals. Ecologically, methanol is expected to have low toxicity to aquatic organisms. Concentrations lethal to half the organisms of a test population are expected to exceed one mg methanol per liter water. Methanol is not likely to persist in water or to bioaccumulate in aquatic organisms.
There is currently no evidence to suggest that this chemical is carcinogenic.

Liquid methanol is likely to evaporate when left exposed. Methanol reacts in air to produce formaldehyde which contributes to the formation of air pollutants. In the atmosphere it can react with other atmospheric chemicals or be washed out by rain. Methanol is readily degraded by microorganisms in soils and surface waters.

Ethylene Glycol

Long-term inhalation exposure to low levels of ethylene glycol may cause throat irritation, mild headache and backache. Exposure to higher concentrations may lead to unconsciousness. Liquid ethylene glycol is irritating to the eyes and skin. Toxic effects from ingestion of ethylene glycol include damage to the central nervous system and kidneys, intoxication, conjunctivitis, nausea and vomiting, abdominal pain, weakness, low blood oxygen, tremors, convulsions, respiratory failure, and coma. Renal failure due to ethylene glycol poisoning can lead to death.

Ethylene glycol readily biodegrades in water. No data are available that report its fate in soils; however, biodegradation is probably the dominant removal mechanism. Should ethylene glycol leach into the groundwater, biodegradation may occur. Ethylene glycol in water is not expected to bioconcentrate in aquatic organisms, adsorb to sediments or volatilize. Atmospheric ethylene glycol degrades rapidly in the presence of hydroxyl radicals.

Acetone

Acetone is a volatile and flammable organic chemical. Acetone is irritating to the eyes, nose, and throat. Symptoms of exposure to large quantities of acetone may include headache, unsteadiness, confusion, lassitude, drowsiness, vomiting, and respiratory depression. Reactions of acetone (see environmental fate) in the lower atmosphere contribute to the formation of ground-level ozone. Ozone (a major component of urban smog) can affect the respiratory system, especially in sensitive individuals such as asthmatics or allergy sufferers.
There is currently no evidence to suggest that this chemical is carcinogenic.
If released into water, acetone will be degraded by microorganisms or will evaporate into the atmosphere. Degradation by microorganisms will be the primary removal mechanism.

Butyl Alcohol	Butyl alcohol vapors irritate and cause cough, it may cause irritation to eyes, nose, throat, and mucous membrane, headache, dizziness, and drowsiness. In high concentration it can cause central nervous system depression. It has high mobility in soil, and it is expected to volatilize from water surfaces

3.2 Impact of Effluents

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. The parameters of relevance to the paints industry are O&G, BOD ,COD, TSS, TDS, S.S, heavy metals, temp., color, and pH.

Discharge of polluted wastewater high in BOD, O&G, and COD into lakes and sea can cause eutrofication and impact bio-diversity. Eutrofication is a natural aging process in which the water becomes organically enriched, leading to increasing domination by aquatic weeds, transformation to marsh land, and eventually to dry land. Eutrofication can be accelerated by human input of nutrients. Die-off and settling of plant growth results in sediment oxygen demand, which tend to decrease dissolved-oxygen levels. The organic material in wastewater stimulates the growth of bacteria and fungi naturally present in water which then consume dissolved oxygen. In addition heavy metals could be toxic to the plants and aquatic life because they interfere with many beneficial uses of the water..

Discharge of high O&G, BOD, and COD loads to the public sewer system will have an indirect environmental impact. Increased loads can cause malfunction of the domestic wastewater treatment plant.

Spent lube oils from garage and workshops could be a cause for concern if discharged into the sewer system because they tend to coat surfaces causing maintenance problems. Also, if they discharged to surface waters, they can interfere with the aquatic life in these surface waters and create unsightly floating matter and films.

In addition, spent solvent and caustic wash wastewater generated from equipment washing and cleaning could make corrosion of the internal sewer system of the plant, if discharged.

3.3 Environmental Impact of Solid and Hazardous Wastes

Most of the generated solid waste is considered hazardous waste, and should be dumped in disposal sites for hazardous waste.

Sludges generated from the filters, solvent recovery unit, and WWTP (if exist) containing heavy metals, could contaminate the soil, surface water and underground water, if disposed.Empty containers of raw materials and chemicals, may be sold to contractor. This solid hazardous waste could affect the human health, if used domestically (food packaging,…).

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 paints 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 solar oil 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 sulfur 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 in boilers are given in table (8) (Ministerial decree no. 495, 2001). The permissible limits of emissions from sources of other fuel combustion sources (Dow-therm oil heater) are given in table (9).

Table (8) Maximum Limits of Emissions from Sources of Fuel Combustion in Boilers

Pollution	Maximum limit mg/m^3 of Exhaust
Sulfur Dioxide	3400
Carbon Monoxide	250
Smoke	50

Table (9) Maximum Limits of Emission from Fuel Burning Sources

Pollutant	Maximum Permissible Limit, mg/ m^3
SMOKE	250
DISPERED ASHES	250 (sources existing in urban regions, or close to residential areas)
	500 (sources far from habitation)
	500 (burning of wastes)
SULPHUR DIOXIDE	Existing 4000 New 2500
ALDEHYDES	Burning of waste 20
CARBON MONOXIDE	Existing 4000 New 2500

4.2 Concerning Effluents

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

Table (10) 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.

4.3 Concerning Solid Waste

A number of laws address solid waste management. The following laws apply to scrap, garbage (paper,..), 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:

- Gas emissions (VOCs and metal particulates) generated in the production lines, are regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex (8), (table 11).
- In the boiler house: gas emissions, regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex 8. The limits for the relevant pollutants are presented in Table (11).
- 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 of the Law (table 12).
- Near heavy machinery: noise is regulated by article 42 of Law 4/1994, article 44 of the executive regulations and table 1, annex 7 of the Law.
- Ventilation is regulated by article 45 of Law 4/1994 and article 47 of the executive regulations (tables 13, 14, 15)
- 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

Table (10) 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 modified by Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
BOD (5day,20 deg.)	60	<600	20	30	Municipal	Industrial
COD	100	<1100	30	40	60	60
pH (Grease)	6-9	6-9.5	6-9	6-9	80	100
Oil & Grease	15	<100	5	5	6-9	6-9
Temperature (deg.)	10C>avg. temp of receiving body	<43	35	35	10	10
Total Suspended Solids	60	<800	30	30	35	35
Settable Solids	—	<10	—	20	50	50
Total Dissolved Solids	2000	—	800	1200	—	—
Chlorine	—	<10	1	1	—	—
PO_4	5	30	1	1	—	10
Total phosphorus		25				
Fluoride	1	<1	0.5	0.5	—	0.5
Cadmium	0.05	0.2	0.01	0.01	—	—
Chromium	1		—	—		

Parameter (mg/1 unless otherwise noted)	Law 4/94: Discharge Coastal Environment	Law 93/62 Discharge to Sewer System (as modified by Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
Chromium Hexavalent	—	0.5	0.05	0.05	Total concentration for theses metals should be: 1 for all flow streams	
Copper	1.5	1.5		1		
Iron	1.5		1	1		
Lead	0.5	1	0.05	0.05		
Mercury	0.005	0.2	0.001	0.001	—	—
Nickel	0.1	1	0.1	0.1	—	—
Silver	0.1	0.5	0.05	0.05	—	—
Zinc	5	<10	1	1	—	—
Cyanide	0.1	<0.1	—	—	—	0.1
Total heavy metals	—	Total metals should not exceed 5 mg/l	1	1	1	1

Table (11) Permissible limits as time average and for short periods

Material	Threshold			
	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
Acetone	750	1780	1000	2375
n- Butyl alcohol	50	150		
Butyl acetate	150	710	200	150
Toluene	100	375	150	560
Xylene	100	435	150	655
Ethyl acetate	400	1400		
Cadmium salts/ particulates	0.05		0.2	
Hexa valent chromium		0.05		
Total particulates	200			

