Ministry of State for Environmental Affairs
Egyptian Environmental Affairs Agency (EEAA)

Inspection Manual
Motor Vehicles Industry

2002

Table of Contents

1. Introduction

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

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

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

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

1.1 Preface

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

- Food Industry with specific reference to the five sub-sectors of Dairy products, Vegetables and Fruit processing, Grain Milling, Carbonated Beverages and Confectionery.
- Pulp and Paper Industry
- Metallurgical Industry with specific reference to the two sub-sectors of Iron and Steel and Aluminum.
- Engineering Industry including the fabricated metal products and the motor vehicle assembly sub-sectors.
- Textile Industry.

1.1.1 Project objectives

The Egyptian Environmental Affairs Agency – EEAA is striving to create an environmental management and policy culture within the local administration. Under this overall objective, the Technical and Institutional Support Component of the Egyptian Pollution Abatement Project – EPAP, funded by the governments of Finland and Egypt, is working out to initiate inspection and self monitoring manuals for specific industrial sectors and sub-sectors to be used by inspectors and plant personnel respectively. These manuals are meant to be simplified but without abstention of any information necessary to the targeted users. Flowcharts, tables and highlighted notes are used for easy representation of information.

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

1.1.2 Organization of the inspection manual

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

The description of the industry in chapter two includes the inputs to each operation, a description of the different production processes with their specific inputs and 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 industry. Chapter five gives examples of pollution abatement techniques and measures applicable to the motor vehicle assemby industry.

The inspection procedures are described in chapters six to ten starting with a brief description of the inspection process in chapter six. The planning aspects that should be considered at the inspectorate level are explained in chapter seven. The different tasks at the inspectors level specific to the motor vehicle assemby industry, are described in chapters eight to eleven. The tasks before field inspection are presented in chapter eight whereas the general inspection tasks for actually performing the field visit are defined in chapter nine. Chapter ten 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.

1.2 Introduction to the motor vehicle assembly industry

The establishments considered are engaged primarily in the manufacture and assembly of equipment for the transportation of passengers and cargo by land. Due to the broad scope of the subject the focus will be on the motor vehicles and vehicle equipment industry also known as the automotive industry.
The following automotive products are not covered in this manual: diesel engines, tires, automobile stampings, vehicle lighting equipment, carburetors, pistons and ignition systems.
The diverse nature of parts required to produce a car requires the support of many industries such as primarily the fabricated metal products industry.

1.2.1 Product characterization

The motor vehicles and motor vehicle equipment industry produces a wide range of diverse products from ambulances and automobiles to the cylinder heads, ball joints, and horns that go into these vehicles.
The motor vehicles and motor vehicle equipment industry is organized into four primary areas bas4ed on the types of products. These are:

- Passenger cars and light trucks
- Medium and heavy duty trucks
- Truck trailers
- Automotive parts and accessories.

The automotive parts industry is further broken down into two sectors, original equipment suppliers that provide parts directly to automakers and aftermarket suppliers that provide exclusively replacement parts.

1.2.2 Egyptian particularities

Fifty years ago, Egypt was making an Egyptian car, Ramses, whose production was protected by imposing customs and duties on imported cars and car parts. Later, an agreement was made with Fiat Consortium (Italy) to produce a Fiat car in Egypt starting with the production of a certain percentage of the car and increasing that percentage according to a specified time table to reach almost 60% of the parts. The rest being imported for assembly. Unfortunately the schedule was not respected.
El Nasr Automotive Company established in 1960, produces buses and trucks. Presently the annual production is about 1000 buses, 1100 trucks, 12000 passenger cars and 1000 agricultural tractors. Ghabbour Company specializes in the fabrication of bus frames of any size.
There are a number of foreign cars being assembled in Egypt, namely Opel, Fiat, Cherokee, Mercedes, BMW….with varying percentages of the car parts being produced locally.

Let us take two examples from the very few pollution data available:
In a large fabricated metal products factory specializing in bus parts production:
The total particulate concentration at the head level of workers exceeds the upper limit allowed by law No 4-1994 (which is 5 mg/m3), in the primer spray area (14 mg/m3), in the painting spray area (16 mg/m3), in the fiber glass machining area (35 mg/m3) and in the wood cutting area (9 mg/m3).
The CO concentration in the welding and cutting areas (75 ppm), the Xylene

concentration in the primer dipping area (115 ppm) exceeds the upper limit allowed by law 4-1994 for full day exposure (50 ppm and 100 ppm respectively).

In a large motor vehicle factory:
The wastewater pollution levels in mg/l, are given in table (1).

Table (1) Pollutants Concentration in Wastewater from A Motor Vehicle Plant

Pollution Parameters	Concentration, mg/ l
COD	1677 (<1100)
O&G	188 (<100)
Cyanide	57.7 (<0.1)
Zinc	22.5 (<10)
TSS	3044 (<800)
Phosphates	18 (30)
Iron	10.4 (1)

Limits set by law for discharge to sewer are given between brackets.

2. Description of the Industry

This section describes the major industrial processes within the Motor Vehicles and Motor Vehicle Equipment industry, including the materials and equipment used, and the processes employed. The aim is to gain a general understanding of the industry, and in the inter-relationship between the industrial process and the topics described in subsequent sections of this profile: pollutant outputs, pollution prevention opportunities, and Egyptian regulations.

In fact the section specifically contains a description of commonly used production processes, associated raw materials, the byproducts produced or released, and the materials either recycled or transferred off-site. This discussion, coupled with schematic drawings of the identified processes, provide a concise description of where wastes may be produced in the process. This section also describes the potential fate (air, water, land) of these waste products.

The main source of this chapter is the excellent notebook delivered by [3]. Also we must not forget that the motor vehicle sub-sector has many in common with the fabricated metal products one. Consequently the reader will certainly benefit consulting the inspection manual of the fabricated metal products sub-sector of the engineering industry [4].

2.1 Raw materials, products and utilities

Motor vehicle parts and accessories include both finished and semi-finished components. Approximately 8,000 to 10,000 different parts are ultimately assembled into approximately 100 major motor vehicle components, including suspension systems, transmissions, and radiators. These parts are eventually transported to an automotive manufacturing plant for assembly.

Material selection plays a vital role in the production process. Materials are ultimately selected based on factors such as performance (strength vs. durability, surface finish, and corrosion resistance), cost, component manufacturing, consumer preference and competitive responses. In the past, automobiles have been composed primarily of iron and steel. Steel has remained a major component because of its structural integrity and ability to maintain dimensional geometry throughout the manufacturing process

According to Automotive industries (AAMA Motor Vehicle Facts and Figures '94), in the average composition of a car, in 1994,there was:

70.2% ferrous metals (sheetmetal, forged steel parts, cast iron…)

8.7% non-ferrous metals (aluminum, copper, lead, zinc)

21.1% non-metals (plastic 38%, rubber 21%, fluid 12%, glass 14%,..)

In response to increasing demands for more fuel efficient cars, the past fifteen years have seen changes in the composition of materials used in automobiles. Iron and steel use has steadily decreased, while plastics and aluminum has steadily increased. Aluminum and plastics are valuable car components not only for their lighter weight, but also because of their inherent corrosion resistance. Although the use of plastics in the automotive industry is increasing, expansion in this area is finite because of limitations in current plastic materials.

The manufacturing processes used to produce the thousands of discrete parts and accessories vary depending on the end product and materials used. Different processes are employed for the production of metal components versus the production of plastic components. Most processes, however, typically include casting, forging, molding, extrusion, stamping, and welding.

Table (2) presents the primary materials used for producing each major part and the production process involved.

Table (2) Materials and processes used in the production of various auto parts

Auto part	Primary Material	Process
Engine		
Block	Iron, Aluminum	Casting
Cylinder head	Iron, Aluminum	Casting, machining
Intake manifold	Plastic, Aluminum	Casting, molding, machining
Connecting rods	Powder metal, steel	Molding, forging machining
Pistons	Aluminum	Forging machining
Camshaft	Iron, Steel, Powder metal	Molding, forging machining
Valves	Steel, magnesium	Stamping, machining
Exhaust systems	Iron, Aluminum, stainless steel	Extruding, stamping
Transaxle		
Transmission case	Aluminum, magnesium	Casting, machining
Gear Sets	Steel	Blanking, machining
Torque converter	Magnesium, steel	Stamping, casting
CV joint assemblies	Steel, rubber	Casting, forging, extruding, stamping
Body Structure		
Body panels	Steel, plastic, aluminum	Stamping, molding
Bumper assemblies	Steel, plastic, aluminum	Stamping, molding
Chassis/Suspension		
Steering gear/column	Steel, magnesium, aluminum	Casting, stamping, forging, machining
Rear axle assembly	Steel, plastic	Stamping, molding
Front suspension	Steel, aluminum	Stamping, forging
Wheels	Steel, aluminum	Stamping, forging
Brakes	Steel, friction material	Stamping, forging
Seats/ Trims		
Seats	Steel, fabric, foam	Stamping, molding
Instrument panel	Steel, fabric, foam	Stamping, molding
Headliner/carpeting	Synthetic fiber	Molding
Exterior trim	Plastic, aluminum, Zinc die casting	Stamping, molding, casting
HVAC system		
AC compressor	Steel, aluminum, plastic	Stamping, molding, casting
Radiator/Heater core	Copper, aluminum, plastic	Extruding, molding
Engine fan	Steel, plastic	Stamping, molding

In the foundry the main raw materials used are silica sand and clay for mold production. Binders such as resins, phenols and formaldehyde are used Additives such as organic materials are added to the mold materials whereas

calcium carbide and magnesium could be added to the molten metal.
In the ***metal workshop*** the input materials depend on the operation performed. Table (3) presents the material inputs to each operation in metal shaping, surface preparation and metal finishing processes. For more details see the fabricated metal products inspection manual.

Table (3) Material inputs to each operation in metal fabrication

Process	Material inputs
Metal shaping	
Metal cutting/ forming	Cutting oils (ethylene glycol), degreasing and cleaning solvents (trichloro-ethane, methyl-ethyl-ketone, acetone ..), alkalis and acids.
Surface preparation	
Solvent degreasing Emulsion degreasing Alkaline/acid cleaning	Solvents Organic solvents dispersed in water (kerosene, mineral oil, glycol) Alkali hydroxides, acids, oranic and inorganic additives, surfactants
Surface finishing	
Anodizing	Acids (chromic acid, sulfuric acid and boric-sulfuric mixture), sealants (chromic acid, nickel acetate, nickel-cobalt acetate)
Chemical conversion coating	Solutions of hexavalent chromium, phosphate salts, phosphoric acid, nitric acid and sodium dichromate.
Electroplating	Acid/ alkaline solutions, heavy-metals bearing solutions, cyanide bearing solutions.
Plating	Metal salts, complexing agents, alkalis
Painting	Solvents and paints
Other techniques	Metal salts and acids

Metal workshops also use solvents (e.g. trichloroethane, methyl ethyl ketone) for degreasing. Acids and alkalis are also used for cleaning the metal surface. The current trend in the industry is to use aqueous non-VOCs to clean the metal, whenever possible. The use of 1,1,1, trichloroethane and methyl ethyl ketone is declining.

In the paint plant zinc phosphate and chromic acid are used for surface preparation. Organic solvents are also added in small amounts to the primer bath. Polyvinyl chloride is used as a sealant to ensure waterproofing. Surface coating consists of pigments, polyester or epoxy ester resins and solvents. The chemical composition of the pigment varies according to its color as illustrated in table (4).

Table (4) Chemical components of pigments found in paint

Pigment Color	Chemical Compounds
White	Titanium dioxide, white lead, zinc oxide
Red	Iron oxides, calcium sulfate, cadmium, selenide
Orange	Lead chromate-molybdate
Brown	Iron oxides
Yellow	Iron oxides, lead chromate, calcium, sulfide
Green	Chromium oxide, copper, phosphotungstic acid, phosphomolybdic acid
Blue	Ferric ferrocyanide, copper
Purple	Manganese phosphate
Black	Black iron oxide
Metallic	Aluminum, bronze, copper, lead, nickel, stainless steel, silver, powdered zinc

Steam is generated in boilers that use either mazot (fuel oil), solar (gas oil) or natural gas as fuel. Steam is used for providing heat requirements and in some plants for electric power generations.
Water is used for cleaning equipment and floor washing, as boiler feed water, as cooling water and for domestic purposes. Boiler grade water is pretreated in softeners to prevent scale formation.
Water sources may be supplied from public water lines, wells or canal water. The type of water will dictate the type of pretreatment.

Note: Defining the Inputs and outputs helps predict the expected pollutants.

2.2 Production processes

Numerous processes are employed to manufacture motor vehicles and motor vehicle equipment. This section will focus on the significant production processes including those used in the foundry, metal fabrication plant, assembly line, and paint shop. The following presents the various productions processes and service units that could be present in a facility.

Production processes	Service Units
Foundry Metal fabrication plant Assembly line Paint plant Post production motor vehicle dismantling	Boilers Cooling towers Softeners Laboratory Electrical workshops Garage Storage facilities. Wastewater Treatment Plant Restaurant and Housing complex

Note: Knowledge of the different steps involved in each production process allows the prediction of pollution hazards and expected violations and helps determine possibilities for implementing cleaner technology.

