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FINAL REPORT

REVIEWING OPPORTUNITIES FOR WASTE MINIMIZATION/ CLEANER PRODUCTION WITHIN THE METAL FINISHING INDUSTRY IN SRI LANKA

INDUSTRIAL POLLUTION REDUCTION PROGRAMME
SUB CONTRACT DG/SRL/91/ 091

Submitted To

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

BY

RESOURCE ORGANIZATION & MANAGEMENT INTERNATIONAL (PRIVATE) LIMITED (ROMIN)

March, 1998

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tables
diagrams

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EXECUTIVE SUMMARY

The amount of recorded information available to assess the current status of the metal finishing industry in Sri Lanka is very limited. There are approximately 200 metal finishing shops in the country. As most of these shops are not registered they are operating under cover. The shops vary in size, from being very small to large.

Technologies applied in the metal finishing sector are quite conservative and the processes adapted are not very stream lined. The general awareness of the industrialists about the environmental impacts due to the industrial processes of the metal finishing process is negligible. This is mainly due to lack of knowledge and interest about the environment.

Several efforts have been made in the past to conduct surveys and systematically record data about this industry, but these attempts have been unsuccessful due to various reasons.

There are many opportunities to improve this industry through waste minimization, therefore a well implemented waste minimization programme will be highly beneficial to the industry. An awareness building programme to educate the industrialists and the general public and enforcement of environmental rules and regulations are extremely important to achieve this. Support from the Local Government Authorities has to be sought and will be crucial for the success of such a programme.

Metal finishing processes used in Sri Lanka include :

Conventional Electroplating, Hot dip galvanizing, Anodizing, Grinding, Polishing, Phosphating, Painting, Powder coating, Heat treatment and Vitreous enameling

Out of the above mentioned processes, the most commonly used methods are:

Zinc Electroplating, Hot Dip Galvanizing and Copper-Nickel-Chromium Electroplating

How the study was conducted

Information was collected about the metal finishing sector in Sri Lanka. General information about the industry was collected from studying the limited accessible literature and through discussions with various institutions such as the IDB (Industrial Development Board, CISIR (Ceylon Institute for Scientific & Industrial Research), the CEA (Central Environmental Authority) and the various chemical suppliers & end users. Concise data about the industries was collected by conducting a survey of 64 companies in the metal finishing sector in Sri Lanka.

After recording the data collected, from the 64 companies surveyed six companies were chosen, on which detailed studies would be carried out. Due to one of these 6 companies

closing down half way through the study, complete studies were conducted on 5 companies in the sector.

By analysing the data collected from this study, the following conclusions were drawn about the metal finishing sector in Sri Lanka.

- Metal finishing is not an organized industry in Sri Lanka and information available about this industry is very limited.

- The implementing agencies such as the Central Environmental Authority and the Industrial Development Board have very little information about these metal finishing shops/ companies. This is a major constraint in further developing this industry and also in reducing environmental pollution.

- The majority of the metal finishing shops are unregistered and operate undercover.

- From analysing the data collected on 64 companies in the metal finishing sector, it was concluded that approximately 18% of the companies could be categorized as being large, 21% as medium and 61% as being small to very small.

- As a whole the metal finishing sector uses very poor technology.

- The knowledge of waste treatment, cleaner production and waste minimization is negligible within the industry. A small percentage of companies are treating wastes in end of pipe control mode, but preventing waste at the source/ using closed loop recovery systems is not understood or commonly practiced.

- Wastes are let out directly to natural water bodies such as the Kelani river and the Bolgoda lake without any form of treatment, thereby polluting the surrounding environment. If the solid and water wastes were recycled a lot of money could be saved by the companies.

- The industry as a whole, is suffering from poor house keeping, poor rinsing, poor process line configuration and lack of recovery/ reuse technologies.

- The 5 companies studied were each handicapped in various areas, the majority of the problems faced being common to all of them i.e. poor house keeping, lack of new technology, unnecessary wastage of resources etc.

- As most the equipment used in this industry are of considerable age, they are of low efficiency and therefore a lot of energy is wasted in the metal finishing process.

- No proper housekeeping methods were apparent at any of the company premises.

- Non of the companies studied had a waste minimization program and their approach to environmental matters was poor.

- Waste minimization options were found and recommended for each of the 5 companies; these options were found to be cost effective and would reduce the production/ operational costs and energy consumption.

This report presents :

- The information relevant to the current status of the metal finishing sector in Sri Lanka.

- Environmental audits for 5 metal finishing companies in Sri Lanka.

- A waste minimization study for each of the 5 metal finishing companies studied.

1.0 INTRODUCTION

With the recent expansion of economic activities, the demand for metal finishing has been rapidly increasing in Sri Lanka. In order to meet this increased demand, the industry needs to make it's products and services available to the market in an efficient manner whilst meeting the required environmental standards.

United Nations Industrial Development Organization (UNIDO) initiated this study on the metal finishing sector in Sri Lanka, with the aim of reducing pollution from industrial operations in Sri Lanka with an emphasis on source reduction.

The scope of this study :

1. To review the metal finishing industry in Sri Lanka on a short time scale, with a view of obtaining the following information :
    - Name, address & telephone numbers of the factories and head offices and name of Director/ Owner/ Chairman.
    - Types of products, production capacity and actual production quantities.
    - Brief description of the processes & equipment used
    - Water, material & energy use water, material & energy use per unit production.
    - Total waste outputs in terms of degree of pollution
    - Approximate waste output per unit production
    - Nature of bodies receiving effluents and condition of these.
    - Estimate of potential for implementing successful waste minimization procedures.
    - Survey of waste generation and disposal practices of small metal finishers
    - Any possibility of recycling or reuse.

2. Based on the data collected and in association with UNIDO & Central Environmental Authority to select 6 companies to for in-depth waste audits, using IPRP methodology.

This report contains the findings of a study carried out to assess the present situation of the industry including it's scope, size, problems involved and recommendations for improvement, with special reference to the environmental issues concerned.

1.1 The Scope of the Metal Finishing Industry in Sri Lanka

The metal finishing process is widely needed for automobile engineering and builders' hardware including metal handicraft components to give them a decorative appearance and to protect them from atmospheric corrosion.

The process also helps to extend the life of components such as automobile pistons, crankshafts, printing rollers, injectors, and compression moulding dyes for plastic components so as to get a better finish and functional properties.

The metal finishing industry involves the use of a great deal of chemicals and other compounds, various metals, water electricity and other fuels etc. As the industry is not systematically operated, high proportions of these valuable resources are wasted. This gives rise to two problems :

* the cost of production is unnecessarily increased

* excessive amounts of effluents and emissions containing various hazardous pollutants are created, thereby posing a great environmental problem.

The full range of metal finishing processes is not found in Sri Lanka. To the best of our knowledge technologies not existing at present include :

Plating on Plastics, Complex printed circuit board manufacturing, Vacuum and vapour deposition, Electrophoresis, Engineering electroless nickel composites, Mechanical plating etc.

1.2 Processes present in Sri Lanka include:

- Conventional electroplating
- Hot dip galvanizing
- Anodizing
- Polishing
- Phosphating
- Painting
- Powder Coating
- Heat Treatment
- Vitreous enameling

Two of the shops studied are involved with screen printing, selective plating and printed circuit boards (PCB). The PCB circuits are only single layer without fine precision lines and holes or through hole plating.

There is an interest in several new technologies including plating on plastics and electrophoretic lacquers. It should be stated that electroplating itself globally accounts for less than 20% of the total industry and the decorative finishes are in decline as alternative, environmentally friendly processes supersede them.

1.3 Equipment Used

At present in Sri Lanka the majority of the metal finishing plants do not follow the most modern scientific methods of cleaning, plating etc. As such, most of the equipment used does not conform to any standards. Some of the main equipment types used are as follows.

- Cleaning and plating process tanks - mostly welded steel and plastic
- Steam boilers and electrical immersion heaters

- External heat exchangers in large facilities
- Filter units
- Centrifugal dryers, plating jugs and racks
- Anodes and cathodes
- Dynamos, rectifiers, transformers
- Bus bars, ammeters, voltmeters and control panels
- Spray painting equipment - mainly manual operation
- Powder coating equipment - mainly manual operation
- Molten salt heat treatment bath
- Induction melting furnaces
- Refrigerator units for cooling
- Hot dip galvanizing baths - non enclosed with lead pre-heat

1.4 This report comprises of two sections :

Section One : Phase I of the study. Comprises of the relevant information collected about the metal finishing sector.

Section Two : Phase II of the study. This section comprises of detailed environmental audits/ waste minimization studies for 5 of the 64 metal finishing companies surveyed

The purpose of the study is to improve the operation of selected demonstration factories in various industrial subsectors and demonstrate the effectiveness and cost benefits of such measures. The present state of the metal finishing industry in Sri Lanka will also be reviewed and specific opportunities for waste minimization identified.

2.0 METHODOLOGY

The study was conducted in two phases. While the first stage comprised of collecting general information about the metal finishing industry in Sri Lanka, the second stage concentrated on analysing the waste problems of a few selected companies studied in the phase one stage.

Phase one :

1. Information was gathered from various institutions such as the Industrial Development Board (IDA), Ceylon Institute of Scientific & Industrial Research (CISIR), Central Environmental Authority (CEA) and the various chemical suppliers and end users.

2. A list of metal finishing companies were compiled using the information gathered from the various sources mentioned above.

3. A questionnaire was sent to all the metal finishing companies to make initial contact with them. (There was no feed back from the industrialists)

4. A team of data collectors were engaged to visit all the companies and to collect information.

5. The industries were categorized into to very small , small, medium and large scale based on the work force.

Phase 2

1. Out of the large number of companies studied, six were chosen by the UNDP for the phase two stage of the study. The companies chosen being :

    - Fedinandis Co. Limited
    - Varna Industries Limited
    - Alumex (Private) Limited
    - Lanka Galvanizing Company
    - City Cycle Industries
    - St. Anthony's Group

2. A waste minimization team was allocated to each of the 6 companies chosen. This team comprised of officials from the respective companies & consultants from ROMIN.

3. Data was collected by each team on their allocated company. Details of the information to be collected was specified by UNIDO in the Terms of Reference (TOR).

4. As one of the companies (St. Anthony's Group) closed down whilst the study was being carried out, ROMIN was only able to conduct complete studies on the other five companies.

5. An Environmental Audit was completed on each of the five companies.

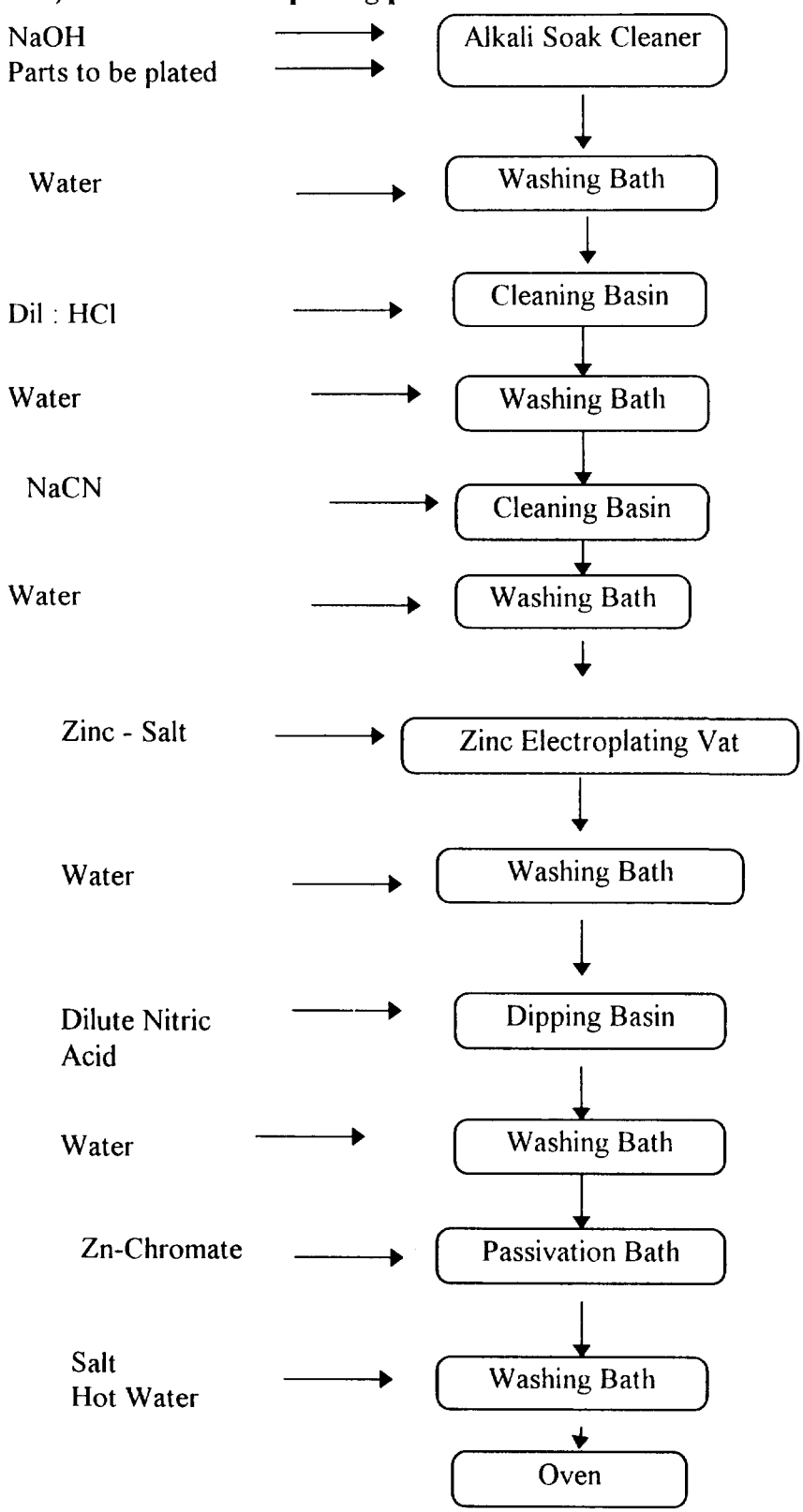
6. The waste problems faced by the companies were identified and waste minimization methods recommended. For each of the minimization methods recommended a cost benefit analysis was done, so as to see the most profitable option.

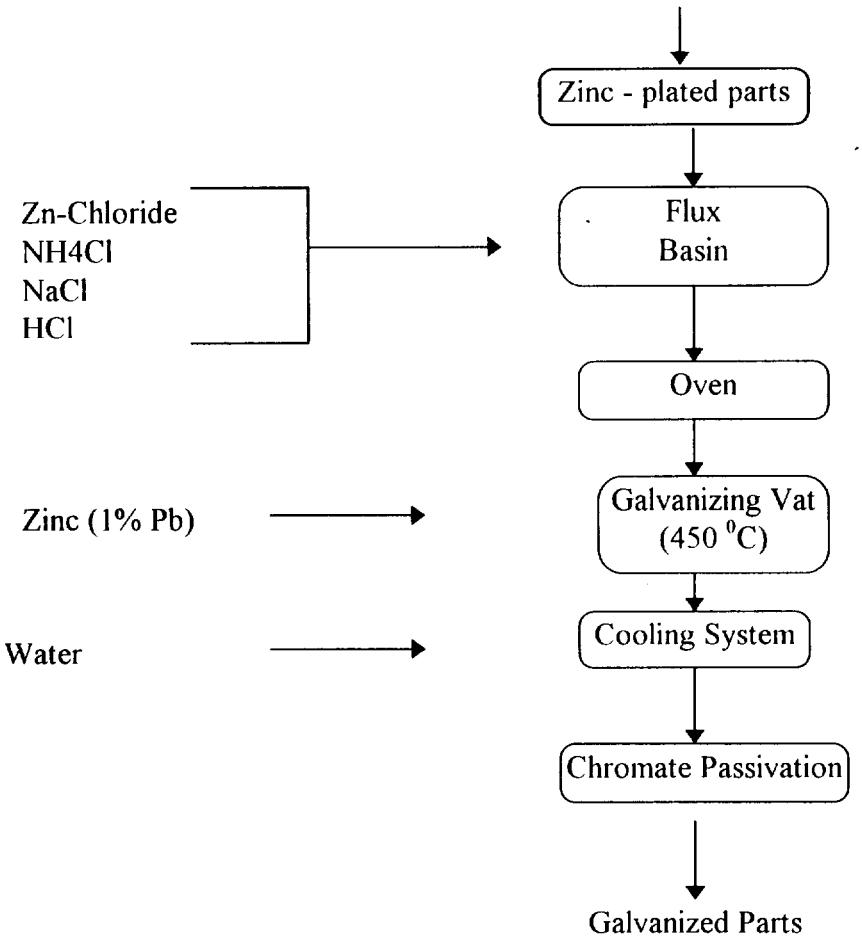
3.0 METAL FINISHING PROCESSES & SUPPLY COMPANIES AVAILABLE IN SRI LANKA

3.1 Metal Finishing processes commonly available in Sri Lanka

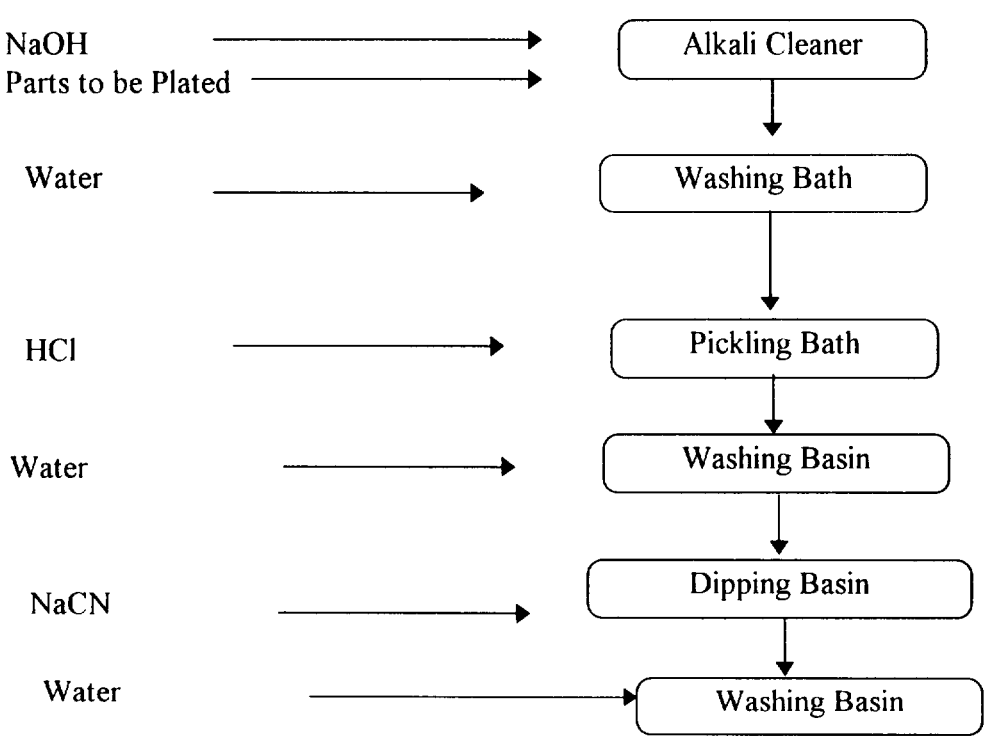
Following are the process diagrams for commonly used metal finishing processes in Sri Lanka.

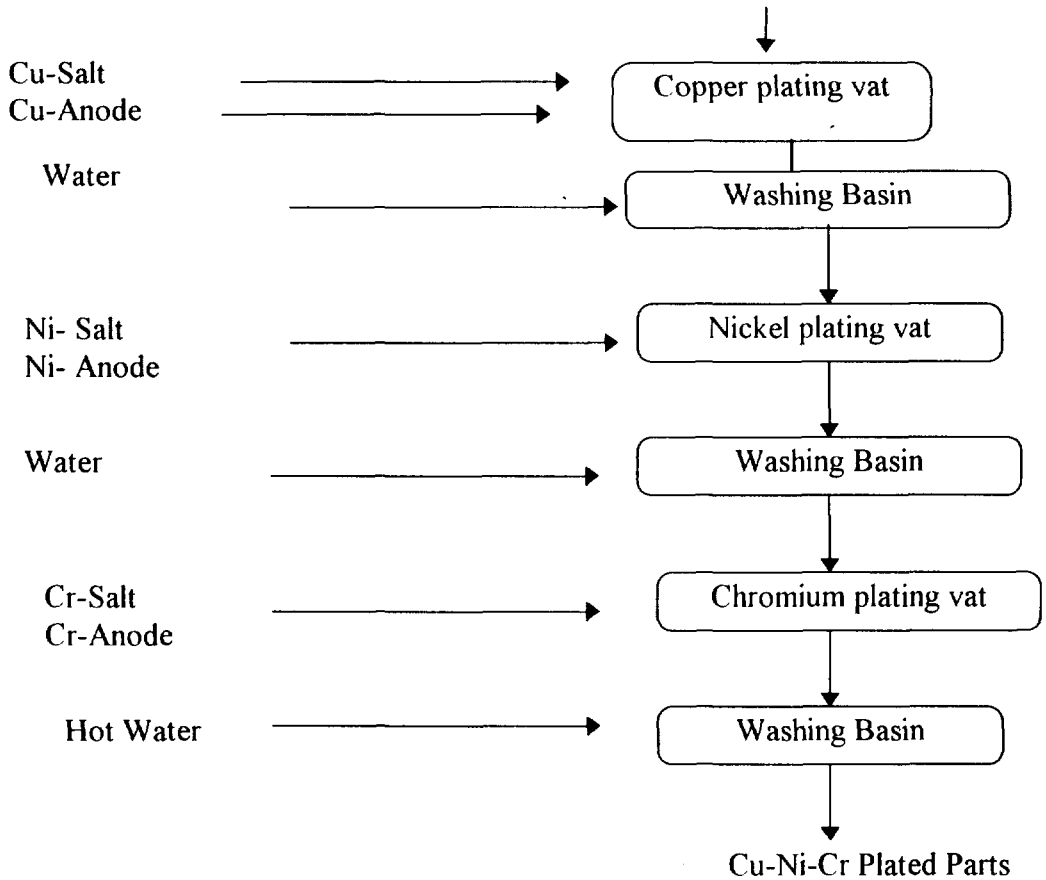
3.1.1 a) Zinc Electroplating process





3.1.1 c) Copper - Nickel - Chromium Electroplating Process





3.2 Supply Companies available in Sri Lanka

Industry supplies, especially the chemicals, are handled in Sri Lanka by a small number of companies. These suppliers do not normally provide their customers (Shop operators) with the necessary technical data. Technical data sheets, material safety data information are not available in many factories.

The main suppliers in the industry are:

3.4.1 Electroplating

1. **Company Name** : C. D. P. Electroplating
   Address : No: 2 - 106 BMICH
   Bauddhaloka Mawatha
   Colombo 7
   Telephone no's : **697420, 07124103**

   Contact Person : Srimath Perera, Managing Director
   Other Information : Complete Supplier of Chemicals & Equipment
   Local Servicing of the Industry
   Representing Ato tech

2. **Company Name** : Metallix Engineering Co. Ltd.
Address : 41 / 18, Epitamulla Road
Kotte
Telephone no's : 862481
Import only from Dr. Ing Max Schlotter - Germany

3. **Company Name** : Udaya Metal Stores
Address : 9, Maliban Street
Colombo 11
Telephone no's : 324130
Other Information : Import only from Cannings UK.
Plus suppliers of local chemicals

4. **Company Name** : Alagesan Trader
Address : 126 Central Road
Colombo 12
Telephone no's : 324149
Other Information : Import only from Cannings UK
Plus suppliers of local chemicals

3.1 Paint / Powder Coating

1. **Company Name** : CIC (Pvt.) Co. - Chemical Industries Colombo Ltd.
Marketing for Paints & General Industries Ltd.
Address : Sri Gnanendra Mawatha
Nawala
Telephone no's : 862575/6
Contact Person : K. Chandika Indikadahena
Works Chemist
Other Information : Licensees to ICI, UK

Major products
- Cobra stoving acrylic (e.g. SISIL Refrigerators)
- Synthamen alkyd melamine
- Stoving paints (e.g. Singer Sewing Machines)

CIC claims 75% market share

Stoving paint sales - approximately 1200 l / month
Automotive paints made locally
- Nitro cellulose base 50000 l / month for refinishing
- All acrylics are imported from ICI

Also manufacture N. C. Putty, Primer, Filler, Finishing & Clear Coatings. All powder coat material is imported at present.

2. **Company Name** : Delmege Forsyth & Co.
Telephone no's : 645243
Contact Person : Mr. Mubarak - Technical Director
Other Information : Local manufacture of primer, stoving enamel & anti corrosive paints.

Primers - Zinc Chromate, Quick dry chromate & oil

Top Coat - Air Dry enamel
- Quick dry alkyd CR (Chlorinated Rubber)
- Stoving - melamine formaldehyde & DCO alkyd

Total Sales - approximately 500,000 l / year

Under Coat - 200,000 l / year (including to the Ceylon Government railways)

Stoving - 150,000 l / year

Other Top Coats - 150,000 l / year. Delmege have approximately 20% of the market

They are agents for Courtolds for powder coating (new agreement)

3. **Company Name** : Lankem Robbialac
Lankem Ceylon Ltd
Address : 760, 762 Baseline Road
Colombo 9
Telephone no's : 698292

Other Information : Low market share in metal finishing.
Manufactures epoxy & anti corrosive paints,
VITIN - 2K automotive paints & Lucite automotive paints.

Bristol paints finishing - no details but little industrial application in metal industry.

Joton (Japan) - Suppliers of Corro Coat powder coat
Epoxy Polyester systems

Imported from S. E. Asia generally

3.2.3 Galvanizing / Anodizing / Heat Treatment

Zinc, Aluminium & Steel are imported from South Africa, Singapore, Australia, U.K. etc. Acids & Salts are imported or purchased locally. Proprietary systems are supplied via import from companies like Diversey & Henkel.

4.0 FINDINGS FROM THE SURVEY

4.1 Data Availability

Metal finishing has never been an organized industry in Sri Lanka. As a result, no systematically documented information is available for the industry. Although there were claims of comprehensive surveys in the past, no such survey of the industry has ever been completed.

The Small and Medium Enterprise Development (SMED) Project has assisted the industry in the form of training the personnel in some specific factories, but has not carried out any survey of the industry. The electroplating center of the Industrial Development Board (IDB) also train personnel in the industry, and has put together a list of about 50 factories.

CEA database has the details of those factories which have applied for annual licenses, but these are very few.

Suppliers of chemicals and other materials are also not willing to give away the information of their customers and specially, of their sales volumes. A search of the External Trade Center for Sri Lanka for 1994 was carried out in relation to specific chemicals used in the trade. However it is difficult to relate this information to the industry as imports are not 100% specific to the trade.

4.2 Industrial Development Board (IDB) - Electroplating Center

Industrial Development Board Electroplating Center at New Nuge Road, Peliyagoda offers training programs and consultancy services to the industry.

Training is provided to electroplating operators, supervisory staff and chemists employed in the industry by short-term training courses (generally 2 day programmes held 3 times a year) on various electroplating activities such as managing plant and equipment, polishing, cleaning, pickling and acid dipping, Copper, Brass, Nickel, Chromium, Zinc plating, passivation, bronzing, colouring and lacquering, effluent treatment, safety precautions and various plating solutions.

Except for a list of some Metal finishing shops who have become it's customers at some stage or other, the Electroplating Center does not have much information about the industry. The objectives of the center are extremely good, but it needs better financial support and organizational strengthening to carry out it's activities comprehensively.

4.3 Nature and state of the industry

By visiting various factories and having discussions with the personnel from the Industrial Development Board, Ceylon Institute of Scientific Research, Central Environmental Authority and chemical suppliers etc., we have been able to put together the following picture of the industry players.

The total number of metal finishing shops in Sri Lanka is approximately 200. However only a handful of these factories are operating in a systematic manner. The majority of the factories are very small and very difficult to locate, many of them being small intermittent operations in backyards or in dwelling attachments.

Table 1 shows the sample of factories visited, categorized as very small, small, medium and large based on the size of the labour force.

Table 1

	Labour Force	Number of shops	%
Very Small	1 - 5	19	29
Small	6 - 14	21	32
Medium	15 - 99	13	21
Large	100 <	12	18
Total		**65**	**100**

As the number of companies visited is about 1/3 of the estimated total of 200 companies, the above results can be treated as a good representation of the whole industry.

4.4 The Material, Water and Energy Usage

The large factories normally run on a full time basis whereas the small shops consist of small tanks and drums of chemicals and some antiquated power supplies. Sometimes the chemicals are purchased when an order is obtained, the baths are made up, used and once the job is completed they are dumped directly into the environment, this procedure is repeated when another order is obtained.

Based on the information obtained (see annexure 1) it can be seen that the following quantities of materials, water and energy are used by the industry as a whole.

4.4.1 Materials

Material	Quantity used / month
Steel	2715 Tonnes
Copper	3 Tonnes
Zinc	132 Tonnes
Aluminium	450 Tonnes
Nickel	5 Tonnes

4.4.2 Chemicals

Chemical	Quantity (Tonnes)
HCl	40
H_2SO_4	30
Ni salt	5
Cr salt	1
Na CN	1
NaOH	>50
Cu salt	>5
Zn salt	not known

4.4.3 Energy

Energy	Quantity
Water	8700 Cu. M
Electricity	1250 MW.H
Fuel Oil	8900 Kg
LPG	not known

A list of available data from the bureau of statistics is included as general information Appendix 1.

4.5 Waste Outputs

Waste water in most of the shops are released to the environment without any treatment. This waste water is partly absorbed directly by the land while some quantities are running into the nearby stream. Many shops release their waste water into the municipality drains. These drains discharge the effluents into the local streams, rivers or to the sea. These bodies which receive the effluents from the factories are used by the people for their domestic uses.

The monthly quantity of waste water is about 8700 Cu. M. Recycling of this waste water is not generally practiced. If a proper recycling process is used more than half of this quantity can be saved.

4.5.1 Water Receiving Bodies

Many companies use their own bore hole water. A few of the waste streams (some neutralized and some not) overflow back into the system via another bore hole. Many untreated or just neutralized wastes go to the local rivers, streams and canals.

There are no official waste water recovering bodies in Colombo at this stage.

4.6 House keeping

Proper house keeping is not practiced in any of the factories. Improvements on plant layouts and production line sequences, and proper maintenance of machinery and equipment are some of the other areas where factories are not concentrating. The loss of heat from various heating equipment is a major problem in the factories. If this wasted heat could be recovered by using heat exchangers, there can be a major saving at least a 1/4 of the electricity used which is 1250 MWH monthly.

5.0 REFERENCE TO THE ANNEXURE

The annexure at the end of this report contains information collected from the survey of the metal finishing sector. The majority of the coompanies who participated in the survey are involved in manufacturing and the electroplating process. The main source of enery for the manufacturing process is electricity while the main problems seem to be the excessive use of raw materials and energy causing alot of wastage and pollution.

6.0 GENERAL ENVIRONMENTAL AUDIT AND WASTE MINIMIZATION STUDY FOR THE SELECTED COMPANIES

Based on the data collected about the 64 metal finishing shops, six companies were chosen as the best and most suited for the purposes of this study. Based on the data collected in the first stage of the study, the six companies to be studied were chosen in association with UNIDO and the CEA.