Table (12) Maximum Permissible Limits for Heat Stress (law 4/1994)

Type of Work	Low Air Velocity	High Air Velocity
Light work	30^{o} C	32.2^{o} C
Moderate work	27.8^{o} C	30.5^{o} C
Severe work	26.1^{o} C	28.9^{o} C

Table (13) Maximum Permissible Noise Levels (law 4/1994)

No	Type of place and activity	Maximum permissible noise decibel (A)
1	Work place with up to 8 hour and aiming to limit noise hazards on sense of hearing	90 dB
2	Work place where acoustic signals and good audibility are required	80 dB
3	Work rooms for the follow up, measurement and adjustment of high performance operations	65 dB
4	Work rooms for computers, typewriters or similar equipment	70 d.B
5	Work rooms for activities requiring routine mental concentration	60 dB

Table (14) Noise Intensity Level Related to the Exposure Period

Noise intensity level decibel (A)	95	100	105	110	115
Period of exposure (hour)	4	2	1	½	¼

Table (15) Noise Intensity Level In Intermittent Knocking Places

Noise Intensity db	Max Allowable Knocks During Daily Work Period
135	300
130	1000
125	3000
120	10,000
115	30,000

4.5 Concerning Hazardous Materials and Wastes

Law 4/1994 introduced the control of hazardous materials and wastes. The paints industry generates any hazardous wastes, such as chemicals empty containers, spent solvents, sludges from the solvent recovery unit and WWTP, and spent filters clothes. Hazardous chemicals such as solvents, and caustic solutions are used for washing vessels. 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 (preventions) 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 paints industry sector has a great potential for implementation of cleaner technology measures. Newly installed factories employing manpower above 100 has acquired relatively newer technologies, which need little in-process or in-plant modifications and are carrying out end-of-pipe treatment to meet the requirement of environmental laws. However, medium size enterprises as well as public sector companies badly need the 3 types of modifications. Small private enterprises are using primitive technologies.

Mitigation measures in paints industry vary from in-process modification or recovery of solvents especially used in cleaning purpose.

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

5.1 Air pollution Abatement Measures

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 formation.

5.2 Work Environment Pollution Abatement Measures

VOCs emissions

- Using VOCs control equipment such as; absorbents (activated charcoal)/ biofilters on exhaust systems, water scrubbers should be implemented where necessary to achieve acceptable odor quality for nearby residents.
- During equipment cleaning process, solvents are released to air. This emissions could be minimized through closing off the immediate area around the axles, and also during operation for dissolvers and stirring equipment.
- Reduction of the use of open strainers (closed filling system).
- Covering of some containers could prevent the evaporation of solvents into air.
- Using mixing system by vibration rather than by stirring. The lake of a shaft holding a stirrer or a paddle means that the coating and solvent can be gently blended in a completely sealed vessel.

Particulates emissions

- Using control equipment such as; Fabric filters should be used to control particulates, from the process of charging pigments and fillers to the mixers, to below 50 milligrams per normal cubic meter (mg/Nm^3) .

- Using of pigments in the form of pastes (premixed with resins) could be used instead of powdered pigments, to minimize particulate emissions during pigments charging and mixing processes.
- Using of closed equipment (mixers, vessels, mills, and tanks), to prevent the fugitive emissions (VOCs and particulates) of the raw materials in the work place.

5.3 Water Pollution Abatement Measures

Equipment cleaning is considered the major source of pollution (liquid waste) in paints industry, hence reducing cleaning process is a useful way for pollution control. The following are some ways for liquid waste control:

In-plant modifications

- Elimination of unnecessary intermediate storage tanks, to minimize the amount of spent solvents generated from the cleaning of these tanks.
- Recycling from intermediate tank directly to the mill instead of using recycling tank, which lead to reducing the pollution (liquid waste) resulting from cleaning of the removed tank.
- Using high efficiency mills, which allows no need for recycling tank.
- Using centrifugal clarifier instead of filter press, to minimize losses (spills and leaks) occur during recycling of the filtrate to the intermediate tank. This will accordingly improve the quality of the wastewater.
- Using high-pressure jets for cleaning of tanks to enhance cleaning process, so reducing the amount of liquid wastes (solvents and caustic solutions) generated from cleaning process.
- Using manual skimmers for removing materials (paints) stuck to the tanks or container walls, before cleaning with solvent or caustic soda solution. This reduces the amount of liquid wastes used in cleaning, and the removed sticky materials could be recycled. Also mechanical skimmers can be used for tubes cleaning.
- Using Teflon-lined tanks to reduce materials sticking to their walls.

- Segregation of sewer systems for liquid wastes, generated from water- based paints production line and solvents-based production line, as this leads to more efficient recycling.
- In all cases, it is recommended the industrial liquid waste discharged separately from domestic wastes as they differ in the pollutant nature.
- The installation of product-capture systems for filling machines can reduce product losses.
- Implementation of a quality control system such as HACCP (Hazard Analysis & Critical Control Point) is recommended to minimize waste.

In-process modifications

- In solvent-based paints production line;
    - Random choice of the cleaning solvent could be replaced by an evaluation process, leading to a choice of one single solvent for all tanks and equipment cleaning.
    - Schedule the production runs and modify the manufacturing procedures to minimize or eliminate the use of wash solvent.
    - Reuse of cleaning solvents (spent solvents) many times, hence reducing the solvent consumption. After that, the solvent can be regenerated distilled and recycled for use in dilution or cleaning.
    - Spent solvent could be recovered through distillation process, with about 90% solvent yield achievable from the still, and 10% sludge (removed paints). This sludge could be used in the production of a new paint product (a primer).
- In Water-based paints production line;
    - Using washing liquids (caustic solutions), generated from cleaning of mills and packing machines, in dilution of next batch.
    - Scheduling operations to produce light color first then dark color paints to reduce the need for equipment cleaning. For white paints we can use intermediate tank to minimize the washing

operations.

- In acrylic paints production line; Wash water generated from *white* acrylic paint manufacture could be reused in the next production run. Also the wastewater generated from the *colored* acrylics could also be stored for reuse in the next production run.

• In all production line;

- Appling quality assurance to reduce the possibility of errors in paints preparation.
- Using counter current cleaning operations to reduce the amount of water or solvent used.
- Cleaning the tanks directly after production step to prevent materials sticking into walls. This means coordination between the production steps and cleaning operation.
- Reusing the rejected or off-spec. paints in new batches.
- Raw materials substitution; replacing the toxic pigments or dyes such as lead and chromium compounds by another non-toxic ones such as organic dyes or iron oxides.
- Controlling raw materials stock using computerized system, which facilitate the detection of any leak in the initial stages and indicate the sources of solid waste pollutants.
- Implementation of a control system involving pressure regulators on the steam lines, temperature controllers, flow controllers…
- Change from batch processes into continuous ones.
- Modernize the equipment and upgrade the system.
- Introduce new environmentally friendly products (water-bases paints) to increase sales and minimize pollution.

- Improving raw materials handling, to prevent spills occur during manual unpacking of sacks and containers, and training of personnel to insure complete unpacking of containers.

- Integration (acidic and alkaline streams), and segregation of sewer lines of water and solvent based paints, 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 treatment unit of small capacity.

End-of-pipe treatment

Because of the typically high content of suspended solids, TDS, TSS, O&G, COD, BOD, pH, and temp., in the paints industry waste-streams, end-of-pipe treatment frequently involves settling tanks and biological treatment. Pretreatment of effluents is required, it is normally followed by biological treatment.