2.2.1 Foundry operations

Foundries, whether they are integrated with automotive assembly facilities or independent shops, cast metal products, which play a key role in the production of motor vehicles and motor vehicle equipment.

The main steps in producing cast iron motor vehicle products (Fig. 1) are as follows:

- Pattern design and production
- Sand formulation
- Mold and core production
- Metal heating and alloying
- Metal molding
- Mold shakeout
- Product finishing and heat treating
- Inspection.

The following presents the main operations in this process, the inputs to the processand the pollution sources. These operations are:

Mold production

The process begins with the mixing of moist silica sand with clay (3 to 20 percent) and water (two to five percent) to produce the "green sand," which forms the basis of the mold. Other additives, including organics such as “seacoal”, may be added to the green sand to help prevent casting defects. The core is then created using molded sand and often includes binders, such as resins, phenol, and/or formaldehyde. The core is the internal section of a casting used to produce the open areas needed inside such items as an engine or a drive train. After the core has been molded, it is baked to ensure its shape, and then combined with the rest of the casting mold in preparation for casting.

Pollution sources: Dust is created during sand preparation, molding and shakeout of the cast. Crystalline silica in the sand is carcinogenic. Baghouse dust is a source of solid waste. If wet scrubbers are used as air pollution control, the wastewater generated will be contaminated with heavy metals.

Casting

At the same time the core is being created, iron is being melted. The iron charge, whether it is scrap or new iron, is combined with coal (as a fuel) and other additives such as calcium carbide and magnesium, and fed into a furnace, which removes sulfur, (usually an electric arc, an electric induction, or a cupola furnace).

Calcium carbide may be added for certain kinds of iron casting, and magnesium is added to produce a more ductile iron. Once the iron reaches the appropriate temperature, it is poured into the prepared mold. The mold then proceeds through the cooling tunnel and is placed on a grid to undergo a process called "shakeout. " During shakeout the grid vibrates, shaking loose the mold and core sand from the casting. The mold and core are then separated from the product, which is ready for finishing.

Pollution sources: Fuel combustion in furnace that melt the metal generate flue gases that may cause air pollution.

Slag is quenched using cooling water to cool it as well as pelletize it. The wastewater generated from this process could contain cadmium and lead.

Wet scrubbers are usually used as air pollution control devices connected to the furnaces that melt the metal. The discharged waste water is usually contaminated with heavy metals.

Calcium carbide de-sulfurization slag is a hazardous solid waste since it reacts with water to create acetylene gas.

Finishing

The finishing process is made up of many different steps depending upon the final product. The surface may be smoothed using an oxygen torch to remove any metal snags or chips, it may be blast-cleaned to remove any remaining sand, or it may be pickled using acids to achieve the correct surface. If necessary, the item may be welded to ensure the tightness of any seams or seals. After finishing, the item undergoes a final heat treatment to ensure it has the proper metallurgical properties. The item is then ready for inspection.

Inspection may take place in any number of ways be it visually, by x- or gamma ray, ultrasonic, or magnetic particle. Once an item passes inspection, it is ready to be shipped to the assembly area.

Pollution sources: Solvents can be used for cleaning and some of them could be characterized as hazardous materials. Oxygen torch and blasting are also sources of particulate emissions to air.

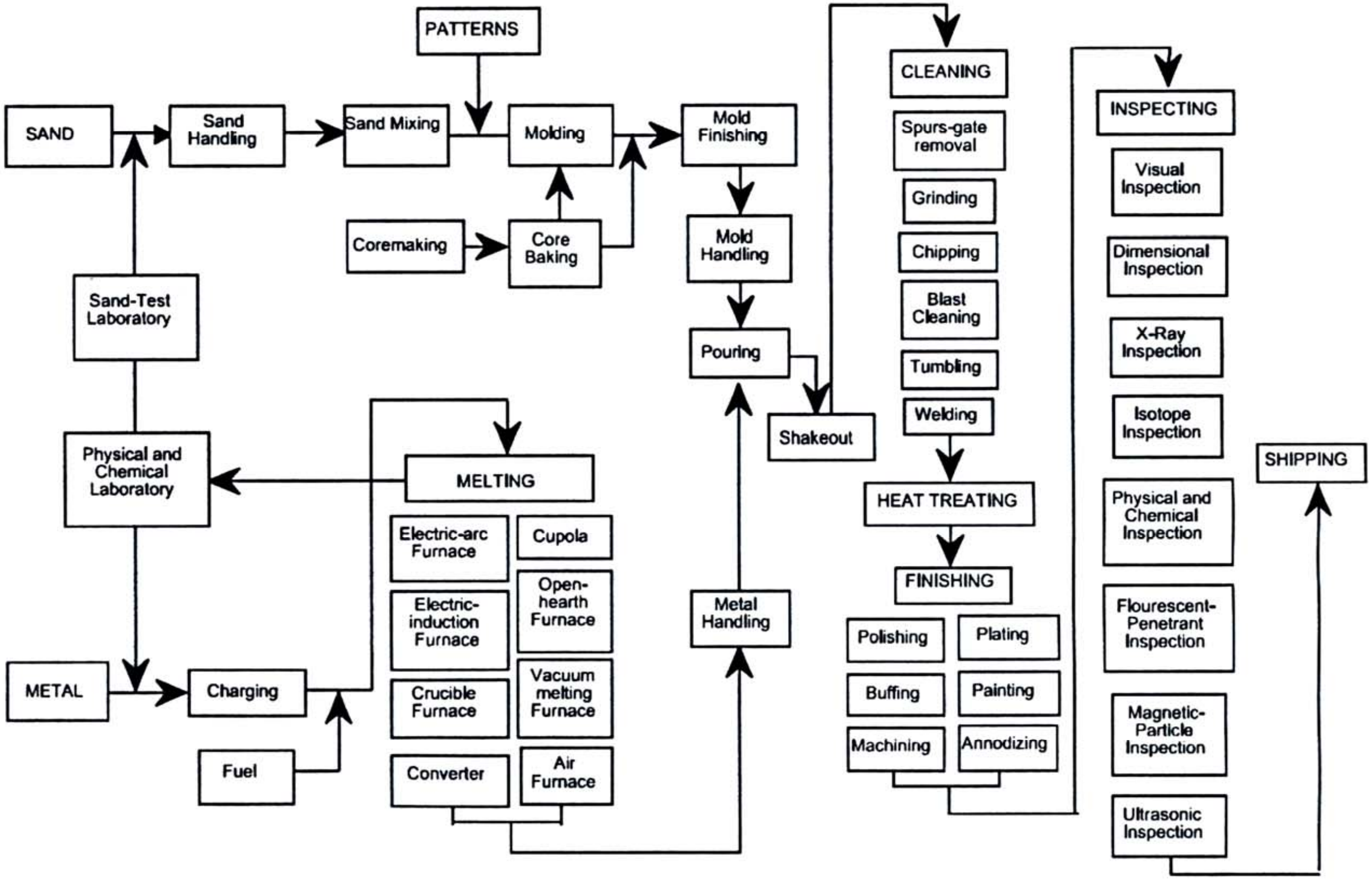


Fig. 1 General Foundry Flow Diagram

2.2.2 Metal fabrication plant

Another major process in the manufacturing automotive parts is metal fabrication. Metal fabrication involves the shaping of metal components. Many automotive parts, including fenders, hubcaps, and body parts are manufactured in metal fabricating shops. A typical large-scale production of these items starts with molten metal (ferrous or nonferrous) containing the correct metallurgical properties. Once the metal has been produced, it is cast into a shape that can enter the rolling process. Shearing and forming operations are then performed to cut materials into a desired shape and size and bend or form materials into specified shapes. Details about metal fabrication processes and their related pollution sources can be found in the Inspection Manual for Fabricated Metal Products Industry (EPAP, 2001).

2.2.3 Motor vehicle assembly

Assembly is performed in two stages: Body assembly prior painting and finishing operations, then hard trim installation followed by soft trim installation then installation of final parts..

Body assembly

Once the various automotive parts are produced, they are ready to be brought together for assembly. Automotive assembly is a complex process that involves many different steps. Assembly begins with parts, which arrive in the assembly plant "just-in-time." "Just-in-time" is a concept that means parts arrive only when they are needed for assembly; only enough product is sent for a given day's work. This concept, which revolutionized the automotive industry, has improved productivity, lowered costs, and provided for better quality management.

Although techniques used to assemble an automobile vary from manufacturer to manufacturer, the first major step in assembly is the body shop. At this stage the car begins to take shape as sides are welded together and then attached to the underbody of the car. The underbody is composed of three primary pieces of galvanized steel, which include the floor pan and components for the engine and trunk. After the underbody has been welded together by robotics, it is tested for dimensional and structural accuracy. It is then joined together in a tab-slot fashion with the side frame and various other side-assemblies. A worker then taps tabs into slots, and a robot clamps the tabs. Roof supports and the roof are now ready for installation. The car is now ready for final welding. Approximately 3,500-4,000 spots require welding. Robots do most welding, with workers doing only spot jobs. Trunk lids and hoods will then be installed.

After assembling the automobile body painting operations takes place as described in the next section.

Pollution sources: Due to advances in technology, well designed operating procedures, and the implementation of strategies to limit waste from assembly, little hazardous waste is generated during the actual assembly of an automobile (with the exception of painting/finishing, which is discussed in the following section).

The majority of wastes generated during assembly are solid wastes resulting from parts packaging. Parts packaging can be grouped into two categories - returnable and expendable. Returnable packaging (containers) is shipped back to the original suppliers once empty. It includes such items as: metal racks, metal skids, returnable bins, and rigid plastic racks. Expendable packaging is used once and recycled, for the most part. Examples include styrofoam peanuts, wood skids, plastic, corrugated boxes, and shrink-wrap.

Advances in packaging design, changes in purchasing, and the elimination of unneeded materials have greatly reduced the amount of expendable waste generated.

Additional wastes generated from assembly operations may be attributed to general plant operations, cleaning and maintenance, as well as the disposal of faulty equipment and parts.

Hard trim installation

After painting and finishing, two types of trim are installed - hard and soft. Hard trim, such as instrument panels, steering columns, and body glass, is installed first. The car body is then passed through a water test where, by using phosphorous and a black light, leaks are identified.

Soft trim installation

Soft trim, including seats, door pads, roof panel insulation, carpeting, and upholstery, is then installed. The only VOC emissions resulting from this stage of the process originate from the use of adhesives to attach items, such as seat covers and carpeting.

Final installations

Next, the automobile body is fitted with the following: gas tank, catalytic converter, muffler, tail pipe, and bumpers. Concurrently, the engine goes through a process known as "dressing," which consists of installing the transmission, coolant hoses, the alternator, and other components. The engine and tires are then attached to the body, completing the assembly process.

2.2.4 Motor vehicle painting/finishing

Automotive finishing is a multi-step process subdivided into four categories:

- Anti-corrosion operations, consisting of cleaning applications, a phosphate bath, and a chromic acid bath;
- Priming operations, consisting of a electrodeposition primer bath, an anti-chip application, and a primer-surfacer application;
- Joint sealant application;

- Finishing operations, consisting of a color coat application, a clearcoat application, and any painting necessary for two-tone color or touch-up applications.

The stages of the automotive finishing process are illustrated in Figure (2).