One of the six companies (**St. Anthony's Group**) closed down while the study was being conducted, therefore only 5 of the companies were studied fully. The five companies being:

1) **Ferdinandis Co. Ltd.**

2) **Varna Industries Ltd.**

3) **Alumex (Private) Ltd.**

4) **Lanka Galvanizing Company**

5) **City Cycles Industries**

The following studies were conducted on each of the five companies mentioned above.

An environmental audit - was conducted, this involved studying the factory site, the surrounding area, storage facilities within the factory site and the sources of release into the media.

A waste minimization study - was conducted on the companies. This involved studying the materials, energy & water used in the manufacturing process and the waste streams. Several waste minimization methods were identified and a cost benefit analysis was completed on each of the options. This analysis enables us to identify the cost effectiveness of each of the minimization options.

Section B of this report shows the results of the investigation for each of the 5 companies. The company profiles have been arranged in a uniform format so that comparisons between the companies can be made easily.

Please note that there are several subsections that "information was not available" appears in the profile this is because no information was able to be obtained from the companies due to lack of co-operation on their behalf. Most of the officials in these companies were not keen in giving information for this study as they thought that this would be a disadvantage for their businesses in the future.

7.0 CLEANER PRODUCTION STUDY - FERDINANDIS CO. (LTD)
Part - I General Environmental Audit

1. Company : FERDINANDIS CO. LTD.

Ferdinandis Co. Ltd. is the only manufacturer of safety pins in Sri Lanka and it satisfies around half the country's requirement of safety pins. The total production capacity of the company is around 50 t/year. However, the company competes with the importers of safety pins from China. As the tax payable for imported pins is fairly high, the Ferdinandis did not find any difficulty in selling their product to the local market. The rural population of the country has been identified as the main target group of the company. However, any tax relief given to the imported product or the unstable economic situation of the country could seriously affect the industry as the Ferdinandis Co. Limited does not have a diversified product range. They also manufacture a small quantity of staple pins for the local market. Specialized jobs are also undertaken by the company. The factory employs 49 people at the time of study comprising 03 office staff members, 39 permanent employees and 07 casual employees.

2. Location of the Site & ownership of the factory

The factory is located at Nagoda, Kalutara, and is easily accessible by road. Distance from Colombo port is around 45 km, and the distance from the Colombo International Airport is about 60 km. Factory is situated approximately 200m away from the Katukurunda junction at Kalutara - Nagoda main road.

The sight is owned by Mr. Marius Ferdinandis, the Managing Director of the company.

3.0 Minimization Team

	Name	Designation
1.	Mr. Marius Ferdinandis	Managing Director
2.	Mr. Sujeewa Fernando	Assistant Manager
3.	Mr. Emil Cooray	Production Supervisor
4.	Dr. Hemantha Wijesundara	ROMIN - Consultant
5.	Mr. Ranasinghe Banda	ROMIN - Consultant

4. Physical Description of the Site

The area of the land where the factory is located is about 80 perches, and the area covered by the factory buildings is around 40%. Factory buildings consist of one permanent office building/workshop and several other temporary buildings. The land was a marshy land and was filled by earth for the purpose of construction of factory buildings. Depth to ground water level is about a meter. One of the four largest rivers in Sri Lanka, the "Kalu Ganga" flows around 3 km away from the factory.

5. Site Use

The site is used for constructing factory buildings where the production processes of safety pins, staple pins and some other goods are carried out. A permanent building is used as a factory office at the same site.

6. Raw Materials

I. Solids

Cold rolled steel strips
Mild steel wires,

II. Chemicals

Nickel chloride
Nickel anodes
Revelux 630
Nickel conc
Wetting agent
Chromium salt
Boric acid
Sulfuric acid
Caustic soda,

III. Water

Water required for electroplating operations & other purposes is obtained from the municipal water supply lines. Diesel, lubricant & saw dust are also purchased locally.

IV. Energy

Almost all the machines except hand operated assembly machines are driven by electric motors. The electricity is obtained from the main grid supplied by the Ceylon Electricity Board.

7. Site Drainage System

As indicated above water is obtained from the municipal water supply lines & it is mainly used for electroplating operations & other domestic purposes. (washing, showers, toilets etc.) Water is stored in an overhead tank (8x8x4 ft) at 8 ft. above the ground level.

Waste water generated at the factory are of two forms; waste water collected after electroplating operation & waste water collected after washing , showers & toilets. Waste water after electroplating operation is collected in a tank just beyond the electroplating section. Waste water formed after day to day activities (washing, showers, etc.) is discharged to a drain in the public road located along the southern boundary of the site. Liquid & solid waste formed in toilets is directed to three septic tanks of 8x3x9 ft.

Sludge formed in electroplating baths & waste water collecting pit is removed periodically & collected by the municipal garbage collectors. Metal scrap is also sold to persons involved with the

lantern making industry. Oil soaked saw dust formed after drying operation of pins is subsequently used for boiling water. Required temperature of some electroplating baths are maintained with the aid of steam formed after boiling water. Exhaust gas from the boiler is discharged to the atmosphere through a 15 ft. high chimney.

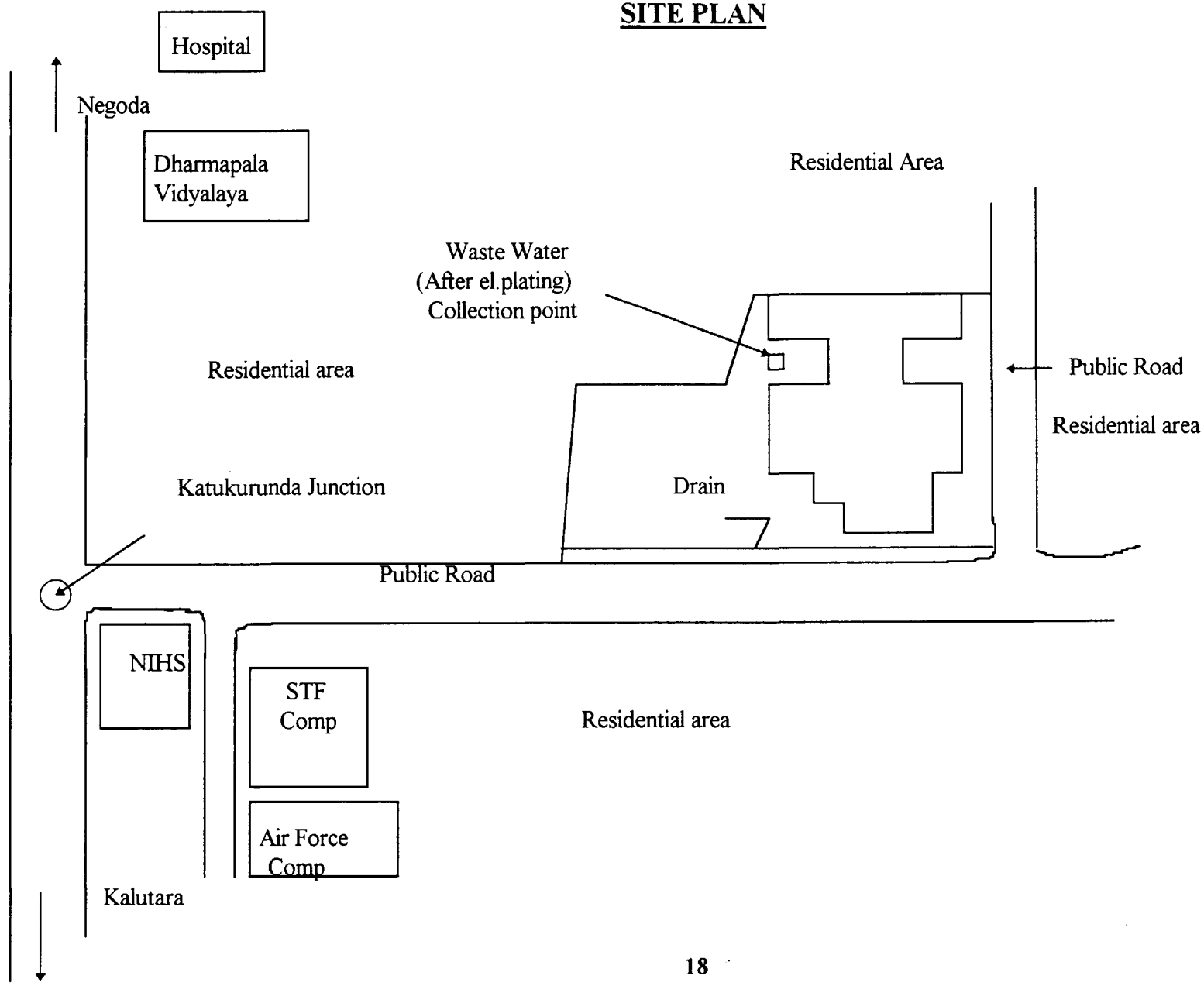
8. Storage of Hazardous Materials

Caustic soda & sulfuric acid are stored in 40kg cans. All other chemicals are also stored in cans or in containers. Floor area ($225ft^2$) of chemical stores is adequate for safe storage of all the chemicals. Well designed racks for storage of hazardous materials are provided in the stores.

9. Description of the Surrounding Land Use

The site is located in a residential area & surrounded by private houses. Sixty feet wide road is available along the western and southern boundaries of the land. A rough site location plan has been prepared to show access road to the factory & the adjacent lands. (see fig-1).

SITE PLAN


Hospital
Negoda
Dharmapala Vidyalaya
Residential Area
Waste Water (After el.plating) Collection point
Residential area
Public Road
Residential area
Katukurunda Junction
Drain
Public Road
NIHS
STF Comp
Residential area
Air Force Comp
Kalutara

10. Sensitive receptors in the vicinity

10.1 Residences and Other Populated Zones

Nagoda general hospital and Katukurunda Dharmapala Vidyalaya are situated within the radius of one km from the factory. The special task force camp & the National Institute of health science are located around 600m away from the factory. Air force camp and the bus deport are also located approximately 1 1/2 Km. away from the factory.

10.2 Water abstraction

There are no water abstraction activities at close proximity to the factory site.

10.3 Water bodies

There are no water bodies at close proximity to the factory site.

11. Sources of Release to Media

11.1 Solid waste disposal

Sludge formed in waste water pit & electroplating baths is disposed by the municipal council garbage collectors. The municipal council checks the effluent treatment method implemented by the factory once a year.

11.2 Aqueous discharges

Waste water formed after electroplating operations is directed to the waste water collecting pit through concrete sealed drains. Samples of the waste water from the pit is taken once a month & sent for analysis. In practice neutralization of waste water is done by adding 50 g. Caustic soda and 50-70 g sodium meta bisulfate every two months to the waste water collecting pit.

11.3 Atmospheric discharges

There is no atmospheric discharge from the operations.

Part II Waste Minimization Study

1. General Information

At the beginning of the study cleaner production team formed comprised of three persons from the factory & two consultants from Resource Organization & Management International Pvt. Ltd. (ROMIN)

From the discussions held with the factory management & the workers, the required general information for the study was collected and presented in table form below.

Worksheet 1

General Information			
Name of the company: Ferdinandis Co.Ltd., No:49, Training College Rd., Nagoda, Kalutara Tel: 034-22414			
a. Major raw material consumption 1. Raw material - (kg / month) a. Cold Rolled Wire	- Size 17.5 mm. - Size 19.5 mm. Total	1194.75 801.00 1995.75	
b. Mild Steel Strips - (kg/ month)	- Size 0 - Size 2 - Size 3 Total	566.75 1110.95 1329.50 3007.20	
ii. Chemical a. Nickel Chloride - (kg /month)		18.00	
b. Nickel Anodes - (kg /month)		38.00	
c. Revelux 630 - (kg /month)		07.00	
d. Nickel Conc - (Liter/month)		04.00	
e. Wetting Agent - (Liter/month)		02.00	
f. Chromium Salt - (kg/ month)		04.00	
g. Boric Acid - (kg/month)		07.00	
h. Sulfuric Acid - (kg/month)		10.00	
i. Caustic Soda - (kg/ month)		08.00	
j. Surclean EC 504 - (liter/ month)		06.00	
iii. OTHERS			
a. Diesel	- (liter/month)	20.00	
b. Lubricant	- (liter/month)	15.00	
c. Saw dust	- (kg/month)	500.00	
d. Polyethylene	- (10130 packets)-(kg/month)	10.13	
e. Tags	- (7229369 pieces)-(kg/month)	10.00	

f. Polyethylene bags	- (253 bags)	
B. Energy Consumption a. Electrical Energy	- (kW hours/month)	3925
Electrical Motor Power 1. Wire cutting machine (kW 1.11) 2. Wire pointing machine (kW 0.55) 3. Cap making machine (kW 0.74) 4. Auto machine (kW 0.37) (kW 5.21) 5. Saw dust polishing mach (kW 0.74) 6. Electro plating (kW 3.91) 7 .Drier (kW 0.74)	**No.** 02 02 03 01 06 01 01 01	**Power/mach** hp 1.5 hp 0.75 hp 1.0 hp 0.5 hp 7.0 hp 1.0 hp 5.25 hp 1.0
C. Water Consumption	- (Units); 1 unit = 1000 litres	202.0
D. Production (installed capacity) a. Wire cutting machine operators) (2 shifts) (1 shift=08 working hours)	- (2 machines- 2 - - -	 4.275 Size 0- (kg/hour) 3.03 size 2- (kg/hour) 4.275 size 3- (kg/hour)
b. Wire pointing machine operators) (1 machine-1 st pointing) (1 machine-2 nd pointing) (2 Shifts)	- (2 machines-2 Size 0- (kg/hr) Size 2- (kg/hr) Size 3- (kg/hr)	 4.275 3.03 4.275
c. Cap making machine operators) (2 Shifts)	- (3 machines- 3 - - -	 0.71 Size 0 - (kg/hr) 0.82 Size 2 - (kg/hr) 1.04 Size 3 - (kg/hr)

d.	Auto machine - (6 machines- 12 operators) (Assembly machine) - Size 0 - (kg/hr) (2 shifts) - Size 2 - (kg/hr) - Size 3 - (kg/hr)	 1.31 1.735 2.375
e.	Saw dust polishing - (2 barrels)- (kg/hr)	60.0
f.	Chemical treatment - Capacity of each bath(Kg/bath) - (1 person /day)	60.0
g.	Volume of each bath - (liter)	90.0
h.	Drying(centrifuge machine) - (kg/drum)	15.0
I	.Bunching - (kg/hr/person) - (17 persons /day)	1.2
j.	Packing - (packets/day)- (1 person)	520
k.	Total production of safety pins- (kg/month) (Before chemical treatment) - Size 0 - Size 2 - Size 3 Total	 767.425 1389.825 1679.637 --------- 3836.887 =========
l. Final production figures of safety pins (kg/m) (After chemical treatment)		3874.887
E. Number of employees in the company-		
	(permanent staff) (Temporary staff) (Office staff) Total	39 07 03 --- 49 ===

2. Range of Products Manufactured

The main product of the factory is safety pins. Small quantities of staple pins are also been manufactured. Three sizes of safety pins (size 0,2 & 3) have been manufactured at the factory by using two sizes(diameter - 0.7, 0.8 and 0.9 mm) of CR wires. A bunch of safety pins consists 04 numbers of pins each from sizes 0, 2 and 3. Several other individual jobs are also undertaken by the factory.

3.0 Major consumption figures

3.1 Major Raw Material Consumption

The main raw material required is MS steel strips and CR wires Both these items are imported from India. It has been found that the sizes of CR wires (diameter- 0.7, 0.8 and 0.9 mm) are awkward sizes for the local wire supplier, Ceylon Steel Corporation Ltd. The quality of the local wire is poor in surface finish, appearance, tensile strength and therefore Ferdinandis imports copper plated wire. Copper plated wire has advantages in drawing and machining and give a better plated finish on the wire.

Actual raw material consumption figures for July, August, September and October 1995 were obtained from the assistant manager. Daily consumption figures of raw materials have been recorded by the assistant managers. Adding all daily consumption figures monthly consumption figures are calculated. Based on that figures the average monthly consumption figures have been calculated.

Table 1 : Average monthly consumption figures

Item	Size	July (kg)	Aug (kg)	Sep (kg)	Oct (kg)	Monthly average (kg)	Total monthly avg. (kg)
CR wire	17.5 19.5	1375 830.5	1291.5 732.5	1286 823	844.5 818	1194.75 801	1995.7
MS steel strip	0 2 3	827 1351.2 893.2	326.6 966.6 1420.6	451.1 1203.8 1508.2	662.3 922.1 1496	566.75 1110.95 1329.50	3007.2

3.2 Chemical consumption

Records of chemicals bought & stored in the main store in the periods of June - July and July - September were available. These records were available with the assistant Manager and are real chemical consumption figures. General practice was to issue the required quantity of chemicals to the production process on the request of a person handling the electroplating operations. However no records were kept at the electroplating section of the remaining quantities of chemicals what have been issued by the main store. Therefore the monthly usage of chemicals were calculated after interviewing the person in-charge of the electroplating section with the aid of the available data. These calculated figures are presented in the last column of the following table .

3.2 **Chemicals** bought in the periods of May - July and July - August and their prices and the calculated average chemical usage per month are given in table 2.

Table 2

Chemical	Quantity (M - J)	Price(Rs)	Quantity (J - S)	Price(Rs)	Calculated Avg. monthly - usage
Nickel Chloride	30kg	480.00	45kg	480.00	18kg
Nickel anodes	78.5kg	789.50	95.10kg	789.50	38kg
Revelux 630	14.4L	750.00	27.8L	750.00	7 L
Nickel conc	7.25 L	750.00	8.75 L	750.00	4 L
Wetting agent	3.75 L	750.00	4.45 L	750.00	2 L
Chromium salt	10.5 kg	500.00	10.4kg	500.00	4kg
Boric acid	13.0kg	120.00	18.0kg	120.00	7kg
Sulfuric acid	15.0kg	25.00	15.0kg	25.00	10kg
Caustic soda	28.00kg	35.00	20.00kg	35.00	8kg
Suclean EC 504	15.00 L	77.90	15 L	77.90	6 L

3.3 Other consumption

Average Monthly consumption of diesel, lubricant and saw dust are calculated with the aid of the figures provided by the factory. Number of polyethylene packets, tags and bags are also calculated average figures. Weight of polyethylene packets were measured by weighing them and the weight of a packet is identified as 0.001 grams. Thereafter the monthly consumption of polyethylene packets were calculated in kilo grams. Similarly, monthly consumption of tags has been calculated.

4. Energy Consumption

Energy consumption of the factory for July, August and September 1995 was taken from the electricity bills paid by the factory for the respective period. The data extracted from the actual electricity bills paid by the company are as follows.

Table 3

Month	Units	Cost (RS.)
July	3617	14885.00
August	3766	15269.00
September	4392	17773.00
Monthly Average	3925	15975.66

From the above data average cost of an electricity unit is calculated.

Average cost of an electricity unit = El.Cost / No of Units used

= Rs. 4.07

5. Water Consumption

Water consumption of the factory for June , July August and September 1995 was taken from the water bills paid by the factory for the respective period. Following table illustrates the actual water consumption and the money paid for water.

Table 4

Month	Units	Cost (Rs.)
June	223	4926.00
July	162	3584.00
August	265	5850.00
September	158	3496.00
Monthly average	**202**	**4464.00**

From the above data average cost of water unit is calculated.

Average cost of a water unit = Water Cost / No. of Units used

= Rs. 22.09

6. Machine Capacities

Machine capacities (pieces /min.) were obtained from the machine catalogs. However, actual production capacities are little lower than the installed machine capacities. These actual figures were experimentally obtained by the WM team in number of pieces and also in kilo grams áfter weighing the quantity of pieces obtained in a hour. (Refer to worksheet 2 below)

Worksheet 2

Machine	Size	Installed Capacity		Actual Capacity		Weight Kg
		Pieces /min	Pieces /hr	Pieces /min	Pieces /hr	
Wire cutting	0	360	21600	306	18360	4.275
	2	180	10800	153	9180	3.03
	3	180	10800	153	9180	4.275
Wire pointing	0	360	21600	306	18360	4.275
	2	180	10800	153	9180	3.03
	3	180	10800	153	9180	4.275
Cap making	0	120	7200	105	6300	0.71
	2	120	7200	105	6300	0.82
	3	120	7200	105	6300	1.04
Auto machine	0	80	4800	68	4080	1.31
	2	80	4800	68	4080	1.735
	3	80	4800	68	4080	2.375

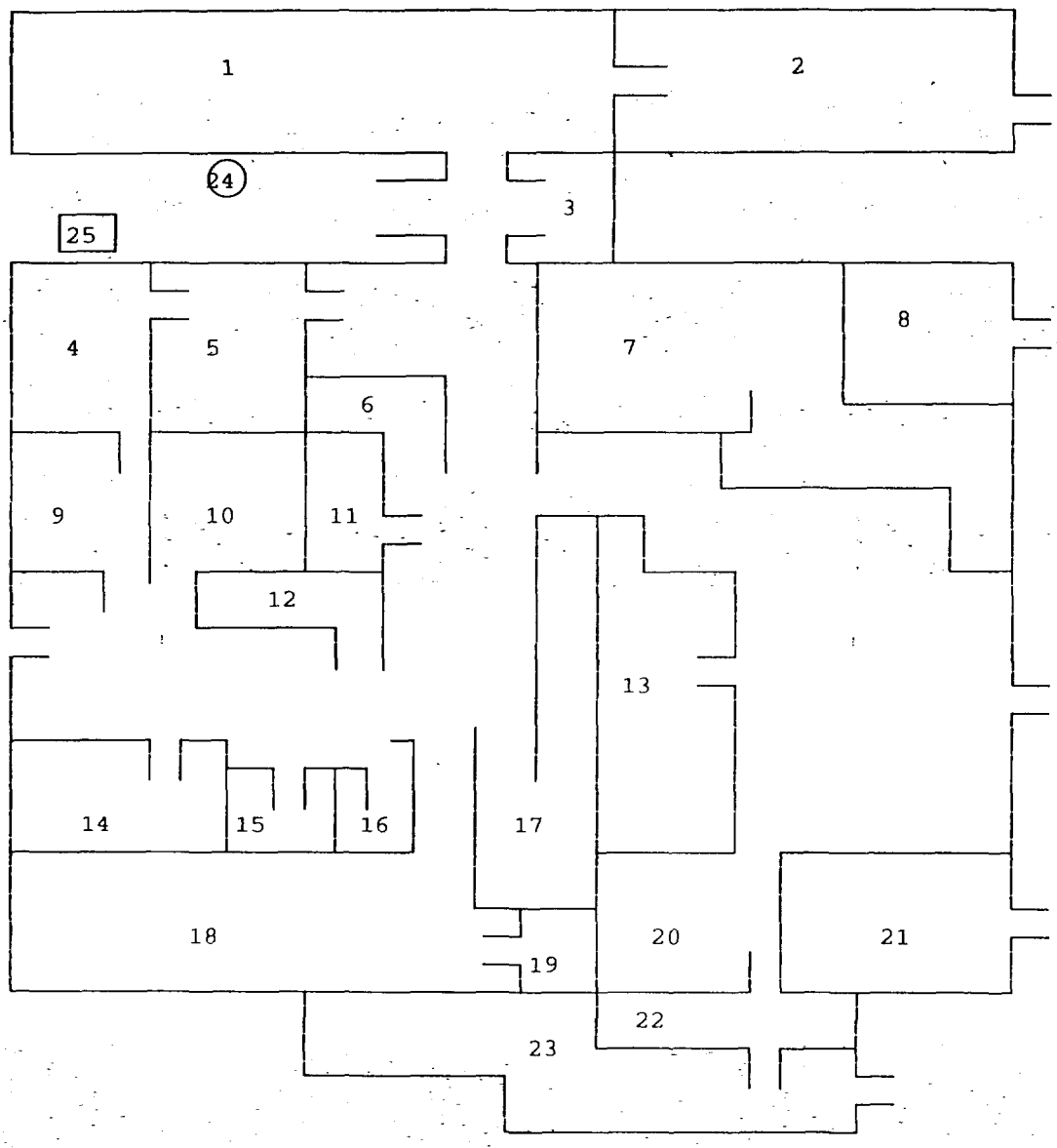
Chemical treatment baths (90 litres)and saw dust polishing machines were designed and manufactured by the factory with the available facilities to accommodate the production capacities of assembly machines.

Drying is done by using centrifuge drying machine, the capacity of which is 15 kg/ drum. Bunching and packing are done manually.

7. Available Information

Process flow diagram was not available for the process of manufacturing safety pins, and therefore the team decided to prepare the flow diagram indicating waste streams at each operation. The prepared diagram is presented in section 9 of this profile. As the plant layout was also not available, a draft layout was prepared indicating the location of the office and workshop buildings. Site plan was also prepared and the neighbouring properties were shown in it. Required data for calculation of raw material prices, production capacities of machines, labour costs, power and water usage capacities were available.

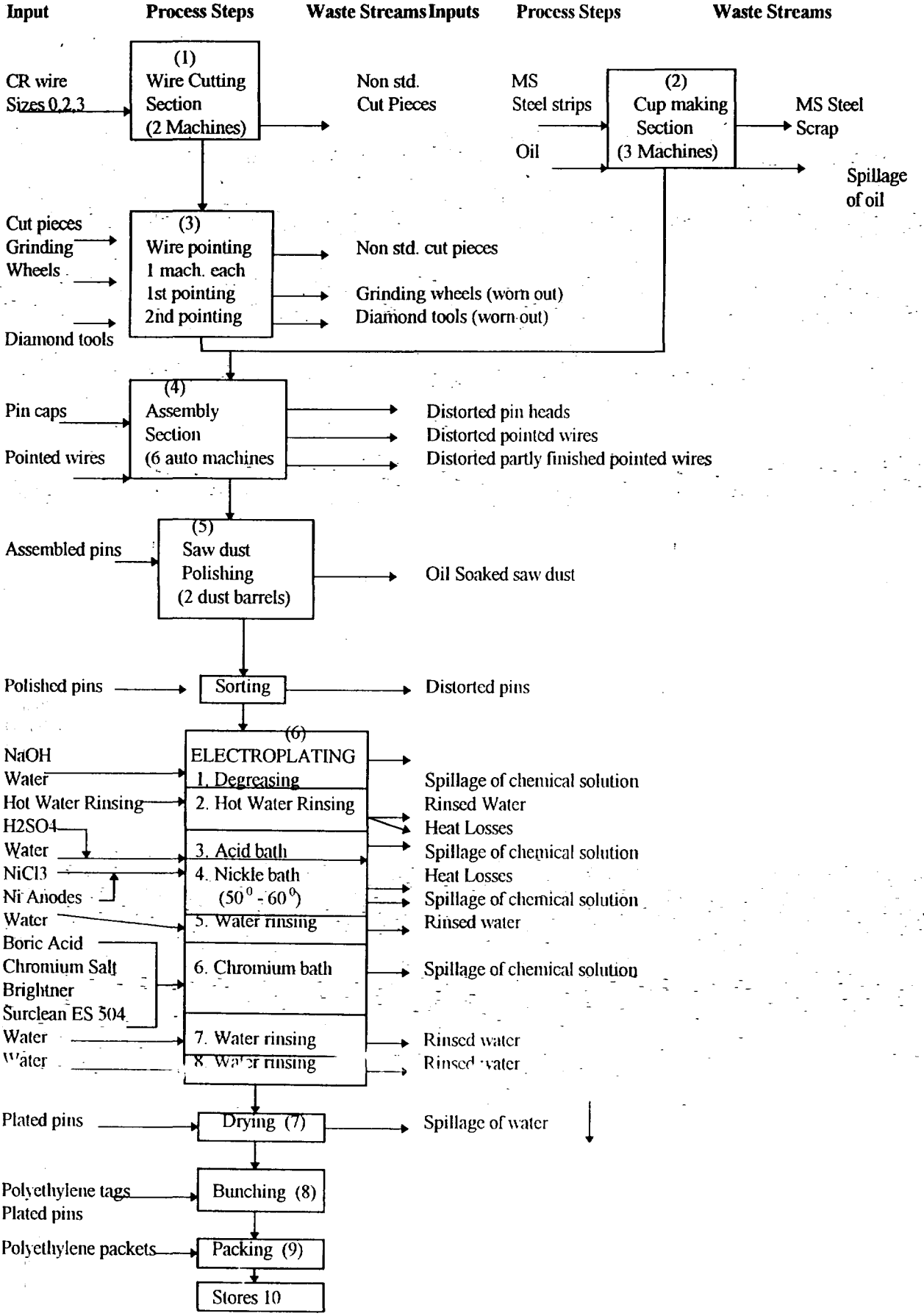
8. PLANT LAYOUT



01. Electroplating section
02. Maintenance workshop
03. Chemical Stores
04. Wire cutting section
05. Raw materials store
06. Saw dust polishing section
07. Stores
08. Workshop
09. Wire pointing section
10. Rest room
11. Stores
12. Stores
13. Cap making section
14. Bunching section
15. Stores
16. Sorting section
17. Bunching section
18. Assembly section
19. Packing section
20. Finished product stores
21. Rest room
22. Stores
23. Office
24. Boiler
25. Effluent treatment sump.

9. *Process for Diagram Indicating Waste Streams*

Name of the Company : Ferdinandis Co., Ltd, Nagoda, Kalutara



10. Waste Streams (Worksheet 3)

Section	Operation
Cap making Section	In this section three punching presses are installed and 03 sizes (0,2,3) of caps are formed. Punching and forming operations take place simultaneously with the aid of a combined die. Wire strips are fed to the machine through an oil bath. The lubricant in the oil bath is diluted by adding 50% diesel. Some of the lubricant is coming along with the scrap formed after punching as Waste Material, and spills around the machines. Hence, MS steel scrap and the oil spilled are the Waste Materials in this operation.
Wire cutting & pointing sections	CR wire is cut to required sizes (0,2,3) by using two wire cutting machines & then subjected to two subsequent pointing operations at two wire pointing machines. CR wire coils are loaded in the machine and fed to the wire cutting zone. Pieces cut during the starting and stoppage of machines non- standard pieces are formed. Apart from that it has been observed a large play in the journal bearing of the machine. Waste streams of this operation are non-standard cut wire pieces, worn out grinding wheels and worn out Diamond tools used for rectifying grinding wheel errors.
Assembly Section	One auto machine driven by a single motor (0.5 hp) & six machines coupled to a driving shaft rotated by a 7hp motor are installed in this section. Three sizes (0.2,3) of safety pins are assembled here and then sent to saw dust polishing section. Distorted pin heads distorted pointed wires and distorted partly finished pointed wires are the waste materials of this operation. However a part of partly finished distorted pointed wires are recycled by a manual assembly back to the process stream.
Saw dust polishing section	Two barrels with a capacity of 60kg each driven by a 1 hp motor is installed in this section. By this operation remaining oil in the surface of safety pins is removed. Running time of a load is about 2hrs, and normally three loads (180kg) are dried during a working day. Oil soaked saw dust is formed as waste material after this operation and this waste material is used for heating the boiler.
Sorting Section	After the previous operation some distorted pins can be found among the polished pins. Two workers are employed here to sort out pins manually.
Electroplating Section	Eight three hundred and fifty liter fiber glass baths are installed in this section for electroplating purposes. A 60 kg batch of safety pins are transported from bath to bath by using a special container. The container is fixed to a special hanging device which can move along the workshop carrying a batch of safety pins.