1)Water-based paints

The wastewater generated from the water-based paints production line is characterized by high values of BOD, COD, S.S, TSS, and TDS. Therefore, the end-of-pipe treatment could be as follows:

- Collection and flow equalization,
- Precipitation, using coagulants and flocculants (such as; lime, alum,…), in a homogenizing tank equipped with mixer, followed by a sedimentation tank to allow the time needed for reactions of chemicals to precipitate the dissolved solids.
- Decantation for removal of generated sludge, and drying of sludge using filter press.
- Filtration using activated carbon filter, to remove any entrained solids.

2) Resins production line

The wastewater generated from the resin production line, contain xylene and other organic compounds, this wastewater could be incinerated in the Dow-therm oil heaters instead of the fuel (Mazot or Solar).

3) Solvent-based paints

The spent solvent generated from equipment cleaning, in the solvent-based production line, could be recovered by vacuum distillation of the spent solvent, then condensation of solvent vapors. The solvent can be recycled for reuse in dilution or cleaning.

The sludge (precipitates) generated from the solvent recovery process could be dried and safely disposed into a landfill.

5.4 Abatement Measures for Solid Waste Pollution

Scrap from workshops and garage

- Scrap metals are collected and sold.

Solid wastes from processes

Hazardous solid wastes sources includes chemicals sacs, packs, empty barrels, filters cartridge, materials spills, and precipitates from liquid wastes (caustic solutions and solvents) clarification by settling or distillation. The following are some ways for reducing solid waste pollution.

- Planning of packaging systems to avoid solid waste and/or to facilitate recycling of packages or packaging wastes.
- Separating hazardous solid waste from non-hazardous ones. This means separating sacs or packs containing hazardous materials such as lead or chromium compounds, from that free from such compounds.
- Gathering the empty sacs containing hazardous compounds in plastic bags, to prevent the spread of hazardous dust in the atmosphere.
- Using water-soluble sacs in making water-based paints can reduce the amount of waste sacs, as the whole sacs can be dissolved in water with their content. This could be done with pigments containing mercury compounds, or in making paints containing anti-fungi compounds, but this in turn affect the degree of shininess of paints.
- Using bag filters instead of cartridge filters, as the spent cartridge should be safely disposed into a landfill or burned, while the bag filters can be used many times. In addition, the bag filters can be washed by water or solvents, for recovery of the toxic material, and recycling of these materials with dilution liquids (solvents and thinners), then the filter bags can be dried and disposed safely.
- Using metallic screens for paints filtration process, which can be reused after cleaning with water or solvent.
- Handling of solid materials spills, by dry cleaning methods such as; vacuum cleaner, or by wet saw dust, to prevent

spreading of these materials. Also the personnel should be trained to close the grills of the internal sewer system, when leaks or spills occur, to reduce the pollution load discharged to the sewer.

- Using automatic methods for unpacking of sacs, which prevent dust spreading in the workplace, also can reduce solid materials spills.
- Cleaning pollutants, from empty sacks and containers by solvent, should be done before storing or selling.
- Solid wastes, generated from spent solvent distillation or pretreatment of alkali solutions, used in cleaning and washing, could be safely disposed into a landfill or burned.
- Generally, recycling of incoming raw materials packaging like steel barrels, plastic barrels, nonce-use pallets, corrugated, paper bags, shrink plastic (PE) and transition to storage of raw materials in tanks. The reuse of these packages is a measure to reduce costs and amounts of waste.

Sludges from water and wastewater treatment

- Effluent treatment processes generate sludge. It can also be hazardous to health by absorbing pathogens that multiply in this favorable medium and toxins. It also contain traces of heavy metals. Raw sludge is saturated with water, should be de-watered and disposed of into landfills.
- Sludge also generated from water treatment unit due to addition of lime and chemicals to water.

5.5 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.
- Use the optimum excess air to perform efficient combustion process
- Install pressure regulators on steam lines.
- Return steam condensate.
- Improvement of power factor and electrical circuits.

6. Industrial Inspection

The inspection of the paints industry will follow the procedures described in the Inspection Guidelines. This chapter presents a summary of the inspection process regarding the purpose and scope of various types of inspection, and the proposed inspection procedure for the paints Industry.

The overall purpose of inspections is to enforce environmental laws. Table (11) lists the various types of inspections and the objectives that have to be fulfilled for each type.

Table (11) The different types of inspections and their objectives

Inspection type	Objectives
Site Inspection	
1. Comprehensive	Evaluate compliance status regarding all aspects of Law 4.
2. Specific	Evaluate compliance status regarding some aspects of Law 4 (usually complaint driven). Review special conditions set by EEAA in EIA studies. Investigate complaints.
3. Follow-up	Check environmental register and implementation of compliance measures.
Inspection campaign	
1. Geographic	Check pollution sources to specific receiving media Check pollution sources from facilities in a specific area.
2. Sector specific	Check aspects relevant to specific sector.

As evident from the above table, comprehensive inspection deals with all aspects of environmental laws and therefore is considered in this manual. Other inspection types can be tailored accordingly.

Developing an inspection strategy and quarterly and/or monthly plans are the responsibility of the inspectorate management. Developing site-specific inspection plans for carrying out the scope of work that fulfills inspection objectives is the responsibility of the inspection team. Planning for inspections is presented in more detail in the General Inspection Manual, GIM (EPAP-2002).

7. Inspection Planning at the Inspectorate Level

The responsibilities of the inspectorate management regarding the specific inspection are to state clearly, in writing, the type of inspection and related objectives as well as the time schedule necessary to carry out inspection. The inspectorate management is also responsible for providing preliminary information about the facility, inspection tools, and logistics.

7.1 Activities Characteristic to the Paints Industry

Taking the comprehensive inspection as an example, the objectives stated in Table (11) dictate the activities required for covering all aspects of compliance with environmental laws and regulations. The required personnel, equipment and logistics are determined accordingly.

Discharge to sea or to surface water of large self-purifying capacity, to canals and agriculture drains is not allowed unless treated to reach the limits set by the law. However, discharge to the public sewer system could be allowed for a surcharge. Large facilities are expected to have most production lines and most service units. These facilities could most probably, sustain pollution abatement measures.

7.2 Providing Information about the Facility

Chapters (2-5) present the technical aspects regarding the paints industry, its pollution sources and relevant environmental laws. Information regarding compliance history related to other inspecting parties (irrigation inspectors, occupational health inspectors, etc.) can be helpful in anticipating potential violations and preparing necessary equipment. Compliance action plans, Environmental Impact Assessment (EIA) studies and IPIS data bases are also important sources of information.

7.3 Providing Resources

The required personnel, tools and equipment depend on the size of the facility to be inspected. The inspection team leaders, in coordination with the inspectorate management, are responsible for assessing the inspection needs. The number of inspectors required depends on the size of the facility and the planned activities. Usually the team members are split and assigned different tasks during the field visit to allow the required activities to be performed in parallel. Each task is rotated among the inspectors to diversify their experience.

Small facilities Small paints facilities will probably produce solvent and water based paints. Most of the service units described in section (2.3) will not be present. The major pollution problem would be the discharge of spent solvents and caustic wash wastewater, generated from the equipment cleaning process, to surface water bodies or the public sewer system. Unless an inspection campaign is planned, only one inspector is required for calculating the amount of this wastewater discharged (amount /equipment * number of equipment * average no. of batches /day), determining type of receiving body, reviewing the licenses, establishing the violation if any, and preparing the legal report.

Medium size facilities These facilities could have a number of production lines or specialize in one or two products with medium production capacity. Inspection of these facilities will be similar to inspection of large facilities using a smaller inspection team depending on the number of production lines and service units.

Large Large facilities will typically have many production lines with

facilities large production capacity. Planning for the comprehensive multi-media inspection will require several inspectors, sampling equipment to provide proper samples for analysis as well as measuring devices. A lab technician will also be needed. The inspectorate management will provide the inspection checklist presented in Annex 1.