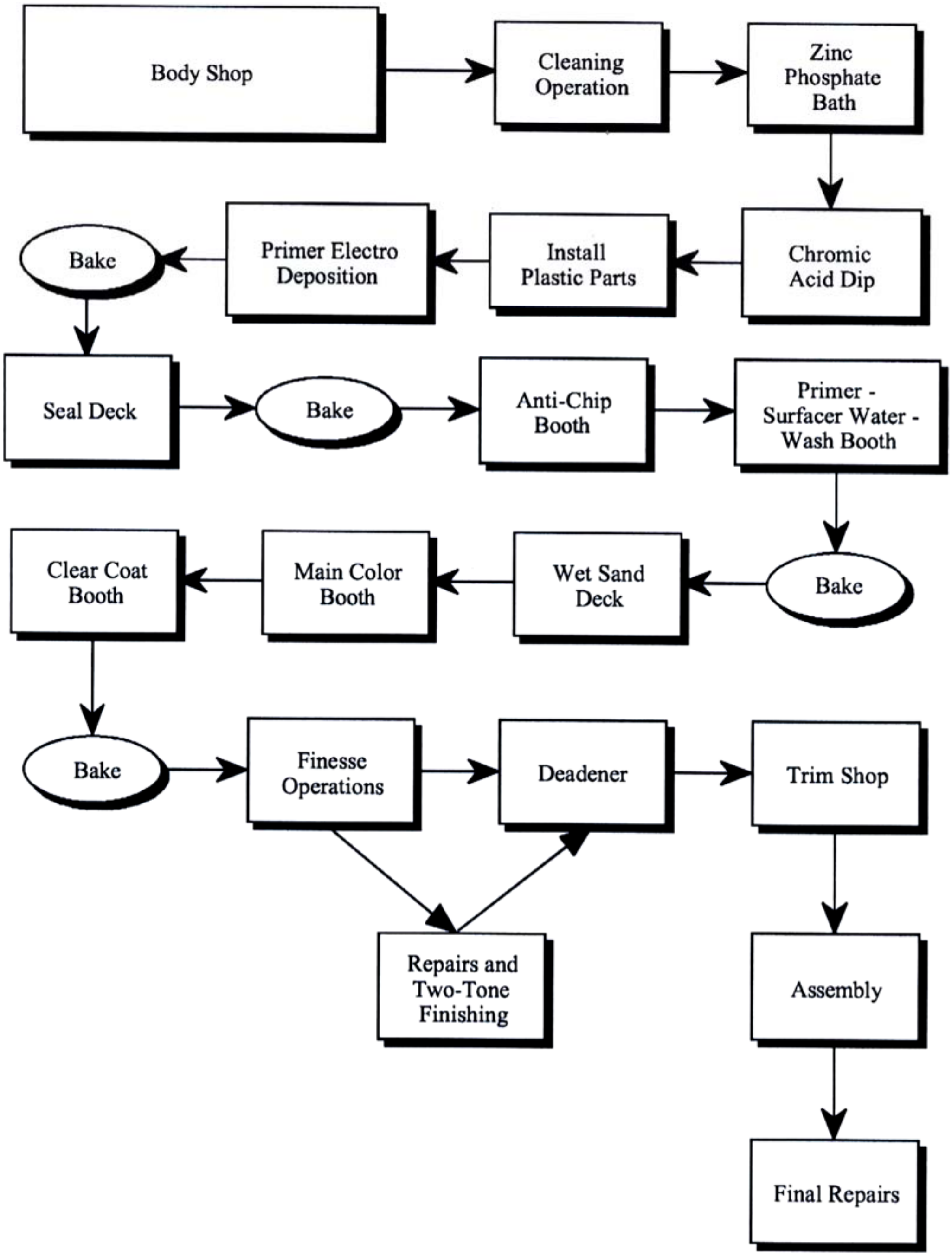


Fig. 2 Car Painting Process

Anti-corrosion operations

After the automobile body has been assembled, anti-corrosion operations prepare the body for the painting/finishing process. Initially, the body is sprayed with and immersed in a cleaning agent, typically consisting of detergents, to remove residual oils and dirt. The body is then dipped into a phosphate bath, typically zinc phosphate, to prevent corrosion. The phosphate process also improves the adhesion of the primer to the metal. The body is then rinsed with chromic acid, further enhancing the anti-corrosion properties of the zinc phosphate coating. The anti-corrosion operations conclude with another series of rinsing steps.

Priming operations

Priming operations further prepare the body for finishing by applying various layers of coatings designed to protect the metal surface from corrosion and assure good adhesion of subsequent coatings. Prior to the application of these primer coats, however, plastic parts to be painted and finished with the body, are installed.

As illustrated in Fig.(3), a primer coating is applied to the body using an electrodeposition method, creating a strong bond between the coating and the body to provide a more durable coating. In electrodeposition, a negatively charged auto body is immersed in a positively charged 225 to 300 m3 bath of primer for approximately three minutes. The coating particles, insoluble in the liquid and positively charged, migrate toward the body and are, in effect, "plated" onto the body surface.
Prior to baking, excess primer is removed through several rinsing stages. The rinsing operations use various systems to recover excess electrodeposited primer. Once the body is thoroughly rinsed, it is baked for approximately 20 minutes at 175 to 195 degrees Centigrade. VOC emissions resulting from the baking stage should be incinerated

Pollution sources: Although the primer bath is mostly water-based with only small amounts of organic solvent (less than five to ten percent), fugitive emissions consisting of volatile organic compounds (VOCs) can occur. However, the amount of these emissions is quite small. In addition to solvents and pigments, the electrodeposition bath contains lead, although the amount of lead used has been decreasing over the years.

Sealant application

Next, the body is further waterproofed by sealing spot-welded joints of the body. Waterproofing is accomplished through the application of a paste or putty-like substance. This sealant usually consists of polyvinyl chloride and small amounts of solvents. The body is again baked to ensure that the sealant adheres thoroughly to the spot-welded areas.

After waterproofing, the automobile body proceeds to the anti-chip booth. Here, a substance usually consisting of a urethane or an epoxy ester resin, in conjunction with solvents, is applied locally to certain areas along the base of the body, such as the front of the car. This anti-chip substance protects the lower portions of the automobile body from small objects, such as rocks, which can fly up and damage automotive finishes.

Finishing operations

The primer-surfacer coating, unlike the initial electrodeposition primer coating, is applied by spray application in a water-wash spray booth. The primer-surfacer consists primarily of pigments, polyester or epoxy ester resins, and solvents. Due to the composition of this coating, the primer-surfacer creates a durable finish, which can be sanded. The pigments used in this finish provide additional color layers in case the primary color coating is damaged. The water-wash spray booth is generally 30 to 50 meters long and applies the primer-surfacer in a constant air stream through which the automobile body moves. A continuous stream of air, usually from ceiling to floor, is used to transport airborne particulate and solvents from primer-surfacer overspray. The air passes through a water curtain, which captures a portion of the airborne solvents for reuse or treatment at a wastewater facility. Efforts have been made at certain facilities to recycle this air to reduce VOC emissions.

After the primer-surfacer coating is baked, the body is then sanded, if necessary, to remove any dirt or coating flaws. This is accomplished using a dry sanding technique. The primary environmental concern at this stage of the finishing process is the generation of particulate matter.

The next step of the finishing process is ***the application of the primary color coating***. This is accomplished in a manner similar to the application of primer-surfacer. One difference between these two steps is the amount of pigments and solvents used in the application process. VOC emissions from primary color coating operations can be double that released from primer-surfacer operations. In addition to the pigments and solvents, aluminum or mica flakes can be added to the primary color coating to create a finish with unique reflective qualities. Instead of baking, the primary color coat is allowed to "flash off," in other words, the solvent evaporates without the application of heat. Pigments, used to formulate both primers and paints, are an integral part of the paint formulation, which also contains other substances. The pigmented resin forms a coating on the body surface as the solvent dries

After the primary color coating is allowed to air-dry briefly, the final coating, a clear coat, is applied. The clear coat adds luster and durability to the automotive finish. This coating generally consists of a modified acrylic or a urethane and is baked for approximately 30 minutes. Following the baking of the clear coat, the body is inspected for imperfections in the finish. Operators finesse minor flaws through light sanding and polishing and without any repainting.

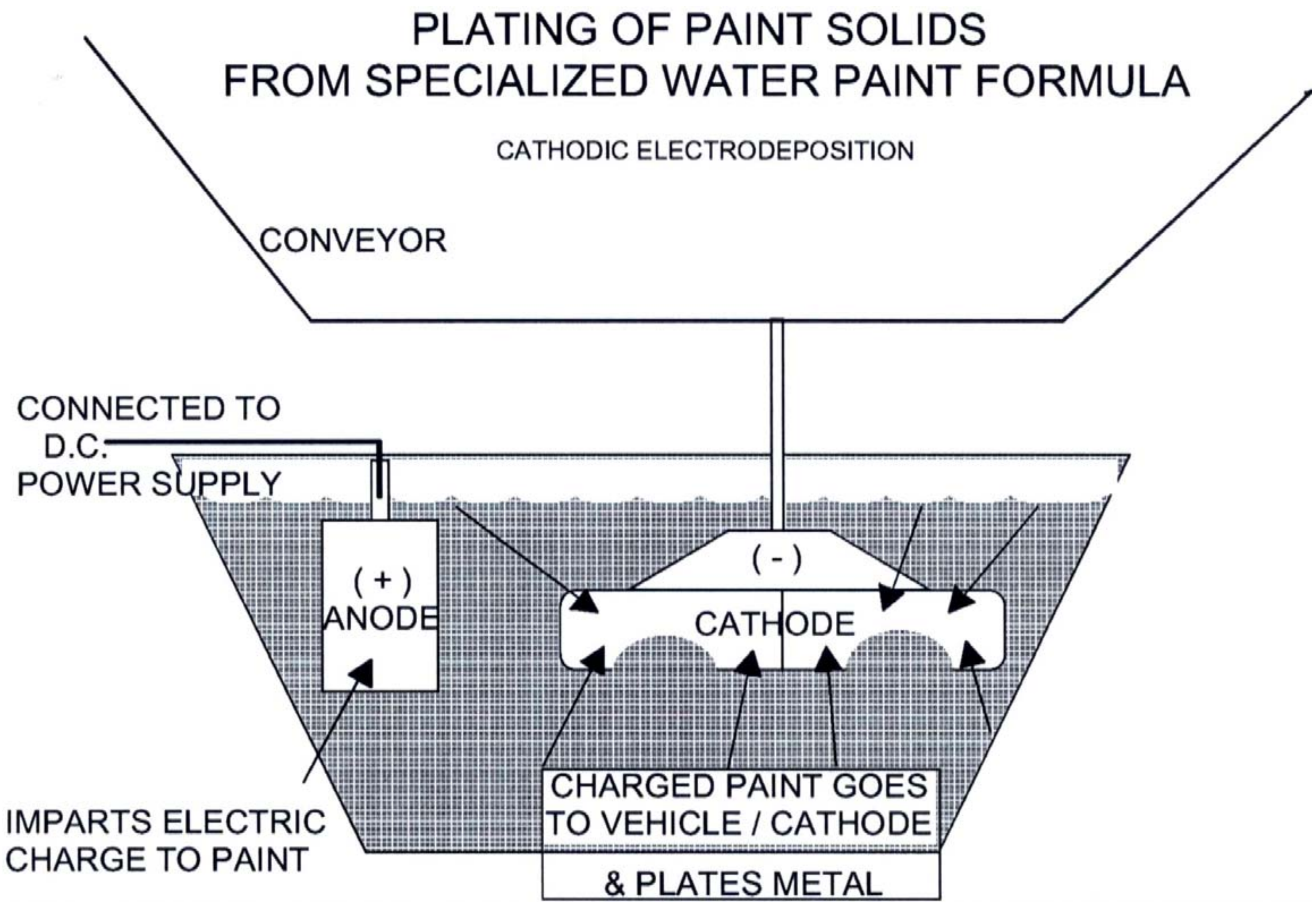
Once the clear coat is baked, a coating known as deadener is applied to certain areas of the automobile underbody. Deadener, generally a solvent-based resin of tar-like consistency, is applied to areas such as the inside of wheel wells to reduce noise. In addition, anti-corrosion wax is applied to other areas, such as the inside of doors, to further seal the automobile body and prevent moisture damage. This wax contains aluminum flake pigment and is applied using a spray wand

Touch-up

The finished vehicle is then rigorously inspected to ensure that no damage has occurred as a result of the final assembly stages. If there is major damage, the entire body part is replaced. However, if the damage is minor, such as a scratch, paint is taken to the end of the line and applied using a hand-operated spray gun. Because the automobile cannot be baked at temperatures as high as in earlier stages of the finishing process, the paint is catalyzed prior to application to allow for faster drying at lower temperatures. Approximately two percent of all automobiles manufactured require this touch-up work. Because the paint used in this step is applied using a hand-operated spray gun, fugitive air emissions are likely to be generated (depending on system design). Generally, spray and immersion finishing methods are to a certain extent interchangeable, and the application method for various coatings varies from facility to facility. The same variance applies to the number and order of rinsing steps for cleaning, phosphating, and electrodeposition primer operations. Spray rinsing the body prior to immersion rinsing decreases the amount of residues deposited in the bath and allows for greater solvent recovery.

In addition to the above-mentioned uses of solvents as ingredients of coatings, solvents are often used in facility and equipment cleanup operations. Efforts have been made at several facilities to reduce the amount of solvent used for this purpose, thereby reducing fugitive VOC emissions, and to reuse these solvents when preparing batches of coatings used in certain stages of the finishing process.

The expanded use of alternative coating methods, such as electrostatic powder spray, is being researched. Powder coatings are being used instead of solvent-based coatings for some initial coating steps, such as the anti-chip and the primer-surfacer process.


PLATING OF PAINT SOLIDS
FROM SPECIALIZED WATER PAINT FORMULA
CATHODIC ELECTRODEPOSITION
CONVEYOR
CONNECTED TO
D.C.
POWER SUPPLY
(+)
ANODE
(-)
CATHODE
IMPARTS ELECTRIC
CHARGE TO PAINT
CHARGED PAINT GOES
TO VEHICLE / CATHODE
& PLATES METAL

2.2.5 Post Production Motor Vehicle Dismantling/Shredding

Dismantling operations involve both automotive fluids and solids. The fluids, such as engine oil, antifreeze, and air conditioning refrigerant, are recovered to the extent possible, reprocessed for reuse or sent to energy recovery facilities. Many solid parts, such as the radiator and catalytic converter, contain valuable metal materials, which are removed for recycling or reuse. In addition, the dismantler will remove and recycle the battery, fuel tank, and tires to reduce shredder-processing concerns.

The shredder processes the remaining automotive hulk, along with other metallic goods (such as household appliances), into ferrous materials, non-ferrous materials, and shredder residue. The residue is a heterogeneous mix that may include plastics, glass, textiles, metal fines, and dirt. This material should be predominantly landfilled in authorized discharges.

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. Table (5) shows the various units with their corresponding raw materials and potential pollution sources.

2.3.1 Boilers

Boilers are used to produce steam for:

- heat supply to the processes
- electric power generation

Conventional steam-producing thermal power plants generate electricity through a series of energy conversion stages. Fuel is burned in boilers to convert water to high-pressure steam, which is then used to drive the turbine to generate electricity.