	Following are the subsequent electroplating operation. a. Batch of pins is kept in a 50% concentrated caustic soda (NaOH) solution for 10-15 minutes. The solution is heated up to 55° C. Concentration is checked daily, and additions are made to keep the required concentration of the solution. Bath is changed every two months. b. Hot water (55° C) rinse for 5 minutes. Bath is changed after rinsing a batch. c. After hot water rinsing the batch in process is moved to the acid bath (H_2 So_4), 1% concentrated and kept there for 3-4 minutes. d. Cold water rinse for 5-6 minutes. Bath is changed after every batch. e. Chromic acid dip for 6 - 6 minutes. f. Cold water rinse 1 for 5 minutes in bath No. 7. Bath is changed after every batch. g. Cold water rinse 1 for 6 minutes in bath No. 8. Bath is changed after every batch. Water used for rinsing operations, spilled chemical solutions and sludge formed in electroplating baths are major waste streams of this operation. As hot water is involved in rinsing operation there are possible heat losses from the surface of the hot water rinse bath.
Dry Section	A capacity of 20kg centrifugal drier is installed in this section. Drying time per batch is about 10-15 minutes. Water squeezed from the load of pins is the waste material of this operation.
Bunching & Packing	Bunching of pins is done manually by 17 employees. It has been observed that a person can make bunches of 1.2 kg per hour. Therefore, calculated time required for gathering of a bunch of safety pins =16.5sec/bunch. Packing is also done manually by a employee. An employee can make 520 packets a day.(260Gg). No waste materials are formed in this operation.

11. House Keeping Status

Generally, house keeping status of the company is not satisfactory. Normal practice was to built extensions to the permanent building when the available space was not adequate for the expansion of workplace for a particular operation. As the production operations were scattered all over the factory, it

was very difficult to maintain the proper sequence of operations thus making the transport cost high. (See the worksheet 04 - Plant layout).
Comments on house keeping status in each section are given in worksheet 05.

11.1 Raw Material Cost

Prices of the raw materials imported are given in the following table. These are real figures obtained from the clerk handling the purchasing operations. Prices of chemicals were given earlier. (Refer to table 5 for Raw material cost)

Table 5

Item	Size	Price/ Ton CIF value in US$
MS strips	17.5x0.2 mm	1012.00
CR wire, cooper coated	0 - 0.7 Size0 0 - 0.8 Size2 0 - 0.9 Size3	965.00 940.00 915.00

11.3 Production figures (Table 6)

Available Production Figures Production	Size of Pins	July 95, kg.	Aug.95 kg.	Sept 95, kg.	Oct. 95 kg.
Total Production of Safety Pins Before Plating	0 2 3	946.7 1554.3 1739.2	912.00 1298.00 1542.00	768.00 1322.00 1721.00	441.00 1383.00 1715.00
Total		**4240.2**	**3781.00**	**3795.00**	**3538.00**
Final Production After electroplating, Available in Grate gross	0 2 3	4057.Gg	4057.Gg	3913.5 Gg	4681.5Gg.

- 1 Grate Gross = 12 x 144 number of pins.
  Weight of a Grate gross was found by weighing the finished product.
- 1 Grate gross = 765 grams.
  Therefore, the calculated monthly production of safety pins = Average Gg x 0.765
  = 4328 x 0.765
  = 3310.9 kg.

Worksheet 04 gives the calculated cost of a kilogram of raw material used in each operation, their monthly consumption (calculated), quantity of raw materials (calculated) consumed for manufacturing of a kilo gram of finished product. All the calculations have been done by using the collected data from the factory. It has been found that the total cost of input raw materials used for producing 1 kg of safety pins is Rs. 91.519.

WORKSHEET - 04
Input Materials Cost

Input Material	Cost (Rs)	Monthly Consumption	Consumption/ kg of finished Products	Cost/kg of Finished Products (Rs)
Wire cutting	Cost/kg	kg.	kg	
M.S. - Size 0	56.90	567.00	0.146	08.30
Wire - Size 2	55.43	1111.00	0.287	15.91
- Size 3	53.96	1330.00	0.343	18.51
Average	55.43	1002.66	0.778	42.72
	Cost/liter	litres	litres	0.067
Lubricant - 51	52.00	05.00	0.00129	
Wire cutting	Cost/kg	kg	kg.	
C.R. - Size 0	57.77	518.00	0.133	39.28
Strip - Size 2	57.77	677.00	0.175	28.3
17.5 - Size 3	57.77	801.00	0.206	27.55
19.5				
for				
	Cost/liter	litres	litres	
Diesel	13.30	20.00	0.0025	0.058
Oil DS 50	68.00	10.00	0.0025	0.134
Wire Pointing				
Grinding Wheel (Two wheels)	Cost/Wheel 2400.00	1/3 GW/Month	GW Material 0.000086	0.41
Diamond Tool	Cost/Tool 675.00	1 DT/Month	DT material 0.000025	0.17
Auto Machine	----	-----	-----	----
Saw Dust polishing	Cost/kg	kg	kg	
Saw dust	0.10	500.0	0.129	0.01
Sorting	----	----	-----	-----

12. Material Balance

Material balance has been done considering the data provided by the factory management. Quantities of real waste (solid, liquid, gas) were not available. However, by interviewing the workers at work places and the factory management, WM team could establish the approximate quantities of waste raw material in each operation percentage vise as shown below (table 7). Material balance done for each operation is shown in worksheet 05.

Table 7

Operation	Input Material 100%	Waste	Possible Causes
Wire cutting	CR wire	2%	Waste due to poor quality of wire, frequent starting and stopping of wire cutting machines.
Wire Pointing	Pre-cut pieces	1%	Waste due to incorrect machine setting, incorrect profile of the grinding wheels, uneven length of pre-cut pieces.
Cap Making	MS strips	40%	Waste due to shape of the workpiece required to form safety pin heads, poor quality of cutting tools
Auto Machine	Pointed wires and pin caps	8% Assembled Pins	Waste due to poor quality of caps received, warn out parts in assembly machines (Auto machine defects). However, 5% of waste can be recovered by using manual assembly. Therefore, the real waste would be around 1.5% of caps and 1.5% of looped pins.
Saw dust polishing	Assembled pins	----	Negligible
Sorting	Polished pins	0.1%	Negligible
Electroplating	Polished pins	----	Negligible
Drying	Plated pins	----	Negligible
Bunching	Plated pins	----	Negligible
Packing	Plated pins	----	Negligible

Five litres of lubricants in wire cutting operating and 30 litres of lubricant in cap making operating have been identified as liquid waste formed in both operations.

Key to worksheet 05

*** - Sold to Scrap Collectors** **# - 50% of waste oil is recollected**
% - Partially recycled **@ - Used for water heating.**

WORKSHEET 05- MATERIAL BALANCE							
Unit Operation	**Input Material**		**Output Material**		**Waste Stream**		
	Name	**Quantity**	**Name**	**Quantity kg/Month**	**Liquid kg/month**	**Solid/Gas kg/month**	
						Name	**Quantity**
Wire Cutting	C R. wire Lubricant	3008.0 05.0 l/month	Cut pieces ------	2948.0 Nil	Nil 05.0 l/month	Non standard cut pieces Nil	60.0 ------
Wire Pointing	Pre cut pieces Grinding wheels (GW) Diamond tools (DT)	2948.0 1/3 GM/month 1 GM/month	Pre cut pointed wire ------ ------	2903.8 Nil Nil	Nil Nil Nil	Non Standard cut pieces worn out GW Worn out DT	44.2 1/3 GW/month 1 DT/ mon th
Cap Making	MS Strips Lubricant (Diesel 20 -l/month) + (Oil DS50-15 l/month	1996.0 30 l/month	Pin caps -------	1197.6 Nil	Nil $ 30.0 l/month	* steel Scrap Nil	798.4 Nil
Assembly	Pre cut pointed wire Pin caps	2903.8 1197.6	Assembled pins	3707.74 partially recycled looped pins + 128.26	Nil Nil	Distorted pins % Looped pins Distorted caps	61.31 288.0 44.35
Saw Dust Polishing	Assembled Pins Saw Dust	3836.0 500.0	Polished Pins -----	3836.0 Nil	Nil Nil	Nil @ Oil soaked saw dust	Nil 500.0
Electro Plating	Sorted pins Ni Chloride Ni Anodes Revelux 630 (l/month) NiConc (l/month) Wetting agent (l/m) Cr Salt Boric Acid H_2SO_4 NaOH Surclean ES504(l/m) Water-	3836.0 18.0 38.0 07.0 04.0 0.2 04.0 07.0 10.0 08.0 06.0 182.0	Plated Pins	3874.0	Nil Waste Water 182.0 Units	Nil Sludge	Nil 05.0

	Unit/m						
Drying	Plated pins	3874.0	Dried Pins	3874.0	-----	-----	---
Bunching	Dried pins Polyethylene Tags	3874.0	Bunches of pins	3894.0	-----	-----	----
Packing	Bunches of Pins Polyethylene bags	3894.0	Packeted Pins	3899.0	-----	-----	----

13. Water Balance

Water Wasted in electroplating has been calculated taking into consideration of capacities of rinsing baths and the monthly production of safety pins. Water used in toilets/washing/showers are estimated as 20,000 l/month. All the above figures presented on tabular form in worksheet 06.

WORKSHEET 06 - Total Water Balance		
Operation	**Fresh Water Used Litres/Month**	**Waste Water Litres/Month**
Electroplating		
NaOH Bath	1500.0	1500.0
Hot water rinsing tank (1)	43500.0	43500.0
Acid Bath	1500.0	1500.0
Ni Bath	50000.0	1500.0
Water rinsing tank (2)	43500.0	43500.0
Water rinsing tank (3)	43500.0	43500.0
Final water rinsing (4)	43500.0	42000.0
Drying	NIL	1500.0
Washing/Toilets/Showers, etc.	200000.0	20000.0
Total	202000.0	202000.0

All the figures indicated in the table 08 are calculated, considering the capacity of rinsing tanks. Water used for washing/Toilets/showers, etc. are estimated figures.

14. Identification and Assessment of Waste Minimization Options & Action List

All identified waste minimisation options in each section are presented in **worksheet 07**. Every option was given a weightage taking into consideration the category (waste minimisation. energy efficiency, quality improvement), implementation time requirement (short term, medium term, long term) and the importance. Importance was rated by using, maximum 10 point system assigning maximum 10 points to extremely important option.

Key to worksheet 07

A - Category : WM = Waste Minimisation, EE = Energy Efficiency
QI = Quality Improvement

B - Urgency : S = Short Term M = Medium Term L = Long Term

C - Importance : Scale of 1 - 10 (10 being extremely important)

IDENTIFICATION AND ASSESSMENT OF WASTE MINIMISATION OPTIONS AND ACTION LIST - WORKSHEET 07					
PROCESS UNIT	**WM OPTION**	**ACTION**	**A**	**B**	**C**
Wire cutting Section (1)	Replace the worn out bearings in the wire cutting machines	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants. (see annex 4 cost benefit analysis of the WM option)	WM QI EF	S	7
	Regular checks on play in the bearings and other moving parts of the machines should be made, so that replacement can be organized before too many rejects are created.	Ferdinandis Co.	WM	M	5
	Place a tray under the body of the wire cutting machine to recover the waste lubricant	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM QI	M	5
	Machine modification Install a clutch to driving shaft to minimise the formation of non standard cut wire pieces in switching on and off the machine	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM	L	3
	Modify the machine to automatically arrange the cut pieces in required manner for the subsequent (wire pointing) operation.	Ferdinandis Co. Design for modification of the machine can be supplied by the UNIDO consultants on the company request	EF WM	L	4

	In order to balance the capacity of Auto machines with the capacity of wire cutting machines, it is recommended to purchase a more productive wire cutting machine as the existing machines are fully utilising their installed capacity.	Ferdinandis Co.UNIDO Consultant can help the company providing information on such machines.	WM WM	L	5

A - Category : WM = Waste Minimisation, EE = Energy Efficiency QI = Quality Improvement
B - Urgency : S = Short Term M = Medium Term L = Long Term
C - Importance : Scale of 1 - 10 (10 being extremely important)

PROCESS UNIT	WM OPTION	ACTION	A	B	C
Cap Making section (2)	Change the composition of lubricant used by adding more diesel and kerosene oil, as the viscosity of currently used lubricant seems to be height.	Ferdinandis Co. (see annex 2 - Cost benefit analysis of the WM option)	WM	S	8
	Hard chromium plating of dies.	Ferdinandis Co. Industrial Development Board	WM	S	8
	Change the shape of the pin heads collecting trays to minimize the pin heads wasted	Ferdinandis Co. (see annex 3 - cost benefit analysis of the WM option)	WM	S	7
	Fix wiper blades to strip feeding mechanisms before and after punching of the caps to reduce the spillage of oil	Ferdinandis Co.	WM	S	7
	Sharpen the die weekly.	Ferdinandis Co. (See annex 1- cost benefit analysis of the WM option).	WM QI	S	9
	Design a mechanism to Collect seeping oil from metal scrap and assemble it.	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM	M	7
	Repair the scrap winding mechanism of the press and assemble it. Place a tray under the scrap winding mechanism to collect seeping oil from the scrap.	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM	M	4
	Find a better use for scrap. (Evaluate the possibility of selling the scrap back to the supplier).	Ferdinandis Co. Cost benefit analysis (CBA) to be done by the ROMIN consultants	WM	L	4
	Design a new combined punching die to obtain two head pieces in one stroke of the punch	CBA to be done by the ROMIN consultants.	WM	M	6

PROCESS UNIT	WM OPTION	ACTION	A	B	C
Wire pointing section	Alter the grinding Wheel assembly.	Ferdinandis Co.	WM QI	M	6
	Import a grinding wheel with required profile from India.	Ferdinandis Co. UNIDO will help the company to find a suitable supplier.	WM QI	L	5
	Use only one grinding wheel instead of two wheels used at present.	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM	M	6
	Find a possible way of selling the used grinding wheels.	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM	M	7
	New buffing operation can be introduced after grinding of pins, in order to enhance the penetrating ability of the pins.	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	QI	L	4
	Use a grinding wheel with fine grains instead of the being used one.	Ferdinandis Co.	QI	L	5

A - Category : WM = Waste Minimisation, EE = Energy Efficiency
QI = Quality Improvement
B - Urgency : S = Short Term M = Medium Term L = Long Term
C - Importance : Scale of 1 - 10 (10 being extremely important)

Process Unit	WM Option	Action	A	B	C
Assembly Section	Hard rubber, leather, graphite or PVC washer should be used to avoid their points becoming blunt.	Ferdinandis Co.	WM QI	S	6
	Direct a compressed air nozzle to the lower part of the cap feeding device, in order that the caps are fed consistently	Ferdinandis Co.	WM QI	S	6
Saw dust polishing section	Use oil soaked saw dust for heating the boiler	That option has already been implemented	WM	S	-
Electroplating Section	Recycle rinsed water from the Nickel bath	Chemical composition analysis of the rinsed water to be done by the Ferdinandis Co. Cost benefit analysis to be done by the ROMIN Consultant (see annex 05 - cost benefit analysis of the WM option)	WM	M	8
	Establish a single direction sequential line consisting of 3 x counter flow rinsing tanks between each operation	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants.	WM	M	6
	Keep the acid dip low in concentration, around 1%. Work should not be allowed to be in this bath for too long.	Ferdinandis Co.	WM QI	S	7
	Insulate the Ni bath properly in order to minimize the heat losses	Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants	WM	M	6
	Close the gaps among the tanks using PVC plates.	Ferdinandis Co.	WM	S	6

15. Selected Options for Implementation

Based on the assessment conducted earlier the following WM options were selected for implementation (worksheet 08).

WORKSHEET - 08

Production Union	No.	WM Option	Remarks
Cap Making Section	01	Sharpen the die weekly.	It was decided to implement this WM option immediately by the Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants
	02	Change the composition of lubricant used by adding more diesel and kerosene oil, as the viscosity of currently used lubricant seems to be high.	By trial and error method identify the quantities of diesel and kerosene to be added to of Diesel and Kerosene to be added to the lubricant. This option should be implemented by the Ferdinandis Co. and the cost benefit analysis should be done by the ROMIN Consultants.
	03	Design and assemble a mechanism to collect seeping oil form metal scrap.	Fixing wiper blades to strip feeding mechanisms before and after punching of the caps to reduce the spillage of oil
Wire Cutting Section	04	Hard chromium plating of dies.	The option has been implemented. However expected quality of surface finish is not obtained again with different organization which would undertake the coating job.
	05	Change the shape of the pin heads collecting trays to minimize the pin heads wasted.	This option has been implemented by the factory. Time wasted for collecting pin caps manually is saved. Cost benefit analysis to be done by the ROMIN consultant.
	06	Replace the worn out bearings of the wire cutting machine	In order to implement the option cutting machine has to be stopped. However, it has been agreed to implement this option immediately by the Ferdinandis Co. Cost benefit analysis to be done by the ROMIN consultants.

Electroplating Section	07	Establish a single direction sequential line consisting of three counter flow rinsing tanks between each operation	The company is willing to implement this option immediately. However, the space and funds available is not adequate. Possibility of receiving funds from UNIDO is sought.
	08	Close the gaps among the tanks using PVC plates	Through the gaps among the tanks, rinsed water and chemicals spill onto the floor. The option helps to keep the workshop clean & reduces the quantity of waste water
	09	Recycle rinsed water from the Nickel bath.	This option has been successfully implemented. Cost benefit analysis to be done by the ROMIN consultant.
Assembly Section	10	Hard rubber, leather, graph or PVC washer should be used to push pins into the caps to avoid their points becoming blunt.	There were complains from the customers that the penetrating ability of pins made by the factory is inferior to imported pins. By implementing this option, this drawback could be avoided.

16. Cost Benefit Analysis of the Waste Minimization measures

01 With the help of the factory the option one was implemented at the beginning of August '96 and the production and waste figures were obtained. Cost benefit analysis done for this option is presented in section 17 of this profile. By Implementing this option the company could save Rs. 12312.97 in three months from August to October.

02 By trial and error method required adding quantities of Diesel and Kerosene oil has been identified. By implementing this option company could sage Rs .651.73.
This option has been implemented in January 1997.

03 Initially the third option was tried by fixing additional steel rollers to the strip feeding mechanisms. However this didn't help to reduce the oil usage. Therefore, the wiper blade option was introduced and considerable saving is experienced. By implementing this option the company could save Rs. 491.60.
This option has been implemented in November 1997.

04 Hard chromium plating of dies has been done. As the expected results were not obtained, it was decided to repeat the coating with the help of another organization. Results of the option implemented will be presented later.

05 Not incurring any additional costs, the factory implemented this option and the factory could save money by way of saving labour time. Calculation of cost benefit analysis is shown in the next section.

06 Replacement of worn out bearings had been done. Calculated savings by implementing the option is presented in the next section.. By implementing the option company could save Rs. 2588.00.

07 As the company management could not find enough funds for the expansion of existing building it was decided to request financial help from the UNIDO project.

08 By using PVC plates the gaps among tanks were closed. It has been observed that the spillage of chemicals has reduced to zero level. However due to unavailability of past data cost benefit could not be calculated.

09 Rinse water collected after Nickel bath was analysed. It was found that a considerable amount of chemicals are dissolved in rinsed water. By adding the rinsed water to the Nickel bath for topping up, a considerable amount of money and chemicals could be saved.

10 Initially this option was implemented by suing rubber washers. When the pin is pushed to the assembly point by the puller over by rubber washer, it was observed that, the sharpened edge of the pin penetrates the rubber washer and the pin is pulled back. Therefore, it was tried to use a leather washer instead of rubber washer. The same result was observed in the latter case too, and finally a graphite washer was used for the same purpose. That worked satisfactorily and the sharpness of pins after operation remains as the same as before the operation. This option cannot be justified economically as it only improves the quality of pins. Quality improvement would help the company in competing with the similar imported products.

WM Option	**Money Saved by implementing the Options per month**	**Pay Back period**
1. Weekly shaping of dies	40104.31	One day
2. Change the composition of lubricant used	651.73	-
3. fixing wiper blades to extract lubricant	491.60	-
4. Hard chrome plating of dies	To be completed	-
	Money Saved by	

WM Option	implementing the Options per month	Pay Back period
5. Change the shape of the pin head collecting trays	360.00	-
6. replace the worn out bearings of the wire cutting machine	2588.00	One month and eleven days
7. Introduction of counter flow rinsing tanks	This option has to be implemented with the help of the UNIDO	To be calculated
8. Close the gaps among the tanks by using PVC plates	Cannot be calculated as the past data is not available	Cost of PVC plates & Labour charges are involved
9. Recycling and rinsing of rinsed water	17271.00	-
10. Graphite washer is used for pushing pins to operating zone.	Quality improvement is observed	-
Total money saved by Implementing WM options per month	Rs. 61366.65	

17. Implemented options and gains, or why implementation was not possible

17.1.1 Details of the Problem

The poor quality of caps was the main problem of the cap making section. Edges of caps were not sharp enough and the appearance was not attractive in comparison with the product imported from China. It has also been identified that the poor quality of caps may increase the reject rate of the assembly operation. If the size of the cap is slightly different from the standard size, feeding of caps to the assembly point becomes irregular. As a result, a considerable quantity of pins, caps and looped pins were thrown away as waste material.

17.1.2 Waste Minimization Option

It has been of served by the consultants that, the above problem had occurred due to poor maintenance of the punching die. The operator was not aware of the fact that each tool can be

effectively exploited until it reaches a pre-identified value of tool wear. Therefore, it has been suggested that all the punching dies should be resharpened or replaced before it reaches the predetermined value. The life of a tool is about one week, and therefore, it was recommended to replace the dies weekly.

17.1.3 Data Collection Procedure

As the quality of caps directly affected the assembly operation, the data required for analysis were the production figures and the quantity wasted before and after implementation the waste minimisation option.

17.1.3.1 Available Data

17.1.3.1.1 Before Implementing the Waste Minimization Option

Month	* Waste (kg)	Production (kg)
February	466.00	2525.650
March	489.00	3914.800
April	370.00	3064.900
May	302.00	2714.600
June	348.00	3193.500
July	389.00	4241.200
Monthly Average	**394.00**	**3442.44**

* - Total amount of rejects (Distorted caps + Distorted pins + Looped wires)

Labour cost of wire cutting operation	=	Rs/kg. 6.00
Cost of wire (after wire cutting operation)	=	Rs/kg. 61.43
Labour cost of wire pointing operation	=	Rs/kg. 6.00
Cost of wire (after pointing operation)	=	Rs/kg. 67.43
Labour cost of punching operating	=	Rs/kg. 2.45
Cost of caps after punching operation	=	Rs/kg. 60.22
Labour cost of assembly operation	=	Rs/kg. 10.30

Accordingly,

Cost of distorted caps after assembly operation	=	Rs/kg. 70.52
Cost of distorted pins after assembly operation	=	Rs/kg. 77.73

Cost of looped wire after assembly operation = Rs/kg. 77.73
Average cost of waste material = Rs/kg. 75.32
=====

Before Implementing the Waste Minimization Option

Month	* Waste (kg)	Production (kg)
August	328.00	3753.900
September	280.00	3812.550
October	209.00	3540.900
Monthly Average	**394.00**	**3720.45**

* Total amount of rejects (Distorted caps + Distorted pins + Looped wires)

17.1.4 Calculation of Cost Benefits

Quantity of waste formed in producing a kg. of products before implementation of the WM option. = kg. 394/3442.44
= kg. 0.144

Cost of waste formed in producing a kg. of products before implementation of the WM option. = Rs. 0.114 x 75.32
Rs. 8.586

Quantity of waste formed in producing a kg. of products after implementation of the WM option. = Kg. 272.3/3702.45
= kg. 0.0735

Cost of waste formed in producing a kg. of products after implementation of the WM option. = Rs. 0.0735 x 75.32
Rs. 5.539

If the WM option had not been implemented, the waste that would have formed during the period from August to October could have been = Kg. 0.114 x 3875
= Kg. 441.75
Actual waste during the same period of time = Kg. **272.30**
Difference = kg. 169.45
Therefore, the money saved after implementation the WM option = Rs169.45x 75.32
= Rs. 12762.97
========

Actual money saved	=	Rs. 12762.97 - (9 x 50.00)
(Money saved for three months - Cost of additional resharpenings)	=	Rs. 12312.97.

17.1.5 Calculation of Pay Back Period

Cost incurred in implementing the option per month (Cost of three re-sharpening per month)	=	Rs. 150.00
Estimated Saving per month	=	Rs. 4104.00

Therefore the pay back period would be only one day.

17.2.1 Problem

During our first visit to the factory we observed that some lubricant is spilt around the cap making machines. It was also observed that the viscosity of lubricant used is excessive than required.

17.2.2 Waste Minimization Option

Members of the WM teem agreed to establish the required viscosity of lubricant used for the operation by adding more diesel and kerosene not making any effect to the operation. Further, it has been observed that the mixture of oil, diesel, and kerosene (4 : 9 : 5) gives the required velocity of lubricant.

In order to reduce the volume of oil spilt, it was suggested to couple an oil extracting device to the feeding and pulling Mechanisms of strip before and after punching is done. Initially, two roller mechanisms were fixed to the feeding and pulling mechanism. As this did not worked satisfactorily it had been decided to fix four wiper blades from both sides of the punching zone above and below the strip.

17.2.3 Procedure of Collecting Data

The data required for analysis were the consumption of diesel and oil before implementing the waste mimimisation option and consumption of diesel, oil and kerosene after implementation of the WM option.

Available Data

Before Implementation the WM Option
Volume of diesel and oil (D.S 50) used in a month before implementing the option and their prices are as follows.

Component	Monthly Usage	Price Rs.
Diesel	10 .00 liters	13.30
(DS 50) Oil	15.00 liters	68.00

Total cost of lubricant used before implementation the WM option = Rs. 226 + 1020

= Rs. 1246

After implementation the WM Option

Data collected during the period from 30th December 1996.

Component	Volume consumed (liters)	Prices Rs.
Diesel	18.00	13.30
(Ds.50) Oil	8.00	68.00
Kerosene	10.00	10.80

Total cost of lubricant used during 1 month period = Rs. 239.40 + 544 = 108

= Rs. 891.40

Therefore cost of lubricant consumption of lubricant = Rs. 594.26

17.2.4 Calculations of Cost Benefits

Total money saved in a month = Cost of lubricant used before implementing the option - Cost of lubricant used after implementing the option.

= Rs. 1246 - 594.26

= Rs. 651.73

As there is no additional cost incurred in implementing this option the pay back period is negligible.

Cost benefit analysis of WM option 03

After fixing the wiper blades, a considerable volume of lubricant was collected during the month of January 1997.

Volume of lubricant collected and recycled = 20 liters.
Assuming the composition of lubricant as the (4 : 9 : 5);
The Cost of lubricant recycled = Rs. (44 x 68.00+10 x 13.30 + 5.5 x 10.80)
= 491.60
= Total money saved in a month = Rs. 491.60

Wiper mechanisms were prepared by using existing resources of the factory. Therefore any additional cost was not incurred in implementing this option. As a result the pay back period is zero.

17.3.1 Problem

Existing pin cap collecting tray do not serve the purpose as they allow to fall the caps from the tray. At the end of the day, an operator has to manually collect the pincaps spilled around the machine. These pin caps are contaminated with dust and spilled oil. Clearing of this collected caps require some more time. As a whole, an operator has to spend half an hour for the collecting cleaning operation.

17.3.2 Waste Minimization Option

Slightly modify the collecting tray, so that all the formed caps to be collected in it, without allowing the caps to be fallen on the floor. The modification had done and satisfactory implemented the option starting from December 96.

17.3.3 Cost Benefit Analysis

Lost working time in collecting and cleaning the caps before implementing the option
= 1/2 hour per day
Lost working time per month = 1/2 x 24 = 12 hours
Payment made to the persons
collecting pin cpas = Rs.360.00

As there was no additional cost was incurred in implementing the suggested option, money saved per month = Rs. 360.00

17.4.1 Problem

It was observed by the team that length of cut pieces of wires are different. Worn out bearings of the wire cutting machine can be considered as the cause for the failure.

17.4.2 Waste Minimization Option

Replace the worn out bearings of the wire cutting machine immediately. It is also recommended to replace the bearing on time not waiting till excessive wear. B y implementing this option standard cut pieces can be obtained and as a result of that reject rates are reduced.

17.4.3 Available Data

Before implementing the WM option around 2% of cut pieces went as waste material.

Average monthly consumption of CR wire	=	3008.0 kg
of that went as waste	=	60 kg
Price of 1 kg of wire	=	Rs. 57.77
Therefore cost of waste material	=	Rs. 3475

After implementing the WM option only 0.5% went as waste.

Therefore the cost of waste material after implementing the
WM option = Rs. 15 x 57.77
= Rs. 868.86

Money saved due to implementation of the WM option = Rs. 2588

17.4.4 Calculation of Pay Back Period

Casting cost of 2 members of bronze bearings	=	Rs. 1200.00
Machining chargers	=	Rs. 1500.00
Fitting chargers	=	Rs. 500.00
Other overheads	=	Rs. 300.00

Total cost incurred in implementing the WM option = Rs. 3500.00

Therefore the pay back period would be only 1.35 month

17.5.1 Problem

Rinse water after Nickel bath is thrown away without recycling or re using.

17.5.2 Waste Minimization Option

Firstly it has been decided to analyse the rinsed water and obtain the chemical composition. If the rinsed water is rich with required chemicals the rinsed water can be recycled and re use. The study has been carried out during the month of December 96. During that month 400 liters of rinsed water is collected. One liter of the rinse water is sent for analysis and the following results were obtained.

Chemical composition of the sample :

Nickel - 16.6 g/l
Boric acid - 3.0 g/l.
Nickel chloride - 23.0 g/l
Nickel sulphate - 39.0 g/l
Accordingly, the chemical composition of the sample volume and the cost of chemicals in it is presented below.

Chemical	Quantity kg	Rate Rs.	Cost of Chemicals Rs.
Nickel	6.64	836/=	5551.00
Boric Acid	1.2	130/=	156.00
Nickel Chloride	9.2	515/=	4738.00
Nickel Sulphate	15.6	460/=	7176.00
	Total cost of the	Chemical in rinsed	17621.00

Adding the above water with chemicals to the Nickel bath Rs. 17621/= can be saved per month. Cost of the option is only the money (Rs. 350/=) paid for analysis. Therefore the total saving per month = Rs. 17271.

18. Recommendations

No other recommendations were made.

8.0 CLEANER PRODUCTION STUDY - Varna (Private) Limited
Part - I General Environmental Audit

1. Company : VARNA (PRIVATE) LIMITED

Varna Industries Ltd., established about 30 years ago is situated at No: 15, Old Airport Road, Ratmalana. It was the only Sri Lankan company for Gravure Printing until recently. Now there are several companies handling gravure printing.

Varna Industries Ltd. Manufactures flexible packaging with printed laminates. The company handles a large number of orders from various clients and produces over 350 different varieties of printed/ unprinted packaging materials for them.

The company's production includes plating and etching of gravure cylinders, approximately 1000 cylinders are completed per annum. Only copper plating is handled at the factory, while cylinders with other forms of plating including hard chromium plating are imported. (Imported cylinders amount to approximately 120 per annum.) The factory has a fairly new plating facility with an automated plating machine.

2. Location of site & ownership of the factory

The factory site is situated in Ratmalana off Old Airport Road, as indicated in the **figure** in section 9 of this profile. The factory and the land are fully owned by the company.