8. Preparation for Field Inspection (inspection team)

As presented in the General Inspection manual, GIM (EPAP-2001), tasks necessary for preparation for field inspection, are:

- Gathering information about the specific facility to be inspected
- Preparing of the inspection plan
- Preparing the checklists and other inspection tools.

This manual presents the case of a comprehensive multi-media site-inspection of a large paints facility since it represents the highest level of inspection complexity. Tasks for carrying out less complicated inspections can be easily deduced.

8.1 Gathering and Reviewing Information

The inspection team should review the general information prepared for the paints industry (chapters 2-5) and then check - if possible - what production lines and service units are present at the targeted facility. In addition to the required information listed in Annex (a) of the General Inspection Manual, GIM (EPAP-2002), it is important at this stage to determine the following:

- The type of receiving body for the industrial wastewater and review relevant Egyptian laws (Chapter 4).
- The scope of inspection and related activities based on the type and objectives of inspection required by the inspectorate management.
- The potential pollution hazards as addressed in section 2.4, and accordingly, define measurement and analyses needs.
- The characteristics of the paints industry as presented in section 2.5, and their implications on the inspection process of the targeted facility.

8.2 Preparation of the Inspection Plan

An example of an inspection plan is included in Annex (E) of the General Inspection Manual, GIM (EPAP-2002). The plan should take into account the following:

- For large paints facilities, the inspection team could be divided into smaller groups. Each group will be responsible for inspecting a number of production lines and service units.
- At the beginning of the field visit, the inspection team should check the environmental register for completeness using the checklist provided in Annex (G) of the General Inspection Manual, GIM (EPAP-2001).
- At the end of the field visit, the information included in the environmental register should be checked based on the field visit observations. If not confident with measurements and analyses results, the inspector should make his own.

Notes to inspector:

- *When the final effluent is expected to be in violation of environmental laws, sampling should be planned.*
- *Because of possible shock loads a grab sample at the time of discharge should be performed. If grab samples are taken when no shock load is discharged the results will not reflect the actual pollutants loads.*
- *To prove that a shock load has been discharged, a composite sample over the shift duration should be analyzed. If the results show higher pollutant concentrations than those of the grab sample, then a shock load was discharged.*
- *Make sure that the polluting production lines are in operation since some factory management resort to halting the polluting lines during the inspection.*

8.3 Preparation of the Required Checklists

The checklist for the paints industry is presented in Annex 1 of this manual. The checklist has been prepared in such a way that it starts with general information about the facility and its operation. Separate checklists are then filled for each production line/service unit independently for relevant environmental aspects and media. The inspection team will compile the checklists relevant to existing production lines and service units in the targeted facility.

The development of the checklists goes through the following steps:

- Draw the block flow diagrams for the production lines with their pollution sources as presented in Figures 21 to 27. Similar figures can be developed for other paints production lines that were not covered by this manual.
- Identify the areas of possible non-compliance and the parameters that need checking. For example, noise should be checked near the mixers, mills, and compressors, but temperature and humidity where steam leaks occur.
- Identify what to observe, ask and/or estimate that can convey information about pollutants. For example:
  - the type of solvent, caustic wash solutions, pigments, and other raw materials, determines the contaminant in the wash streams,
  - oily effluents from production lines or oily cooling water indicates the contamination of the plant effluent with oil,

Note to inspector:

*Law 4 does not specify standards for effluent from production lines but only for final disposal points. However, effluent quality from production lines is an important indicator of the final discharge***.**

8.4 Legal Aspects

As evident from chapter 2, a large paints facility is expected to be in violation of several environmental laws, specifically with respect to wastewater if no treatment is performed. The inspection team should be prepared for legally establishing such a violation.

Note to inspector:
It is the responsibility of the inspector to assess the seriousness of the violation upon which the enforcement action will be based. His information about the nature and cause of the violation must be well documented and the evidence sound. The case could be contested in court and the inspector will be asked to defend his technical judgment.

9. Performing the Field Inspection

9.1 Starting the Field Visit

The General Inspection Manual, GIM (EPAP-2002) describes the procedures involved for entering an industrial facility. The inspector's attitude and behavior are very important from the start and will dictate the factory's personnel response to the inspection tasks.

Note to inspector:

- *It is better at this stage not to ask direct questions about the spent solvents and caustic wash wastewater, and chemicals empty containers. Interviewing the workers on-site in an indirect manner can give better results.*
- *Check the results of effluent analyses, time and place of sampling. If suspicious make your own analyses.*
- *The disposal method of the spent solvents and caustic solutions, used for cleaning are important information for determining the type of pollutant in the effluent. In this case a direct question is preferred.*
- *Get a sketch of the factory layout with sewer lines and final disposal points.*

9.2 Proceeding with the Field Visit

Information gathered during the facility tour is dependent on interviews of facility personnel and visual observation. Annex (H) of the General Inspection Manual, GIM (EPAP-2002) presents some useful interviewing techniques.

Using the facility layout, start by checking the final disposal points and the various plants and/or service units connected to each point. This will determine where and how to take the effluent samples. Visual observations about the condition of the sewer manholes should be recorded. In some facilities the discharge to the receiving body is performed through a bayyara (cesspit), septic tanks or holding tanks. If the lining of the holding tank is defective, contamination of the underground water could occur.

Note to inspectors:
Cesspits, septic tanks and holding tanks are a form of pre-treatment that generates settled sludge. Check:

- *The presence of accumulated sludge and related hygienic conditions*
- *The disposal of the sludge*

Inspection of the production lines should start with the feeding of raw materials and end with the product packaging and storage. Referring to Figures 21 to 27, check the following:

Production Lines

Solvent- based production line

- Is there spills and leaks?
  - during handling unpacking of raw materials
  - during mixing and grinding
  - during packing and storage

and how does cleaning occur?

- How does handling of raw materials (pigments and solvents) occur?
- How and when does cleaning of equipment and floors occur? And how does the cleaning-waste disposal occur?
- What type of tanks cleaning solvent is used? Is it recycled or recovered?
- Is there work environment measurements?
  - noise, near mixers and grinding mills.
  - volatile organic compounds VOCs, in the whole work place (see table 11).
  - particulates, during unpacking of raw materials sacks, and near mixers and grinding mills.
- What happens to the refused batches?
- What happens to the sludge generated from the filters?
- Is the machinery (mills) cooling water, closed or open circuit?
- What happens to the chemicals empty containers; cleaned (how) and reused, sold, disposed,… ?
- Is the plant fitted with a ventilation system (suction duct) to ventilate the whole atmosphere? and does it work efficiently?

Water-based production line	• Is there spills and leaks? – during handling unpacking of raw materials – during mixing and grinding – during packing and storage and how does cleaning occur? • How does handling of raw materials (pigments and dyes such as titanium dioxide) occur? • How and when does cleaning of equipment and floors occur? And how does the cleaning-waste (caustic solution) disposal occur? • Is there work environment measurements? – noise, near mixers and grinding mills. – volatile organic compounds VOCs, and ammonia in the whole work place (see table 11). – particulates, during unpacking of raw materials sacks, and near mixers and grinding mills. • What happens to the refused batches? • What happens to the sludge generated from the filters? • Is the machinery (mills) cooling water, closed or open circuit? • What happens to the chemicals empty containers; cleaned (how) and reused, sold, disposed,… ? • Is the plant fitted with a ventilation system (suction duct) to ventilate the whole atmosphere? and does it work efficiently?
Printing inks production line	• Is there spills and leaks? and how does cleaning occur? • How does handling of raw materials (pigments, varnishes, and oils) occur? • How and when does cleaning of equipment and floors occur? And how does the cleaning-waste disposal occur? • What type of tanks cleaning solvent is used? Is it recycled or recovered? • Is there work environment measurements (noise, volatile organic compounds VOCs, particulates? (see table 11) • What happens to the refused batches?