The gaseous emissions generated by boilers are typical of those from combustion processes. The exhaust gases from burning fuel oil (Mazot) or diesel oil (solar) contain primarily particulates (including heavy metals if they are present in significant concentrations in the fuel), sulfur and nitrogen oxides (SOx and NOx) and volatile organic compounds (VOCs).

The concentration of these pollutants in the exhaust gases is a function of firing configuration (nozzle design, chimney height), operating practices and fuel composition.

Gas-fired boilers generally produce negligible quantities of particulates and pollutants.

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

In the case of power plants, water is used for cooling the turbines and is also generated as steam condensate. The amount of wastewater generated depends on whether cooling is performed in open or closed cycle and on the recycling of steam condensate. Contamination may arise from lubricating and fuel oil.

2.3.2 Water Treatment Units

There are different types of water used in industry. Depending on the application and the water source, different treatment processes are applied.

a) ***Water Softening for medium hardness water:*** Calcium and magnesium ions are removed from hard water by cation exchange for sodium ions. When the exchange resin has removed the ions to the limits of its capacity, it is regenerated to the sodium form with a salt solution (sodium chloride) in the pH range of 6-8. This is performed by taking the softener out of service, backwashing with the salt solution, rinsing to eliminate excess salt, then returning it to service. The treated water has a hardness level of less than 1 ppm expressed as calcium carbonate.

b) ***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. 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 filer 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.

c) ***Reverse Osmosis:*** Demineralization 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

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

2.3.4 Laboratories

Laboratories are responsible for:

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

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

2.3.5 Workshops and Garage

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

- Noise
- Rinse water contaminated with lube oil

Pollution in the garage area will depend upon the services offered. The presence of a gasoline or diesel station implies fuel storage in underground or over the ground tanks that require leak and spill control plans.

Replacing lube oil implies discharge of spent oil to the sewer lines or selling it to recycling stations.

2.3.6 Storage Facilities

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

- Fuel is used for the boilers and for the cars and delivery trucks. It is stored in underground or over ground tanks. The types of fuel usually used are fuel oil (Mazot), gas oil (solar), natural gas and gasoline.

2.3.7 Wastewater Treatment Plants

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

The potential pollution sources from the WWTP are:

- Metal bearing Sludge which could represent a hazardous waste problem
- Treated water could represent a water pollution problem if not complying with relevant environmental laws

2.3.8 Restaurants, Washrooms and Housing Complex

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

Table (5) Service Units and Their Related Pollution Sources

Inputs	Service Units	Pollution
Water Lime + chemicals Fuel	Treatment Softening Units Boilers Steam	Sludge Back/wash blow-down (TDS) Flue Gases
Hot Water	Cooling Towers	Cooling Tower Blowdown (TDS)
Chemicals	Laboratory	Wastewater Hazardous Materials (handling)
Lube Oil Floor and equipment rinse water Cleaning Chemicals	Electrical & Mechanical Workshops	Oily Rinse Water Solid Wastes
Fuel Oil Rinse Water	Garage	Oily rinse water Solid wastes
Fuel Chemicals	Storage	Spills Hazardous material
Wastewater	Wastewater Treatment Units	Treated water Sludge
Water	Restaurant and restrooms	Sanitary Wastewater

2.4 Emissions, Effluents and Solid Wastes

The following emissions, table (6), can be found in the motor vehicle assembly industry:

2.4.1 Air emissions

The main sources of air emission in the fabricated metal products industry are:

Foundry	The main causes of air pollution are : • Dust created during preparation of sand molds • Gases containing lead, cadmium, particulate matter, sulfur dioxide during melting of iron • Flue gases in melting operation if heating is performed by combustion of fuel
Metal fabrication	Refer to the inspection manual for fabricated metal products for air emissions
painting/ finishing	VOCs result from paint storage, mixing application of paint and drying. Cleaning solvents also result in VOCs, mainly dimethyl-benzene, 2 pranone, 4-methyl-2 pentanone, butyl ester, acetic acid, light aromatic solvent naphta, ethyl benzene, 2 butanone, toluene, butanol
Service units	Exhaust gases resulting from fuel consumption used to generate steam from boilers. The violating parameters would be: particulate matters, (PM10), sulfur oxides, nitrogen oxides, carbon monoxide.

2.4.2 Effluents

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

Foundry	The wastewater generated from slag quenching or from the wet scrubbers used for air pollution control is contaminated with cadmium, lead and iron
Metal fabrication	The quality of effluent depends on the type of metal fabrication operation used. Look-up for the specific operation in the inspection manual for fabricated metal products

painting/ finishing	The main sources of water pollution are : • Discharging leftover and unused paint • Clean up of equipment and paint booth area • Paint booth collection system • Water curtains used to capture paint overs pray The type of pollutant depends on the type of paint used (see table 3). The effluent will be contaminated with the metal constiyuting the paint pigments.
Service units	• Blowdowns from the cooling tower and boilers as well as backwash 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).

2.4.3 Solid wastes

The main sources of solid wastes are:

Foundry Operation	• Calcium carbide desulfurization slag reacts with water to create acetylene gas • Wastewater sludge generated when suspended solids are precipitated may contain cadmium, lead and iron • Bad house dust may contain toxic materials such as lead and cadmium
Motor vehicle assembly	• Returnable parts-packaging (metal or plastic racks, metal skids, bins) are stored then shipped back • Expendable parts-packaging (styrofoam, wood skids, plastic corrugated boxes,…) • Faulty equipment
painting/ finishing	Paint containers
Dismantling/ shredding	Dismantling valuable parts for recycling or reuse. The rest is sorted into ferrous materials, non-ferrous materials and residues.
Service units	• Sludge from wastewater treatment plant • Scrap from workshops.

Table (6) Material Inputs and Pollution sources

Process	Material Input	Air Emission	Process Wastewater and liquids	Other Wastes
Metal Shaping				
Metal Cutting and/or Forming	Cutting oils, degreasing and cleaning solvents, acids, and metals	Solvent wastes (e.g 1,1,1. trichloroethane, acetone, xylene toluene, etc)	Acid/alkaline wastes (e.g. hydrochloric, sulfuric and nitric acids) and waste oils	Metal wastes (e.g., copper, chromium and nickel) and solvent wastes(e.g. 1,1,1 trichloroethane , acetone, xylene toluene, etc)
Heat Treating	Acid/alkaline solutions (e.g. hydrochloric and sulfuric acid) cyanide salts and oils		Acid/alkaline wastes, cyanide wastes, and waste oils	Metal wastes (e.g. copper, chromium and nickel)
Surface Preparation				
Solvent cleaning	Acid/alkaline cleaners and solvents	Solvent wastes (e.g. acetone, xylene, toluene, etc)	Acid/alkaline wastes	Ignitable wastes, solvent wastes (e.g. 1,1,1 trichloroethane , acetone, xylene toluene, etc) and still bottoms
Pickling	Acid/alkaline solutions		Acid/alkaline wastes	Metal wastes

Surface Finishing				
Electroplating	Acid/alkaline, solutions, metal bearing and cyanide bearing solutions		Acid/alkaline wastes, cyanide wastes, plating wastes and wastewaters	Metal wastes, reactive wastes and solvent wastes
Surface finishing	Solvents	Solvent wastes (e.g. 1,1,1 trichloroethane , acetone, xylene toluene, etc)		Metal paint wastes, solvent wastes, ignitable paint wastes and still bottoms
Facility cleanup	Solvents	Solvent wastes (e.g. 1,1,1 trichloroethane , acetone, xylene toluene, etc)		Solvent wastes and still bottoms

3. Environmental and health impacts of pollutants.

Metals and chemicals used in the surface finishing industry can affect, to a wide range, environmental species as well as cause serious human health effects. Some effects occur immediately, others may take some years to manifest themselves. Health effects are often closely linked to pollution.

Processes which involve the use of chemicals should always be examined for their possibility to cause pollution. Loss of chemicals can occur from rinsing operations, from spills, or discarding the spent solutions. Also, a number of ancillary operations may give rise to loss of chemicals to the environment. Ancillary operations include storage of chemicals, transfer and handling or chemicals, wastewater treatment and discharge, discharges from process control laboratories, disposal of residues and reuse or disposal or empty chemical containers.

Chemical pollutants can cause a wide variety of environmental effects, which may vary from one target species to another, and also depend on the particular pathway that a chemical takes in the environment. Chemicals can migrate in the environment from one media to another, e.g. from soil into water, or from water into air. Some chemicals tend to degrade rapidly in the environment, while others are more or less persistent and can, over time, migrate to new locations under the influences of natural forces [5].

With respect to the workplace it is useful to identify a number of common hazards. Corrosive chemicals (acids, alkalis) eat away at materials and tissues. Strong oxidizing chemicals may cause burns, or cause fires if they into contact with paper, packing materials, timber, or textiles. Many solvents are flammable and can therefore cause a risk for a fire or an explosion.

> ***Note*** :
> The potential environmental impacts will vary from situation to situation, depending on the type of industrial process, location, local environmental conditions and so on.

A simple checklist for assessing the potential impact of metal finishing plants includes:

- Occupational exposure of workers to process chemicals and waste residues;
- Water pollution from wastewater or wash water;
- Discharge or chemicals to drains streams, or to soil;
- Impact on public sewer systems, leading to damage to the sewer itself, to the wastewater treatment process, and to the environment near the wastewater outfall; as well as presenting danger to sewer maintenance personnel.
- Contamination or sewage sludge by persistent, bio-accumulative, and toxic residues;
- Groundwater contamination through leakage;

- Disposal of surplus chemicals and/or treatment sludges.
- Soil contamination from spills, at chemical and waste storage areas;
- Transport accidents involving chemicals transported to or from the plant;
- Accidents in the plant involving the release of chemicals;
- Energy and resource consumption;
- Air emissions or chemicals with and subsequent workplace and public exposure

3.1 Top ten pollutants of the engineering industry

The following is a synopsis of current scientific toxicity and information for the top chemicals (by weight) that facilities within this sector self-reported as released to the environment based upon 1993 TRI (Toxic Release Inventory) data in the USA [3].
The top TRI release for the ***motor vehicles and motor vehicle equipment*** industry as a whole are as follows: toluene, xylene, methyl ethyl ketone, acetone, glycol ethers, 1,1,1,-trichloroethane, styrene, trichloroethylene, dichloromethane, and methanol.
As a matter of comparison, the top ten TRI releases for the ***Fabricated Metal Products industry*** as a whole, glycol ethers,n-butyl, xylene, methyl ethyl ketone, trichloroethylene, toluene-1, dichloromethane, methyl isobutyl ketone, acetone, and tetrachloroethylene [6].
Also the top ten TRI releases for ***the coating, engraving and allied services portion of the fabricated metal products industry*** include: methyl ethyl ketone, toluene, glycol ethers, trichloroethylene, xylene (mixed isomers), 1.1,1-trichloroethane, dichloromethane, tetrachloroethylene, hydrochloric acid, and methyl isobutyl ketone[6].

3.2 Impacts of the main pollutants

The main sources for this section are the EPA’s annual toxics release inventory public data release book and the hazardous substances data bank (HSDB).

Acetone

Toxicity: 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 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.

Carcinogenicity: currently no evidence

Environmental Fate: if released into water, acetone will be degraded by microorganisms or will evaporate into the atmosphere. Degradation by microogranisms will be the primary removal mechanism. 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.

Physical Properties. Acetone is a volatile and flammable organic chemical.

Glycol Ethers

Due to data limitations, data on diethylene glycol (glycol ether) are used to represent at glycol ethers.

Toxicity: Diethylene glycol is only a hazard to human health if concentrated vapors are generated through heating or vigorous agitation or if appreciable skin contact or ingestion occurs over an extrended period of time. Under normal occupational and ambient exposures, diethylene glycol is low in oral toxicity is not irritating to the eyes or skin, is not readily absorbed through the skin, and has a low vapor pressure so that toxic concentrations of the vapor cannot occur in the air at room temperatures.

At high levels of exposure, diethylene glycol causes central nervous depression and liver and kidney damage. Symptoms of moderate diethylene glycol poisoning include nausea. Vomiting, headache, diarrhea, abdominal pain, and damage to the pulmonary and cardiovascular systems. Sulfanilamide in diethylene glycol was once used theraopeutically against bacterial infection; it was withdrawn from the market after causing over 100 deaths from acute kidney failure.

Carcinogenicity: currently no evidence

Environmental Fate: Dietylene glycol is a water-soluble, volatile organic chemical. It may enter the environment in liquid from via petrochemical plant effluents or as an unburned gas from combustion sources. Diethylene glycol typically does not occur in sufficient concentrations to pose a hazard to human health.

Hydrochloric acid	***Toxicity:*** Hydrochloric acid is primarily a concern in its aerosol form. Acid aerosols have been implicated in causing and exacerbating a variety of respiratory aliments. Dermal exposure and ingestion of highly concentrated hydrochloric acid can result in corrosivity. Ecologically, accidental releases of solution forms of hydrochloric acid may adversely affect aquatic life by including a transient lowering of pH (i.e., increasing the acidity) of surface waters. ***Carcinogenicity:*** Currently no evidence ***Environmental Fate:*** Releases of hydrochloric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems. The extent of these reactions will depend on the characteristics if the specific environment. ***Physical Properties***: Concentrated hydrochloric acid is highly corrosive.
Methanol	***Toxicity:*** Methanol is readily absorbed from the gatrointestinal 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 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 1mg methanol per liter water. Methanol is not likely to persist in water or to bioaccumulate in aquatic oganisms. ***Carcinogencity:*** currently no evidence ***Environmental Fate:*** 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. ***Physical properties:*** Methanol is highly flammable.