3. Minimization Team

The Waste Minimization Team for Varna Industries Ltd. comprised of the following specialists

NAME	DESIGNATION	COMPANY
Hugh Indrujith	Operations Director	Varna Industries Ltd
T. Rajasegaran	Technical Director	Varna Industries Ltd
Ramachandran	Finance Director	Varna Industries Ltd
C. Perera	Accountant	Varna Industries Ltd
Arambewela	Supervisor	Varna Industries Ltd
Botheju	Supervisor	Varna Industries Ltd
Mohan Rathnayake	Consultant	Romin (Pvt) Ltd
Nihal Gunaratne	Consultant	Romin (Pvt) Ltd
Yasantha Jayasinhe	Chemist	Romin (Pvt) Ltd
Saliya Ratnayake	Chemist	Romin (Pvt) Ltd

The team worked under the guidance of Mr. Andrew Milsted, Chief Technical Advisor (CTA), UNIDO and Dr. Reeves, UNIDO consultant.

4. Physical Description of the Site

The full extent of the site is *0.45 Hectares*, and about 35% of it is sealed surface. The topography of the site is generally flat and free draining. Surface storm water drainage and culverts are provided to drain the land. The ground water table is approximately 1 meter below the surface.

5. Site Use

The factory consists of 8 permanent buildings as shown in Figure 1. The main production processes such as extruding of polythene materials, printing, laminating, slitting and bag making etc. are carried out in five buildings while the other three buildings house the administrative and storage facilities.

6. Raw Materials and Energy

The company uses the following raw materials for the electroplating process.

I. Solid Materials

Steel base cylinders	-	circumference -	350 - 690 mm
		length -	420 - 840 mm
Copper anodes	-	bars & balls	
		Bar dimensions-	60 x 15 x 750 mm
Nickel anodes			

II. Chemicals

530 C Developer		
530 A Copying solution		
530 B Thinner		
Turpentine		
Sulphuric Acid	-	H_2SO_4
Nickel chloride	-	$NiCl_2$
Hydrogen chloride	-	HCl
IPA and Toluene		
Tar	-	Asphalt
Carbonic Acid	-	CH_3COOH
Copper Sulphate	-	$CuSO_4$
Sodium Hydroxide	-	NaOH
Ferric chloride	-	$FeCl_3$
Calcium Carbonate	-	$CaCO_3$

III. Sources of Water

Municipal Mains
Shallow Wells

IV. Energy

The Factory uses electricity mainly as its energy. Diesel is used only for stand-by generators. 20% of the electricity used in the factory is used for the electroplating process.

7. Site Drainage System

There is a surface drainage system which discharges the site liquid wastes into the municipal drainage system. There are no lagoons, swamps or basins near by. There are 6 septic tanks including four normal tanks and one Indian Hume pipe system.

8. Storage of Hazardous Material

There are no hazardous material stored in bulk at the site. Such materials like solvents, ink etc. are stored in a yard away from the site.

9. Description of Surrounding Land Use

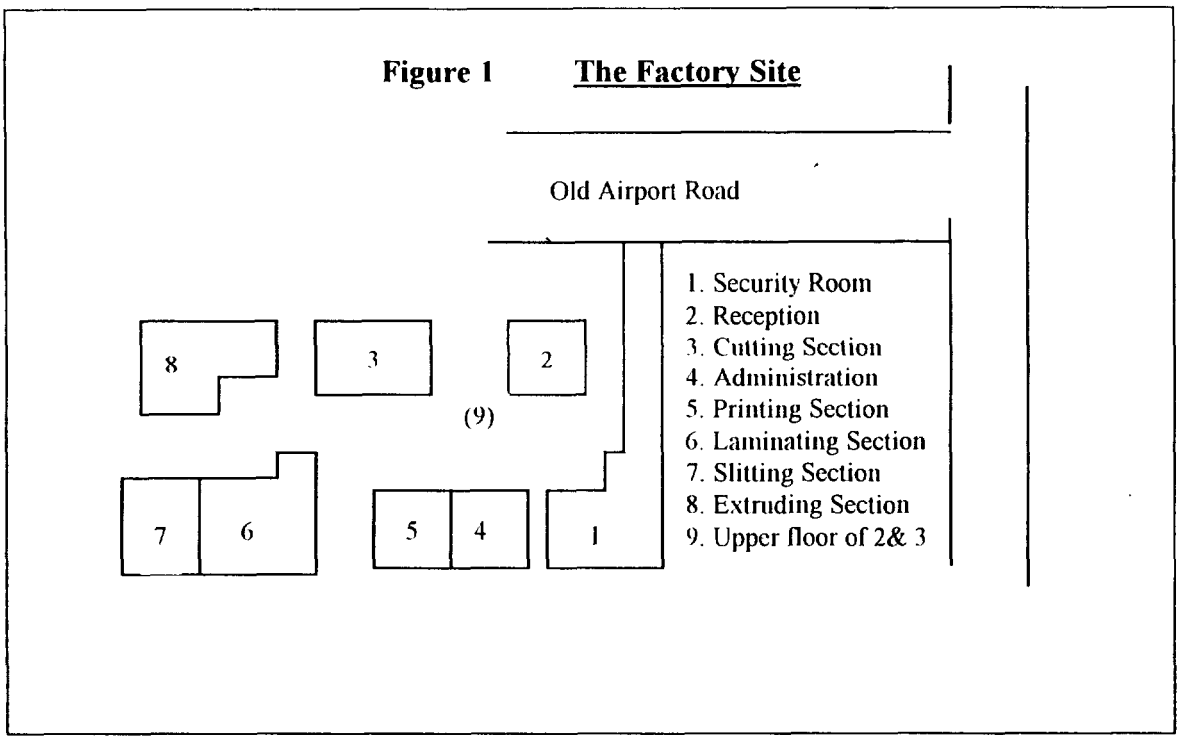
North - Lanka Galvanizing factory, which produces galvanized roofing sheets

East - Residences

South - Old Airport Road

West - Sri Ramya Industries, a paint production company

Figure 1 The Factory Site



10. Sensitive Receptors in the Vicinity

10.1 Residences & other populated zones

People around the area normally use municipal water for bathing and washing and hence the surface water abstraction in the area is minimal.

No schools or hospitals are located close by. Aththidiya marshy land and the bird sanctuary are approximately 4 km away.

10.2 Water abstraction

The company abstracts water from shallow wells for the production process. (No other information was available.)

10.3 Water Bodies

The main surface water bodies in the area are the sea and the Bolgoda lake which are 2 km away.

11. Sources of release to media

11.1 Solids waste disposal

Information not available.

11.2 Aqueous Discharges

- The Aqueous effluent discharge volume is 85 m^3 per day
- The facility does not have an aqueous effluent discharge permit.
- There has not been any correspondence with the authority regarding this discharge.
- There have not been any civil actions concerning this discharge.

11.3 Atmospheric Discharges

- Extruding, printing and laminating are the main operations that make significant atmospheric discharges.
- These emissions are mainly solvents (Toluene, MEK etc.)
- All the exhaust ducts are about 30 inches high (one is 50 inches high), all are 2 inches in diameter.
- No pretreatment of the above discharges takes place
- The facility does not have an atmospheric discharge permit
- There have not been any civil actions concerning these discharges

Part II - Waste Minimization Study

1. General Information

Although Varna Industries Ltd. produces more than 350 flexible packaging products, the company had no proper system to keep records of it's input materials, outputs and waste generation etc. The company changed the production from one form to another depending on the orders they received.

The number of cylinders used in one production run depends on the number of colours in that particular flexible package.

The maximum number of cylinders used in any one production run is six and general information about the cylinders are as follows.
Generally 50 steel based cylinders and 120 hard chromium plated cylinders are imported while 10 - 15 copper based cylinders and 4 - 5 chromium plated cylinders are removed annually due to corrosion and damages. Chromium based cylinders have a life time of 1 million impressions while copper plated cylinders have a life time of only half this amount. 1000 base copper deposited cylinders are produced per year, while 960 skin copper deposited (fully completed)

cylinders are produced per year. The production figures over the first seven months in 1997 are given in **Table 1***. At the same time the chemical inputs for the month of July 1997 are shown in **Table 2***.

The circumference of these cylinders range from 350 - 640 mm, while the circumference of the widely used variety ranges from 400 - 525 mm. The Thickness of the copper base is 200 - 500 μm and the thickness of the skin layer ranges from 75 - 100 μm.

TABLE 1*: No of Fully Completed Cylinders over January to June 1997

MONTH	NO: CYLINDERS
January	91
February	98
March	72
April	85
May	67
June	47
July	66

3. Consumption

3.1 Major Raw Materials

1. Solid

Copper anodes (bars and balls) - approximately 108 kg

3.2 Chemical consumption

Table 2* Materials Inputs (Chemicals) for the month of July 1997

CHEMICAL	AMOUNT
530 C Developer	21 liters
530 A Copying solution	4 liters
530 B Thinner	3 liters
Turpentine	15 liters
Hydrochloride Acid	5 liters
IPA and Toluene	20 liters
Sulphuric Acid	40 kg
Carbolic Acid	70 kg
Copper sulphate	34 kg
Sodium Hydroxide	1 kg
Ferrous chloride	30 kg

4. Energy consumption

Data unavailable

5. Water consumption

Data unavailable

6. Machine capabilities

Data unavailable

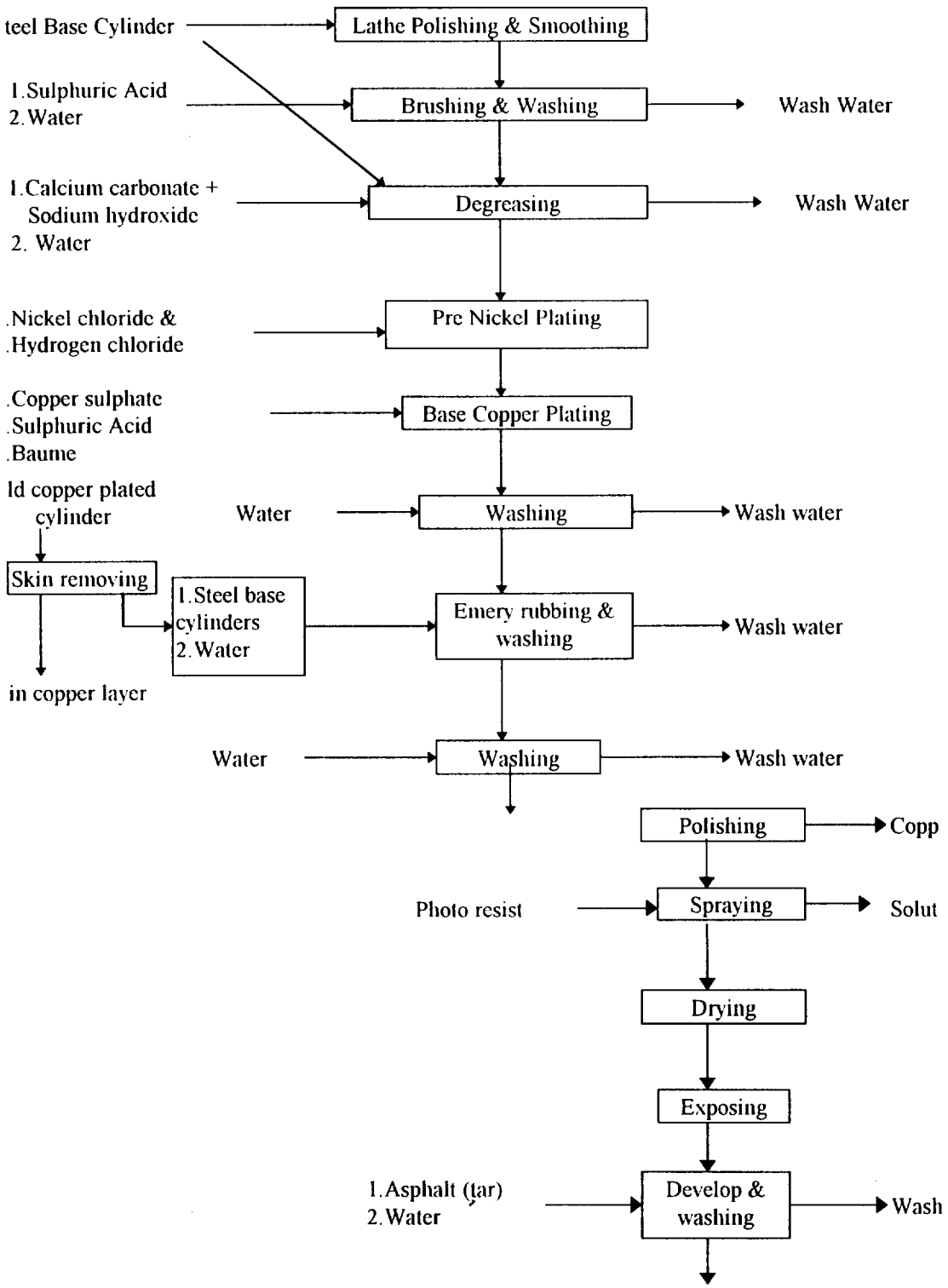
7. Available information

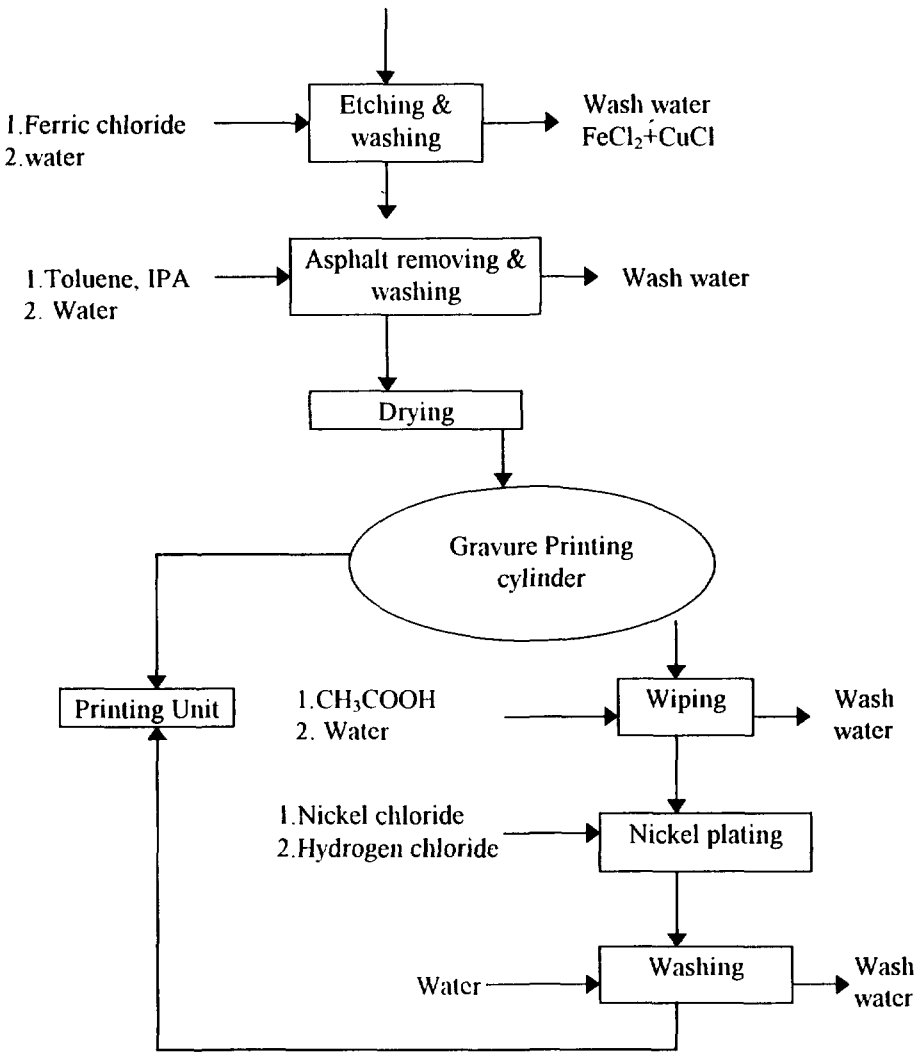
Only a process flow diagram, and material balance diagram was able to be complied by the team for this company. Information such as water consumption, plant layout, machine capabilities were not available.

8. Plant layout

Data unavailable

9. PROCESS FLOW DIAGRAM - ELECTROPLATING PLANT (INCLUDING WASTE STREAM)




1.Ferric chloride
2.water
Etching & washing
Wash water
$FeCl_2$+CuCl
1.Toluene, IPA
2. Water
Asphalt removing & washing
Wash water
Drying
Gravure Printing cylinder
Printing Unit
1.CH_3COOH
2. Water
Wiping
Wash water
1.Nickel chloride
2.Hydrogen chloride
Nickel plating
Water
Washing
Wash water

10. Waste streams worksheet

Detailed data not available to compile a worksheet

11. House Keeping Status : Table 3*

SECTIONS	LAPSES IN HOUSE KEEPING
1. Storage	Cylinders are not stored properly, therefore they are not well protected. The cylinders get damaged easily while handling causing a substantial loss due to defective output.
2. Rinsing	Spillage of water and chemicals

12. Material Balance for the Process : Table 4*

Operation	Input Material		Output Material	Waste Stream	
	Name	Quantity	Quantity	Name	Quantity
Electroplating Process	Copper anode (Bar)	36 kg	Base Copper deposition 27 kg	Added to the electrolyte Due to polishing edging	1.8 kg -0.2 kg
TOTAL	=	**36 kg**	**27 kg**		**9.0 kg**

13. Water Balance for the Process

Data unavailable

14. Identification and assessment of waste minimization options and action list

WASTE	CAUSE	ACTION
1. Chromium plated cylinder damages due to corrosion in the storage	Due to Hydrogen chloride, Ammonium chloride and Sulphur dioxide fumes discharging from neighbouring factories	Covering the chromium plated cylinders using cotech P.E film
2. Wastage of large volumes of chemicals and water	Ineffective rinsing & the absence of counter flow system	Installation of a new sequential process line
3. Wastage of copper due to lathing of the edges (edging) & polishing of the cylinders	Uneven copper deposition on the cylinder surface	Use of brightner chemicals (this requires a demineralising plant)
4. Waste of copper to the electrolyte (copper sulphate)	adding of corroded particles from the cavity of the cylinder	Cavity touch up with cobalt or nickel
5. Excess copper wasted	Poor etching system	New copper etch system & etch recovery system
6. Copper wastage due to replating of cylinders	Low value of impression & damages to the cylinder surface	Hard chromium plating in house
7. Removal of copper	Emery rub	Dissolve copper & sulphuric acid to make copper sulphate

Wastage from the Electroplating process (old electroplating machine)
(For the time duration of 28-06-96 to 26-06-97)

1. Total copper waste from electroplating process = 75 kg

COST (Rs)

2. Added to the electrolyte 15 kg
   15kg @ Rs 1350/ kg = 20250

3. Wastage due to polishing & lathing
60kg @ Rs 1350/ kg = 81000

Therefore **cost of total copper waste** = **101250**
Total value of copper anodes as per factory figures = Rs 400,000

Cost of waste materials as a percentage of the value of copper anodes = **25.3%**

15. Selected Options for implementation

As mentioned in section 14 above the main options selected were to minimize the excessive wastage of materials in the production process.

16. Cost Benefit Analysis of Waste Minimization measures

16.1 Using Cotech P. E. film covers for cylinders

Problem : Damaged cylinders from corrosion

Solution : Corrosion protection of cylinders in storage cover, chromium plated cylinders by using cotech P.E. film

Results : Protecting chromium plated cylinders from corrosion.

Cost : Cost of cotech P.E. film per roll x chromium plated cylinders in the storage = $ 55 x 120 = $ 6600
= 6600 x 60 = Rs 396,000

Savings : No: chromium plated cylinders damaged per year
= 5 cylinders
Price per cylinder (approximate)
= Rs 25,000
Cost of loss (saving per year)
= Rs 125,000

Pay back : 3.2 years

16.2 Use of brightner chemicals

Problem : Uneven copper deposition on the cylinder

Solution : Use of brightner chemicals (De-mineralizing plant needed)

Result : Copper wastage minimized (edging & polishing is minimized)

Cost : De- mineralizing plant = DM 25,000
= Rs 850,000

Savings : Copper wastage due to edging & polishing can be reduced to 5%
Use of copper anodes / year (Total = 1300kg copper balls + bars)
Copper wastage due to edging & polishing per year = 260 kg
Price of copper anode (average) = Rs770/kg
Total copper savings per year = 195 kg/year
= Rs 195 x 770 = Rs 150,150

Pay back : 5.7 years

16.3 New Etching System

Problem : Excess copper wasted

Solution : New copper etch system & etch recovery system
Regenerates etch out ferric chloride

Result : Disposal cost reduced
Etchout maintained at optimum
Improvement in the quality of the design

Cost : DM 150,000 + Recovery Unit = 150,000 x 34 = Rs 5,100,000

Savings : Ferric chloride used (when etching) = 0.25kg/day
0.25 kg/ day can be recovered by recovery unit

$FeCl_3 + Cu \rightarrow FeCl_2 + CuCl$ (etch)
$FeCl_2 + CuCl \rightarrow FeCl_3 + Cu$ (recovery)

$FeCl_3$ amount per year = 56.25 kg
Price per $FeCl_3$ kg = Rs 50.00

Savings per year = 56.25 x 50= Rs 2813

Pay back : The pay back period cannot be calculated from the above savings, as it only gives the advantages of the recovery of $FeCl_3$. It actually improves the quality of the print so that it would not be necessary to redo the process In case of bad etching.

16.4 New Hard Chromium Plant

Problem : Low value of impression, regular damages to the cylinder

Solution : Hard chromium plating in house

Result : Reduction of copper
Quality improved in cylinder

Cost : Plant & make up cost = DM 275,000
= 275,000 X 34 = Rs 9,350,000

Usable hard chromium cylinder impressions = 1 million,
copper plating cylinder impressions = 500,000

Savings : Annually 120 chromium plated cylinders are imported. These are used for major orders requiring continuous cylinder use, while copper plated cylinders are used for small and medium orders. However, some of these medium orders also require the cylinders to be copper plated for a second time. This duplication could be avoided by using the chromium plating plant, resulting in savings on second time processing. As such that the company feels that it is advantages to chromium plate 500 cylinders per year altogether using the new plant.

Savings on chromium plating -

Assume the number of cylinders chromium plated per year
= 500 cylinders/ year
Cost for steel base cylinders = Rs 8,000
Cost for processing copper base, copper plating and skin copper plating = Rs10,000 per cylinder
Cost of chromium plating per cylinder= Rs 2,000

∴ total cost of a chromium plated cylinder = Rs 20,000 (average)

Cost - imported chromium plated cylinder = Rs 25,000 (average)

Therefore, savings per cylinder = Rs 5,000

∴ savings for 500 cylinders on plating = Rs 5,000 x 500 / year
= Rs 2,500,000 / year
= Rs 2.5 million / year

Savings - avoiding 2nd plating process per cylinder
Consider 1 million impressions per cylinder

Processing cost per cylinder = Rs 10,000
∴ processing cost for 500 cylinders = Rs 10,000 x 500
= Rs 5,000,000 / year
= Rs5million/yr. (average)

Therefore total savings = Rs 2.5 + 5.0 million/yr.
= Rs 7.5 million / year

Pay back : = 9.35 / 7.5
= 1.25 years

16.5 Generating copper sulphate with waste

Problem : Landfill

Solution : Generates copper sulphate

Result : Disposal cost reduced
Copper sulphate maintained at optimum

Cost : Rs 50,000 (Equipment & Filter)

Savings : Amount of copper in emery rub per day = 0.2 kg
This copper can be dissolved in sulphuric acid and filtered

$Cu + H_2SO_4 \rightarrow CuSO_4 + H_2$

Generated copper sulphate, used in copper bath.
From the equation 0.2kg of copper generates 0.5kg of copper sulphate
Amount of copper sulphate generated per year
= 112.5kg
Cost of copper sulphate per kg = Rs250
Cost of generated copper sulphate per year
= Rs28,125

Amount of sulphuric acid for this purpose (from eq.)
= 67.5 kg/year
Cost of sulphuric acid per year at Rs 27.50/kg
= Rs1856.25
Annual consumption of copper sulphate = 120kg
Cost for copper sulphate per year at Rs250/kg
= Rs 30,000

When, use generated copper sulphate in copper-bath
Savings = Rs26268.75

Pay back : 1.9 years

17. Implemented options and gains or why implementation was not possible

Non of the waste minimization options have been implemented, this is mainly due to the fact that the industrialists are not concerned about the effects on the environment and they are not yet ready to invest money (which they do not have much of) in measures that are new to them.

18. Recommendations

a) Installation of a new chromium plating plant so that excessive use and wastage of copper can be avoided. The performance of the cylinders could be improved there by resulting in large savings.

b) Using brightner chemicals by installing a water demineralizing plant to save copper that goes to waste by lathing to get a smoother surface of the cylinders.

c) Plated cylinders to be protected with cotech P. E. Films.

d) To reduce high chemical and water cost waste, effective rinsing a counter flow system is suggested.

e) The old copper plating tank has become corroded, so that the immersion of the copper cylinder now becomes less than 20%. The tank can be repaired and the immersion can be improved. This will reduce the time and the cost for the cylinder plating.

f) When removing the skin copper layer (99.6% copper), more than a 100μm thickness of a mainly copper layer is removed. Presently it is not recycled. Since to plate this layer Silver Nitrate is used, the cost is also high. Suggested that the printing should be done on the square copper base and to remove that print using a sophisticated lathe machine.

9.0 CLEANER PRODUCTION STUDY- ALUMEX (PVT) LTD
Part-1 General Environmental Audit

1. Company - Alumex (Private) Limited

Alumex (Pvt.) Ltd., founded 8 years ago, is a Sri Lankan & South Korean joint venture with 55% shares of United Ceylon Insurance Ltd. at 45% of Houng in enterprises of South Korea. Alumex produces more than 300 different aluminum section & its daily production is about 4 tones Alumex caters to about 50% of the local market while arrangements are in hand to break into the export market.

2. Location of site & ownership

Alumex (Pvt.) Ltd. is located at Makola. 30 Km. From Colombo. The factory is owned by the company it self.

3. Waste Minimization Team

Name	Designation
1. Mr. C. Jayasinghe	- Production Manager
2. Mr. I. J. K. Abeykoon	- Ass. Manager (Maintenance)
3. Mr. Mohan Wicramwnayake	- Finance Manager
4. Mr. W.H.N. Rajapaksa	- Ass Section Chief
5. Mr. Ananda Thilakarathna	- Supervisor
6. Dr. A. R. Rupasinghe	- ROMIN consultant
7. Mr. Andrew Milsted	- UNIDO consultant

4. Physical Description of site

- 1.5 hectares of site area at Makola
- Site & Building arrangement - Factory, Office & General storage.
- Site Topography is flat
- Surface drainage channels are down the hill.
- 6-10 meter depth to ground water

5. Site use

The factory and the administrative office are located on site along with the storage of Aluminum and other chemicals.

6. Raw Material & Energy

I. Solid Materials

Aluminum Billet.

II. **Chemicals:-**
Nitric Acid
Sulphate
Nickel Sulphate
Sodium hydroxide
Sulphuric Acid
Degreasing Chemicals

III. **Sources of Water**
Municipal mains
Shallow wells

IV. **Energy**
Mainly electricity is used as energy. Heavy diesel, LP gas and other fuels are also used.

7. Site Drainage system

- Surface Drainage system
- Waste water collect from anodizing section to a settling tank. It is contaminated with acid, salt, etc. Waste water drains to Kelani river through channels.
- No exterior lagoons, sump or basin.
- No septic tank.

8. Storage of Hazardous material

Chemicals of HNO_3 NaOH, H_2SO_4 , etc. are in drums in a store room.

9. Description of Surrounding Land use

neighbouring properties -
North - Paddy field
South - Road
East - Bare land
West - Bare land

10. Sensitive Receptors in the vicinity

10.1 Residences and other populated zones.

- Residences are 1/2 Km off the factory
- No school and hospitals close- by.
- No protected habitants and colonies close-by.

10.2 Water Abstraction

Abstraction of water from domestic wells, 1/2 Km. away from the factory.

10.3 Water bodies

- Source of water- Open wells
- The Kelani river is about 7 Km. away from the factory.

11. Sources of release to the media

11.1 Solid waste disposal

300 Kg. Of aluminium ash/ week & aluminium scrap
The facility does not have a permit covering its waste disposal
There has not been any correspondence with authority regarding this discharge.

11.2 Aqueous Discharges

- Quantity of aqueous effluent discharge is around 2800 gal/ hr.
- Effluent collects in settling tank and discharge in to open drain.
- The facility does not have an aqueous effluent discharge permit
- There has not been any correspondence with the authority regarding this discharge.

11.3 Atmosphere discharges

No atmospheric discharges

Part II- Waste Minimization Study

1. General Information

The company uses the aluminum billets imported from South Africa. However, they also have a billet casting process to utilize their offcuts & scrap sections.

The oil fired melting furnace has a 2.5 ton capacity. Once the aluminum is melted, it is poured into mould manually. After the ingots are formed they are homogenized at 570^0 C for 7-8 hours.

Extrusion is done at 420^0 C billets & the dies are preheated to 420^0 C before extruding.

Anodizing process commences with degreasing using 14% Nitric Acid. The process continues with rinsing with cold water , etching with Caustic Soda, rinsing neutralizing with 12% Sulphuric Acid, rinsing, Sulphuric Acid Anodizing and rinsing.