	• What happens to the sludge generated from the filters? • Is the machinery (mills) cooling water, closed or open circuit? • What happens to the chemicals empty containers; cleaned (how) and reused, sold, disposed,… ? Is the plant fitted with a ventilation system (suction duct) to ventilate the whole atmosphere? and does it work efficiently?
Varnishes production line	• Is there spills and leaks? and how does cleaning occur? • How does handling of raw materials (resins, oils, and solvents) occur? • How and when does cleaning of equipment and floors occur? And how does the cleaning-waste disposal occur? • What type of tanks cleaning solvent is used? Is it recycled or recovered? • What type of reactor cleaning chemicals is used? Is it recycled or recovered? • Is there work environment measurements? – noise, near mixers and grinding mills. – volatile organic compounds VOCs, in the whole work place (see table 11). – Heat stress, near the reactor. – particulates, during unpacking of raw materials sacks, and near mixers and grinding mills. • What happens to the refused batches? • What happens to the sludge generated from the filters? • Is the machinery (mills) cooling water, closed or open circuit? • What happens to the chemicals empty containers; cleaned (how) and reused, sold, disposed,… ?

	• Is the plant fitted with a ventilation system (suction duct) to ventilate the whole atmosphere? and does it work efficiently?
Alkyd resin production line	• Is there spills and leaks? and how does cleaning occur? • How does handling of raw materials (oils, and solvents) occur? • How and when does cleaning of equipments and floors occur? And how does the cleaning-waste disposal occur? • What type of tanks cleaning solvent is used? Is it recycled or recovered? • What type of rectors cleaning chemicals are used? Is it recycled or recovered? • What happens to the reaction-water (wastewater contaminated with xylene) ? Is it discharged to sewer, or incinerated, or recycled? • Is there work environment measurements? – noise, near mixers and grinding mills. – volatile organic compounds VOCs, in the whole work place (see table 11). – Heat stress, near the reactor. – particulates, during unpacking of raw materials sacks, and near mixers and grinding mills. • What happens to the refused batches? • Is the machinery and reactors cooling water, closed or open circuit? • What happens to the chemicals empty containers; cleaned (how) and reused, sold, disposed,… ? • What is the disposal method of the sludge generated after the resin filtration step? • Is there a ventilation system and a scrubber equipped with the reactor? Is the effluent from the scrubber discharged to the sewer? • Is the plant fitted with a ventilation system (suction duct) to ventilate the whole atmosphere? and does it work efficiently?

For all lines	• Check for steam leaks (if it used for heating), which affect humidity and temperature in the work environment. • Check for losses during packaging and spill prevention measures. • How is solid waste managed (leaks or spills to floor, and empty containers cleaning)? Is it washed down to the sewer? This housekeeping practice increases the pollution load in the effluents. • Is the sewer system in the plants made of open gutters covered with a grill or closed pipes with drains? Open gutters contribute to the foul smell in the plant and contamination of effluent with solids.

Service Units

Water treatment units	– If chemicals and coagulants are used, such as lime, alum and ferric sulfate, inorganic sludge will be generated. Check the amount and method of disposal. – In case of ion-exchange units and reverse osmosis the effluent wastewater will be high in dissolved solids.
Boilers	– Check the height of the chimney in relation to surrounding buildings. – Perform flue gas analysis if Mazot is used as fuel or if suspicious about results of analysis presented by facility management in the opening meeting. – Check for fuel storage regulations and spill prevention. – Check noise, humidity, and heat stress.
Cooling towers	– The amount of blow-down from the cooling towers is about 10-15% of the make-up water and is low in BOD and high in TDS.
Dow-therm oil heater	– Check the height of the chimney in relation to surrounding buildings. – Perform flue gas analysis if Mazot is used as fuel or if suspicious about results of analysis presented by facility management in the opening meeting. – Check for fuel storage regulations and spill prevention.

	–	Check noise, humidity, and heat stress.
Garage, and Workshops	–	Check for noise and take measurements if necessary.
	–	Check solid waste handling and disposal practices.
	–	Check for spent lube oil disposal method. Ask for receipt if resold.
Storage facilities	–	Check storage of hazardous materials and fuel as per Law.
	–	Check spill prevention and containment measures for storage of liquids.
WWTP	–	Check for sludge accumulation and disposal.
	–	Analyze the treated wastewater.

Effluent analysis

Receiving body	–	The nature of the receiving body determines the applicable laws.
	–	Check if effluent discharge is to public sewer, canals and Nile branches, agricultural drains, sea or main River Nile.
	–	Accordingly, define applicable laws, relevant parameters (BOD, COD, TDS, TSS, S.S, pH, heavy metals and temp.) and their limits.
Sampling	–	A composite sample must be taken from each final disposal point over the duration of the shift or a grab sample at peak discharge. Each sample will be analyzed independently.
	–	According to legal procedures in Egypt, the effluent sample is spilt and one of them is sealed and kept untouched.

9.3 Ending the Field Visit

When violations are detected a legal report is prepared stating information pertaining to sampling location and time. Violations of work environment regulations should also state location and time of measurements. Other visual violations such as solid waste accumulation, hazardous material and waste handling and storage, and material spills should be photographed and documented. It is preferable that facility management signs the field-inspection report but this is not a necessary procedure. A closing meeting with the facility management can be held to discuss findings and observations.

> *Note to inspector:*
> *The less certain the team leader is about a specific violation the more reason not to discuss it at the closing meeting.*

10. Conclusion of the Field Inspection

The activities performed during the site inspection are essential for preparation of the inspection report, for assessing the seriousness of the violations, for pursuing a criminal or civil suit against the facility, for presenting the legal case and making it stand in court without being contested, and for further follow-up of the compliance status of the facility.

10.1 Preparing the Inspection Report

An example of an inspection report is included in Annex (K) of the General Inspection Manual (EPAP, 2002). The inspection report presents the findings, conclusions, recommendations and supporting information in an organized manner. It provides the inspectorate management with the basis for proposing enforcement measures and follow-up activities.

10.2 Supporting the Enforcement Case

Many issues may be raised and disputed in typical enforcement actions. Enforcement officials should always be prepared to:

- Prove that a violation has occurred. The inspector must provide information that can be used as evidence in a court of law.
- Establish that the procedures were fairly followed.
- Demonstrate the environmental and health effect of the violating parameter.

10.3 Following-up Compliance Status of Violating Facility

After performing the comprehensive inspection and detecting the violations the inspectorate management should:

- Decide on the sanctions and send the legal report to the judicial authority.
- Plan routine follow-up inspections. This type of inspection focuses on the violating source and its related pollution abatement measure. Self-monitoring results are reviewed during the visit.
- Follow-up the enforcement case (legal department).

Annex (1)

Inspection Checklist for
Paints Production Facility

Annex (1- A)

Basic Data Sheet

(To be fed to the database of the inspection units)

Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency
Basic Data Sheet

Date of visit:……………………………………. Visit number:………………………….

Facility name:……………………………………

Commercial name:…………………………………………………………………….

Licensed Activity:……………………………... Days off:………………………

Legal status:……………………………………………………………………………

Address of facility

Area of facility:………………………………… Governorate:………………………….

City:…………………………………………… Zone:……………………………….

Phone no. :………………………………… Fax no.:……………………………….

……………………………….. …………………………………….

Year of operation :……………………………….. Postal code:……………………………

The Facility Representative:…………………………………………………………..

Environmental management representative:…………………………………………………….

Chairman/Owner:………………………………………………………………………….

Address of Administration

e-mail:……………………………………………..

Phone no. :………………………………… Fax no.:……………………………….

……………………………….. …………………………………….

The industrial sector:………………………………………………………

No. of male employees: …………………… No. of female employees:…………………

Do they work in production …………………………….

Total no. of employees: ………………………….

Number of shifts/day:…………..…………shifts/ day

Duration of shift:………………….….…hrs/ shift

Environmental register:………………………….. Hazardous waste register:…………….

EIA:…………………………………………….. Self monitoring:……………………….