Methylene Chloride (Dichloro-methane)	***Toxicity:*** Short-term exposure to dichloromethane (DCM) is associated with central nervous system effects, including headache, giddiness, stupor, irritability, and numbness and tingling in the limbs. More severe neurological effects are reported from longer-term exposure, apparently due to increased carbon monoxide in the blood from the break down of DCM. Contact with DCM causes irritation of the eyes, skin, and respiratory tract. Occupational exposure to DCM has also been linked to increased incidence of spontaneous abortions in women. Acute damage to the eyes and upper respiratory tract, unconsciousness, and death were reported in workers exposed to high concentrations of DCM. Phosgene (a degradation product of DCM) poisoning has been presence or an open fire. Populations at special risk from exposure to DCM include obese people (due to accumulation of DCM in fat), and people with impaired cardiovascular systems. ***Carcinogenicity:*** DCM is a probable human-carcinogen via both oral and inhalation exposure, based on inadequate human data and sufficient evidence in animals. ***Environmental Fate:*** When spilled on land, DCM is rapidly lost from the soil surface through volatilization. The remainder leaches through the subsoil into the groundwater. Biodegradation is possible in natural waters but will probably be very slow compared with evaporation. Little is known about bioconcentration in aquatic organisms or adsorption to sediments but these are not likely to be significant processes. Hydrolysis is not an important process under normal environment conditions. DCM released into the atmosphere degrades via contact with other gases with a half-life of several months. A small fraction of the chemical diffuses to the stratosphere where it rapidly degrades through exposure to ultraviolet radiation and contract with chlorine ions. Being a moderately soluble chemical, DCM is expected to partially return to earth in rain.
Methyl Ethyl Ketone	***Toxicity:*** 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. ***Carcinogenicity:*** Current no agreement over

carcinogenicity.

Environmental Fate: 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.

Physical Properties: Methyl ethyl ketone is a flammable liquid.

Toluene

Toxicity: Inhalation or ingestion of toluene can cause headaches, confusion, weakness, and memory loss. Toluene may also affect the way the kidneys and liver function. Reaction 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 conditions in humans.

Carcinogenicity: currently no evidence

Environmental Fate: The majority of releases of toluene to land and water will evaporate. Toluene may also be degraded by microorganisms. Once volatized, toluene in the lower atmosphere will react with other atmopheric components contributing to the formation of ground-level ozone and other air pollutants.

Physical Properties: Toluene is a volatile organic chemical

Trichloroethane

Toxicity: Repeated contact of 1,1,1-trichloroethane (TCE) with skin may cause serious skin cracking and infection. Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. Exposure to high concentrations of TCE causes reversible mild liver and kidney dysfunction, central nervous system depression, gait disturbances, stupor, coma, respiratory depression, and even death.
Exposure to lower concentrations of TCE leads to light-headedness, throat irritation, headache, disequilibrium, impaired coordination, drowsiness, convulsions and mild changes in perception.

Carcinogenicity: Currently no evidence

Environmental Fate: Releases of TCE to surface water or land will almost entirely volatilize. Releases to air may be transported long distances and may partially return to earth in rain. In the lower atmosphere, TCE degrades very slowly by photoozidation and slowly diffuses to the upper atmosphere where photodegradation is rapid. Any TCE that does not evaporate from soils leaches to groundwater. Degradation in soils and water is slow. TCE does not hydrolyze in water, nor does it significantly bioconcentrate in aquatic organisms.

Trichloroethylene

Toxicity: Trichloroethylene was once used as an anesthetic, though its use caused several fatalities due to liver failure. Short term inhalation exposure to high levels of trichloroethylene may cause rapid coma followed by eventual death from liver, kidney, or heart failure. Short-term exposure to lower concentrations of trichloroethylene causes eye, skin, and respiratory tract irritation. Ingestion causes a burning sensation in the mouth, nausea, vomitting and abdominal pain. Delayed effects from short-term trichloroethylene poisoning include liver and kidney lesions, reversible nerve degeneration, and psychic disturbances. Long-term exposure can produce headache, dizziness, weight loss, nerve damage, heart damage, nausea, fatigue, insomnia, visual impairment, mood perturbation, sexual problems, dermatitis, and rarely jaundice. Degradation products of trichloroethylene (particularly phosgene) may cause rapid death due to respiratory collapse.

Carcinogenicity: Trichloroethylene is a probable human carcinogen via both oral and inhalation exposure, based on limited human evidence and sufficient animal evidence.

Environmental Fate: trichloroethylene breaks down in water in the presence or sunlight and bioconcentratesb moderately in aquatic organisms. The main removal of trichloroethylene from water is via rapid evaporation. Trichloroethylene does not photodegrade in the atmosphere, though it breaks down quickly under smog conditions, forming other pollutants such as phosgene, dichloroacetyl chloride, and formly chloride. In addition, trichloroethylene vapors may be decomposed to toxic levels of phosgene in the presence of an intense heat source such as open arc welder.
When spilled on the land, trichloroethylene rapidly volatilizes from surface soils. The remaining chemical leaches through the soil to groundwater.

Xylene (Mixed

Toxicity: Xylenes are rapidly absorbed into the body after

Isomers)	inhalation, ingestion, or skin contact. Short-term exposure of humans to high levels of xylenes can cause iritation of the skin, eye, nose, and throat, difficulty in breathing, impaired lung function, impaired memory, and possible changes in the liver and kidneys. Both short and long-term exposure to high concentrations can cause effects such as headaches, dizziness, confusion, and lack of muscle coordination. Reactions of xylenes 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. ***Carcinogenicity*: **currently no evidence ***Environmental Fate:*** The majority of releases to land and water will quuickly evaporate, although some degradation by microogranisms will occur. Xylenes are moderately mobile in soils and may leach into groundwater, where they may persist for several years. Xylenes are volatile organic chemicals. As such, xylenes in the lower atmosphere will react with other atmospheric components, contributing to the formation of ground-level ozone and other air pollutants.

3.3 Other pollutants and their impacts

Particulate matters	Recent epidemiological evidence suggests that much of the health damage caused by exposure to particulates is associated with particulate matters smaller than 10 microns. These particles oenetrate 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. Acid condensate, sulphates and nitrates as well as lead, cadmium, and other metal can also be detected in the flue gases.
Sulfur oxides	Air pollution by sulfur oxides is a major envionment 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 the form of rain. Ac id rain is corrosive to metals, limestone, and other materials.
Nitrogen oxides	Nitrogen oxides also dissolve in atmospheric water

droplets to form acid rain.

Carbon dioxide Combustion of fossil fuels to produce electricity and heat contrinbute to the green house by the formation of carbon diopxide (heat radiation from earth is absorbed by the gases causing a surface temperature increase).

Waste waters Typical effluent characteristics of the Egyptian Fabricated Metal products industry are shown in the following data taken from the analysis of the waste waters of a large plant near Cairo.

BOD	765 mg O_2 /liter
COD	1524 mg O_2/liter
Total phosphorus	18.2 mg/liter
Total zinc	72 mg/liter
TSS	1128 mg/liter
O & G	196 mg/liter
pH	10

It must be taken into consideration that the overall wastewater stream is typically extremely variable, even inside the same process. For instance according to a world report, one square meter of surface plated can generate anything between one litre and 500 litres of wastewaters usually high in heavy metals such as cadmium chrome, lead, copper, zinc, nickel and also in cyanides, fluorides and oil and grease.

Spent lube oil from garage and workshope could be a cause for concern if discharged into the sewer system. The organic material in wastewater stimulates the growth of bacteria and fungi naturally present in water which then consume dissolved oxygen.

The environmental impact of the wastewater depends on the receiving water body. The Egyptian Ministry of Irrigation has set limits for the pollutants in the wastewater discharged into agriuculture canals and drains as well as the Nile river for their detrimental effect on agriculture. The parameters of relevance besides BOD, COD, O & G, could be for instance phosphorus, cadmium, chromium (hexavalent and total), copper, lead, mercury, nickel, silver, zinc, total metals, cyanides (free) and fluorides.

The discharge of wastewaters to natural waterways could be damaging the natural ecosystems and impacting on bio-diversity. If the waste waters are too concentrated and discharged into a public sewer system, it can interfere with the purification system of the wastewater treatment plant and let metals accumulate in the sewage sludge.

Note :
Any or all of the substances used in the processes (as electrophlating for instance) can be found in the wastewater, either via rinsing of the product or from spillage and dumping of rpocess baths. In the example already taken of electrophlating, the mixing of cyanide (sometimes used) and acidic wastewaters can generate lethal hydogen cyanide gas !!

Relevant solid waste	Dumping of treatment sludges and chemical wastes into poorly located, badly constructed or carelessly managed landfill sites can lead to groundwater pollution problems. In the surface treatment plant if present, a considerable amount of solid waste can be dewatered sludge from wastewater treatment, if the wastewaters containing metals are treated by chemical treatment such as hydroxide precipitation. The fate of this dewatered sludge should be known (sold to a metal recuperation society, disposal in an approved and controlled landfill…). In fact solid waste is mainly scrap that is collected and sold, causing no significant impact.

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 fabricated metal products industry [9].

4.1 Concerning air emissions

Let us first define some technical terms :

Threshold Limit is the concentration of airborne chemical substance to which a person can be exposed day after day without adverse effects to his health. If we consider workers in the factory, we use a working day of 8 hours, five days a week.

Threshold Limit for short periods is the threshold limit for an exposure of an average period of 15 minutes and which may not be exceeded under any circumstances during the day. The exposure should not be repeated more than four times during the same day and the period between each short exposure and the next must be at least sixty minutes.

Ceiling Limit is the concentration of airborne chemical substance which may not be exceeded even for a moment.

Note:
If we consider simple asphyxiate gases which have no significant physiological effects, the decisive factor shall be the concentration of oxygen in the atmophere which may not be less than 18 % according to law No 4/1994.

According to the law No 4/1994 – Annex (6), the permissible limit for emissions of overall particles in outdoor air, in the case of ferrous industries, is down from 200 to 100 mg/m3 of exhaust.
According to Table (2) of Annex (6) of the above law, the maximum limit of lead, mercury, copper, nickel and total heavy elements in the gas and fume emissions from industrial establishments should be respectively 20, 15, 20, 20, 25 mg/m3 of exhaust.
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 mazot 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 carbon dioxide shall be emitted through chimneys rising sufficiently high in order that these gases become lighter before reaching the ground surface, or using fuel that contains high proportions of sulfur in power generating stations, as well as in industry and other regions lying away from inhabited urban areas, providing that atmospheric factors and adequate distances to prevent these gases from reaching the dwelling and agricultural zones and regions, as well as the water courses shall be observed.
- Chimneys from which a total emission of wastes reaches 7000 – 15000 kg/hr, shall have heights ranging between 18 – 36 meters.
- Chimneys from which a total emission of gaseous wastes reaches more than 15000 kg/hour, shall have heights exceeding at least two and a half times the height of surrounding buildings, including the building served by the chimney.

The permissible limits of emissions from sources of fuel combustion are given in tables (7 and 8).

Table (7) Maximum limits of emissions from sources of fuel combustion

(for furnaces)

Pollution	Maximum limit, mg/m^3 of exhaust	
	Existing	New
Sulfur Dioxide.	4000	2500
Carbon Monoxide.	4000	2500
Volatized ashes in urban regions.	250	250
Volatized ashes in remote regions.	500	500
Smoke.	250	250

Table (8) Maximum limits of emissions from sources of fuel combustion

(for Boilers)

Pollutants	Maximum limit, mg/m^3 of exhaust
Sulphur Dioxide	3400
Carbon Monoxide	250
Smoke	50

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 BOD, COD, pH, temperature, residual chlorine, TSS, TDS, Oil and Grease and heavy metals.

Table (9) 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.

As interesting non-binding information, let us consider the two recommendations PARCOM 92/4 [10] and HELCOM 16/6 [11] concerning wastewater discharges from the metal surface industry in the Baltic sea area presented in Table (10):

Table (9) 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	
					Municipal	Industrial
BOD (5day,20 deg.)	60	<600	20	30		
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	—	—

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	
					Municipal	Industrial
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		—	—	Total concentration for theses metals should be: 1 for all flow streams	
Chromium Hexavalent	—	**0.5**	0.05	0.05		
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	—	—

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	
					Municipal	Industrial
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 (10) Maximum permissible concentrations in wastewater discharges from the metal surface treatment industry

Substance	Concentration in mg/liter	
	HELCOM recommendation 16/6	PARCOM recommendation 92/4
Cadmium	0.2	0.2
Mercury	0.05	0.05
Chromium (total)	0.7	0.5
Chromium IV	0.2	0.1
Copper	0.5	0.5
Lead	0.5	0.5
Nickel	1.0	0.5*
Silver	0.2	0.1
Zinc	2.0	0.5
Tin	-	2.0
Unbound Cyanides	0.2	0.2
Volatile Organic Halogens (VOX)	0.1	0.1

* Only in justified cases a maximum zinc concentration of 2 mg/l may be allowed

4.3 Concerning solid waste

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

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

Note :
Fabricated metal products quite often use other materials than metal in the products. Plastic, rubber, glues, insulation materials are typical inputs, producing also solid wastes besides possible emissions

4.4 Concerning work environment

Violations of work environment could be encountered:

- In the boiler house: gas emissions, regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex 8. The limits for the relevant pollutants are presented in Table (11).
- According to the Annex (8) of the law 4/1994, the maximum limits of some air pollutants of concern for the fabricated metal products industry, inside the work place, are gathered in Table (12).
- 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.
- Near heavy machinery: noise is regulated by article 42 of Law 4/1994, article 44 of the executive regulations and table 1, annex 7.
- Ventilation is regulated by article 45 of Law 4/1994 and article 47 of the executive regulations.
- Smoking is regulated by article 46 of Law 4/1994 and article 48 of the executive regulations, and Law 52/1981.
- Work environment conditions are addressed in Law 137/1981 for Labor, Minister of Housing Decree 380/1983, Minister of Industry Decree 380/1982.