Coloring also done whenever necessary with Nickel & Tin Sulphate, Sulphuric Acid etc.
Finishing without water seal at 95- 98^0 C

2. Range of products manufactured

Extrusion Al- section		87.28 mt/m
1.	Mild Finished Product	30.00 mt/m
2.	Natural & colored product	90.00 mt/m

3. Major Raw Material Consumption

Process 01

Aluminium ingot	35 tone/m	(m - month)
Al Scraps	40 tone/m	
Magnesium	0.35 tonnes/m	
Silicon	0.34 tone/m	
Manganese	0.2 tone/m	

Process 02

Al Billets	125.00 tone/m

4. Energy Consumption

Electrical Energy	150.4 mwh/month
Furnace Oil	2909 l/month
Heavy Diesel	788 l/month

5. Water consumption

1528 m^3 of water is consumed per month

6. Machine capabilities

No information was available

7. Available Information

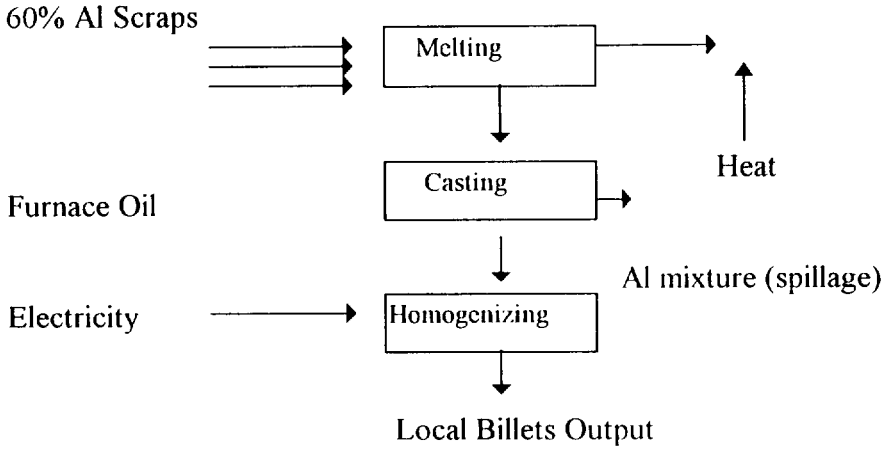
Information	Availability	Remark
Process Flow Diagram	Yes	Produced as a result of the program
Material Balance	Yes	"
Energy Balance	No	-
Water Balance	No	-
Producing Log Sheet	Yes	Production as a result of the program

8. Plant Layout

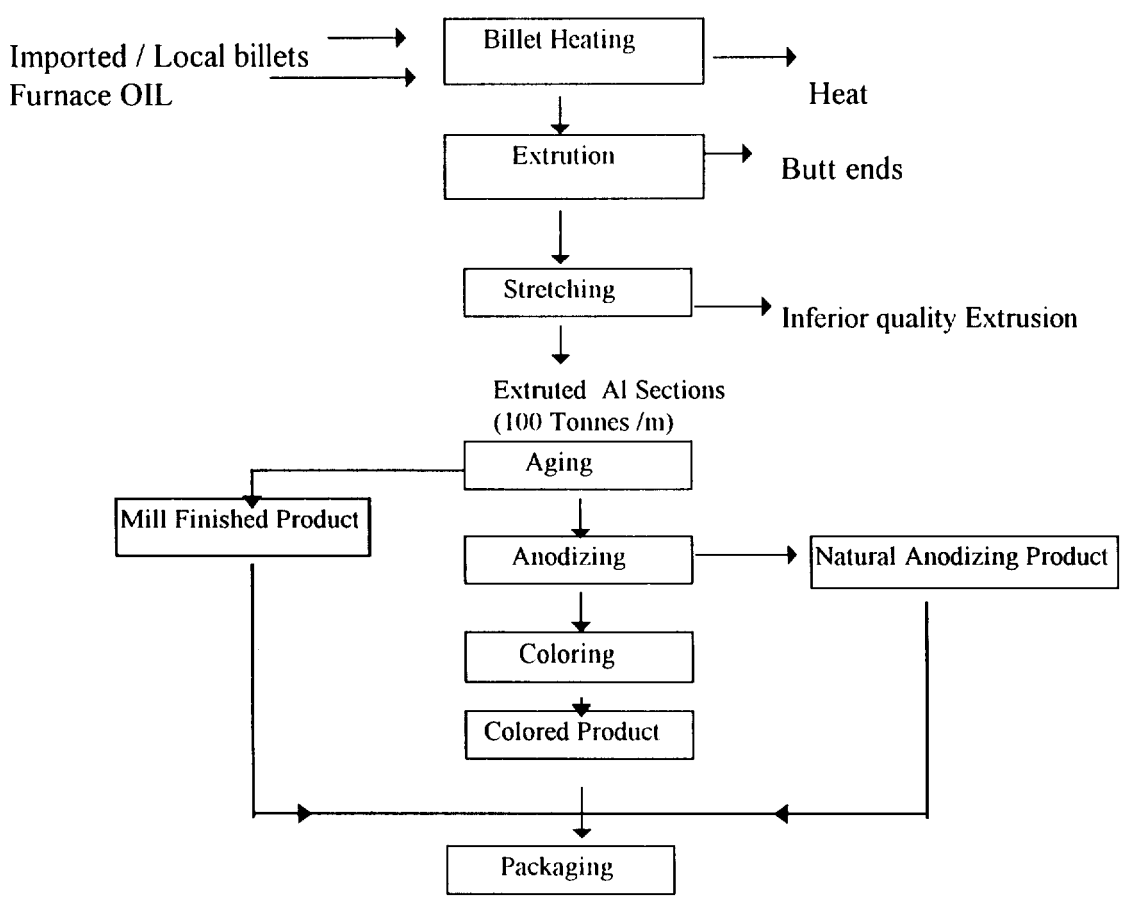
No drawing available

9. Process diagram (including waste streams)

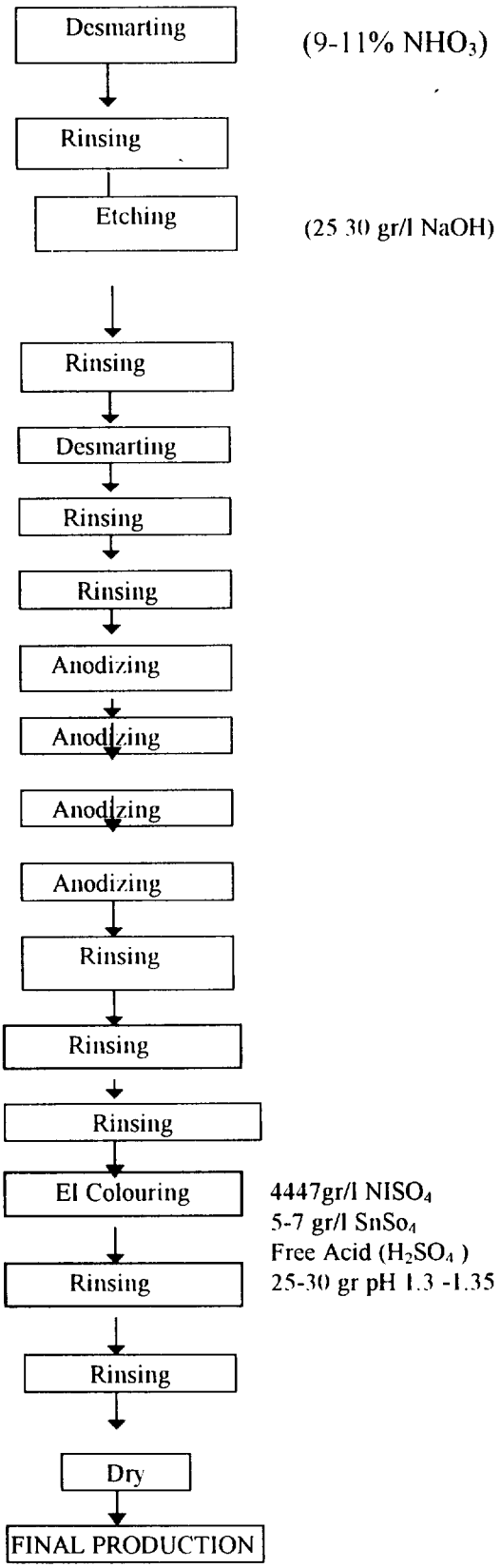
9.1 Process - 01- Production of local Billets



9.2 Process -02- Production of extended Al- section



ANODIZING PROCESS



10. Waste Streams (Work sheets)

No detailed data is available to compile a work sheet for the waste streams of the process.

11. House Keeping Status

Section	Lapses in Housekeeping
Melting	Workers feel uncomfortable due to heat created inside the melting unit.
Casting	Spillage of Al- mixture.
Extrusion machine.	Spreading of AL-billets scraps around the extrusion
Cutting 2nd stage (Final cutting)	Spreading of Al- Dust (No exhaust fan)

11.1 Material, Consumption

11.1.1 Material, Input, Output, & Waste for process-01

Material Average	Units	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Monthly
Al- Ingot	MT	20.87	37.55	39.32	29.66	40.28	25.93	32.27
Al- Scrap	MT	32.29	40.15	41.03	29.72	45.21	39.32	37.95
Magnesium	kg	177.0	293.0	328.0	1052.0	330.0	261.0	436.33
Silicon	Kg	-	300.0	-	160.0	200.0	300.0	240.0
Alisi Alloy	Kg	550.5	907.0	1191.0	891.0	1786.0	538.0	977.25
Al- Billets	MT	45.71	68.75	73.57	52.45	75.95	60.14	62.76
Waste	MT	8.17	10.44	8.3	9.04	11.86	6.21	9.00

11.1.2 Material Input ,Output & Waste for Process-02

Material	Apr.	May	Jun.	Jul.	Aug.	Sep.	Monthly Average
Billet Input	86.6	128.54	136.36	136.36	95.55	109.18	115.43
Extrusion Output (MT)	63.0	98.55	104.52	71.13	81.99	87.28	-
Scraps	23.6	29.99	31.84	31.84	24.42	27.19	28.14

11.1.3 Chemical consumption for Anodizing & coloring process.

	Apr.	may.	Jun.	Jul.	Aug.	Sep.
HnO_3 (Kg)	680.0	1080.0	1000.0	960.0	2040.0	2280.0
NAOH (Kg)	2400.0	2900.0	2900.0	2200.0	2600.0	2400.0
H_2SO_4 (Kg)	3000.0	5800.0	5320.0	4600.0	5360.0	4200.0
$NiSO_4$ (Kg)	140.0	275.0	275.0	225.0	285.0	260.0
$SnSo_4$ (Kg)	65.0	104.0	104.0	95.0	120.0	100.0
Cresol Sulphate (Kg)	25.0	-	-	50.0	50.0	25.0
Nalko-N- 19 (Kg)	6.0	6.0	6.0	6.0	6.0	6.0
Nalko L/S 340	2.63	2.63	2.63	2.63	2.63	2.63
Nalco 8300	3.71	3.71	3.71	3.71	3.71	3.71

11.2 Energy consumption

11.2.1 Electricity (Total Process)

	Apr.	May.	Jun.	Jul.	Aug.	Sep	Monthly Average
KVA	710.0	700.0	750.0	760.0	720.0	720.0	726.0
Mwh	119.0	153.5	140.4	152.5	161.6	175.5	150.4

11.2.2 Fuel Consumption (Total Process)

	Apr.	May.	Jun.	Jul.	Aug.	Sep.	monthly Average
Heavy Diesel(L)	243.0	1279.0	792.0	953.0	476.0	987.0	788.0
Furnace Oil (L)	1014	4704.0	3085.0	3493.0	2445.0	2812.0	2909.0

11.3 Production figures

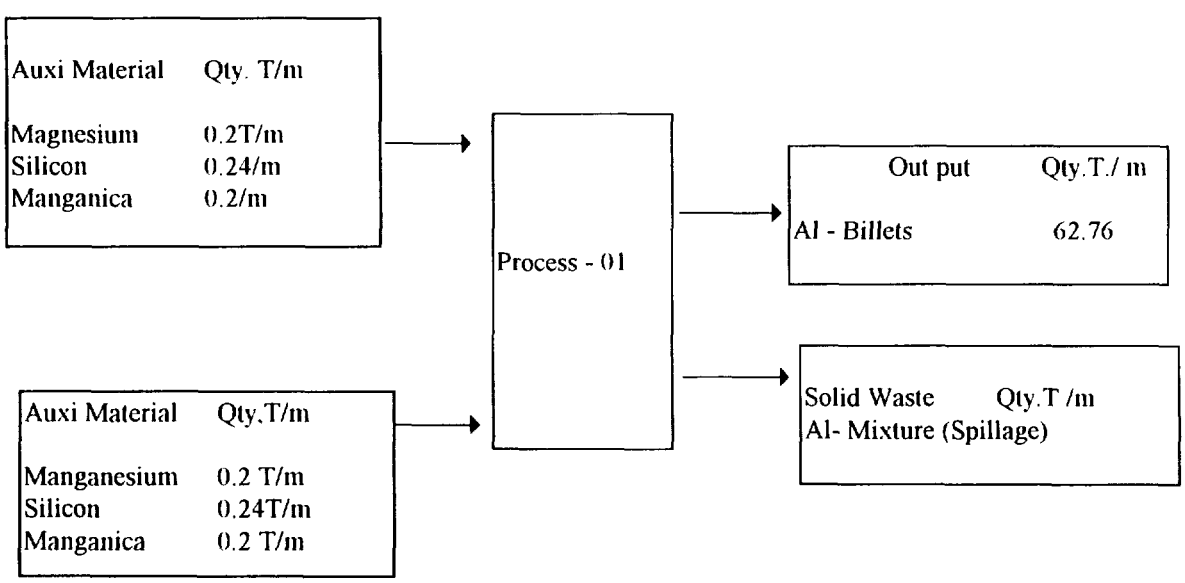
Month	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Monthly Average
Out Put (MT)	44.5	83.26	45.0	66.7	84.21	65.45	64.85

11.4 Production costs

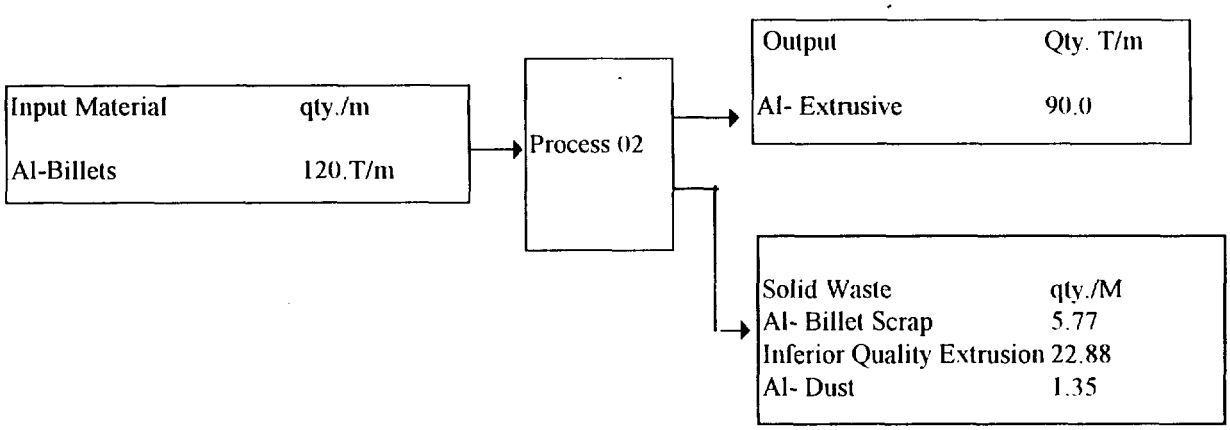
Figures not available

12. Material Balance

12.1 Material Balance Process - 01



12.2 Material Balance Process 02



13. Water balance

Figures are not available

14. Identification & assessment of waste minimization options and action list

Waste minimization options are necessary to curtail the excessive use of water, sodium hydroxide, sulphuric acid & heat.

15. Selected options for implementation

Minimization of the wastage of water, sodium hydroxide, sulphuric acid & heat have been selected for implementation.

16. Cost benefit analysis of Waste Minimization measures

16.1 Rinsing

Problem	:	Excessive use of water
Solution	:	Installation of Counter flow rinsing tanks
Results	:	Reduced water by half
Costs	:	Rs: 200000/=
Savings	:	30,000/=
Pay Back	:	7 Months

16.2 Caustic Etch

Problem	:	Excessive use of Sodium Hydroxide
Solution	:	Installation of Extra caustic etch tank
Results	:	Reduction of Sodium Hydroxide 35% Higher quality work
Costs	:	Rs: 1.7 Million
Savings	:	520,000/=
Pay Back	:	2.6 Years

16.3 Anodizing

Problem	:	Excessive use of sulfuric Acid
Solution	:	Installation of extra Anodizing tank
Results	:	Acid use reduction Higher quality work, Sludge reduction
Cost	:	Rs: 2.3 Million (For a local tank)
Savings	:	Rs:475,000/=
Pay Back	:	Rs: 4 .9 Years

16.4 Heat Treatment

Problem	:	Heat wasting
Solution	:	Installation of heat recovery system
Results	:	Reduction of heat wasting Reduction of air pollution (less chemical gasses) Better Efficiency-less energy
Cost	:	Rs: 2 Million

Savings : Energy & Maintenance Rs: 540,000/=

Pay Back : 3.7 Years

17. Implemented options and gains on why implementation was not possible

Non of the options were implemented due to their high financial costs and lack of understanding and effort on the management side.

18. Recommendations

a) Installation of counter flow rinsing tanks to reduce water usage by half.

b) Installation of extra caustic etch tank thereby reducing the use of sodium hydroxide by

c) Installation of extra anodizing tank for sludge reduction, acid use reduction and higher quality work

d) Installation of a heat recovery system for reducing heat waste, reducing air pollution and for better energy efficiency.

10.0 CLEANER PRODUCTION STUDY - LANKA GALVANIZING Co. Ltd

Part - 1 General Environmental Audit

1 Company - LANKA GALVANIZING CO. LTD.

Lanka Galvanising Plant is 16 years old. The plant produces corrugated & plain roofing sheets. Its daily production is about 15- 17 Tonnes. Factory production capacity is 35 Tonnes per day.
The company uses mostly the cold rolled steel coil (CRSC - 24--34 gauge) imported from India or South Africa. and 99% Zn is purchased from Pasminco Australia .

2. Location & Ownership of site

Lanka Galvanising Company is located at Ratmalana. 14 km , from Colombo. This factory is fully owned by the company .

3. Waste Minimisation Team

Name	Designation
Mr. S.M.P. Silva	Factory Manager
Mr. N. Jayamanne	Chemist
Mr. Walgama	Mech: Eng.
Mr. Musaffath	Mech: Eng.
Mr. P.M.K.T.P.Palansooriya	Chemist (ROMIN)
Dr. K.W.S. Kularatne	Consultant (ROMIN)
Mr. D. Kapurubandara	Consultant (ROMIN)

4. Physical Description of site

The factory site is about 0.8 hectares .Factory, Office and general are arranged on the site area. Factory is controlled under management organisation of the factory.
No marshy areas and ground water under 1.2-1.5 m.

5. Site use

The site is used for factory building where production processes of corrugated & plain roofing sheets are carried out .Two building are used for factory office and store room.

6. Raw Material

6.1 Solids & Chemicals

Major raw materials involved in the production of corrugated & plain sheet -CRSC (roofing sheet) are, cold rolled steel coil , Zinc and some other chemicals such as Ammonium chloride (NH_4Cl),Hydrochloric acid (HCl)and Chromic acid etc. CRSC are imported and Chemicals are purchased locally in required quantities.

6.2 Water

Mainly water required for rinsing, cooling operations and other purposes is taken from municipal water supply lines.

6.3 Energy

Electricity is used for machine operation and other factory work.
Furnace oil which is used for heating of galvanised bath is also purchased locally.

7. Site drainage System

Mainly waste water generated at the factory are two units . It is collected after rinsing and cooling operations. Rinsing water contaminated with Hydrochloric acid ,goes through the primary waste treatment plant and drains to the sea via municipal drainage system .

8. Storage of hazardous material

Chemicals of Hydrochloric Acid, Ammonium Chloride and Chromic Acid are stored in store room on site .All chemicals are kept in containers.

9. Description of Surrounding Land Use

The site is surrounded by the Road in north, Varna (Pvt) Ltd.. in South, Residences & Wimaladarma Industries respectively in East & West.

10. Sensitive Receptors in the vicinity

10.1 Residences & other populated zone

Nearest residence on east boundary, No hospitals or Schools are located close by.
People could be affected by atmospheric releases of Ammonium Chloride (NH_4Cl) fume coming out from the factory.
Protected Athtidiya marshy land and birds colony are about 4 km off the site. There is no natural lagoon.

10.2 Water Abstraction

People use generally municipal water for bathing & washing. Effluent Discharge into the municipal drainage system. Therefore surface water abstraction is very limited.

10.3 Water Bodies

The Bolgoda lake and the sea area about 2 km away from the factory.

11. Sources of Release to the Media

11.1 Solid waste disposal

Zn-dross formation (30 Tonnes per year) containing from galvanising process unit .
25 Tonnes of metal scrap (cold rolled steel coil) is disposed from shearing section.
10 tonne of flux slag out from fluxing section every year, contaminated with Zinc and lead .

11.2 Aqueous discharge

Waste water is discharged from process units of Rinsing , Pickling , cooling & Scrubber units .
Waste water containing Hydrochloric Acid , Iron & ammonium chloride.

11.3 Atmospheric Discharge

Emission of NH_4Cl fume 24 Tonne per year from fluxing unit. Hydrochloric Acid fume is also released to the atmosphere from pickling unit.

Part -II Waste Minimization Study

1. General Information

The factory production capacity is 35 Tonnes per day. The company uses mostly the cold rolled steel coil (CRSC - 24--34 gauge) imported from India or South Africa. and 99% Zn is purchased from Pasminco Australia .

2. Range of products manufactured

The plant produces corrugated & plain roofing sheets

3. Major Consumption

3.1 Raw material consumption

Cold Rolled Steel Coil(CRSC)	3500.00 T/Yr
Zinc (Zn)	379.00 T/Yr.

3.2 Chemical consumption

Ammonium Chloride	24.00 T/Yr.
Hydrochloric Acid	20.00 T/Yr.
Chromic Acid	0.015 T/Yr.

4. Energy Consumption

Electrical Energy	216 Mwh/Yr.
Fuel(Furnace Oil)	241kl/Yr.

5. Water Consumption

Well Water	135 Cubic Meter/Yr.

6. Machine capabilities

Data not available.

7. Availability of Information

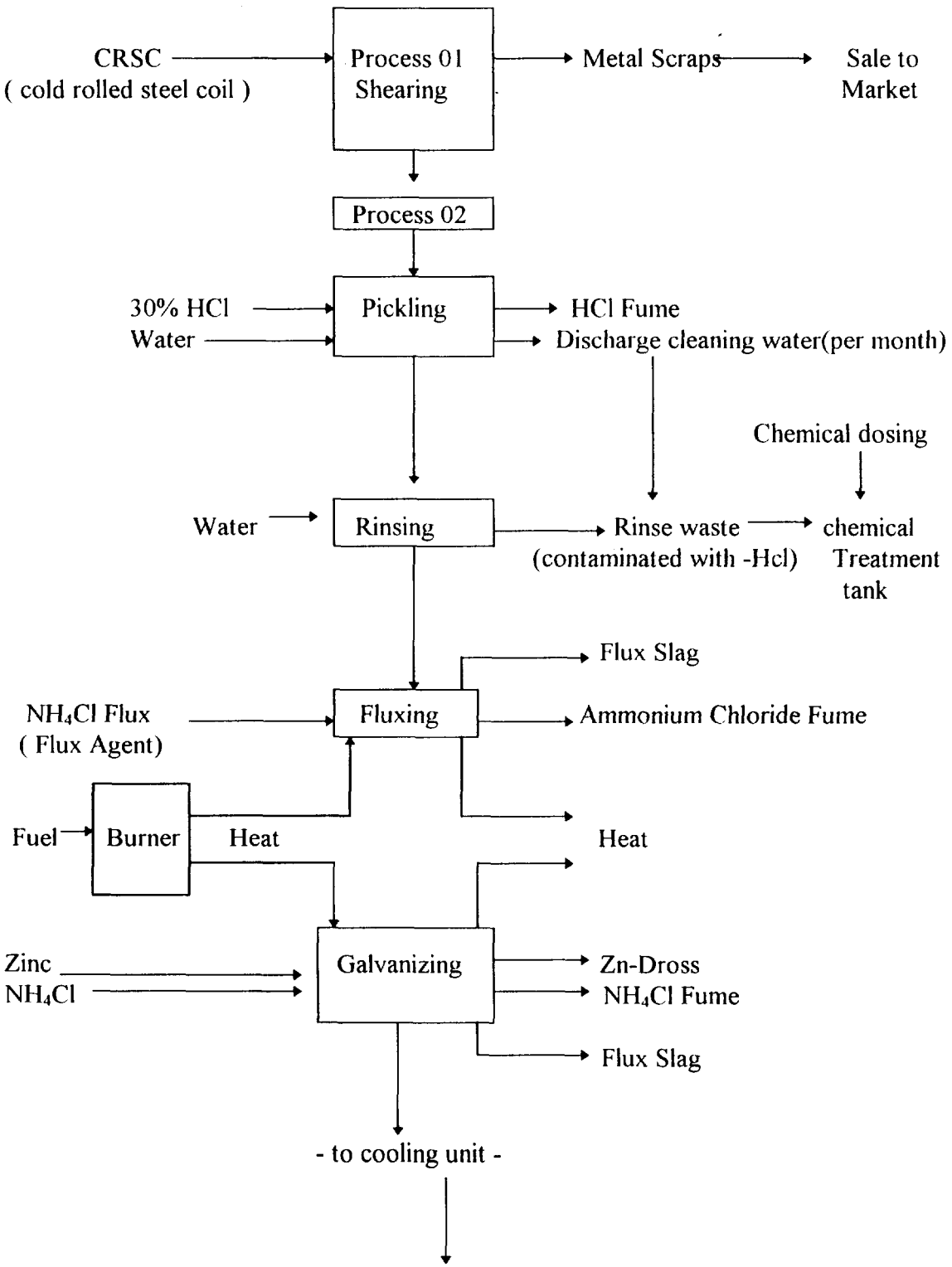
INFORMATION	AVAILABILITY	REMARKS
Process Flow Diagram	Yes	Produced As Result Of the Programme
Material Balance	Yes	,,
Energy Balance	No	-
Water Balance	Yes	Produced As Result Of the Programme
Production Log Sheet	Yes	"

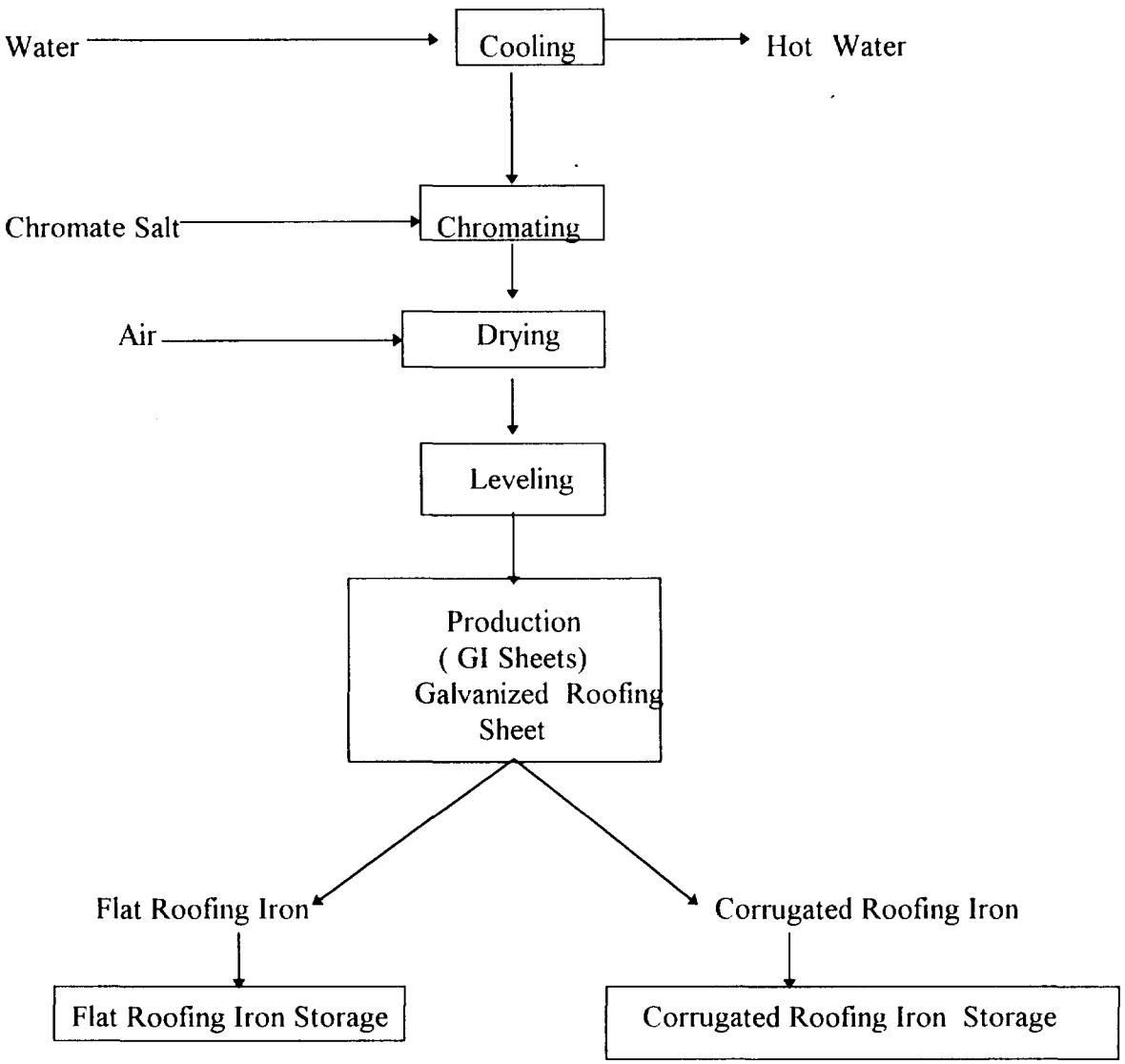
8. Plant layout

Not available.

9. Process diagram

Process Flow Diagram- Including Waste Stream





10. Waste streams worksheet

Detailed data unavailable to produce a worksheet

11. Housekeeping Status

Table - 9.9

Housekeeping Status	
Sections	**Lapses in Housekeeping**
• Storage	Corrosion on CRSC. Damaging CRSC.
• Shearing	Spread of Steel offcut around the shearing machine.
• Pickling	Spillage of HCl Acid. Spread HCl fume in side the factory
• Rinsing	Spillage of water.
• Fluxing & Galvanizing	Spreading NH_4Cl in side the factory. Workers feel uncomfortable due to heat generated inside the galvanizing unit.

Material Energy Consumption & Cost

11.1 Material Consumption

11.1.1 Major Raw Material Consumption

Month 1996	CRSC Consumption (Tones)	Zn (Tones)
June	161.88	5.796
July	354.08	31.364
August	305.79	23.224
September	288.85	13.481
Monthly Average	270.025	18.466

11.1.2 Chemical Consumption

Month 1996	NH_4Cl Consumption (kg)	Chromic Acid Consumption (kg)	HCl Consumption (kg)
June	960.00	1.00	962.00
July	3720.00	2.00	1166.00
August	3450.00	2.00	2302.00
September	1560.00	0.25	1512.00
Monthly Average	2422.5	1.31	1485.00

11.2 Energy Consumption

11.2.1 Electricity Consumption

Month	Kilowatt hour
June	5915.00
July	19090.00
August	17690.00
September	16720.00
Monthly Average	14853.75

11.2.2 Fuel Consumption -

Furnace Oil 216 Tone Per year

11.3 Production figures

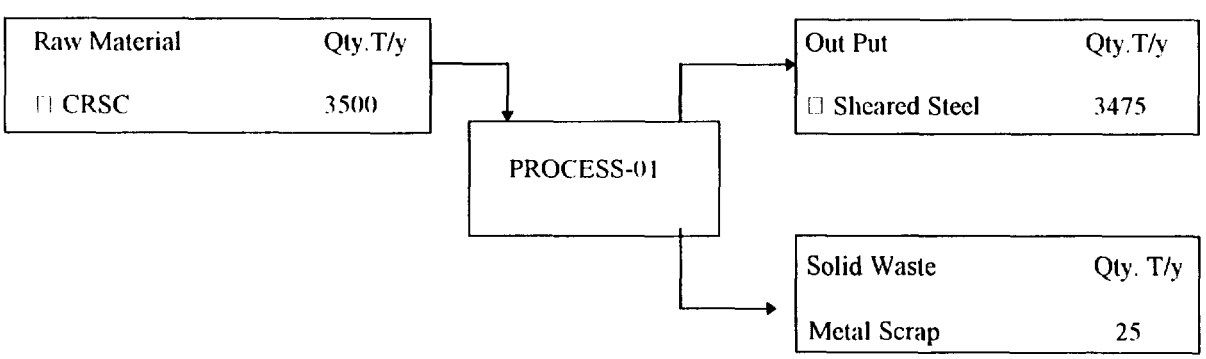
The daily production is about 15- 17 Tonnes of corrugated and plain roofing sheets.