Nature of Surrounding Environment

Industrial ❑ Coastal ❑ Coastal/ Residential ❑

Industrial/ Residential ❑ Residential ❑ Agricultural ❑

Agricultural/ Industrial ❑ Agricultural/ Residential ❑ Desert ❑

Power Consumption

Electricity ❑ Fuel ❑

Electric power: ……………...kWh/(day-month-year)

Type of fuel	Fuel consumption	
Mazot	………………………	Ton/(day-month-year)
Solar	………………………	Ton/(day-month-year)
Natural gas	………………………	Ton/(day-month-year)
Butagas	………………………	Ton/(day-month-year)
Other ….	………………………	Ton/(day-month-year)

The GPS (Global Positioning System) reading for Gaseous Emissions

1- LAT(Latitude):..……. LONG(Longitude):…….
2- LAT(Latitude):……… LONG(Longitude):…….
3- LAT(Latitude):……… LONG(Longitude):…….

Production

Product	Quantity/ (day-month-year)
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
………………………………………………	………………………………………………
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………………………………………………	………………………………………………

Water Supply

Artesian well ❑ Municipal water ❑ Treated water ❑ Nile water ❑

Canal water ❑ Other………….. ❑

Water Consumption

Amount of water consumed in operation (day-month-year):

Process ……..m^3/ Boilers…………………..m^3/

Domestic usage………....m^3/ Cooling………………....m^3/

Other…….. …………….m^3 /

Total amount of water consumed (day-month-year)……… …………..m^3/

Type of waste water:
Industrial ❑ Domestic ❑ Mixed ❑

Wastewater Treatment:
Treated ❑ Untreated ❑

Type of Treatment:
Septic tanks ❑ pH adjustment ❑ Biological treatment ❑
Chemical treatment ❑ Tertiary treatment ❑

Amount of treated water/ (day-month-year)……………..m^3 /
Amount of waste water/ (day-month-year)……………………….m^3 /

Final wastewater receiving body:
Nile ❑ Lakes (fresh water) ❑ Drain ❑
Groundwater ❑ Public sewer system ❑ Canals❑
Agricultural Land ❑ Desert Land ❑ Other………………………❑

The Global Positioning System(GPS) reading for final disposal
1-LAT(Latitude):……. LONG(Longitude):…….
2-LAT(Latitude):……. LONG(Longitude):…….

Engineering Drawings for the Facility
Gaseous emissions map Yes ❑ No ❑

Sewer map: Domestic ❑
Industrial ❑
Mixed ❑
Factory Layout ❑
Production process flow diagram ❑

Raw material consumption

No.	Trade name	Scientific name	CAS no.	UN no.	Physical state	Type of container	Amount	Classification	
								Hazardous	Non-Hazardous

Inspection Team Member:

Team member	**Position**

Date:

Inspector signature:

Annex (1- B)

Inspection Checklist for Hazardous Materials and Wastes

Annex (F-2)
Inspection checklists for hazardous materials and wastes for a facility

1. Hazardous materials (to be filled in case the facility uses hazardous materials) [1]

Fill the following table according to the codes below

Hazardous material	Amount	Field of utilization	Storage method[2]	Method of disposal of the containers	Conformity of containers to specifications[3]	Presence of MSDS[4]

[1] To be filled from the list of used raw material and chemicals according to the hazardous material list issued by the Ministry of Industry, checking the presence of a valid license for handling

[2] According to law 4/1994, does the storage area have:
S_1: alarm, precaution and fire fighting system? S_2: first aid procedures?

[3] Check containers' compliance with law4/1994:
C_1: sealed and don't cause any threats while handling
C_2: unaffected with along storing period
C_3: labeled with hazard and toxicity signs
C_4: labeled in Arabic (production, origin, utilization instruction)
C_5: labeled with its content, the effective substance and its concentration

[4] Material safety data sheet

2. Hazardous wastes (to be filled in case the facility generates hazardous wastes)[1]

Fill the following table according to the codes below										
Hazardous waste	Source	Amount generated/ year	Storing method			On-site treatment and disposal			Transportation method	Presence of documents indicating off-site disposal[6]
			Method of storage inside the facility	Compliance of containers' specifications and labels with law 4/1994[2]	Compliance of storage areas with law 4/1994[3]	Treatment[4]	Final disposal[5]	Compliance of treatment and disposal with law 4/1994		

[1] Hazardous wastes can be identified according to law 4/1994 and by using the hazardous wastes list of the Ministerial decree no.65 for 2002 as refrence

Is there a hazardous wastes register? Yes ❑ No ❑

[2] Does the facility take into consideration that the storage containers should be:
C_1: with sealed covers to protect the container from rain water and dust and to prevent any wastes leakage during storage and/or transportation
C_2: constructed or lined by impermeable material which doesn't react with the contained material
C_3: of suitable capacity C_4: labeled

[3 Specification of storage area: determining specified locations for storage of hazardous wastes where safety conditions are set up to prevent the occurrence of any harm to the public or to those persons exposed to the wastes

[4] Which of the following methods are used by the facility for the treatment of hazardous wastes?
N_1: biodegradation N_2: incineration N_3: physical or chemical treatment

[5] Which of the following methods are used by the facility for the hazardous wastes final disposal?
F_1: land filling in specially engineered landfill F_3: other (specify)……………….

[6] Contracts with wastes' contractors and receipts.

Annex (1- C)

Inspection Checklist for Production Lines and Service Units

Checklist for Water-based Paints Production Line

1. General	
1.1 The housekeeping status Floor condition Wash water/ solvents leaks Raw materials/ products spills Accumulation of solid waste (chemicals empty containers, filter sludge, spent filter bags, ...)	 -- -- -- -- --
1.1 Make sure that the operation line is operated	--
1.3 Type of operation	Batch ❑ Continuous ❑
2. Status of Ambient Air	
2.1 Check if there are dust collectors (or bag filters), or other end of pipe control techniques for total particulates emissions?	-- --
2.2 Check the total particulates emissions measurements from the stack of the dust collector (or bag filter)? Is it attached to the environmental register?	-- -- --
Note : If suspicious, take your own measurements.	
3. Status of the Work Environment	
3.1 Is there noise in the workplace?	❑ Yes ❑ No
3.2 Check for VOCs and ammonia emissions from mixing and grinding steps	-- --
3.3 Check for particulates emissions from sacks unpacking, and mixing steps	-- --
3.4 Is the unit fitted with a ventilation system? And does it operate efficiently?	-- --
Note : If suspicious, measure noise/ VOCs/ Particulates	
4. Status of Effluents (Wastewater)	
4.1 Is raw materials (pigments, fillers,…) dust settling on the floor, washed to the sewer ?	❑ Yes ❑ No
4.2 When during the shift is equipment & floor washing performed?	-- --
4.3 What is the amount of wash water of equipment and floor? are there any chemicals used for washing (caustic soda, sodium hypochloride,…)	-- -- -- --
4.4What is the disposal method of the cleaning wastewater?	-- --
4.5 Is the cooling water circuit of mills open or closed?	❑ Open ❑ Closed
5. Status of Solid Wastes	
5.1 What happens to the refused batches?	--
5.2 What happens to the empty containers of chemicals and paints?	-- --
5.3 What happens to the filter sludge?	-- --
5.4 What happens to the spent filter bags?	-- --
5.5 Is the related documents attached to the environmental register?	-- --