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
Carbon dioxide	5000	9000	15000	27000
Carbon monoxide	50	55	400	440
Sulfur dioxide	2	5	5	10

Table (12) Threshold limits for some air pollutants of concern

Substance	Threshold limit		Threshold limit for short periods	
	ppm	mg/m^3	ppm	mg/m^3
Acetone	750	1780	1000	2375
Aluminum metal and oxides	10		20	
Soldering smoke fumes	5			
Carbon dioxide	5000	9000	15000	27000
Carbon monoxide	50	55	400	440
Ethylene glycol vapor	50	125	50	125
Methyl Ethyl Ketone	200	590	300	885
Trichloro-ethylene	50	270	150	805
Soft timber dust		5		10
Xylene	100	435	150	655
Carbon tetrachloride			5	

4.5 Concerning hazardous material and waste

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

4.6 The Environmental Register

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

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

5. Pollution abatement measures

Pollution abatement is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes. It also includes practices that reduce the use of hazardous materials, energy, water or other resources, and practices that protect natural resources through conservation or more efficient use.

5.1 General concepts

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

The term Cleaner Production (CP) refers to the same concepts of pollution reduction through in-process, in-plant and resource conservation, in contradiction to end-of-pipe treatment. In many cases, the adoption of CP can eliminate the need for (EoP) treatment.
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 the effluent streams causing violation of Law 4 that takes into consideration the concentration of the pollutant rather than its load. Both energy and water conservation measures will provide both financial and economic benefits.

> ***Note*** :
> Pollution abatement is often cost effective because it may reduce raw material losses and reliance on expensive end-of-pipe treatment technologies and disposal practices. It may also conserve energy, water, chemicals, and other inputs.

Pollution prevention techniques and processes currently used by the metal fabricating and finishing industry can be grouped into seven general categories:

- Production planning and sequencing

- Process or equipment modification
- Raw material substitution or elimination
- Loss prevention and housekeeping
- Waste segregation and separation
- Closed-loop recycling
- Training and supervision

Each of these categories is discussed briefly below [6].

Production planning and sequencing is used to ensure that only necessary operations are performed and that no operation is needlessly reversed or obviated by a following operation. One example is to sort out substandard parts prior to painting or electroplating. A second example is to reduce the frequency with which equipment requires cleaning by painting all products of the same color at the same time. A third example is to schedule batch processing in a manner that allows the wastes or residues from one batch to be used as an input for the subsequent batch (e.g., to schedule paint formulation from lighter shades to darker) so that equipment need not be cleaned between batches.

Process or equipment modification is used to reduce the amount of waste generated. For example, manufacturers can change to a paint application technique that is more efficient than spray painting, reduce over-spray by reducing the atomizing air pressure, reduce drag-out by reducing the withdrawal speed of parts from plating tanks, or improve a plating line by incorporating drag-out recovery tanks.

Raw material substitution or elimination is the replacement of existing raw materials with other materials that produce less waste, or a non-toxic waste. Examples include substituting alkali washes for solvent degreasers, and replacing oil with lime or borax soap as the drawing agent in cold forming.

Loss prevention and housekeeping is the performance of preventive maintenance and equipment and materials management so as to minimize opportunities for leaks, spills, evaporative losses, and other releases of potentially toxic chemicals. For example, spray guns can be cleaned in a manner that does not damage leather packings and cause the guns to leak; or drip pans can be placed under leaking machinery to allow recovery of the leaking fluid.

Waste segregation and separation involves avoiding the mixture of different types of wastes and avoiding the mixture of hazardous wastes with non-hazardous wastes. This makes the recovery of hazardous wastes easier by minimizing the number of different hazardous constituents in a given waste stream. It also prevents the contamination of non-hazardous wastes. Specific examples include segregating scrap metal by metal type, and segregating different kinds of used oils.

Closed-loop recycling is the on-site use or reuse of a waste as an ingredient or feedstock in the production process. For example, in-plant paper fiber waste can be collected and recycled to make pre-consumer recycled paper products.

Training and supervision provides employees with the information and the incentive to minimize waste generation in their daily duties. This might include ensuring that employees know and practice proper and efficient use of tools and supplies, and that they are aware of, understand, and support the company's pollution prevention goals.

5.2 Pollution prevention options

Some of the most important techniques that may be useful to companies specializing in motor vehicle assembly are presented below. These are options available to facilities, but are not to be considered as requirements. The information is organized by metal shaping, surface preparation, plating, and other finishing operations besides motor vehicle assembly, dismantling/ shredding and auxiliary services such as power generation plants.
It should be stressed here that, what is given in the following, are examples of real applications of cleaner production in the fabricated metal products industry and not applications that are in the R & D stage. Through the internet, interested enterprises can easily obtain from [6], the addresses of societies which have already implemented successfully the suggested modifications.

5.2.1 Metal shaping operations

Production planning and sequencing	*Option 1* - Improve scheduling of processes that require use of varying oil types in order to reduce the number of clean-outs.
Process and equipment modification	*Option 1* - Standardize the oil types used for machining, turning, lathing, etc. This reduces the number of equipment clean-outs, and the amount of leftovers and mixed wastes. *Option 2* - Use specific pipes and lines for each set of metals or processes that require a specific oil in order to reduce the amount of clean-outs. *Option 3* - Save on coolant costs by extending machine coolant life through the use of a centrifuge and the addition of biocides. *Option 4* - Install a chip wringer to recover excess coolant on aluminum chips. *Option 5*- Install a coolant recovery system and collection vehicle for machines not on a central coolant sump *Option 6* - Use an ultra-filtration system to remove soluble oils from wastewater streams.

Raw material substitution	*Option 1* - In cold forming or other processes where oil is used only as a lubricant, substitute a hot lime bath or borax soap for oil. *Option 2* - Use a stamping lubricant that can remain on the piece until the annealing process, where it is burned off. This eliminates the need for hazardous degreasing solvents and alkali cleaners.
Waste segregation and separation	*Option 1* - If filtration or reclamation of oil is required before reuse, segregate the used oils in order to prevent mixing wastes. *Option 2* - Segregation of metal dust or scrap by type often increases the value of metal for resale (e.g., sell metallic dust to a zinc smelter instead of disposing of it in a landfill. *Option 3* - Improve housekeeping techniques and segregate waste streams (e.g., use care when cleaning cutting equipment to prevent the mixture of cutting oil and cleaning solvent.
Recycling	*Option 1* - Where possible, recycle oil from cutting/machining operations. Often oils need no treatment before recycling. *Option 2* - Oil scrap mixtures can be centrifuged to recover the bulk of the oil for reuse. *Option 3* - Follow-up magnetic and paper filtration of cutting fluids with ultrafiltration. By so doing, a much larger percentage of cutting fluids can be reused . *Option 4* - Perform on-site purification of hydraulic oils using commercial “off-the-shelf” cartridge filter systems. *Option 5* - Use a settling tank (to remove solids) and a coalescing unit (to remove tramp oils) to recover metal-working fluids.

5.2.2 Surface preparation operations

a) Solvent cleaning (degreasing)

Training and supervision	:*Option 1*: Improve solvent management by requiring employees to obtain solvent through their shop foreman. Also, reuse waste solvents from cleaner up-stream operation in down- stream, machines shop type processes.
Production planning and sequencing	*Option 1* - Pre-cleaning will extent the life of the aqueous or vapor degreasing solvent (wipe, squeeze, or blow part with air, shot, etc.). Aluminum shot can be used to pre-clean parts. *Option 2* - Use countercurrent solvent cleaning (i.e., rinse initially in previously used solvent and

progress to new, clean solvent).

Options 3 - Cold clean with a recycled mineral spirits stream to remove the bulk of oil before final vapor degreasing.

Option 4 - Only degrease parts that must be cleaned. Do not routinely degrease all parts.

Process or equipment modifications

Option 1 - The loss of solvent to the atmosphere from vapor degreasing equipment can be reduced by:

- Increasing the freeboard height above the vapor level to 100 percent of tank width;
- Covering the degreasing unit (automatic covers are available);
- Installing refrigerator coils (or additional coils) above the vapor zone;
- Rotating parts before removal from the vapor degreaser to allow all condensed solvent to return to degreasing unit;
- Controlling the speed at which parts are removed (3 metres or less per minute is desirable) so as not to disturb the vapor line;

Option 2 - Reduce grease accumulation by adding automatic oilers to avoid excess oil applications.

Option 3 - Use plastic blast media for paint stripping rather than conventional solvent stripping techniques

Raw material substitution

Option 1 - Use less hazardous degreasing agents such as petroleum solvents or alkali washes. For example, replace halogenated solvents (e.g., trichloroethylene) with liquid alkali cleaning compounds. (Note that compatibility of aqueous cleaners with wastewater treatment systems should be ensured.)

Option 2 – Prefer water-based surface cleaning agents where feasible, instead of organic cleaning agents, some of which are considered toxic [12]. Try to optimize bath operation to enhance efficiency, e.g. by agitation.

Option 3 - Substitute chromic acid cleaner with non-fuming cleaners such as sulfuric acid and hydrogen peroxide.

Throughput Information: rinse water flowrate of 2 gallons per minute.

Option 4 - Substitute less polluting cleaners such as tri-sodium phosphate or ammonia for cyanide cleaners.

Recycling

Option 1 - Recycle spent degreasing solvents on site using batch stills

Option 2 – Acid mists and vapors should be scrubbed with water before venting and recycled solvent collected from air pollution control systems. In some cases VOC levels of the vapors are reduced bu use of carbon filters, which allow the reuse of solvents [10].

Option 3 - When on-site recycling is not possible, agreements can be made with supply companies to remove old solvents.

Option 4 - Arrange a cooperative agreement with other small companies to centrally recycle solvent.

Option 5 – Manage properly the residue from solvent recovery (e.g. blending with fuel and burning in a combustion unit with proper controls for toxic metals).

Option 6 – Clean degreasing solutions to extend lifespan (by skimmimg, centrifuge, etc.) and recirculation, reutilization of oily sludge.

b) Chemical treatment

Process or equipment modification

Option 1- Increase the number of rinses after each process bath and keep the rinsing counter-current in order to reduce drag-out losses.

Option 2 - Recover unmixed acids in the wastewater by evaporation.

Option 3 - Reduce rinse contamination via drag-out by:

- Slowing and smoothing removal of parts, rotating them if necessary;
- Using surfactants and other wetting agents;
- Maximizing drip time;
- Using drainage boards to direct dripping solutions back to process tanks;
- Installing drag-out recovery tanks to capture dripping solutions;
- Using a fog spray rinsing technique above process tanks;
- Using techniques such as air knives or squeegees to wipe bath solutions off of the part; and
- Changing bath temperature or concentrations to reduce the solution surface tension.

Option 4 - Instead of pickling brass parts in nitric acid, place them in a vibrating apparatus with abrasive glass marbles or steel balls. A slightly acidic additive is used with the glass marbles, and a slightly basic additive is used with the steel balls

Option 5 - Use mechanical scraping instead of acid solution to remove oxides of titanium.

Option 6 - For cleaning nickel and titanium alloy, replace alkaline etching bath with a mechanical abrasive system that uses a silk and carbide pad and pressure to clean or "brighten" the metal.

Option 7 - Clean copper sheeting mechanically with a rotating brush machine that scrubs with pumice, instead of cleaning with ammonium persulfate, phosphoric acid, or sulfuric acid which may generate non-hazardous waste sludge.

Option 8- Reduce molybdenum concentration in wastewater by using a reverse osmosis/precipitation system.

Option 9 - When refining precious metals, reduce the acid/metals waste stream by maximizing reaction time in the gold and silver extraction process.

Raw material substitution

Option 1 - Change copper bright-dipping process from a cyanide dip and chromic acid dip to a sulfuric acid/hydrogen peroxide dip. The new bath is less toxic and copper can be recovered.

Option 2 - Use alcohol instead of sulfuric acid to clean copper wire. One ton of wire requires 4 liters of alcohol solution, versus 2 kilograms of sulfuric acid.

Option 3 - Replace caustic wire cleaner with a biodegradable detergent.

Option 4 - Replace barium and cyanide salt heat treating with a carbonate/chloride carbon mixture, or with furnace heat treating.

Recycling

Option 1 - Sell waste pickling acids as feedstock for fertilizer manufacture or neutralization/precipitation.