11.4 Production costs

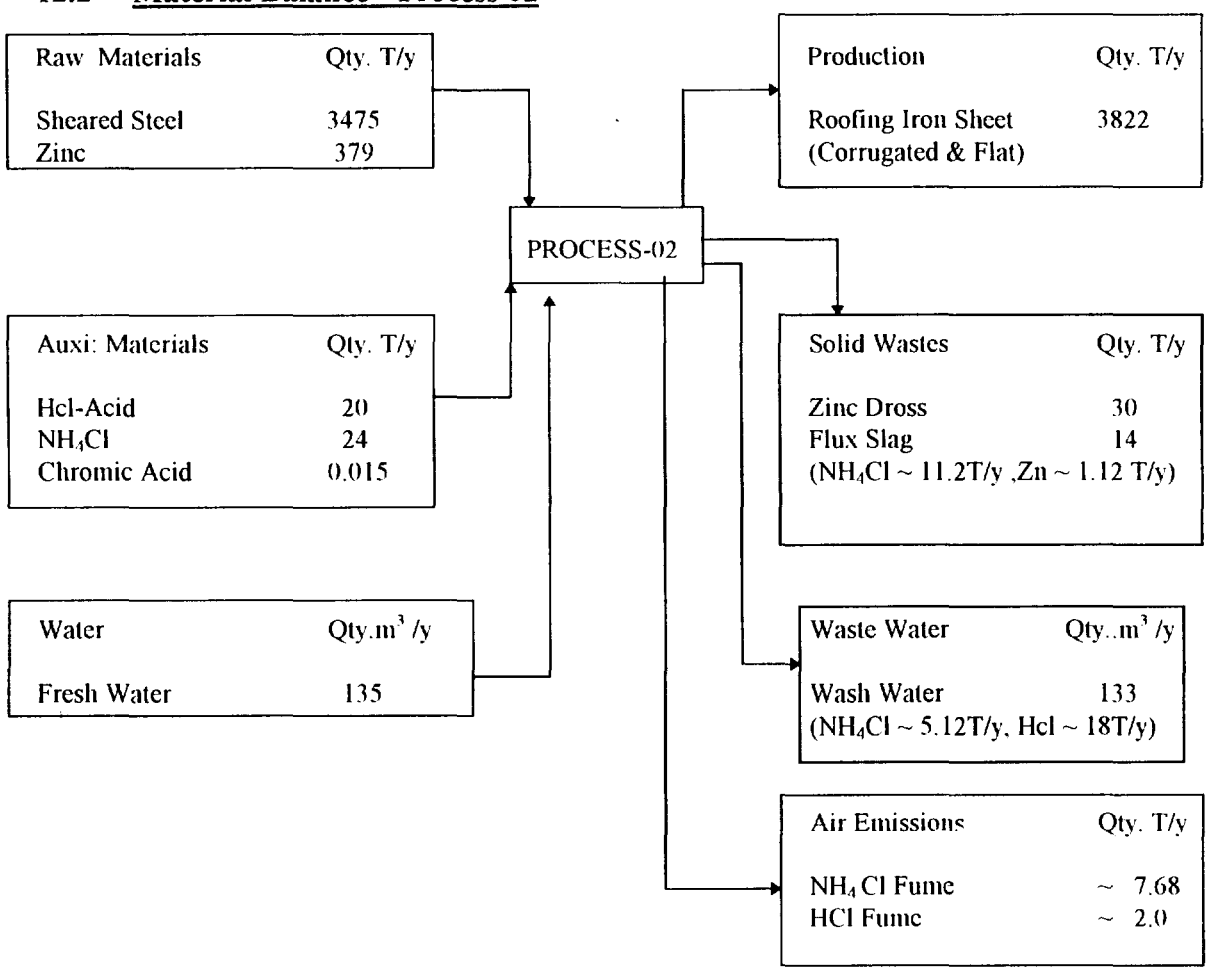
Name of the input Material	Cost/kg Rs.	Annual Consumption
Solid Materials		
Cod rolled steel coil	50.00	3500 Tons
Zinc	80.00	210 Tons
Chemicals		
Ammonium Chloride	30.75	32 Tons.
Hydrochloride Acid	27.75	20 Tons
Chromic Acid	39.50	15 Tons

12 Material Balance

12.1 Material Balance Process - 01



12.2 Material Balance - Process 02



Auxi: - Auxiliary
m^3- Cubic meter, Qty. - Quantity
T- Tonne, y - year, Pb - Lead, NH_4Cl- Ammonium Chloride

12.3 Ammonium Chloride Balance

Consumption of NH_4Cl amount = 24 T/y
Flux Slag - 14 T/y (Containing NH_4Cl ~ 80% = 11.2 T/y , Zinc ~ 8% = 1.12 in flux slag)
NH_4Cl in Flux slag = 11.2T/y
NH_4Cl fume (24 - 11.2) T/y = 12.8 T/y
NH_4Cl in water (scrubber efficiency ~ 40% = 5.12 T/y , NH_4Cl fume ~ 7.68 T/y

12.4 Zinc Balance

Use of Zn amount = 379 T/y
Zn-dross amount = 30 T/y
Zinc in Zn-dross = 29.5 T/y (98.5% of Zn in Zn-dross)

Zinc in Production ~ 347.5 T/y , Zn in flux slag = 1.12 T/y

13. Water Balance

Table - 07

Process Unit	Fresh Water m^3/y	Waste Water m^3/y
Pickling	4.50	3.50
Rinsing	17.00	16.00
Cooling	1.00	1.00
Scrubber	112.50	112.50
Total	135.00	133.00

50 liter of fresh water use for cooling unit which is using approximately 15 days and recycling .

14. Identification and assessment of waste minimization options and action list

14.1.1 Available Information of Waste Streams

Month	Total Damaged- CRSC(Kg)	Zn dross (Kg)
June	1489	1856.12
July	2379	1806.22
August	1772	1775.10
September	1021	1887.30
Monthly Average	1665	1831.18

14.1.2 Raw Materials

Waste	Amount T/Y	Average Amount kg/m
Metal Scraps	25	2083
Flux Slag	14	1166
NH_4Cl Fume	20	1666

14.1.2 Costing of waste Streams

Raw Materials -

Item	Quantity Kg/M	Unit Cost Rs/kg	Total Cost Rs. Cts.
Metal Scraps	2083.00	50.00	104150.00
Zinc Dross	1831.08	75.00	137338.50
Damage CRSC	16665.00	50.00	83250.00
Total			324738.50

Chemicals

Item	Quantity kg/M	Average Unit Cost Rs./kg	Total Cost Rs. cts.
NH_4Cl Fume	1666	30.75	51,229.50
NH_4Cl Slag	933	30.75	28,689.75
Total			79,919.25

14.2 Identification & assessment of Waste Minimization Options

Process Unit	Waste	Cause	Action	Category	Urgency Timing	Importance
Shearing	Metal scraps .	Cutting the steel in different shapes.	Sale as scrap metal.	WM	S	10
Pickling	HCl fume.	Use high conc.30% of HCl to remove rust on steel.	Install 3 tank of 5% Hcl at 40^0C and increase dipping time of steel in HCl (Height of tank is ~ 1m)	WM	S	10
Rinsing	Rejected (Product)	oil spot on the steel. due to Rinsing which is not sufficient	Install an alkaline soak cleaner .& 3 counter flow at the line before pickling.	WM	M	10
Fluxing	Ammonium Chloride fume	Temperature of Flux bath.	Use blanket(water shower).	WM	M	10
	Flux slag	The sheets carrying over acid and water to flux bath. & Impurities of raw materials.	Install triple counter flow at the line after pickling.	MW	M	10

Cont.....

Cont...

Unit	Waste	Cause	Action	Category	Urgency Timing	Importance
Galvanizing	Zn - Dross & rejects	Temperature Variation due to manually controlling.(450^0-465^{0}C)	Control temperature in the galvanized bath. Install automatic temperature controlled burner equipment.	WM.	L	6
		Zn - Iron reaction. (Zn-Fe Alloy)	Install ceramic bath instead of Iron galvanizing bath.	WM.	L	6
	Zinc (Over coat on steel.)	Speed , Temperature.	Install Air knife controller (To control over coating Zn on the Sheets & add 0.02% of Aluminium for bright coating.	WM.	L	10
	Flux slag & Fume	Temperature, Reaction of Zn-NH_4Cl	Not necessary to use of NH_4Cl after installation.			
Cooling	Water	Not reused.	Recycle, the water	WM	M	10

Zn - *Zinc*
NH_4Cl - *Ammonium Chloride*
Category : WM = *Waste Minimization*; EE = *Energy Efficiency*
Urgency : S = *Short Term*; M = *Medium Term*; L = *Long Term*
Importance : Scale of 1 - 10 *(10 being extremely Important)*

15. Selected options for implementation - Hot dip galvanizing as detailed in the above table.

16. Cost Benefits Analysis of Waste Minimisation measures

16.1 Hop Dip Galvanizing - Corrugated & Plain Steel Sheet

Problem - (a) Rejected due to shine defects
(b) Zn dross formation due to temperature variation

Solution - Control the temperature in the Galvanizing Bath.
Install Automatic Temperature Controlled Burner Equipment(ATC).

Results - Minimize of Zn-dross formation & rejected.

Costs - Rs. 100,000.

Savings - (a) Reject- (due to shine defects)

Amount of rejected sheets per year	= 200
Length of a sheet	= 10 foot
Selling Price of sheet per foot	= Rs. 30
Selling price of rejected sheet per foot	= Rs. 24
cost of loss per foot	= Rs. 6

After installation automatic temperature controller,

saving per year Rs. = 200x10x6
Rs. = 12,000.

(b) Zn - dross (due to temperature variation)

Amount of Zn - dross formation per year		= 120 kg
Price of Zinc per kg	Rs.	= 80

After installation - ATC
Savings per year Rs = 120 x 80
Rs. = 9600

Total saving per year Rs = 12,000 + 9,600
Rs. = 21,600.

Pay Back - 4.6 years.

16.2 Hot Dip Galvanizing - Corrugated & Plain Steel Sheet

Problem - Rejected (oil spot on the steel due to rinsing which is not sufficient)

Solution - Install an alkaline soak cleaner & Triple counter flow at the beginning the line before pickling.

Results - Minimize of rejects & Consumption of water

Cost - Rs. 255,000.

Savings - Reject (1% rejects from total production)

Amount of rejects per year	= 3822 x 1% T
	= 38.22 T
selling price of production per kg	= Rs. 60
Selling price of rejects per kg	= Rs. 15
cost of loss per kg	= Rs. 45

After installation , 38.22 T/y rejects can be prevented.

Savings per year	Rs.	= 38.22x1000x(60-15)
	Rs.	= 1,719,900

Pay back - 2 months

16.3 Hot Dip Galvanizing - Corrugated & Plain Steel Sheet

Problem - Flux Slag formation

Solution - Triple counter flow at the line after pickling
Install 2 new tanks , currently use 1 tank

Results - Reduce of flux slag formation & Water consumption

Cost - Rs.95,000.

Savings - Amount of flux slag formation per year = 14 T
Percentage of NH_4Cl in flux slag = 80 %
Price of ammonium chloride per kg = Rs. 30

After install counter flow system, Flux slag can be reduced by 40% from total amount,

Amount of saving flux slag per year	= 14x40% T
	= 5.6 T

Amount of saving NH_4Cl per year = 5.6x 80% T
= 4.48 T

Savings per year Rs. = 4.48x1000x30
Rs. = 134,400

Pay back - 9 months

16.4 Hot Dip Galvanizing - Corrugated & Plain Steel Sheet

Problem - (a) Over coating of Zinc
- (b) NH_4Cl fume & Flux slag.

Solution - Install Air knife controller in galvanizing bath.
& add 0.02% of aluminium for Bright coating

Result - Save of Zinc & NH_4Cl

Cost - Rs. 200,000.

Savings - (a) Loss of Zn amount (as over coating) per year = 675 kg
Price of Zinc per kg Rs. = 80

After installation Air knife controller ,
savings per year Rs. = 675x80
Rs. = 54,000.

(b) Amount of NH_4Cl Use for galvanizing bath per year = 11,250kg
Price of NH_4Cl per kg Rs. = 30

After installation Air knife , not necessary to use Ammonium chloride
save of NH_4Cl amount per year = 11,250 kg
Saving per year Rs. = 337,500.

Total Savings per year Rs. = 54,000 + 337,500
Rs. = 391,500.

Pay Back - 7 Months

16.5 Hot Dip Galvanizing - Corrugated & Plain Steel Sheet

Problem - Fume & spillage of HCl

Solution - Install 3 tank of 5% HCl at 40^0 C instead of 30% HCl tank at room temperature in Pickling section.

Result - Approximately , 2 T/y of Hcl (fume & spillage) can be saved

Cost - Rs. 150,000.

Savings - Amount of HCl (fume & spillage) per year = 2 T
Price of HCl per kg . Rs. = 27.75

After installation , 3 bath of Hcl
savings per year Rs. = 2x1000x27.75
Rs. = 55,500.

Pay back - 2.7 Years

16.6 Hot Dip Galvanizing - Corrugated & Plain Steel Sheet

Problem - Zinc dross formation
Install new galvanizing bath every 1.5 years due to reaction of Zinc & iron.

Solution - Install ceramic bath instead of Iron galvanizing bath.

Results - Minimize of Zn - dross formation & save of spent for new galvanizing bath

Cost - Rs.3,000,000.

Savings - Reduce of Zn-dross amount(reaction of Zn -Iron) per year = 15 T
Price of Zinc per kg Rs = 80
Loss of cost per year Rs. = 15x1000x80
Rs. = 1,200,000.

Every 1.5 years has to change the galvanizing bath and for that propose spend 600,00 rupees
Spend for year Rs. = 400,000.

After install ceramic bath,

Total saving per year Rs. = 1,200,000 + 600,000.
Rs. = 1,600,000.

Pay Back - 1.87 Years

17. Implemented options and gains, or why implementation was not possible

Non of the options were implemented due to lack of interest shown by the company.

18. Recommendations

a) Installation of alkaline soak cleaner. Sometimes oil spots on the steel produces rejects. This should be followed by 2 counter flow rinses.

b) Hydrochloride pickle - installation of a foam blanket, use low concentrations of HCl.

c) Three rinses needed to prevent flux sludge formation at the entry point. Efficient roller system to be installed to prevent the sheets carrying acid and water into the flux.

d) Automatic temperature controlled burner equipment to be installed to prevent Zn-dross formation and temperature to be maintained at 460°C. Even 1°C rise in temperature affects the production rate as a result of formation of sticky Zn-dross.

e) Automatic feeding and continuing galvanizing will reduce the waste of CRSC, Zn and NH_4Cl

f) Zinc dross sale to market - Brass manufacture

g) Air knife to be installed to control eveness of Zn coating on the sheet thus minimizing the Zn waste.

11.0 CLEANER PRODUCTION STUDY - CITY CYCLES INDUSTRIES

Part -I General Environmental Audit

1. Company - CITY CYCLES INDUSTRIES

2. Location of the site and ownership of the factory

City Cycle factory is situated at Henamulla off Colombo - Panadura, Main road and about a mile from Panadura town towards Colombo.

The Factory consists of a floor area of 30,000 square meters, and equipped with the latest machinery and has over 450 employees, including foreign trained skilled technicians.

The Company started 40 years ago with a production of ten bicycles per day. In 1995 it produced an average of 500 bicycles per day. It has the production capacity to execute with confidence, large scale orders for the export of its bicycles and tricycles to Middle East, Africa, Italy or to any part of the world.

It also undertakes specific orders to make bicycles conforming strictly to customers' requirements. The company enjoys 75% of the local market.

3. The Waste Minimize Team

Name		Designation
M. B. Ghouse	-	Team Leader
A.F. Mafas	-	Production Manager/Finance
A.A. Zawahir	-	Supervisor (Phosphate)
R. Premalal	-	Supervisor (Plant)
M. Piyasena	-	Senior Hand
D.W. Karunadasa	-	Shop Floor
Deepal Sirinagar	-	Supervisor phosphate (chemical)
Dr. A.A.H.P. Wijesundara	-	External Expert (ROMIN)
Dr.A.R. Rupasinghe	-	External Expert (ROMIN)

4 Physical Description of the Site

Site consists of a floor area of 30,000 m^2 and flat land. Factory, office and General storage are arranged on the site area.

5 Site use

The site is used for factory building where the production of cycle is carried out.

6. Raw Materials & Energy use

I. Major Raw Material :
Mild steel sheet

II. Chemicals :
Paint
Thinner
Caustic degreaser
Sulphuric Acid
Phosphate solution.
Some other parts are purchased locally and from overseas.

III. Sources of Water :
Water used for rinsing and other purposes, is taken from municipal water line.

IV. Energy :
Most of the machines are electrically operated. The electricity is obtained by Ceylon Electricity Board.

7 Site drainage system

All the waste water is discharged into a surface drainage system which ultimately ends up in the municipal drains.

8 Storage of Hazardous material

Chemicals of sulphuric acid and phosphate solution are contained in vessels on site store room.

9. Description of Surrounding Land Use

The factory is surrounded by Road in west, Residences in North and East and a canal in the South.

10. Sensitive Receptors in the vicinity

10.1 Residence & Other Populated Zone

Nearest residence on East & North, Hospital & school are situated 7 km from the factory.

10.2 Water Abstraction Activities

Water abstraction from wells and municipal waster supply lines.

10.3 Water Bodies

Shallow wells exist about 1/2 km away from the factory.

11. Sources of release to the media

11.1 Solid waste disposal

Solid waste of metal scraps disposed form Head lug fabrication unit.

11.2 Aqueous discharges

Aqueous discharge from rinsing units contaminated with acid, alkali, solvents and paint sludge. Phosphate sludge out from phosphate unit.

11.3 Atmospheric discharges

No information available

Part II Waste Minimisation Study

1. General Information - Table 1

Name of the company : City Cycles Industries, 64-66 Wattapola Rd, Maligawatte Colombo 14	
i. Major raw material consumption **1. Raw material -** a. Mild steel sheets b. Steel tubes for seated cycles c. Steel tubes for sports cycles	 - 8000 Kg/ month - 10,000 pieces/ month - 5,000 pieces/ month
II. a. Paint b. Thinner	- 3,400 liters/ month - 1,800 kg/ month
ii. Chemical a. Sulphuric acid b. Phosphate solution c. Caustic grease	 - 2,800 kg/ month - 650 kg/ month
iii Energy consumption Electricity	- 30,000 kWh/ month
iv. Water Consumption	- 1,240 m^3/ month
v. Production cycles a. Installed capacity (bicycles) b. Actual production (bicycles)	 - 10,000 / month - 7,905 / month

2. Range of products manufactured

- Cycles
- Motor cycle spare parts

3. Major raw materials, chemicals and other consumption

1. Raw material -

a. Mild steel sheets - 8000 Kg/ month
b. Steel tubes for seated cycles - 10,000 pieces/ month
c. Steel tubes for sports cycles - 5,000 pieces/ month

II. a. Paint - 3,400 liters/ month
b. Thinner - 1,800 kg/ month

ii. Chemical

a. Sulphuric acid - 2,800 kg/ month
b. Phosphate solution - 650 kg/ month
c. Caustic grease

4. Energy Consumption

Electricity - 30,000 kWh/ month

5. Water Consumption

Water Consumption - 1,240 m^3/ month

6. Machine capacities

Information not available

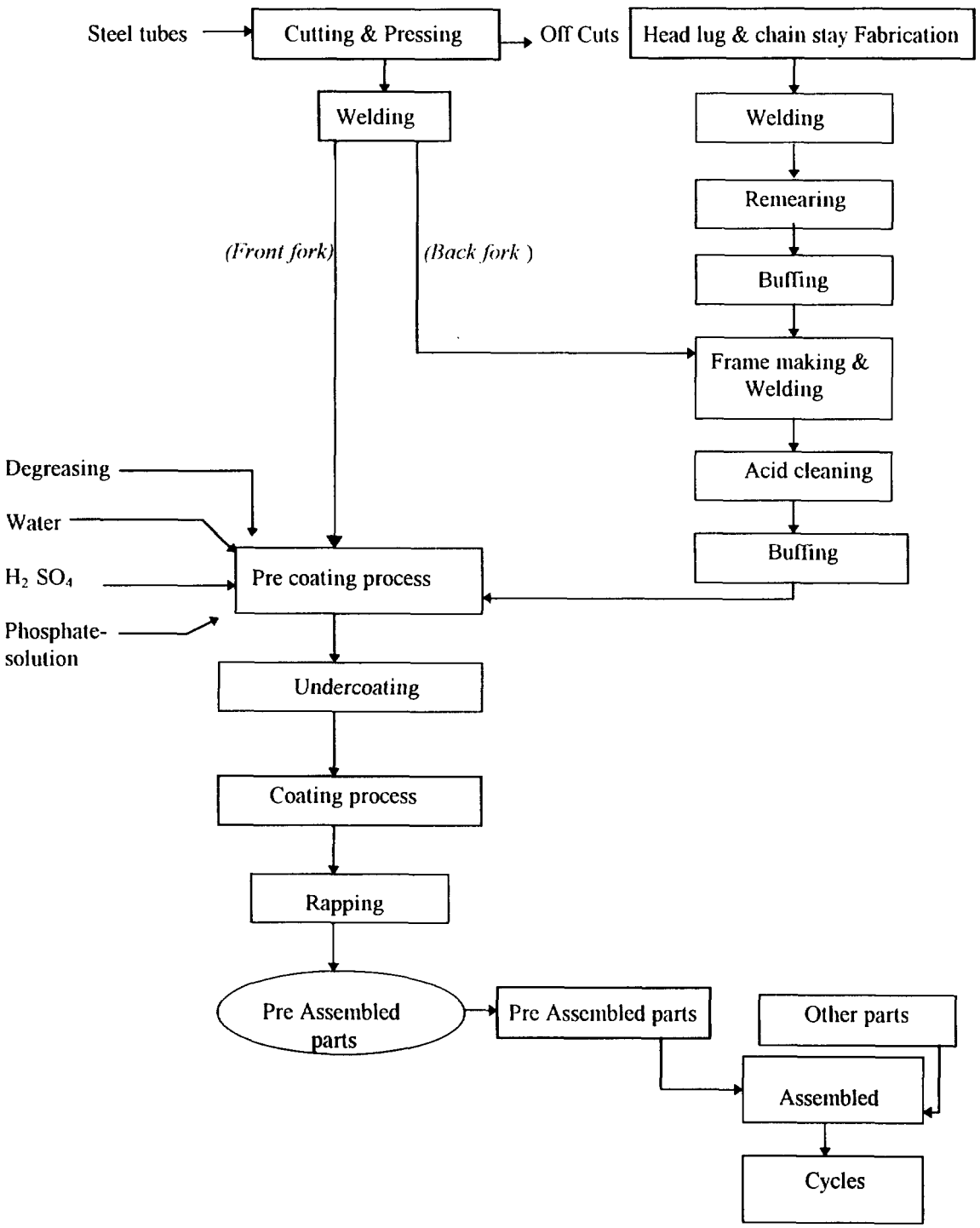
7. Available information

INFORMATION	AVAILABILITY	REMARKS
Process Flow Diagram	Yes	Produced As Result Of the Programme
Material Balance	No	-
Energy Balance	No	-
Water Balance	No	-
Production Log Sheet	No	-

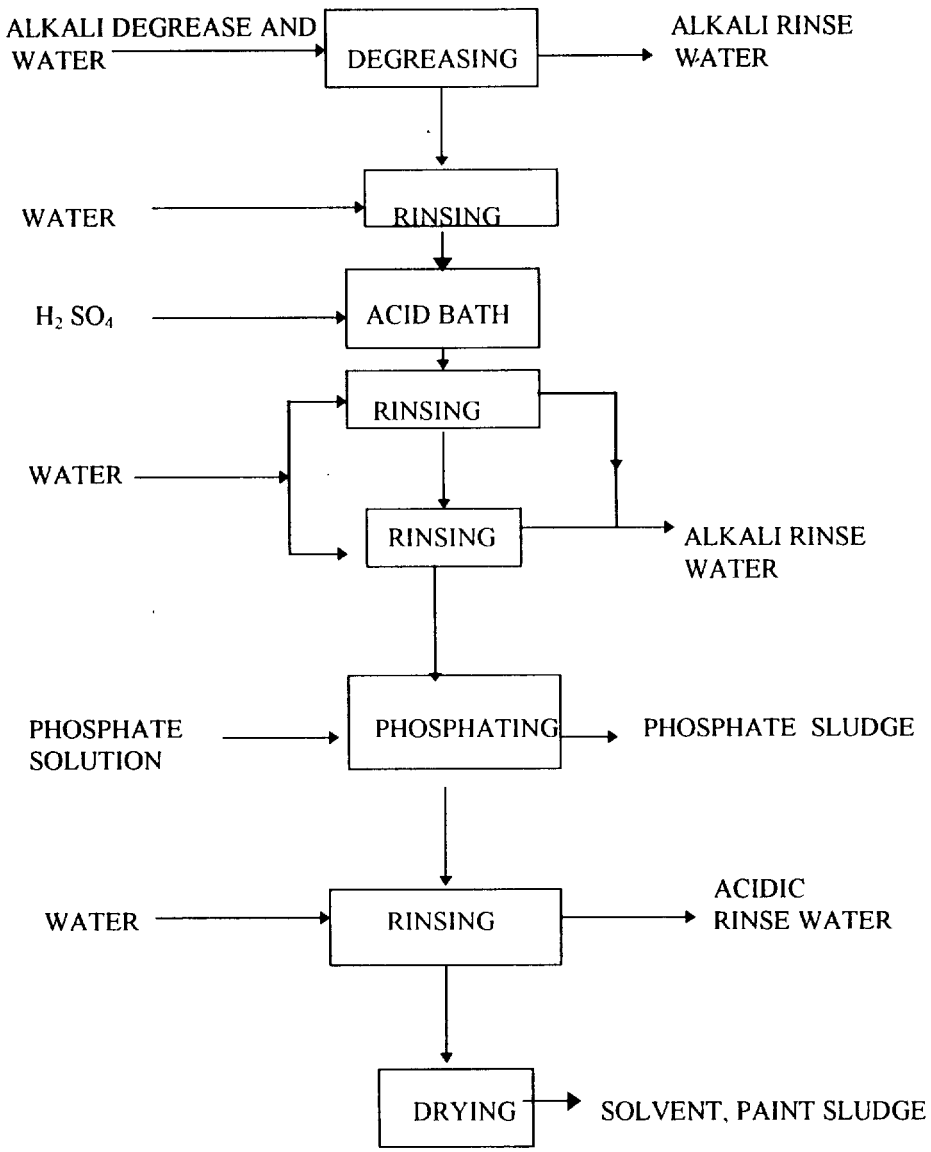
8. Plant Layout

Not available

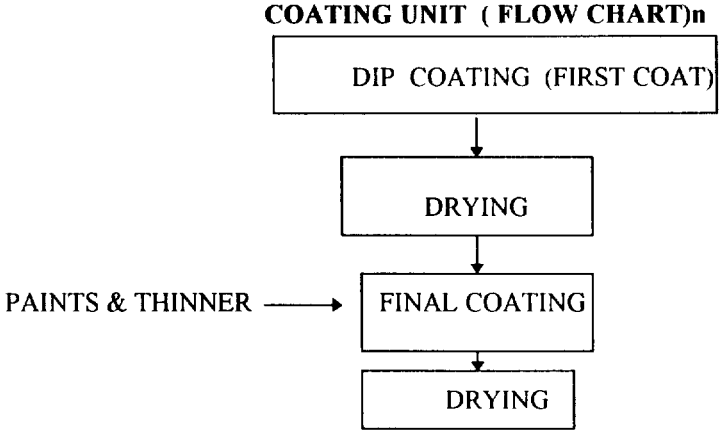
9. Process flow diagrams



PRE COATING UNIT (FLOW CHART)



COATING UNIT (FLOW CHART)n



10. Waste streams

No detailed data was available to compile a worksheet

11. House keeping status

No information available

12. Material balance

No information available

13. Water balance

No information available

14. Identification & assessment of Waste Minimisation Options and Action List

Key to table - Category : WM = *Waste Minimisation*, EE = *Energy Efficiency*, QI = *Quality improvement; M = Medium.*
Urgency : S = *Short Term*, L = *Long Term*, C = *Completed*,
Importance : Scale of 1 - 10 (*10 being extremely important*)

	Process	WM Option	Action	Category	Urgency	Importance
1	Head LUG 1.1	Use air blower or whiper for oil	City cycles	WM	S	5
	1.2	Rolled cut strips instead of plates	City cycles to get the prices of rolled cut stripes and ROMIN to do the cost analysis.	WM	M	6
	1.3	Design new dies to cut several items simultaneously	City cycle has to introduce new dies and ROMIN to identify the cost benefit	WM	S	6
	1.4	Assessment of departmental rejects	City cycle has to measure and recover the rejection of three weeks	WM	S	5
	1.5	Off cuts for secondary items	Cite cycle has to identify the type of products.	WM	S	6
	1.6	Clearly estimate, cost of scrap production & ensure maximum earnings from scrap sale	City cycle has to attend to this	WM	S	M

	Process	WM Option	Action	Category	Urgency	Impor-tance
2	Fork 2.1	Reduction in the amount of rejects	City cycles has to record the rejection for three weeks	WM	M	5
	2.2	Review of use of oxygen and L.P.G	Analyse the cost of weld length reference to other suitable techniques (mig welding or brazing)	EE	M	5
3	Frame Making (Reverting) 3.1	Replacing reverting with jig	City cycle should attend to this job	WM	L	2
	3.2	Immediate brazing after assembly instead of reverting (introduce jig or fixture for this)	City cycle should attend to this job	WM	M	7
	3.3	Streamline the production line to reduce the amount of Work in progress	ROMIN with City Cycle should further study for this	WM	L	6
4	Chemical Bath 4.1	Separating oil form water with degreasing bath	Construct a tank and install a pump. City cycle will look in to this.	WM	M	5
	4.2	Introduce two tank current rinsing, in order to save the acid and to clear the material properly	Construct an additional tank, City cycle will attend to this job.	Q1	S	4
	4.3	Introduce new method to remove sludge regularly	Further investigation by the team	Q1	L	4
	4.4	Introduce counter flow rinsing system so as to clean properly and to reduce the water consumption	Attend by city cycles	Q1	S	5
5	Phosphate tank					
	5.1	Heating the phosphate bath with new thermal control so as to reduce the power consumption	City Cycle	EE	M	6

	Process	WM Option	Action	Category	Urgency	Imp'ance
5	Phosphate tank 5.2	Insulate the phosphate tank with a suitable material so as to reduce the power consumption	Attend by City Cycle	EE	S	8
	5.3	Insulate the drying oven properly to reduce the power consumption	Attend by city Cycle	EE	S	8
	5.4	Design a special kind of rack system to load the material for the various process in the chemical bath. This will save labour cost	Further investigation	WM	L	5
6	Painting 6.1	If we introduce the sludge removal in the phosphate bath we can avoid the cleaning of the items before dipping for under coating	Attend by City Cycle	EE	M	5
	6.2	Use kerosene oil instead of thinner but maintain higher temperature for heating	Further investigation	WM	M	5
	6.3	Avoid under coat so as to reduce cost	Further study	WM	M	4
	6.4	Optimise the paint coating thickness so as to reduce the cost	Attend by City cycle	WM	S	5
6	Painting 6.5	Introduce dipping stead of spray painting for standard bicycle parts	Further study	EF	M	5
	6.6	To find more efficient spray nozzles for spray paintings	Get more information	WM	L	6
	6.7	Use tube oven to dry final coat items instead of small ovens, so as to reduce the labour cost and to reduce power consumption	Further Investigation	EE	M	7

	Process	WM Option	Action	Category	Urgency	Imp'ance
	6.8	Introduce conveyor system for the dipping of frames (first coat) so as to save the paint and reduce the labour cost	Attend by City cycle	WM	L	8
6	Painting 6.9	Install rotating disc, electrostatic gun to reduce paint waste	City Cycle	WW	M	7
	6.10	Purchase a magnetic tester to maintain the thickness of paint	City Cycle	Q1	M	8
7	7.1	All phosphates line tanks should be lifted up off the ground to prevent bottom cooling & detect leaks	City cycle	EE	S	6
	7.2	Oven in phosphate line needs lagging & perhaps the installation of an air knife to reduce hot air escape	Attend by City cycle	WM	L	8

15. Selected options for implementation

- To reduce paint wastage
- To reduce chemical wastage
- Increase the efficiency of the steel tube processing work

16. Cost benefit analysis of waste minimization options

16.1 Steel Tube Pressing Work

Problem : Compressed air blower to remove excess oil carry over.