Checklist for Solvent-based Paints Production Line

1. General	
1.2 The housekeeping status Floor condition Wash water/ solvents leaks Raw materials/ products spills Accumulation of solid waste (filter sludge, filter bags,...)	 -- -- -- -- --
1.2 Make sure that the operation line is operated	--
1.3 Type of operation	Batch ❑ Continuous ❑
2. Status of Ambient Air	
2.1 Check if there are dust collectors (or bag filters), or other end of pipe control techniques for total particulates emissions?	-- --
2.2 Check the total particulates emissions measurements from the stack of the dust collector (or bag filter)? Is it attached to the environmental register?	-- -- --
Note : If suspicious, take your own measurements.	
3. Status of the Work Environment	
3.1 Is there noise in the workplace?	❑ Yes ❑ No
3.2 Check for VOCs emissions from mixing and grinding steps	-------------------------------------- --------------------------------------
3.3 Check for particulates emissions from sacks unpacking, and mixing steps	-------------------------------------- --------------------------------------
3.4 Is the unit fitted with a ventilation system? Does it operate efficiently?	❑ Yes ❑ No ❑ Yes ❑ No
***Note** : If suspicious, measure noise/ VOCs/ Particulates*	
4. Status of Effluents (Wastewater)	
4.1 Are raw materials (pigments, fillers…etc.) dust settling on the floor, washed to sewer?	❑ Yes ❑ No
4.2 When during the shift is equipment & floor washing performed?	-- --
4.3 What is the amount of solvent, used for equipment and floor washing?	-- --
4.4 What happens to the spent cleaning solvent?	--
4.5 Is the cooling water circuit of the mills open or closed?	❑ Open ❑ Closed
5. Status of Solid Wastes	
5.1 What happens to the refused batches?	-- --
5.2 What happens to the empty containers of chemicals and paints?	-- --
5.3 What happens to the filter sludge?	-- --
5.4 What happens to the spent filter bags?	-- --
5.5 Is the related documents attached to the environmental register?	-- --

Checklist for Printing Inks Production Line

1. General	
1.1 The housekeeping status Floor condition Wash water/ solvents leaks Raw materials/ products spills Accumulation of solid waste (filter sludge, filter bags,...)	 -- -- -- -- --
1.2 Make sure that the operation line is operated	--
1.3 Type of operation	Batch ❑ Continuous ❑
2. Status of Ambient Air	
2.1 Check if there are dust collectors (or bag filters), or other end of pipe control techniques for total particulates emissions?	-- --
2.2 Check the total particulates emissions measurements from the stack of the dust collector (or bag filter)? Is it attached to the environmental register?	-- -- --
Note : If suspicious, take your own measurements.	
3. Status of the Work Environment	
3.1 Is there noise in the workplace?	❑ Yes ❑ No
3.2 Check for VOCs emissions from mixing and grinding steps	-- --
3.3 Check for particulates emissions from sacks unpacking, and mixing steps	-- --
3.4 Is the unit fitted with a ventilation system? And does it operate efficiently?	❑ Yes ❑ No ❑ Yes ❑ No
Note : If suspicious, measure noise/ VOCs/ Particulates	
4. Status of Effluents (Wastewater)	
4.1 Are raw materials (pigments, fillers…etc.) dust settling on the floor, washed to the sewer?	❑ Yes ❑ No
4.2 When during the shift is equipment & floor washing performed?	-- --
4.3 What is the amount of solvent used for equipment and floor washing?	-- --
4.4 What happens to the spent cleaning solvent?	❑ recycled ❑ Not recycled
4.5 Is mills cooling water open or closed circuit?	❑ Open ❑ Closed
5. Status of Solid Waste	
5.1 What happens to the refused batches?	---------------------------------------
5.2 What happens to the empty containers of chemicals and inks?	--------------------------------------- ---------------------------------------
5.3 What happens to the filter sludge?	-------------------------------------
5.4 What happens to the used filter bags?	-------------------------------------
5.5 Is the related documents attached to the environmental register?	-- --

Checklist for Varnishes Production Line

1. General	
1.1 The housekeeping status Floor condition Wash water/ solvents leaks Raw materials/ products spills Accumulation of solid waste (filter sludge, filter bags,...)	 -- -- -- -- --
1.2 Make sure that the operation line is operat	--
1.3 Type of operation	Batch ❑ Continuous ❑
2. Status of Ambient Air	
2.1 Check if there are dust collectors (or bag filters), or other end of pipe control techniques for total particulates emissions?	-- --
2.2 Check the total particulates emissions measurements from the stack of the dust collector (or bag filter)? Is it attached to the environmental register?	-- -- --
Note : If suspicious, take your own measurements.	
3. Status of the Work Environment	
3.1 Are there noise in the workplace?	❑ Yes ❑ No
3.2 Check for VOCs emissions- check the odor	--
3.3 Check for particulates emissions from sacks unpacking during reactor feeding?	-- --
3.4 Check the heat stress & humidity near the reactor	-- --
3.5 Is the unit fitted with a ventilation system? Does it operate efficiently?	❑ Yes ❑ No ❑ Yes ❑ No
***Note** : If suspicious, measure noise/ VOCs/ Particulates*	
4. Status of Effluents (Wastewater)	
4.1 Are raw materials spills or leakages on the floor, washed to the sewer?	❑ Yes ❑ No
4.2 When during the shift is equipment & floor washing performed?	-- --
4.3 What is the amount of wash water, used for equipment and floor washing? Are there any chemicals used for washing (caustic soda, sodium hypochloride,…etc.)	-- -- -------------------------------------- -------------------------------------- --------------------------------------
4.4 What is the disposal method of the cleaning wastewater?	-- --
4.5 Is mills cooling water open or closed circuit?	❑ Open ❑ Closed
5. Status of Solid Waste	
5.1 What happens to the refused batches?	-- --
5.2 What happens to the empty containers of chemicals and varnishes?	-- --
5.3 What happens to the filter sludge?	-- --
5.4 What happens to the spent filter bags?	-- --
5.5 Is the related documents attached to the environmental register?	-- --

Checklist for Alkyd Resin Production Line

1. General	
1.1 The housekeeping status: Floor condition Wash water/ solvents leaks Raw materials/ products spills Accumulation of solid waste (filter sludge, filter bags,...)	 -- -- -- -- --
1.2 Make sure that the operation line is operat	---
1.3 Type of operation	Batch ❑ Continuous ❑
2. Status of Ambient Air	
2.1 Check the type of fuel used in the furnace	---------------------------------------
2.2 Check the analysis readings of flue gases from the furnace stack	---------------------------------------
2.3 What is the height of the stack	
Note : *the height of the stack must be 2.5 times the height of adjacent buildings.* *in case of suspicious perform your own measurements.*	
3. Status of the Work Environment	
2.1 Is there noise in the workplace?	❑ Yes ❑ No
2.2 Check for VOCs emissions- check the odor.	-- --
2.3 Check for particulates emissions from sacks unpacking, during reactor feeding.	-- --
2.4 Check the heat stress near the reactor.	-- --
2.5 Is the unit fitted with a ventilation system? Does it operate efficiently?	❑ Yes ❑ No ❑ Yes ❑ No
Note *: If suspicious, measure noise/ VOCs/ Particulate*	
3. Status of Effluents (Wastewater)	
3.1 Are raw materials spills or leakages on the floor, washed to the sewer?	--------------------------------------- ---------------------------------------
3.2 When during the shift is equipment & floor washing performed?	-- --
3.3 What is the amount of wash water, used for equipment and floor washing? Are there any chemicals used for washing (caustic soda, sodium hypochloride,…).	-- -- ❑ Yes ❑ No ---
3.4 what is the disposal method of the wash water?	--- ---
3.4 What happens to the wastewater containing xylene generated from the reaction?	❑ Discharged to sewer ❑ Incinerated
3.5 Is mills cooling water open or closed circuit?	❑ Open ❑ Closed
4. Status of Solid Waste	
4.1 What happens to the refused batches?	-- --
4.2 What happens to the empty containers of chemicals and resins?	-- --
4.3 What happens to the filter sludge?	-- --
4.4 What happens to the spent filter bags?	-- --
4.5 Is the related documents attached to the environmental register?	-- --