Option 2 - Recover metals from solutions for resale.

Option 3 - Send used copper pickling baths to a continuous electrolysis process for regeneration and copper recovery.

Option 4 - Recover copper from brass bright dipping solutions using a commercially available ion exchange system.

Option 5 - Treat industrial wastewater high in soluble iron and heavy metals by chemical precipitation.

Option 6 - Oil quench baths may be recycled on site by filtering out the metals.

Option 7 - Alkaline wash life can be extended by skimming the layer of oil (the skimmed oil may be reclaimed).

5.2.3 Surface finishing operations

a) Plating

Training and supervision	*Option 1* - Educate plating shop personnel in the conservation of water during processing and in material segregation.
Production planning and sequencing	*Option 1*: Pre-inspect parts to prevent processing of obvious rejects
Process or equipment modification	*Option 1* - Modify rinsing methods to control drag-out by: • Increasing bath temperature • Decreasing withdrawal rate of parts from plating bath • Increasing drip time over solution tanks; racking parts to avoid cupping solution within part cavities • Shaking, vibrating, or passing the parts through an air knife, angling drain boards between tanks • Using wetting agents to decrease surface tension in tank. *Option 2* - Utilize water conservation methods including: • Flow restrictors on flowing rinses • Counter current and cascade rinsing systems • Reactive rinsing • Conductivity controllers • Flow control valves.

Option 3 Reduce the drag out [10]:

- Minimize drag-out through effective draining of bath solutions from the plated part, e.g. by making drain holes in bucket-type pieces, if necessary.
- Use drip bars,and/or drain boards between tanks.
- Increase parts drainage time to reduce drag-out, e.g. by allowing dripping time of at least 10-20 seconds before rinsing.
- Use fog spraying of parts while dripping.
- Maintain the density, viscosity and temperature of the baths to minimize drag-out.
- Place recovery tanks before the rinse tanks (also yielding makeup for the process tanks). The recovery tank provides for static rinsing with high drag-out efficiency.
- Install ion exchange system, or reverse osmosis system or electrolytic metal recovery, or electrodialysis to reduce generation of drag-out.
- Reuse drag-out waste back into process tank.

Option 4 – Rationalize the management of process baths [12].

- Recycle process baths after concentration and filtration. Spent bath solutions should be sent for recovery and regeneration of plating chemicals, not discharge into wastewater treatment units.
- Regenerate plating bath by activated carbon filtration to remove built up organic contaminants.
- Regularly analyse and regenerate process solutions to maximize useful life.

- Clean racks between baths to minimize contamination.

Option 5 - Install pH controller to reduce the alkaline and acid concentrations in tanks.

Option 6 - Improve control of water level in rinse tanks, improve sludge separation, and enhance recycling of supernatant (floating on the surface) to the process by aerating the sludge.

Raw material substitution	*Option 1* - Substitute cyanide plating solutions with alkaline zinc, acid zinc, acid sulfate copper, pyrophosphate copper, alkaline copper, copper fluoborate, electroless nickel, ammonium silver, halide silver, methanesulfonate-potassium iodide silver, amino or thio complex silver *Option 2* - Substitute sodium bisulfite and sulfuric acid for ferrous sulfate in order to oxidize chromic acid wastes, and substitute gaseous chlorine for liquid chlorine in order to reduce cyanide reduction. *Option 3* - Replace hexavalent chromium with trivalent chromium plating systems. *Option 4* - Replace conventional chelating agents such as tartarates, phosphates, and ammonia with sodium sulfides and iron sulfates in removing metal from rinse water which reduces the amount of waste generated from precipitation of metals from aqueous wastestreams. *Option 5* - Replace methylene chloride, 1,1,1-trichloroethane, and perchloroethylene (solvent-based photochemical coatings) with aqueous base coating of 1 percent sodium carbonate *Option 6* - Replace methanol with nonflammable alkaline cleaners. *Option 7* – Replace galvanizing processes requiring high temperature and flux with one that is low temperature and does not require flux.
Waste segregation and separation	*Option 1* - Wastewater containing recoverable metals should be segregated from other wastewater streams.

Note:
Several different waste streams will generally oeriginate from a single metal finishing plant. The different composition and concentrations of waste streams will require different treatment procedures. Segregation and separate pretreatment of certain effluents is more efficient than trying to treat a complex mixed wastewater stream. Segregation of different types of wastewaters also avoids the possibility that incompatible wastes will undergo undesirable reactions in the storage tanks. Undesirable reactions can be a hazard to personel by generating toxic gases (lethal hydrogen cyanide gas) or complexes may form, e.g. nickel cyanide, which are difficult to treat. Various options to treat waste effluents should be carefully assessed for each entreprise.

Recycling	*Option 1* Reuse rinse water. *Option 2*- Reuse drag-out waste back into process tank. *Option 3*- Recover process chemicals with fog

rinsing parts over plating bath
Option 4- Evaporate and concentrate rinse baths for recycling.
Option 5- Convert sludge to smelter feed
Option 6- Remove and recover lead and tin from boards by electrolysis or chemical precipitation.
Option 7 - Install a closed loop batch treatment system for rinse water to reduce water use and waste volume
Option 8.- Implement the electrodialysis reversal process for metal salts in wastewater.
Option 9.- Oxidize cyanide and remove metallic copper to reduce metal concentrations.

b) Painting operations

Training and supervision

Option 1: Always use proper spraying techniques
Option 2: Improved paint quality, work efficiency, lower vapor emissions can be attained by formal training of operators
Option 3: Avoid buying excess finishing material at one time due to its short shelf-life

Production planing and sequencing

Option 1: Use the correct spray gun for particular applications:

- Conventional air spray gun for thin film build requirements
- Airless gun for heavy film application
- Air assisted airless spray gun for a wide range of fluid output

Option 2: pre-inspect parts to prevent painting of obvious rejects

Process or equipment modification

Option 1: Ensure the spray gun air supply is free of water, oil and dirt
Option 2: Investigate use of transfer methods that reduce material loss such as:

- Dip and flow coating
- Electrostatic spraying
- Electro-deposition

Option 3 - Change from conventional air spray to an electrostatic finishing system.
Option 4 - Use solvent recovery or incineration to reduce the emissions of volatile organics from curing ovens.

Raw material substitution

Option 1. Use alternative coatings for solvent based paints to reduce volatile organic materials use and emissions. Such as:

- High solids coatings (this may require modifying the painting process; including high speed/high pressure equipment, a paint distributing system, and paint heaters): Waste savings/reduction: 30 percent net savings in applied costs per square foot.

- Water based coatings, waste savings/reduction: 87 percent drop in solvent emissions and decreased hazardous waste production
- Powder coatings

Waste segregation and separation	*Option 1*: Segregate non hazardous paint solid from hazardous paint solvents and thinners
Recycling	*Option 1* - Do not dispose of extended shelf life items that do not meet your facility's specifications. They may be returned to the manufacturer, or sold or donated as a raw material. *Option 2* - Use activated carbon to recover solvent vapors, then recover the solvent from the carbon by steam stripping, and distill the resulting water/solvent mixture. *Option 3* - Regenerate caustic soda etch solution for aluminum by using hydrolysis of sodium aluminate to liberate free sodium hydroxide and produce a dry, crystalline hydrate alumina byproduct.

c) Paint clean-up

Production planning and sequencing	*Option 1*: Reduce equipment cleaning by painting with lighter colors before darker ones. *Option 2* - Reuse cleaning solvents for the same resin system by first allowing solids to settle out of solution. *Option 3* - Flush equipment first with dirty solvent before final cleaning with virgin solvent. *Option* 4 - Use virgin solvents for final equipment cleaning, then as paint thinner. *Option 5* - Use pressurized air mixed with a mist of solvent to clean equipment.
Raw material substitution	*Option 1* - Replace water-based paint booth filters with dry filters. Dry filters will double paint booth life and allow more efficient treatment of wastewater.
Loss prevention and housekeeping	*Option 1*: To prevent spray gun leakage. Submerge only the front end (or fluid control) of the gun into the cleaning solvent.

Waste segregation and separation	*Option 1*: Solvent waste streams should be kept segregated and free from water contamination.
Recycling	*Option 1* - Solvent recovery units can be used to recycle spent solvents generated in flushing operations. • Install a recovery system for solvents contained in air emissions. • Use batch distillation to recover xylene from paint equipment cleanup. • Use a small solvent recovery still to recover spent paint thinner from spray gun cleanups and excess paint batches. • Install a methyl ethyl ketone solvent recovery system to recover and reuse waste solvents. *Option 2* - Arrange an agreement with other small companies to jointly recycle cleaning wastes.

5.2.4 Auxiliary equipment

a) Fuel combustion equipment

Fuel combustion is an important source of pollution and the following measures can be implemented to reduce pollution.

Flue gases	*Particulate matter* in flue (exhaust) gases are due the ash and heavy metal content of the fuel, low combustion temperature, low excess oxygen level, high flow rate of flue gases. *Sulfur dioxide* is due to the sulfur content of the fuel. *Nitrogen oxides* are formed when maximum combustion temperature and high excess oxygen. *Carbon monoxide* is formed when incomplete combustion occurs at low air to fuel ratio. The following measures can be adopted to minimize air pollution from flue (exhaust) gases: • Replace Mazot by solar or natural gas. Mazot is high in sulfur content. • Regulate the fuel to air ratio for an optimum excess air that ensures complete combustion of carbon monoxide to dioxide. • Keep the combustion temperature at a moderate value to minimize particulate matter and nitrogen oxides.

b) Wastewater Treatment Plant

End-of-pipe treatment	• If cyanide is present in the wastewater, its destruction (oxidation of cyanide) must be performed upstream of the other treatment processes.

- If hexavalent chromium exists in the wastewater, the wastewater must be pre-treated to reduce the chromium to a more easily precipitated trivalent form using a reducing agent, such as sulfur compounds (e.g. sulfur dioxide gas, sodium metabisulfite).
- The common wastewater treatment processes are equalization, pH adjustment for precipitation, flocculation and sedimentation/filtration. The optimum pH for metal precipitation is usually in the range of 8.5 to11, but this depends on the mixture of metals present.
- Wastewaters containing soluble metals can be treated by chemical precipitation either by continuous process or as batch treatment. Normally calcium or sodium hydroxide is used for precipitation and therefore metals are precipitated as metal hydroxides. After precipitation, metals can be separated by clarification and sedimentation and/or filtration. Metal hydroxide sludge can be dewatered e.g. with a filter press.
- The presence of significant levels of oil and grease may affect the effectiveness of the metal precipitation process; hence the level of oil and grease affects the choice of the treatment options and the treatment sequence. It is preferred that the degreasing baths be treated separately. Also the presence of complexing agents may affect the effectiveness of the metal precipitation.
- Flocculating agents are sometimes used to facilitate the filtration of suspended solids. Modern wastewater treatment systems use ion exchange, membrane filtration, and evaporation to reduce the release of toxics and the quality of effluent that needs to be discharged.

c) Water conservation measures

- Install water meters;
- 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 to minimize floor washing.

5.3 Possible Pollution Prevention future plans

There are numerous pollution prevention trends in the metal fabrication and finishing industry. These include recycling liquids, employing better waste control techniques, using mechanical forms of surface preparation, and/or substituting raw materials. One major trend is the increased recycling (e.g., reuse) of most process liquids (e.g., rinse water, acids, alkali cleaning compounds, solvents, etc.) used during the metal forming and finishing processes. For instance, instead of discarding liquids, companies are containing them and reusing them to cut down on the volume of process liquids that must eventually be disposed of. Also, many companies are replacing aqueous plating with ion vapor deposition.

Another common approach to reducing pollution is to reduce rinse contamination via drag-out by slowing and smoothing the removal of parts (rotating them if necessary), maximizing drip time, using drainage boards to direct dripping solutions back to process tanks, and/or installing drag-out recovery tanks to capture dripping solutions. By slowing down the processes and developing structures to contain the dripping solutions, a facility can better control the potential wastes emitted.

To reduce the use of acids when cleaning parts, the industry is using and encouraging the use of mechanical scraping/scrubbing techniques to clean and prepare the metal surface. Emphasizing mechanical approaches would greatly diminish the need for acids, solvents, and alkalis. In addition to the mechanical technique for cleaning surfaces, companies are encouraged to substitute acids and solvents with less harmful liquids (e.g., alcohol).

6. Industrial inspection

The inspection of the motor vehicle assembly industry will follow the procedures described in the General Inspection Manual, GIM (EPAP, 2002). 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 motor vehicle assembly Industry.

The overall purpose of inspections is to enforce environmental laws. Table (13) lists the various types of inspections and the objectives that have to be fulfilled for each type.

Table (13) 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 motor vehicle assembly Industry

Taking the comprehensive inspection as an example, the objectives stated in Table (13) dictate the activities required for covering all aspects of compliance with environmental laws and regulations. The required personnel, equipment and logistics are determined accordingly.