Solution : Compressed Air

Results : Reduced Oil Usage (40%)
Disposal Costs Reduced

Capital Cost : Rs 50000.00. (for compressed air unit)

Savings : Current usage of Oil l/ month

Oil - DS 40 100 l/m
Prices of oil - DS 40 Rs.190.00 Per Litre
Spend Rs. 228000.00 Per Year.

Oil Waste : 2 l/day , And 44 l/month

Annual Waste : 528 l / Year
Expenditure + clean - up costs (future)
(50,000/100,000x12)

Pay Back Period 6 Months

16.2 Steel Tubes

Used to buy long lengths and now buy cut to size
Cost savings on steel tubes imported as per required length

Item	Cost per length Rs.Cts.	Cost per cut pieces Rs.Cts.	Savings Rs.Cts.	Savings/m Rs.Cts.
Chain stay for std bicycle	16.85	16.75	00.10	1000.00
Seat stay for std bicycle	12.50	12.38	00.12	1200.00
Fork pipe for std bicycle	15.10	15.00	00.10	1000.00
Chain stay for sport bicycle	13.75	13.65	00.10	500.00
Seat stay for sport bicycle	10.37	10.30	00.07	350.00
Fork pipe for sport bicycle	14.49	14.40	00.09	450.00
Savings per month				4500.00

Savings per year = Rs. 54000.00

16.3 Painting Work

Problem Paint Wasting(> 80% Loss)

Solution Installed **NORDSON RA 12**- Rotary electrostatic atomizer.
(superior combination of painting performance reliability & safety)

Results Reduce paint usage (60%)
Reduced disposal costs.

Capital Cost Rs. 3 Million

Savings Paint consumption per day - 67 Litres

	Price of one Litre	- Rs.365.00	
	Expenditure per day	- 67x 365.00	= Rs.24450.00
	Expenditure per month	- 24450.00 x 22	= Rs.538010.00
	Expenditure per year	- 538010.00 x 12	= Rs.6456120.00

Waste

Paint Wasting 54/l per day

Expenditure for wasting	= 54 x 365.00 Rs.	= Rs.19710.00
Expenditure for wasting per month	= 19710.00 x 22	= Rs.433620.00
Expenditure for wasting per year	= 433620.00 x 12	= Rs.5203440.00

Savings Rs.122064.00

Pay Back Period 12.5 months

16.4 Phosphate Tank

Problem Chemical wastage

Solution Revert to Smaller Tank

Results Reduce of Phosphate, Heat and Time for Sludge Cleaning Approximately 40%.

Capital Cost Rs.25000 (for construction/ alterations to existing tank to make into a smaller tank plus rinsing station -by using baffles)

Savings

Current Consumption of Phosphate
180 L & extra 15 l/day

Consumption	= Rs.510 L/M
Phosphate price per litre	= Rs.125.00 or 63750.00 month or 765,000.00/year
Expenditure for heating	= Rs.20,000.00 /month=240,000.00 / year
Total expenditure	= Rs.1005,000.00/year

After Installation Of Smaller Tank
Total expenditure = Rs. 813,000.00/year

Savings Rs.195250.00/year

Pay Back Period < 2 Months

17. Implemented options and gains on why implementation was not possible

None of the options were implemented due to high cost and the management was not interested in implementing the options.

18. Recommendations

Apart from the waste minimization options recommended in section 14 of this report no other recommendations were made

12.0 CONCLUSIONS

12.1 Phase I Conclusions

Metal finishing is not an organized industry in Sri Lanka. Although it is estimated that there are about 200 metal finishing shops altogether, information available on them is very limited.

Many medium and small shops operate illegally and therefore they remain undercover due to the fear of being caught by the statutory Authorities, for violation of environmental, labour and tax and such other rules and regulations

This is evident from the fact that out of the estimated 200 shops only a handful of those are registered with and have applied for licenses from the Central Environmental Authority.
Under the present circumstances, almost all the shop owners are very reluctant to divulge information on their businesses. However, we managed to visit around seventy shops and gather whatever information they were willing to part with. These shops are involved in various kinds of metal finishing processes, at various levels and are listed along with all the relevant information in Appendix 1.

The implementing agencies such as the Central Environmental Authority and the Industrial Development Board have very little information on the companies involved in the industry. This is a major constraint for improving the industry, as well as reducing the environmental pollution.

Having collected as much information's possible on the 64 companies under this study, a reasonable assessment has been made on the size of the industry, i.e. only about 18% of the companies can be categorized as large, 21% as medium, while small and very small together comes to 61%.

The metal finishing industry in Sri Lanka as a whole uses very poor technology. The knowledge of waste treatment, cleaner production or waste minimization is negligible within the sector. Comparatively a small percentage of companies are treating wastes in end of pipe control mode. Preventing waste at the source or the use of closed loop recovery systems is not understood or practiced much.

Although great savings can be made from recycling, the solid and water wastes are not generally recycled. Wastes are let out directly to natural water bodies such as Kelani River, Bolgoda Lake without any form of treatment polluting the environment.

As a whole, the industry is suffering from poor house keeping, poor rinsing, poor process line configuration and lack of recovery / reuse technologies.

General Comments - About the metal finishing industry in Sri Lanka

a) Black Magic

The suppliers of processes & systems are guilty in Sri Lanka, like many developing countries, of keeping the customer in the dark about the chemistry & detailed technology details.

With some exceptions, adequate servicing is missing. Technical data sheets & material safety data sheets are not common in many factories.

b) Cleaner Production

The knowledge of cleaner production or waste minimization is negligible. Only a small percentage of companies are treating wastes in end of pipe control mode. Preventing waste at source or use of closed loop recovery systems is not understood or practiced much.

12.2 Phase II Conclusions

1. The 5 companies studied were each handicapped in various areas, the majority of the problems faced being common to all of them i.e. poor house keeping, lack of new technology, unnecessary wastage of resources etc.

2. As most the equipment used in this industry are of considerable age, they are of low efficiency and therefore a lot of energy is wasted in the metal finishing process.

3. No proper housekeeping methods were apparent at any of the company premises.

4. Non of the companies studied had a waste minimization program and their approach to environmental matters was poor.

5. Waste minimization options were found and recommended for each of the 5 companies; these options were found to be cost effective and would reduce the production/ operational costs and energy consumption.

13.0 RECOMMENDATIONS

13.1 Phase I Recommendations

1. An awareness building programme has to be launched in order to educate the industrialists as well as the general public.

2. Encouraging all the metal finishing industrialists to divulge the information is extremely necessary. Licensing of metal finishing shops and enforcing all the environmental rules and regulations is highly important to impose sanctions on wrong-doers. The very small shops should be closed down or combined together for registration.

3. Such a programme will not be successful if centrally implemented, for example by the Central Environmental Authority. Involvement and support of the local Government Authorities should be sought and will be crucial in getting the required information.

4. Once all the shops are registered, an attempt should be made to accurately estimate the waste volumes, energy, water and chemical consumption.

5. Several new technologies should be able to be brought to Sri Lanka as a result of the in depth plant studies and include closed loop continuous purification systems and more efficient process technologies. Application to good housekeeping practices, modification to operating techniques and production planning and sequencing will also result in less waste and increased efficiency and profitability.

6. There are vast opportunities for waste minimization in the industry. A well executed waste minimization programme can improve the industry immensely. As most countries, including neighbouring competitors, are embracing cleaner production as the second industrial revolution, Sri Lanka must follow suit & leap-frog over waste treatment and demand the state of the art cleaner production technologies.

7. Education

Universities and Research Institutes must quickly recognize & adopt cleaner production philosophies for inclusion in faculty courses and research & development methodology.

Overseas training & viewing of cleaner production in the metal finishing sector should be a matter of urgency for selected personnel in the short term.

8. Technology Transfer

Several new technologies should be able to be brought to Sri Lanka as a result of the in depth plant studies & include closed loop continuous purification systems and more

efficient process technologies. Application of good housekeeping practices, modification to operating techniques and production and planning sequencing will also result in less waste & increased efficiency and profitability.

13.2 Phase II Recommendations

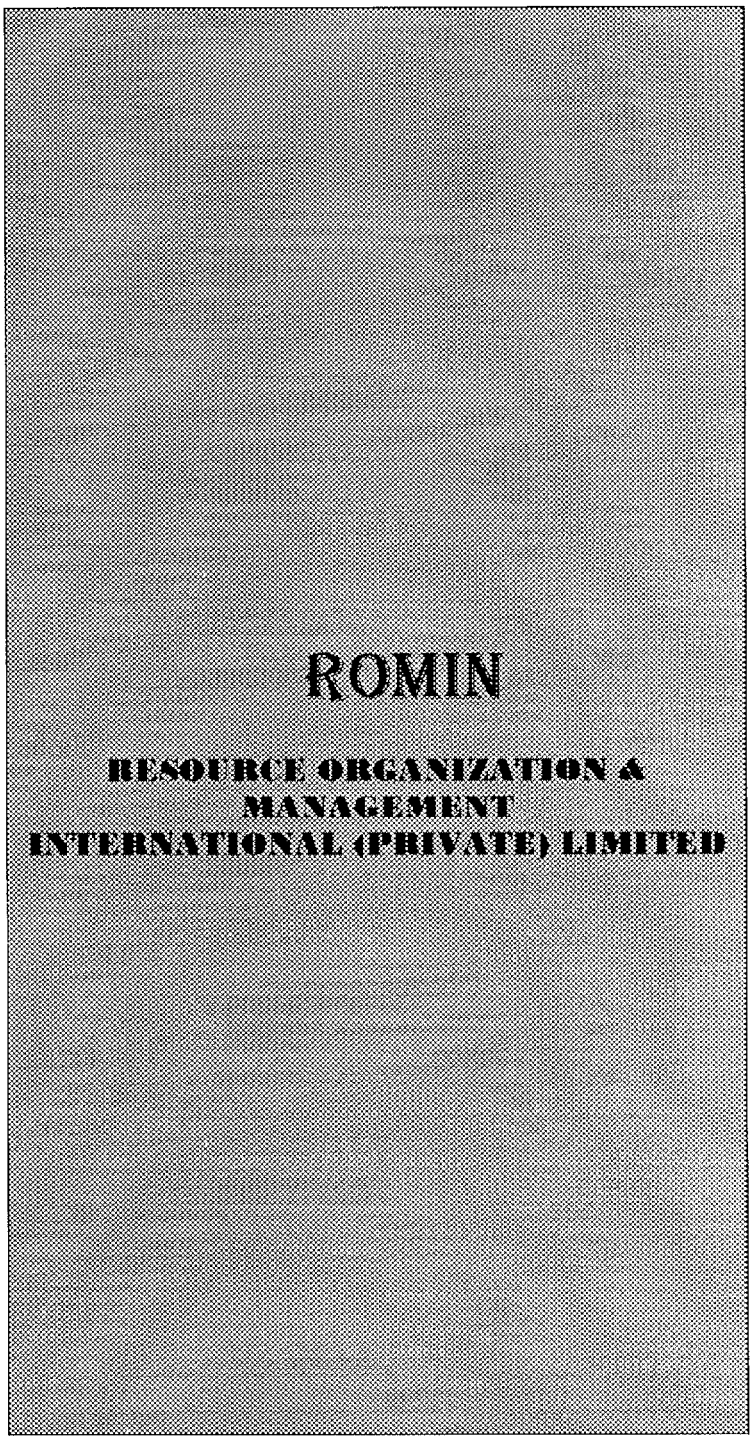
Reccommendations made for each company are included in the respective company profiles.

ANNEXURE

A FURTHER LIST OF COMPANIES WITH LESS DETAILS

Company Name	Production	Utilities	Opportunities
Agro Technica Ltd. Factory Unit D–4 Industrial Estate Ekala – Ja–Ela 536422 P.M. Samarasinghe, Fact. Mgr. R. Perera, Tech. Supervisior (Subsidiary of Hayley's Ltd.)	Manufacture Agricultural Sprayers 85% local market Brass components cast, shot blasted, Nickel (only) plated	Well water purchased 200 gals/hr No waste treat. self neutralise Nickel 180 kg/y Electricity 20 units/hr.	Line sequence rinsing, technique house keeping, maintenance Casting heat loss
Lanka Fasteners Phase 11, IPZ Katunayake 452048/ 078–77784 T.F.N. Perera, Factory Manager M. Mendis, Gen. Mgr.	To restart Sept.95 Nuts Manufacturing Acid zinc Electroplating 3 t/day	Water ex River Via BOI 8 million l/month at 22 Rps/m3 Conventional Waste Treat.	Mechanical handling Reduction of oil loss Heat Efficiency
Danet Electroplating 321, Jayantha Weerasekara MW Colombo 10 329288	Nickel, Chromium Silver, Gold electroplating Motor Cycle parts	V.Small	
Auto Crafts 506, Galle Road Wellawatte Colombo 6 585089 (near Dehiwela Bride)	Brass work Stainless steel Sign Boards Electroplating with Silver, Chromium, Nickel Polishing, Lacquering		

Company Name	Production	Utilities	Opportunities
Ceylon Steel Corporation Ltd. Oruwala – Athurugiriya J.M. Ranasinghe Banda – Chief Metallurgist. 561022 Michael Perera, G. Mr S.A. Dhanasena, Dept G. Mgr.	Steel Rolling Mill 100 t/y Annealing of steel castings Old Galvanising Plant shut down 10 years ago Small scale carburising	Steel ex UK & S. Africa Oil fired furnaces Big problem with mill scale	Building new wire annealing plant 200 t/year Furnace emissions Smoke, Sulphur Fluidised bed Heat Treatment
Francies C Perera Kandy Mrs. L.R. Ellawala Mr. S.F. Perera	Brass Foundry Elecrroplating of brass artware & Jewellery with gold, silver, copper & nickel	Water – Municipal free Waste to drain & river	Need sequential line Tank insolation Electro ploretic lacquer



No 1 6th Lane Colombo 3 Sri Lanka
Tel 94-1-577690/1/2
Fax 94-1-577690
E- mail : romin@sri.lanka.net

Table 1A

Company Name	Processes Involved	Equipment	Production		
			Category	Capacity (in)	Quantity /M
Waliketiya Foundary Koholwila Kelaniya	* Manufacturing * Oxidizing * Foundry working	* Tools * Mould	Antiques	10	8
	* Manufacturing * Cu, Ni, Cr - Electroplating * Polishing	* Electroplating Plant (Anode, cathode Chemical vat) * Blower * Mould	Handles Bath Room fitting set	1000 150	600 75
Premasiri Enterprises Waboda North Waboda	* Manufacturing * Hot Dip galvanizing	* Tools * Drill Maching * Galvanizing Vat * Lathe Machine * Burner	* Electricity Board * Equipment sets (Including 5 Items)	800	500
C.A. Pramarathne 446, Waboda North Waboda	* Manufacturing * Hot Dip galvanizing	* Tools * Drill Maching * Galvanizing Vat * Lathe Machine * Burner	* Electricity Board * Equipment sets (Including 3 Item)	450	350
Sugath Eksath Brother 170, Kandy Road Yakkala	* Manufacturing * Cu, Ni, Cr-Electroplating.	* Electroplating Plant * Tools * Drill Maching * Lathe Machine	Bath Room - - Fittings Sets (Including 5 Item)	600	400
Sunjaya Metal Industries Bogamuwa Yakkala	* Manufacturing * Zn-Electroplating	* Zn-Electroplating - plant * Tools * Lathe, Bending - Machine	* Hooks * Nut & Bolts	1000 3500	850 2200
Super Electrical 39, 1st Cross Street Colombo 11 (Plant Nawala)	* Manufacturing * Ni-Electroplating * Polishing	* Electroplating Plant * Tools * Bending Mechine	Emusion Heators	600	475
Place Garden Enterprises 172, Jumma Masjid Road Maligawatt Colombo 10	* Manufacturing * Zn-Electroplating	* Electroplating Plant * Tools * Polishing Bending, Laith Machine	Side Glass Handle (Motor Cycle spare part)	1500	1000
Jumbo Products 29/2B, Dharmalankara M (Off Hall St.) Dehiwela	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending Mechine	* Souveniers	250	160
Ukwatta & Company 555/5F, 4th Lane Elhenwatta Gonahena Road Kadawatha	* Manufacturing * Ni-Electroplating * Polishing	* Electroplating Plant * Tools * Bending, Laith, Polishing Machine	* Emulsion Heators	700	550

Table B

		aterial			Energy	C	Water used		
		Amount			Amount				
ity	Type	For total Prodtion Kg/M	For Unit Prodtion Kg	Type	For total Production /M	For Unit Production	For total Production L/M	For Unit Prodtion L	Type
	Cu Ti Pb Zn	100 3 2 7	12.5 0.4 0.3 0.9	Furnace oil Electricity	200 L 40 kwh	25 L	20 5 kwh	2.5	Wash Water Bronze dust
	Brass	90	0.15	Electricity Furnace oil	25 kwh 30 L	0.04 kwh	125 0.05 L	0.2	Wash Water Brass dust
	Brass	400	2	Furnace oil Electricity	115 L 75 kwh	1.53 L	325 1 kwh	4.3	Wash Water Containing - Acid Salt. Brass dust
	Mild steel- Rod/plate Zn-1% Pb	2000	4	Furnace oil Electricity	200 L 1000 kwh	0.4 L	200 2 kwh	0.4	Wash Acid water Mild steel scraps
	Mild steel- Rod/plate Zn-1% Pb	750	2.5	Furnace oil Electricity	70 L 300 kwh	0.2 L	70 0.87 kwh	0.2	Rinse Water Containing Acid Metal Scraps
	Brass	900	2.25	Furnace oil Electricity	90 L 110 kwh	0.22 L	500 0.27kwh	1.25	Wash Water Containing Acid, Salts. Brass Scraps.
	Mild Steel - Rod Mild Steel - Rod	127 550	0.15 0.25	Electricity Electricity	5 kwh 250 kwh	0.006 kwh 0.1 kwh	400 650	0.47 0.29	Wash Water Metal Scraps. Wash Water Mild Steel dust - & Scraps
	Cu-Tube, Element wire	60 7	0.13 0.01	Electricity	10 kwh	0.02 kwh	600	1.26	Wash Water Containing Acid, Cyanids. Cut Off-Cu Tube
	Mild Streel	300	0.3	Electricity	10 kwh	0.01 kwh	500	0.5	Wash Water Containing Acid, Cyanids. Mild Steel Scraps.
	Brass sheet Cupper Plate	80 12	0.5 0.075	Electricity	10 kwh	0.06 kwh	150	7.18	Wash Water Containing Acid, Salt, Cu dust & Brass chips
	Cu - Tube Element wire	75 10	0.14 0.02	Electricity	30 kwh	0.05 kwh	675	1.25	Wash Water Containing Acid, Cyanide, salt. Cu -Tube Scraps

Table c

Waste			Chemical		Size of Industry		Opportunities For	Recycling
Volume For total Production L/M	Volume For Unit Prod'tion L	Receiving body of Effluent	Type	Amt Kg/M	No:	c l a s		
15 L small amount	1.9 l -	Kelani Rever	Oxidizing Salt	5	12	S	Reduction of Heat Losses, Need sequential Line and Safety Methods, House Keeping.	Reuse of Brass dust
100 L 10 kg	0.16 L 0.02 kg		Oxidizing Salt Cu-Salt	4 6				
300 L 28 kg	4 L 0.37 kg		Cu - Salt Ni - Salt Cr - Salt HCl NaCN	14 10 4 12 12				
175 L 100 kg	0.35 0.2 kg	Kalani River	HCl Acid	10	12	S	Reduction of Heat Losses and Zn losses, Improvements on Equipment.	Reuse of Metal Scraps
50 L 65 kg	0.14 L 0.18 kg	Kalani River	HCl Acid	6	10	S	Reduction of Heat Losses, Sequential line.	Reuse of Metal Scraps
425 L 50 kg	1.06 L 0.13 kg	Attanagalu Oya	Cu - Salt Ni - Salt Cr - Salt NaCN HCl	15 12 5 8 8	10	S	Safety methods, New Building, Reduction of Heat Losses.	Reuse of Metal Scraps
350 L 20 kg 600 L 50 L	0.41 L 0.02 kg 0.27 L 0.02 kg	Attanagam Oya	Zn - Salt NaCN HCl Acid Zinc Chromate Salt Nitric Acid	7 5 6 2 6	6	S	Reduced Chemical Losses, Waste Treatment Plant, New Building, Safety Methods.	Reuse of Metal Scraps
550 L 5 kg	1.16 L 0.01	Kirulapona Cannal	Ni - Salt H2-So4 NaCH	3 6 6	5	V.S	Waste Treatment Plant, House Keeping, Safety Methods.	-
475 L 60 kg	0.47 L 0.06	Kalani River	Zn - Salt NaCN HCl Acid Zn Chromate Salt Nitric Acid	3 1.5 4 2 4	7	S	Waste Treatment Plant, House Keeping, Safety Methods.	Reuse of Metal Scraps
1000 L 10 kg	6.25 L 0.06 kg	Kalani River	Cu-Salt Ni- Salt Cr-Salt NaCN HCl	5 7 3 5 5	7	S	Waste Treatment Plant, House Keeping, Safety Methods,	-
650 L 12 kg	1.18 l 0.02 kg	Kalani River	Ni- Salt NaCN H2 SO4 Acid	4 5.5 8	8	S	Waste Treatment System, House Keeping.	Reuse of Scraps

Table 2A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (nos)	Quantity /M	Type
Loyd Industries Gummeda Road Delatur Ja-Ela	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending Mechine	* Luggage Career * Foot Rest	175 250	100 125	Mild Steel Mild Steel
Sasico Enterprise Galle Road Ratmalana	* Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending, Laith, Polishing Machine	* Service for Motor cycle - spares Luggage Career	-	125	-
Metalray Main Street Kandana	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending, Polishing Machine	* Bath Rooms fitting Sets (Including 5 Item)	2000	1150	Brass Billets
Duro Metal Industries 596, Maradana Road Colombo 10	* Manufacturing * Cu, Ni, Cr - Electroplating * Polishing	* Electroplating Plant * Tools * Bending Polishing Machine	T.V. Stands Crash Bars	70 80	20 30	Mild Steel Mild Steel
Danet Electroplating 321, Jayantha Weerasekar	* Manufacturing * Cu, Ni, Cr - Electroplating * Polishing	* Electroplating Plant * Tools * Bending Polishing Machine	Crash Bars Silencer	100 60	40 35	Mild Steel--Tube Mild Steel-Plain sheet
The City Trading Co. 343 & 345 Sea Street Colombo 11	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending Polishing - Machine	T-Troly	100	40	Mild Steel--Tube
Nandana Elec: Works 86-8, Panchikawatta Rd Colombo 10	* Cu, Ni, Cr - Electroplating * Polishing	* Electroplating Plant * Tools * Polishing Machine	Plating Service for T.V. Stand Plating Service for Crash Bar	- -	12 20	- -
Andrew Perera Kamal Mawatha Palliyawatta Hendala	* Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Polishing Machine	Plating Service for Laggage career Plating Service for Crash Bar	- -	20 15	- -
Eltro Industries 690, Kapuwatta Station Road Ja-Ela	* Zn-Electroplating	* Zn-Electroplating Plant * Tools	Plating Service for Rings Plating Service for Nut & Bolt	- -	30 25	- -
Central Industries Yakkala Road Ganpana	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending Machine * Polishing Machine	Silencer Luggage Career	60 75	35 50	Mild steel-plain sheet Mild steel-Tube
New Lanka Electroplating 150, Galle Road Wellawatta	* Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending Machine * Polishing Machine	Plating Service For * Luggage Career * Plating Service for Side Glass Handle	- -	50 30	- -
Sarasavi Electroplates No. 26, K.D. David Aven Colombo 10	* Cu, Ni, Cr, Electroplating * Polishing	* Electroplating Plant * Tools * Bending Machine * Polishing Machine	Plating Service For Mud gard	-	40	-

Table 2B

aterial			C					
		Energy		Water used			Waste	
Amount			Amount					Volume
For total Prodtion Kg/M	For Unit Prodtion Kg	Type	For total Production /M	For Unit Production	For total Production L/M	For Unit Prodtion L	Type	For total Production L/M
120	1.20	Electricity	14 kwh	0.15kwh	800	8	Wash Water Metal Scrap	700 L 15 kg
32	0.26	Electricity	10 kwh	0.08 kwh	575	4.6	Wash Water Metal Scrap	500 L 5 kg
-	-	Electricity	10 kwh	0.08 kwh	1200	9.6	Wash Water Containing Acid, Cyanide salt.	1100 L
2300	2	Electricity Furnace oil	125 kwh 975 L	0.1 kwh	1775 0.8 L	1.02	Wash Water Containing Acid, Cyanide salt Brass Chips	1600 L 275 kg
200	10	Electricity	30 kwh	1.5 kwh	500	25	Wash Water Metal Scraps	425 L 25 kg
240	8	Electricity	35 kwh	1.16 kwh	650	21.6	Wash Water Steel Scraps	550 L 20 kg
350	8.75	Electricity	50 kwh	1.25 kwh	900	22.5	Wash Water Metal Scraps	825 L 35 kg
175	5	Electricity	12 kwh	0.34 kwh	700	20	Wash Water Metal Scraps	600 L 20 kg
400	10	Electricity	45 kwh	1.12 kwh	1100	27.5	Wash Water Containing Acid Cyande, Salt. Metal Tube-Scrps	975 L 35 kg
-	-	Electricity	25 kwh	2.08 kwh	300	25	Wash Water	275 L
-	-	Electricity	22 kwh	1.1 kwh	425	21.25	Wash Water	375 L
-	-	Electricity	12 kwh	-	300	15	Wash Water	275 l
-	-	Electricity	20 kwh	-	225	15	Wash Water	200 l
-	-	Electricity	10 kwh	0.3 kwh	525	17.5	Wash Water	490 l
-	-	Electricity	15 kwh	0.6 kwh	350	14	Wash Water	310 l
179	5.1	Electricity	15 kwh	0.43 kwh	575	16.43	Wash Water Metal Scraps	525 L 18 kg
140	2.8	Electricity	22 kwh	0.44 kwh	325	6.5	Wash Water Metal Scraps	300 L 12 kg
	-	Electricity	22 kwh	0.44 kwh	425	8.5	Wash Water	400 L
	-	Electricity	15 kwh	0.5 kwh	75	2.5	Wash Water	60 L
	-	Electricity	24 kwh	0.6 kwh	415	10.4	Wash Water	390 L

Table 2 C

For Unit Prodtion L	Receiving body of Effluent	Chemical C Type	Amt Kg/M	Size of Industry No:	c l a s	Opportunities For	Recycling
7 L 0.15 kg 4 L 0.17 kg	Ja-Ela	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	10 8 4 6 6	10	S	Waste Treatment System, Safety Methods, Reduction of Chemical Losses.	Reuse of Metal Scraps
8.8 L	Bolgoda Lake	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	5 3 1 6 5	4	V.S	Safety Methods, House keeping.	Recycling of water
1.39 L 0.24 kg	Ja-Ela	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	9 6 2 7 7	8	S	Waste Treatment System, Sequential line, House keeping.	Reuse Brass Scraps
21.25 1.25 18.3 L 0.6 kg	Kalani River	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	15 12 5 14 12	10	S	Waste Treatment System, Sequential line, New Building.	Reuse of Scraps
20.6 L 10.9 kg 17.1 L 0.57 L	Kalani River	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	24 18 10 18 15	10	S	Waste Treatment System, Sequential line, New Building.	Reuse of Metal Scraps
24.37 L 0.87 kg	Berelake	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	20 17 6 18 15	15	M	Treatment Plant, Need Sequential Line, House keeping.	Reuse of Metal Tube
22.9 L 18.75 L	Berelake	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	15 10 8 12 12	8	S	Need Sequential Line, House keeping.	-
13.75 L 13.3 L	Ja-Ela	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	13 9 6 9 11	7	S	House keeping.	-
16.3 L 12.4 L	Ja-Ela	Zn-Salt NaCN HCl Acid Zn Chromate Salt Nitric Acid	2 3 1.5 1 1.5	3	V.S	Need Sequential Line, Safety Methods, Waste Treatment System.	Reuse of Metal scraps
15 L 0.5 kg 6 L 0.2 kg	Attanagalu Oya	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	10 12 4 4 6	10	S	Need Sequential Line, House keeping.	Recycle of Water
8 L 2 L	Kalani River	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	12 10 4 8 10	8	S	Waste Treatment System, New Building	-
9.75 L	Kalani River	Cu-Salt Ni- Salt Cr-Salt HCl Acid NaCN	10 7 3.5 8 10	5	V.S	Machinery System, Need Sequential Line.	-

Table 3A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (m)	Quantity /M	Type
Rano Steel 26th Mile Post Kandy Road Nittambuwa	* Manufacturing * Painting	* Spray Machine * Tools * Bending Machine * Lathe Machine	Chair Cup Board	400 50	225 20	Mild Steel Tube Mild Steel Plate
El Steel Ring Road Katunayake	* Manufacturing * Powder Coating	* Burner * Blower * Overn * Bending & Lathe Machine	* Switch Board Cabinet	350	200	Mild Steel- Plain Sheet
Metallix Eng Company Lt 41/81, Epitamulla Rd, Sri Jayawardeanapura Kotta	* Manufacturing * Cu, Ni, Cr, Electroplating * Zn- Electroplating * Powder Coating * Polishing	* Cu, Ni, Cr - Electroplating Plant * Tools * Bending, Lathe, Polishing. * Drilling Machines * Polishing Machine	* Office Furniture (Cupboard)	200	150	Mild Steel- Sheet
			* Domestic Application (Chairs)	300	200	Mild Steel- Tube
			* Compass Sets	500	400	Mild Steel- Plate & Rod
			* Kettles	600	350	Stainless steel Cu-Tube Element wire
Flexport Ltd, 127, Jambugasmulla MW Nugegoda	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing * Metal * Etching * Oxidising * Aluminium anodizing	* Cu, Ni, Cr - Electroplating Plant * Tools * Laith & Polishing Macine	* Name Plate, Trophies Souverniers Item	-	300	Brass Stainless Steel,
			* Badges	-	100	Brass sheets
Martinus C. Perera & Sons 167, Union Place Colombo 2	* Manufacturing * Gold Plating * Cu, Ni, Cr, Electroplating * Polishing	* Cu, Ni, Cr - Electroplating Plant * Spray Machine * Lathe, Polishing Bending Machine	* Awards	200	150	Brass sheets Gold
			* Chairs	400	200	Mild steel- Tube
Lankaloha Hardware Ltd, 117, Hunupitiya Lake Rd, Colombo 2 Factory - Kandy Rd, Yakkala	* Manufacturing * Polishing * Heat Treatment	* Bending, Polishing, Curving, Spray Machine * Heat Generator * Tool * Lathe Machine * Drill Machine	* Agriculture - Equipment set	100000	80000	Steel
			* Hinges Set	20,000	100,000	Mild Steel