Checklist for Boilers and Water Treatment Units

1. General	
1.1 Number of boilers and capacity	--- ---
1.2 What is the method used for water treatment?	❑ Lime ❑ Ion exchange ❑ Reverse osmosis
2. Status of Air Pollution	
2.1 What is the height of the stack of each boiler	Boiler (--)--------------------------- Boiler (--)--------------------------- Boiler (--)---------------------------
***Note**: the height of the stack must be 2.5 times the height of adjacent buildings.*	
2.2 Type of fuel used for boilers	❑ Mazout ❑ Solar ❑ Natural gas ❑ Other…….
2.3 In case of using mazot for boilers, is the surrounding area residential?	❑ Yes ❑ No
***Note**: The use of mazot as fuel in the residential area is Prohibited by law.*	
2.4 If mazot is used in non residential area, are there analysis of the flue gases for sulfur dioxide, carbon monoxide, and particulate matter	❑ Yes ❑ No
2.5 If Yes Check the compliance of the analysis readings in the register with your observations	-- -- --
***Note** : Whatever the fuel used ,if you notice any smoke, take a sample for analysis*	
3. Status of Work Environment	
3.1 Check the heat stress next to the boilers	---
3.2 Check the noise next to the boilers and duration of exposure	-- ---
3.3 Are they included in the environmental register?	❑ Yes ❑ No
***Note** : In case of suspicious perform your own measurements*	
4. Status of Effluent (Wastewater)	
4.1 What is the blow down rate from the boilers?	--- m^3/d
4.2 What are the blow down and back wash rates for the treatment units?	--- m^3/d --- m^3/d
4.3 Steam condensate is	❑ Recycled to the boilers ❑ Discharged to sewer
5. Status of Solid Waste	
5.1 If lime method is used, sludge is generated, what is the amount of sludge produced per day?	--- ---
5.2 What is the sludge disposal method?	---
6. Status of Hazardous Material	
6.1 Check the storage method of chemicals used in the treatment process. Is it in compliance with law 4?	--- --- ❑ Yes ❑ No
6.2 Is there any fuel leaks from fuel tanks	❑ Yes ❑ No
6.3 Is there any fire extinguishing devices and fire fighting measures?	❑ Yes ❑ No
6.4 Is there a spill prevention plan?	❑ Yes ❑ No
6.5 Do you notice anything that can provoke a fire? Such as the presence of a pump underneath the fuel tank (the start-up of the engine can produce a spark)	**❑ Yes ❑ No** **Comment** -- --

Checklist for Cooling Towers

1.General	
1.1 Number and capacity of cooling towers	-- -- --
1.2 Sources of cooling water: • Compressors • Rollers • Mills • Mixers • Resin reactor	 ❑ Open Cycle ❑ Closed Cycle ❑ Open Cycle ❑ Closed Cycle ❑ Open Cycle ❑ Closed Cycle ❑ Open Cycle ❑ Closed Cycle ❑ Open Cycle ❑ Closed Cycle
1.3 Cooling tower make-up rate Note : Blow-down = 10-15% of make-up	Rate -- Blow-down --
1.4 Are biocides, antifouling agents, and slimicides added to the water? And is the blow-down treated before discharge?	-- -- --

Inspection Checklist for Wastewater Treatment Plant

1. General	
1.1 What is the capacity of WWTP?	--
1.2 Specify the units included in WWTP : Pumping station Equalization tank Aeration tank Sedimentation tank Sludge thickening tank Sludge drying Others	 ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found --
1.3 List any chemical and its quantity used for wastewater treatment (coagulants,…..)	-- --
2. Status of Effluent	
2.1 Are there analysis readings for the effluent? If not make your own	❑ Yes ❑ No
2.2 Are the analysis readings included in the environmental register?	❑ Yes ❑ No
3. Status of Solid Wastes	
3.1 Determine the sludge disposal	--
Note : *Sludge can be use in liquid or dry form in agricultural purposes,according to the Ministrial decree 214/97 issued by the Ministry of Housing*	
3.2 If a third party is involved in disposal, check the presence of contracts and receipts	❑ Found ❑ Not found Comment -- --

Checklist for Garage

1. General	
1.1 Is there any detergent or solvent used for washing equipment parts, trucks, floor,….etc	☐ Yes ☐ No
1.2 What is the amount of oil and grease used per day?	--
1.3 What is the amount of spent lube oil produced per day ?	--
1.4 How does the facility dispose of the spent oil?	--
2. Status of the Effluent	
2.1 What is the amount of wastewater produced ?	--
2.2 Do you observe any oil / foams / solid matter in the inspection manhole ?	☐ Yes ☐ No

Checklist for Workshops

1. Status for the Effluent	
1.1 What is the amount of wastewater produced ?	--
1.2 What is your visual observation for the inspection manhole of the workshop ?	--
2. Status of solid waste	
2.1 What is the amount of solid waste produced	--
2.2 How does the facility get rid of the solid waste produced ?	--
3. Status Of the Work Environment	
3.1 Are there any noise in work place If yes 3.2 Are there any measurements for noise 3.3 Check the exposure time If not Perform measurements	☐ Yes ☐ No ☐ Yes ☐ No ☐ Yes ☐ No --

Checklist for Storagee area

Are there preventive basins around the storage tanks?	☐ Yes ☐ No
Are the covers (paving) of the outdoor storage (raw materials, products, and wastes) water proof?	☐ Yes ☐ No
Is the drainage from storage areas equiped with possibility of closing it?	☐ Yes ☐ No

Check list for L abooratories

1. General	
1.1 What is the amount of wastewater produced per day?	---
1.2 List the chemicals and materials used in the laboratories	--- --- ---
2. Status of the work Environment	
2.1 Are there any odor/ gases/noise in the work environment? 2.2 Check the exposure time	☐ Yes ☐ No ---
3. Handling of Hazardous Materials and Wastes	
3.1 Inspect storage of hazardous material. Is it in compliance with the requirements of law 4?	☐ Yes ☐ No
3.2 Are there any first aid measures in place?	☐ Yes ☐ No
3.3 How are the spent chemicals and empty containers disposed of?	---

Checklist for Solvent Recovery Unit

1. General	
1.1 What is the amount of spent solvent generated per day ?	---
1.2 What is the amount of recovered solvent per day ?	---
2. Status of hazardous solid waste	
2.1 What is the amount of hazardous solid waste (sludge) produced?	---
2.2 How does the facility get rid of the solid waste produced ?	---
2.3 If a third party is involved in the disposal, get documents for proof	☐ Found ☐ Not found
2.4 Is there any analysis results for this hazardous waste (heavy metals, VOCs,….)?	---
2.5 Inspect storage of hazardous waste (sludge). Is it in compliance with the requirements of law 4.	☐ Yes ☐ No
3. Status Of the Work Environment	
3.1 Check for VOCs (solvents) emissions?	-- --
3.2 Is the unit fitted with a ventilation system? And does it operates efficiently?	-- --
Note : If suspicious, measure VOCs.	

Inspection Checklist for Wastewater Treatment Plant

1. General	
1.1 What is the capacity of WWTP?	--
1.2 Specify the units included in WWTP : Pumping station Equalization tank Aeration tank Sedimentation tank Sludge thickening tank Sludge drying Others	 ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found ❑ Found ❑ Not found --
1.3 List any chemical and its quantity used for wastewater treatment (coagulants,…..)	-- --
2. Status of Effluent	
2.1 Are there analysis readings for the effluent? If not make your own	❑ Yes ❑ No
2.2 Are the analysis readings included in the environmental register?	❑ Yes ❑ No
3. Status of Solid Wastes	
3.1 Determine the sludge disposal	--
Note : *Sludge can be use in liquid or dry form in agricultural purposes,according to the Ministrial decree 214/97 issued by the Ministry of Housing*	
3.2 If a third party is involved in disposal, check the presence of contracts and receipts	❑ Found ❑ Not found Comment -- --