> ***Note to inspectorate management***:
> *Usually small and medium size facilities cannot afford the cost of treatment. Repeated inspections and fines would not solve the problem. Inspectorate management should have a clear plan on how to proceed with these facilities even if the plan is to ignore temporarily these facilities.*

7.2 Providing information about the facility

Motor vehicle assembly facilities will typically have assembly lines that start with the receiving and storage of parts. These parts may need surface preparation and finishing before being brought to the assembly line. Painting is an essential operation in these facilities as well as plants for fabricating metal parts. The size of the fabricated metal depends on the percentage of local manufacturing in the agreement with the foreign counterpart. Mechanical and electrical workshops are major service units in this industry. The processes related to metal fabrication are not included in this manual. The inspectors are referred to the Inspection manual for the Fabricated Metal products for information dealing with metal shaping, metal preparation and metal finishing to avoid repetition. The checklists for such operations will also be found in the sector-specific guidelines for Fabricated Metal.

Chapters (2-5) present the technical aspects regarding the industry (except for the metal fabrication workshops), 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.

Other sources of information can be found on the Internet at the following sites:

- http://www.eippcb.jrc.es/pages/FActivities.htm;
- http://www.epa.gov/oeca/sector;

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 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.

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) but they should be tailored to the inspected facility to include operations that are dealt with in other sector manuals.

8. Preparation for field inspection (inspection team)

As presented in the General Inspection manual, GIM (EPAP-2002), 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 dairy 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 in this manual for the motor vehicle assembly as well as relevant information found in the inspection manual for the Fabricated Metal products industry (chapters 2-5 in each manual). The inspectors should check - if possible - what production operations and service units are present at the targeted facility. In addition to the required information listed in Annex (C) 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 motor vehicle assembly 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:

- The inspection team could be divided into smaller groups. Each group will be responsible for inspecting a specific plant at the facility or the 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-2002).
- 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.*
> - *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 fabricated metal products 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 operation/service unit independently and for includes all the relevant environmental aspects and media. The inspection team will compile the checklists relevant to existing production processes 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 operations with their pollution sources.
- Identify the areas of possible non-compliance and the parameters that need checking. For example, noise should be checked near machinery and temperature and light intensity in casting operations.
- Identify what to observe, ask and/or estimate that can convey information about pollutants. For example:
  - The type of working and cutting oil will determine the type of VOC to be checked in air.
  - Oily effluents from production processes 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 operations is an important indicator of the final discharge quality***.**

8.4 Legal aspects

As evident from chapter 2, a motor vehicle assembly facility is expected to be in violation of several environmental laws, specifically with respect to workplace air quality if no pollution abatement measures are implemented. 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 judgement.

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. 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.*
- *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 holding tanks are not properly lined, underground water contamination 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*

Production operations

Foundry Operations

Mold preparation

Refer to fig.1-General foundry flow diagrams

- If sand molds are fabricated in the facility
- List the chemicals used in the molding process ?
- Does core baking utilize fuel or electricity ?
- Is metal melting performed by electricity or fuel ?

In case of using fuel

- Check the flue gases analysis and chimney height.

Note : *Using mazot fuel in residential areas is prohibited by the law*

- Check the temperature and light intensity
- Are there a protective measures for workers handling melted metal ?
- Are there measurements for dust emissions created during sand preparation, molding and shake out of the cast ?
- Check air analysis results for lead, cadmium, particulate, sulfur sulfur dioxide emitted during melting of iron
- Check the ventilation system in place
- Are there cyclones for air pollution control ?

Note: Crystalline silica in the sand is carcinogenic

- What happens to solid waste (Baghouse dust) generated from the process ?
- What happens to solid waste generated from metal cleaning operations (grinding, chipping…..etc)
- Check for heavy metal in the wastewater, if wet scrubber are used as air pollution control

Metal Fabrication

- Refer to the Inspection Manual for fabricated metal products industry

Assembly Line

- Check for noise in the work place
- Are there any hazardous material used in cleaning process
- What happens to solid waste generated from parts packaging
- What is the disposal way of faulty equipment and parts

Motor Vehicle Painting/Finishing

- List the type of pigments used in paint , organic or inorganic (see table 3)
- Check the presence of VOC emissions during painting ?
- Check ventilation
- If spray painting is used
  - Is there a water curtain for minimizing air emissions?
  - Are the workers using protective measures?
  - Record the amount of contaminated effluent from water curtains
  - Record the schedule of discharging the electrodeposition bath containing lead
  - Record the schedule of discharging the painting baths (Zinc phosphate bath,….etc)
- Check the sources of solid and liquid phase wastes from :
  - Equipment washing and drying,
  - Excess paints discarded after expiration of the paint shelf life,
  - Paint application devices.
- Estimate the contribution of cleaning solvents, dry powder paint and still bottom wastes to solid and liquid wastes

Post Production Motor Vehicle Dismantling/Shredding

- What are the different types of wastes ?
  - Which type is reprocessed for reuse and which type sent to energy recovery facilities
- What type of solid waste must be landfilled in authorized discharges ?

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.
Cooling	- The amount of blowdown from the cooling towers is about 10-15% of the make-up water and is low in BOD

towers		and high in TDS.
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 4.
	-	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 and their limits.
Sampling	-	A sample must be taken from each final disposal point. 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. The facility management should sign the inspection report, but it is not necessary. A closing meeting with the facility management can be held to discuss findings and violations.

> *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 GIM (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 Motor Vehicles Assembly Facility

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- LA T(Latitude):……… LONG(Longitude):…….

Production

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

Water Supply

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

Canal water ❑ Other………….. ❑

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

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 ❑

Ministry of Environmental Affairs-EEAA
30 Misr Helwan Agricultural road - Maadi- Cairo 11728
Tel. (02)5256452-(02)5256453 Ext.8849 Fax(02)5256490

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 Boilers and Water Treatment Units

1. General	
1.1 Boiler number and capacity	--- --- ---
1.2 Type of fuel used for boilers In case of using mazot for boilers Is it a dwelling zone Note :	☐ Mazot ☐Solar ☐ Yes ☐No
Note : The use of mazot as fuel in the dwelling zone is Prohibited by law.	
1.3 What is the method used for water treatment	☐ Lime process ☐ Reverse osmosis ☐ Other
2. Status of Air Pollution	
2.1 What is the height of the chimney	---
Note : the height of the chimney must be 2.5 times the height of adjacent buildings.	
2.2 If mazot is used in non dwelling regions, or smoke is detected	Are there analyses of the flue gases for sulfur dioxide, carbon monoxide, and particulate matter ☐ Yes ☐No If Yes Are they enclosed in the environmental register ☐ Yes ☐No If No Ask for preparation of these records and their inclusion in the environmental register
Note : Perform analysis, if necessary	
3. Status of Effluent (wastewater)	
3.1 What is the blow down rate from the boilers	-- m^3/d
3.2 What are the blow down and back wash rates for the treatment units	-- m^3/d -- m^3/d
3.3 Steam condensate is	☐ Recycled to the boiler ☐Discharged to the sewer
4. Status of Solid Waste	
4.1 If the lime method is used, sludge is generated. What is the amount of sludge produced per day	---

4.2 What is the sludge disposal method	---
5. Storage and Handling of Hazardous Material	
5.1 Check the storage of chemicals used in the treatment process. Is it in compliance with law 4?	❑ Yes ❑ No
5.2 Is there any fuel leaks from fuel tanks	❑ Yes ❑ No
5.3 Is there any fire extinguishing devices and equipment	❑ Yes ❑ No
5.4 Is there a spill prevention plan	❑ Yes ❑ No
5.5 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 --- --- ---
6. Status of Work Environment	
6.1 Check the noise next to the boilers	---
6.2 Check the heat stress next to the boilers	---
6.3 Are there any existing measurements? Are they included in the environmental register?	❑ Yes ❑ No ❑ Yes ❑ No

Checklist for Cooling Towers

1.General	
1.1 Number and capacity of cooling towers	-- --
1.2 Cooling tower make-up rate Note : Blow down = 10-15% of make-up	Rate: ---m^3/d Blowdown: ----------------------------------m^3/d
2. Status of the Effluent	
2.1 Cooling water is performed in	☐ Open Cycle ☐Closed Cycle
Note : If performed in open cycle it will dilute the final effluent	
2.2 Record the amount of open cycle cooling water	-- -- --

Checklist for Garage

1. General	
1.2 Is there any detergent or solvent used for washing equipment parts, trucks, floor,….etc	☐ Yes ☐No
1.3 What is the amount of oil and grease used per day?	--
1.4 What is the amount of spent lube oil produced per day ?	--
1.5 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 --

Check list for Laboratories

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 Material	
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

Checklist for Wastewater Treatment Unit

1. General	
1.1 What is the capacity of WWTP	---
1.2 Specify the units included in WWTP :	
Pumping station	☐ Found ☐Not found
Equalization tank	☐ Found ☐Not found
Aeration tank (ditch or channel)	☐ Found ☐Not found
Final sedimentation tank	☐ Found ☐Not found
Sludge thickening tank	☐ Found ☐Not found
Sludge drying	☐ Found ☐Not found
Others	☐ Found ☐Not found
1.3 List any chemical and their quantity used for wastewater treatment	--- --- --- --- ---
2. Status of Effluent	
2.1 Are there analyses for the effluent If not Make your own	☐ Yes ☐No
2.2 Are the results of the analysis included in the environmental register	☐ Yes ☐No
3. Status of Solid Waste	
3.1 Determine the sludge disposal method *Note : It can be use in liquid or dry form, in agriculture*	--
If a third party is involved in disposal, get documents for proof	☐ Found ☐Not found Comment --- --- --- ---

Checklist for Foundry Operation

1. General	
1.1 The housekeeping status Floor condition Wash water leaks Piling of solid waste	 -- -- --
1.2 Make sure that the operation line is operated	--
1.3 Type of operation	❑ Batch ❑ Continuous
1.4 Amount of raw material processed per day and per shift	----------------------------------Ton/ shift ----------------------------------Ton/ day
1.5 If sand molds are fabricated in the facility • Is core baking utilize fuel or electricity • Is metal melting perform by electricity or fuel	 ❑ Electricity ❑ Fuel ❑ Electricity ❑ Fuel
1.6 ***In case of using fuel*** Check the flue gases analysis and chimney height	--
Note : Using mazot fuel in the residential areas is prohibited by the law	

2. Status of Gaseous Emissions	
2.1 Check stacks emissions measurements - Are they included in the environmental register - Do they include heavy metals	 Yes ❑ No ❑ Yes ❑ No ❑
2.2 In case of suspecting the measurement, then take your own one.	
2.3 Identify the stack height w.r.t the building height.	----------------------------
Note*: The stack height should be 2.5 the height of surrounding buildings*	

3. Status of the Work Environment	
3.1 Check for thermal stress and light intensity	--
3.2 Are there a protective measures for workers handling melted metal	❑ Yes ❑ No
3.3 Are there measurement for dust emissions created during sand preparation, molding and shake out of cast	❑ Yes ❑ No
3.4 Check for the analysis for lead, cadmium, particulate matter, sulfur dioxide in air generated during melting of iron	-- -- --
3.5 Check the ventilation system in place	--
3.6 Are there cyclones for air pollution control	❑ Yes ❑ No
Note : Crystalline silica in the sand is carcinogenic.	

4. Status of Effluents (Wastewater)	
Check for heavy metal in the wastewater, if wet scrubber are used as air pollution control	--
5. Status of Solid Waste	
5.1 What happens to solid waste (baghouse dust) generated from the process	--
5.2 What happens to solid waste generated from cleaning operations (grinding. Chipping,….etc)	--
6. Status of Hazardous Materials	
If sand molds are fabricated in the facility List the chemicals used in the molding process	-- -- --

Checklist for Motor Vehicle Painting /Finishing

1. General	
1.1The housekeeping status Floor condition Solid waste accumualtion	---
1.2 Make sure that the operation is operated	---
1.3 Type of operation	❑ Batch ❑ Continuous
1.4 Amount of raw material processed per day and per shift	-------------------------------------Ton/shift -------------------------------------Ton/day
1.5 List the type of pigments used in paints (organic or inorganic)	---
2. Status of Effluents (wastewater)	
2.1 If spray painting is used. Is there a water curtain	---
2.2 Record the amount of contaminated effluent from water curtains	---
2.3 Record the schedule of discharging the electrideposition bath contains lead	---
2.4 Record the schedule of discharging the painting baths (zinc phosphate bath,…etc)	---
3. Status of Solid Waste	
Is solid waste produced from cleaning solvents, dry powder paint and still bottom waste	--- ---
4. Status of Work Environment	
4.1 Check the presence of VOC emissions during painting ?	---
4.2 check for the presence of efficient ventilation system	---
4.2 If spray painting is used. Are the workers using protective measures	---

Checklist for Assembly Line

1. General	
1.1The housekeeping status Floor conditions Piling of solid waste	--
1.2 Make sure that the operation is operated	--
1.4 Amount of raw material processed per day and per shift	------------------------------------Ton/ shift ------------------------------------Ton/ day
2. Status of the Work Environment	
2.1 Check for noise in the work place	--
3. Status of Solid Waste	
3.1 What happens to solid waste generated from parts packaging	--
3.2 What is the disposal way of faulty equipment and parts	--
4. Status of Hazardous waste	
4.1 Are there any hazardous waste generated from the process	❑ Yes ❑ No

Checklist for Post Production Motor Vehicle Dismantling/ Shredding

1. Status of Solid Waste	
1.1 What are the kinds of solid wastes	--
1.2 Which type reprocessed for reuse and which type sent for energy recovery facilities	-- -- --
1.3 What type of solid waste must be landfilled in authorized discharges	--