Table 3B

aterial Amount For total Prodtion Kg/M	Amount For Unit Prodtion Kg	Energy Type	Amount For total Production /M	Amount For Unit Production	Water used For total Production L/M	For Unit Prodtion L	Type	Waste Volume For total Production L/M
800	3.5	Electricity	175 kwh	0.77 kwh	2100	9.3	Wash Acid Water Metal Scraps	2000 L 175 kg
600	30	Electricity	220	11 kwh	1200	60	Wash Acid Water Metal Scraps	1100 L 75 kg
1400	7	Electricity	315 kwh	1.6 kwh	2500	12.5	Rinse Water Containing Acid Metal Scraps	2350 L 40 kg
5000	33.3	Electricity	600 kwh	4 kwh	500	3.3	Wash water Metal Scraps	500 L 750 kg
600	3	Electricity	50 kwh	0.25 kwh	2000	10	Wash water Metal Scraps	2000 L 80 kg
130	0.32	Electricity	75 kwh	0.19 kwh	150	0.37	Wash water Metal Scraps	100 L 15 kg
200 45 4	0.57 0.13 0.01	Electricity	50 kwh	0.1 kwh	200	0.57	Wash water Stainless steel Scraps	150 L 25 kg
90 40 10	0.3 0.1 0.03	Electricity	15 kwh	0.05 kwh	100	0.3	Wash water Metal dust/Scraps	75 L 12 kg
20	0.2	Electricity	10 kwh	0.01	80	0.8	Wash water Brass Chips	50 L 5 kg
22 Small amount	0.15	Electricity	10 kwh	0.06 kwh	200	1.3	Wash water	150 L
1100	5.5	Electricity	100 kwh	0.5 kwh	150	0.75	Wash water Metal Scraps	125 L 150 kg
2000000	2.5	Electricity Heat Treatment-oil	60,000kwh 12,000 kg	0.75 kwh	200,000 0.15 kg	0.1	Wash water Metal Scraps	200,000 L 15,000 kg
200,000	2	Electricity	6,000 kwh	0.06 kwh	12,000	0.12	Wash water Metal Scraps	10,000 L 2500 kg

Table 3C

For Unit Prodtion L	Receiving body of Effluent	Chemical Type	Chemical Amt Kg/M	Size of Industry No:	Size of Industry Class	Opportunities For	Recycling
8.9 l 0.7 kg 55 l 3.7 kg	Attanagalu Oya	HCl Lacquer	45 75	30	M	Reduction of Paint. House keeping.	Reuse of Metal Scraps and Recycling of Water
11.75 0.2 kg	Seeduwa-Lagoon	HCl Tel Coating-Powder	30 75	35	M	Reduction of Powder Losses	Reuse of Metal Scraps
3.3 L 5 kg	Kalani River	HCl Acid Coating Powder	10 200	200	L	Waste Treatment Plant. House keeping, Heat Recovery.	Reuse of Metal Scraps
10 L 0.4 kg		HCl Lacquer	20 50				
0.25 L 0.1 kg		Zn-Salt NaCN HCl Acid Zn Chromate Salt Nitric Acid	3 2 4 1 4				
0.43L 0.07 kg		Cu-Salt Ni- Salt Cr-Salt NaCN	8 6 2 6				
0.25 L 0.04 kg	Kalani River	Cu-Salt Ni- Salt Cr-Salt NaCN HCl	6 4 2 5 5	15	M	Waste Treatment Plant, Reduction of Heat Losses, House Keeping.	-
0.5 L 0.05 kg		Cu-Salt Ni- Salt Cr-Salt NaCN HCl	6 4 1 5 5				
1 L	Kalani River	Cu-Salt Ni- Salt Cr-Salt NaCN HCl	5 3 1.5 4 4	30	M	Waste Treatment Plant. Need Sequential Line	Reuse of Metal Scraps
0.62 L 0.75 kg		Cu-Salt Ni- Salt Cr-Salt NaCN HCl	7 4 2 5 5				
0.1 0.007 kg	Attanagalu oya	Paint	15,000	1200	L	Waste Treatment Plant. Process Improvements, House Keeping	Reuse of Metal Scraps
0.10 L 0.013 kg		HCl Acid NaNO3 NaOH	5000 2000 1000				

Table 4 A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (m)	Quantity /M	Type
Metco Industries Chilan Road	* Zn-Electroplating	* Zn-Electroplating plant, * Tool * Bending Machine	Plating service for- Rings	-	200	-
			Plating service for- Silencer (Tractor)		20	-
Metro Industries Kochchikode	*Zn-Barral Electroplating	* Zn-Electroplating plant, * Tool * Bending Machine	Plating service for- Nut and Bolt	-	50 kg	-
			Rings		20 kg	-
Auto Crafts 506, Galle Road Wellawatte Colombo 6	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating plant * Tool * Polishing & Lathe Machine	* Stainless steel badges	2000	1500	Stainless steel
			* Sign Board	-	50	Brass sheet
Pure Metals Weston Seaton Estate Deman Handiya Negombo or 418, Galle Road Horetudowa Road	* Cu, Ni, Cr, Electroplating * Polishing * Zn-Electroplating	* Electroplating plant * Tool * Bending & Polishing Machine	* Plating service for (Tractor spare parts) * Handle (Lever) 2 * Silencer cup * Nut & Bolt	- - -	50 25 125 kg	-
Mt. Lalin Edirisuriya 375/31, Old Kottawa Roa Udahamulla Nugegoda	* Manufacturing * Ni- Electroplating * Polishing	* Electroplating plant * Tool * Laith, Polishing Machine	*Emulsion Heators	500	450	Cu-Tube Element wire
Pioncer Wire Forming Industries (Pvt), Ltd, No. 6D, 1st Floor Maradana Shopping Com Colombo 12	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing	* Electroplating plant * Tool * Laith, Polishing Machine	* Garment Accessories (Hooks)	200 kg	100 kg	Mild steel Rods
Mr. Wimal Perera 72, Deegama Road Palanwatta Pannipitiya	* Manufacturing * Zn- Electroplating	* Electroplating plant * Tool * Laith machine	J-Bolts	3000	2500	Mild steel Rods
Hytrac Metal Industries 243, Colombo Road Weligampitiya Ja-Ela	* Manufacturing * Zn- Electroplating	* Electroplating plant * Tool * Laith machine	Nut & Bolt	150 kg	100 kg	Mild steel Rods
United Electroplating Wor 457, Old Moor Street Colombo 12	* Manufacturing * Zn- Electroplating	* Electroplating plant * Tool * Laith machine	Hooks	200 kg	150 kg	Mild steel Rods
Kulutota Enterprises 49, Hudson Road Kollupitiya	* Zn- Electroplating	* Zn- Electroplating plant * Tool	Plating service for Nut & Bolt	-	75 kg	-
Mr.K. Mahesh 41, Gajaba Place Kirulapona	* Zn- Electroplating	* Zn- Electroplating plant * Tool	Plating service for Weel & Bolt	-	100kg	-

Table 4B

aterial		Energy			Water used		
Amount		Type	Amount				Type
For total Prodtion Kg/M	For Unit Prodtion Kg		For total Production /M	For Unit Production	For total Production L/M	For Unit Prodtion L	
-	-	Electricity	8 kwh	0.04 kwh	20	0.1	Wash water
-	-	Electricity	12 kwh	0.6 kwh	40	2	Wash water
-	-	Electricity	7 kwh	0.057 kwh	15	0.3	Wash water
-	-	Electricity	5 kwh	0.25 kwh	10	0.5	Wash water
120	0.8	Electricity	20 kwh	0.01	300	0.2	Wash water Solid waste (steel)
250	5	Electricity	30 kwh	0.12	500	2	Wash water Brass scraps
-	-	Electricity	20 kwh	0.4	300	6	Wash water
-	-	Electricity	15 kwh	0.6	75	3	Wash water
-	-	Electricity	10 kwh	0.08	250	2	Wash water
63 9	0.14 0.02	Electricity	20 kwh	0.04	600	1.3	Wash water Solid waste - Cu tube
100 kg	0.95	Electricity	25 kwh	0.25	450	5	Wash water Solid Waste Steel
500	0.2	Electricity	50kwh	0.02	125	0.05	Wash water Metal Scraps
120	1.2	Electricity	8 kwh	0.08 kwh	100	1	Wash water Metal Scraps
175	1.16	Electricity	10 kwh	0.06 kwh	150	1	Wash water Metal Scraps
-	-	Electricity	5 kwh	0.06 kwh	100	1.3	Wash water
-	-	Electricity	10 kwh	0.1 kwh	100 L	1 L	Wash water

Table 4C

Waste			Chemical C		Size of Industry		Opportunities	Recycling
Volume For total Production L/M	Volume For Unit Prodtion L	Receiving body of Effluent	Type	Amt Kg/M	No:	c l a s	For	
10 L	0.05 L	Daduru Oya	Zn-Salt	2	5	V.S	Waste Treatment	-
			NaCN	3			Plant,	
			HCl Acid	3			House Keeping.	
30 L	1.5 L		Zn Chromate Salt	1.5				
			Nitric Acid	2				
15 L	0.3 L	Daduru Oya	Zn-Salt	4	5	V.S	Waste Treatment	-
			NaCN	6			Plant,	
			HCl Acid	6			Need Sequential	
10 L	0.5 L		Zn Chromate Salt	2			Line.	
			Nitric Acid	5				
350 L	0.23 L	Kalani River	Cu- Salt	6	10	S	Waste Treatment	Reuse
			Ni- Salt	5			Plant,	Off-cutts
20 kg	0.01 kg		Cr- Salt	2			House Keeping.	
			NaCN	4				
450 L	1.8 L		HCl	4				
50 kg	0.2 kg							
250 L	5 L	Seeduwa	Cu- Salt	5	6	S	Waste Treatment	-
50 L	2L	Lagoon	Ni- Salt	5			Plant,	
200L	1.6 L		Cr- Salt	2			Need Sequential	
			NaCN	8			Line.	
			HCl	10				
			Zn-Salt	3				
			Zn-Chromate	2				
			Nitric Acid	4				
550 L	1.2 L	Kalani River	Ni-Salt	3	4	V.S	Waste Treatment	
			Na CN	4			Plant,	
10 kg	0.02 kg		H2SO4	6			Need Sequential	
							Line.	
							House Keeping.	
400	4L	Kalani River	Cu- Salt	4	5	V.S	Waste Treatment	
			Ni- Salt	2			Plant,	
			HCl	4			House Keeping.	
15 kg	0.15 kg		NaCN	4				
			Zn-Salt	2	5	V.S	House Keeping.	Reuse
100 L	0.04 L	Kalani River	NaCN	2				Off-Cuts
			HCl Acid	1				
			Zn Cromate Salt	0.5				
20 kg	0.008 kg		Nitric Acid	1				
75 L	0.75 L	Hamilton Ela	Zn-Salt	1	4	v.S	House Keeping,	Reuse of
			NaCN	1			Waste Treatment	Metal Scraps
			HCl Acid	0.5			Plant, Need	
20 kg	0.2 kg		Zn Cromate Salt	0.5			Sequential Line.	
			Nitric Acid	0.75				
125 L	0.8 L	Kalani River	Zn-Salt	1	5	V.S	Waste Disposal,	Reuse of Metal
			NaCN	1			House Keeping.	Steel scraps
			HCl Acid	0.5				
30 kg	0.2 kg		Zn Cromate Salt	0.75				
			Nitric Acid	0.75				
80 L	1.06 L	Kalani River	Zn-Salt	1	3	V.S	Need Sequential	-
			NaCN	1			Line.	
			HCl Acid	0.75				
			Zn Cromate Salt	0.5				
			Nitric Acid	1.0				
80 L	0.8 L	Kalani River	Zn-Salt	1	4	V.S	House Keeping.	-
			NaCN	1.5				
			HCl Acid	1				
			Zn Cromate Salt	0.5				
			Nitric Acid	1.0				

Table 5A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (m)	Quantity /M	Type
Mr. Ranishka Wijasingha 21, Sri Sumanagala Road South Kuluara North	* Zn- Electroplating	* Zn- Electroplating plant * Tool	Plating service for Nut & Bolt	-	125kg	-
Mr. Gerad. M. Lufer No.3, UC Vihara Mawatha Kolonnawa	* Cu, Ni, Cr, Electroplating * Polishing	* Electroplating plant * Tool * Polishing machine	Plating service for Brass Engraving models	-	50	-
Mount Electroplaters 527, Galle Road Mt. Lavinia	* Cu, Ni, Cr, Electroplating * Polishing	* Electroplating plant * Tool * Polishing machine	Plating service for Luggage carrer	-	75	-
Mount Brass Center 386, Galle Road Rawathawatta Moratuwa	* Manufacturing * Cu, Ni, Cr, Electroplating * Polishing * Oxidizing	* Electroplating plant * Tool * Polishing machine * Laith Machine * Burner	Badges Awards	200 150	150 100	Brass sheet Brass sheet
Rupa Electroplaters 149, Galle Road Ratmalana	* Manufacturing * Cu, Ni, Cr, Electroplating * Casting	* Electroplating plant * Tool * Polishing machine * Laith Machine * Burner	Antiques Number Plate	- 100	5 75	Brass Brass Sheet Aluminium
Ekanayake Industries Trisking College Ja-Ela	* Zn- Electroplating	* Zn- Electroplating plant * Tool	Plating Service for Nuir & Bolts	-	50 kg	-
Wire Forming Industory Katukurunda Kalutara	* Manufacturing * Cu, Ni, Cr, Electroplating	* Electroplating plant * Formimg Machine * Polishing Machine	File Clips, Pins	750 kg	]	Mild Steel v
Ceylon Galvanizing Industries Lady Catherine East Rd Ratmalana	* Manufacturing * Galvanizing	* Galvanizing Vate * Tools * Oven * Laith Maching * Burner * Forming Machine	Corrugated & Flat. roofing Iron	23,000 kg	10,000 kg	Cold Rolled steel coil Zink Pb.
Lanka Transformers Ltd, 154/11, Station Rd, Angulana, Moratuwa	* Manufacturing * Hop Dip Galvanizi	* Galvanizing Vate * Tools * Drill Machine * Oven * Laith Maching * Burner * Laith Machine Bending Machine	Electricity Board Items (Including 5 Items)	400,000 kg	150,000 kg	Mild Steel Zn Pb
USS Electrical Company (397, Galahitiyawa (South) Ganemulla	* Manufacturing * Zn-Electroplating	* Zn-Electroplating Plant * Tools * Drill Machine * Laith Machine	Nut & Bolts	40,000 kg	20,000 kg	Mild Steel

Table 5B

aterial Amount For total Prodtion Kg/M	For Unit Prodtion Kg	Energy C Type	Amount For total Production /M	For Unit Production	Water used For total Production L/M	For Unit Prodtion L	Type
-	-	Electricity	12 kwh	0.09 kwh	150 L	1.2 L	Wash water
-	-	Electricity	10 kwh	0.16 kwh	100 L	2 L	Wash water
-	-	Electricity	15 kwh	0.2 kwh	60 L	-	Wash water
7	0.04	Electricity	30 kwh	0.2 kwh	150 L	1 L	Wash water
							Brass chips
25	0.25	Electricity	40 kwh	0.4 kwh	400 L	4 L	Wash water
							Solid waste - Brass chips
5	1	Electricity	10 kwh	2 kwh	25	5	Wash water
22	0.29	Electricity	5 kwh	0.06 kwh	100	1.3	Wash water
5	0.07	Furnace Oil	25 kg		0.33 kg		
-	-	Electricity	5 kwh	0.1 kwh	75	1.5	Wash water
490	0.98	Electricity	50 kwh	1.0 kwh	1500	3	Wash water
							Off cuts-M/steel
95,000	0.95	Electricity	6,000 kwh	0.06 kwh	18,000	0.18	Wash water
4.100	0.041	Furnace oil	5,500 kg		0.055 kg		Metal Scraps
900	0.009						Zn/Pb dross
140,000 kg	0.933	Electricity	10,000 kwh	0.06 kwh	25,000 L	0.16	Wash water
10,000 kg	0.066						
2,000 kg	0.013						
		Furnace oil	10,000 kg		0.06 kg		.....
140,000 kg	0.933	Electricity	10,000 kwh	0.06 kwh	25,000 L	0.16	Wash water

Table 5C

Waste Volume For total Production L/M	Waste Volume For Unit Prodtion L	Receiving body of Effluent	Chemical Type	Chemical Amt Kg/M	Size of Industry No:	Size of Industry c l a s	Opportunities For	Recycling
125 L	1 L	Kalugaga	Zn-Salt NaCN HCl Acid Zn Cromate Salt Nitric Acid	1.5 1 1 0.75 1	4	V.S	New Building, Need Sequential Line, Waste treatment system.	-
80 L	1.6 L	Kalani River	Cu- Salt Ni- Salt Cr- Salt NaCN HCl	2 1 0.5 3 2	4	V.S	House Keeping. Waste Disposal	-
50 L			Cu- Salt Ni- Salt Cr- Salt NaCN HCl	1.5 1 0.5 2 1	3	V.S	House Keeping. Waste Disposal	-
100 small amount 350 L 5 kg	0.6 L 3.5 L 0.05 L	Balgoda wawa	Cu- Salt Ni- Salt Cr- Salt NaCN HCl Oxidizing salt	5 2 1 4 5 2	7	S	House Keeping. Waste treatment plant, Need Sequential Line.	-
20 L 75 L	4 L 1 L	Kirula-Ela	Cu- Salt Ni- Salt Cr- Salt NaCN HCl	5 3 1 4 5	4	V.S	House Keeping. Chemical Loss reduction.	-
50 L	1 L	Dadugam Oya	Zn-Salt NaCN HCl Acid Zn-Chromate Salt Nitric Acid	0.75 1.0 0.75 0.5 1.0	2	S	House Keeping. Chemical Losses, New Building, Waste Treatment System.	
1300 15 kg	2.6 L 0.03 kg	Kalugaga	Cu- Salt Ni- Salt NaCN HCl	10 6 8 6	10	S	Reduction of Chemical Losses.	Reuse off-cuts of M/Steel wire
12,000 L 700 kg 150 kg	0.12 L 70.007 kg 0.001 kg	Kirula Ela	Ammonium Chloride HCl Chromic Acid	800 500 1.2	25	M	Acid Pickle & Flux recovery.	Reuse Zn/Pb dross and Metal scraps
20,000 1500 kg 500 kg	0.12 L 0.01 kg 0.003 kg	Kalugaga	HCl Acid Ammonium Chloride	750 1800	150	L	Waste treatment Plant, House Keeping.	Reuse of Zn/Pb Metal scraps.
20,000	0.12 L	Kalugaga	HCl Acid	750	25	M	Waste treatment Plant, Safety Method.	Reuse of Zn/Pb Metal Scraps

Table 6A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (lit)	Quantity /M	Type
St. Therersa Industries 399, Gunasekara Mawath Heiyantudwa Sapugaskanda	* Manufacturing * Hop dip Galvanizin	* Galvanizing Vate * Tools * Berner * Bending Laith Machine	Electricity Board Items (Including 5 Items)	50,000 kg	20,000 kg	Mild Steel Zn Pb
Karder Industry Maligawatta Colombo 14	* Manufacturing * Cu, Ni, Cr - Electroplating * Polishing	* Electroplating Plant * Tools * Polishing * Bending Machine * Forming Machine	Crash Bar (Motor Cycle spare parts)	225	100	Mild Steel
Lanka Aluminium Ind. 20, Temple Lane, Ekala, Ja-Ela Tel: 536941/ 5 Dinal Peiras, MD	* Al - Extrusion * Powder coating * Electro static spray	* Blower Lathe * Engraving * Moulding machine * Spray machine * Anodising Plant * Electro colouring plant	Aluminium sections	30000kg	21820kg	Aluminium Billets
Electro Chemical Eng. (Pvt.) Ltd. 10, 3rd lane Maligawatte Ratmalana Tel: 622677 R. Dewamuni, MD	* Zn Electroplating	* Zn electroplating-plant, tools * Printed circuit Braod plating	Plating service for Name plates	150	100	
Sugathadasa Bandara & sons (Pvt), Ltd. 120/ 2, 2nd Lane (off Old Kesbewa Rd) Delkanda, ND Tel: 810468	* Manufacturing * Aluminium anodizing	* Lathe machine * Chemical vats * Cutting machine * Anodizing plant	Aluminium labels	800kg	500kg	Aluminium sheets
Jaysons Industries Ltd. 342, Awissawella Rd Kalanimulla Angoda Tel: 578319	* Manufacturing * Hot dip galvanizing	* Galvanizing plant * Tools * Lathe, bending machine * Burner * Drill machine	Electricity Board-equipment set (including 5 items)	1750	1000	mild steel-rods Zinc (1% Pb)
Kesel Watte Agencies & Industries Ltd. 224, Diygala Rd. Kesel Watte Panadura Tel: 652962 M. R. Silva; Factory Manager	* Manufacturing * Hot dip galvanizing	*Galvanizing plant *Tools *Lathe bending machines * Burner * Drill machine * Plating plant	Steel buckets	15000	10000	Mild steel plate & rod Zinc (1% Pb)
	* Zn Electroplating		Nuts & bolts	2500 kg	1150 kg	Mild steel-rod
Ceyco Galvanizing, Diyagala Rd Keselwatte	*Manufacturing *Hot dip Galvanizing	* Tools * Lathe, bending machine *Burner *Drill machine	Steel Buckets	12000	8000	Mild steel-Rod & plate Zn (1% Pb)
Rupa Electroplaters 149, Galle Rd Ratmalana Tel: 612791	*Manufacturing *Cu,Ni,Cr electroplating *Casting	*Cu,Ni,Cr electroplating *Tool *Polishing machine *Lathe machine *Burner	Antiques Number plate	 100	5 75	Brass Brass sheet Aluminium sheet

Table 6B

aterial		Energy			Water used		
Amount			Amount				
For total Prodtion Kg/M	For Unit Prodtion Kg	Type	For total Production /M	For Unit Production	For total Production L/M	For Unit Prodtion L	Type
18,500 1500 250	0.925 0.07 0.01	Electricity Furnace oil	3,000 kwh 3,750 kg	0.15 kwh	15,000 L 0.19 kg	0.75 L	Wash water Metal steel Scraps Zn/Pb dross
850 kg	8.5	Electricity	25 kwh	0.25 kwh	1300 L	13 L	Wash water Metal Scraps
28857kg	1.32	Electricity Furnace oil	37608KWh 860 ltr	1.72KWh	382000 0.04 ltr	17.50	Wash water Aluminium scraps
		Electricity	75 KWh	0.75 KWh	250	2.5	Wash water - containing acid, salt
590	1.18	Electricity	200KWh	0.4 KWh	3000	6	Wash acid- water Aluminium- scraps
4500 300	4.50 0.30	Electricity Furnace oil	3750 KWh 3100 ltr	3.75 KWh	5500 3.1 ltr	5.50	Rinse water- containing acid M/Steel Scrap rod, Zn-dross
5250 350	0.53 0.36	Electricity Furnace oil	11000KWh 12000 ltr	1.1 KWh	22000 1.2 ltr	2.20	Wash acid- water Steel scraps, Zn-dross
1000	0.87	Electricity	1200 KWh	1.2 KWh	12000	12.00	Wash water containing - acid, cyanide, salt M/steel scraps
4800 3100	0.60 0.39	Electricity Furnace oil	12000KWh 15000 ltr	1.5 KWh	20000 1.87 Ltr	2.50	Wash acid- water Zn-dross Metal scraps
5 22 5	1.00 0.29 0.07	Electricity Electricity Furnace oil	10 KWh 5 KWh 25 Kg	2 KWh 0.06 KWh	25 100 0.33 Kg	5.00 1.30	Wash water Wash water

Table 6 C

Waste			Chemical C		Size of Industry		Opportunities For	Recycling
Volume For total Production L/M	For Unit Prod'tion L	Receiving body of Effluent	Type	Am't Kg/M	No:	c l a s		
11,000 250 kg 75 kg	0.55 L 0.01 kg 0.004 kg	Kalani River	HCl Acid Ammonium Chloride	125 250	25	M	Acid Pickle & Flux recovery, Waste water treatment plant.	Reuse of Mild Steel Scraps
1100 20 kg	11 L 0.2 kg	Kalani River	Cu - Salt Ni-Salt NaCN HCl	8 6 2 5 5	10	S	Reduction of Heat Losses, House Keeping New Building	Reuse of Metal Scraps
378000ltr 7200kg	17.5 ltr 0.33kg	Seeduwa lagoon	Nitric acid Caustic etch Sulphuric acid Telecoating powder Spray Lacqure Tin Colouring	390 690 1410 177 730	30	M	Over spray, waste Caustic Etch recovery	Reuse of Al scraps & recycling of water
200ltr	2ltr	Kelani river	Zn salt NacN HCl acid Zn chromate salt Nitric acid Circuit board Plating chemicals	5 4 3 1 3	5	V.S	change to acid Zinc	water
2700ltr 75 kg	5.4 ltr 0.15 kg	Kelani river	Nitric acid Sulphuric acid Caustic pellets Anodizing powder	4 8 2 20	30	M	House keeping	Reuse of Al scraps
5000 ltr 375 kg 45 kg	5.0 ltr 0.38 kg 0.045 kg	Kelani River	NaOH HCl acid Zn Cl2 NH4Cl NaCl	22 98 12 12 12	25.00	M	House keeping Processes improvement	Reuse metal scrap & Zn-dross Recovery of acid, pickel & flux
20000 ltr 425 Kg 52 Kg	2.0 ltr 0.04 Kg 0.005 Kg	Bolgoda lake	NaOH HCl acid ZnCl2 NH4Cl NaCl	52 300 50 50 50	200	L	Closed loop flux recovery, Reduced chemical loss	Reuse of metal scrap
11000 ltr 110 kg	11 ltr 0.11 Kg	Bolgoda Lake	Zn salt NaCN HCl acid Zn-chromate Nitric acid	70 90 50 35 50	200	L	Improved rinsing	Water reuse
19000 ltr 55 Kg 400 Kg	2.4 ltr 0.01 Kg 0.05 Kg	Bolgoda lake	HCl NaOH ZnCl2 NH4Cl NaCl	305 55 50 50 50	150	L	Reduced heat loss	Reuse of metal scraps
20 ltr 75 ltr	4 ltr 1 ltr	Kirula Canal	Cu-Salt Ni-Salt Cr-Salt NaCN HCl	5 3 1 4 5	4.00	V.S	House keeping Chemical loss reduction Improved rinsing	Water

Table 7A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (in)	Quantity /M	Type
Ekanayaka Industries Trisking College Ja -Ela	* Zn electroplating	Zn electroplating plant * Tool	Plating service for nuts & bolts		50 kg	
Wire forming industry Katukurunda Kalutara	* Manufacturing * Cu, Ni, Cr, Electroplating	* Cu, Ni, Cr, electroplating * Forming machine *Polishing machine	File clips, Pins	750 kg		Mild steel wire
Ceylon Galvanizing Industries, Lady Catherine East Rd, Ratmalana Tel. 638116	* Manufacturing * Galvanizing	* Galvanizing plant * Tools, Oven * Lathe machine * Burner * Forming machine	Corrugated & flat roofing iron	23000kg	10,000kg	Cold rolled-steel coil Zn (1% Pb)
St. Anthony's Industries Group (Pvt.) Ltd. Base line Rd Colombo Tel. 692961-4 /7 (Plant not operating now)	* Manufacturing wire drawing, bolt ma * Painting * Powder coating * Vitreous enamelling * Phophating	* wire cutting mach. * spray paint mach. * formng & lathe-mach. * Phosphating plant * Zinc plating plant	wire drawn wire annealed	200000kg	136862 kg	hot rolled wire
			cupboards, filing cabinets, ceiling fans gas cooker, hot water geysers			M/S sheet copper sheet, stanless steel sheet
Varna Industries 15, Old Airport Road Ratmalana Te. 632971/637314 L.L. Wickremesighe M.D	* Manufacturing * Gravure printing	* Printing machine * Electroplating plant * Laminating & slitting machine	Printed polythene bags	50,000 kg	30,000 kg	Polyethane
			Plating of cylinders	150	90	
City Cycles, 64-66 Wattapola Rd, Henamulla, Panadura Tel 034-32964, 072-54315 M.B Ghouse, Fac. M.	* Manufacturing * Phosphating * Polishing * Painting	* Lathe, forming, bending * Drill & spray mach. * Chemical vat * Phosphate plant * Painting & colouring plant	Cycles	10000	7905	Mild-steel strip
Ferdinandis Ltd. 49, Training college rd., Nagoda, Kalutara Tel. 034-22414	* Manufacturing * Ni Electroplating	* Wirecutting pointing machine * Cup making machine * Polishing machine * Drier, electroplating plant	Safety pins	4200kg	3874kg	Cold rolled wire, Mild steel strips, Nickle anode, saw dust
Lanka Galvanizing No. 34, 5 th lane Ratmalana Tel. 612126 Dinal Peiras M.D.	* Manufacturing * Hot dip galvanizing	* forming machine * Burner, lathe mach., * Galvanizing plant	Corrugated & Plain sheets	635800 kg	290000	Cold rolled - steel coil, Zn (% Pb)
Alumex (Pvt), Ltd. Sapugaskanda Makola Tel. 520459 C. Jayasinghe (Pro. Mgr.), Weerasinghe (Finance Mgr.)	* Al- alloy casting * Al - Extrusion * Anodizing * Colouring	* Cutting & lathe mach. *Chemical vat * Excluding mach. * Induction furnace * Moulding Equip. * Annealing furnace * Anodizing plant	Extruted Al - sec.	95000kg	87280 kg	Al - Billets

Table 7B

aterial Amount For total Prodtion Kg/M	For Unit Prodtion Kg	Energy C Type	Amount For total Production /M	For Unit Production	Water used For total Production L/M	For Unit Prodtion L	Type
		Electricity	5 kwh	0.1 kwh	75	1.50	wash water
490	0.98	Electricity	50 kwh	1.0 kwh	1500	3.00	wash water off-cuts-M/steel
95000	0.95	Electricity	6,000 kwh	0.06 kwh	18000	0.18	wash water
4100	0.04	furnace oil	5,500 kg		0.055 kg		metal scraps Zn dross
140257	1.02	Electricity flux gas	15500 kwh 2200 kg	0.11 kwh	24500 0.02 kg	0.18	wash water cut pieces
40,000 kg	1.60	Electricity	24900 kwh	2.49 kwh			Polythene (cut pieces)
		Electricity	240 kwh	2.6 kwh	2100	23.30	Wash water containing acid salt
25220	3.20	Electricity	33556 Kwh	4.24 kwh	1240386	156.90	Rinse water containing- acid. metal scraps
1995 3000 38 500	0.51 0.77 0.01 0.13	Diesel Electricity .	20 ltr 3925 kwh	0.005 ltr	202000 1.01 kwh	52.14	cut pices & distorted pins wash water containing- acid
292000	1.00	Electricity	18000 kwh	0.06 kwh	436000	1.50	wash acid- water Metal scraps
17500	0.06	Furnace oil	18000 kg		0.06 kg		Zn-Dross
115430	1.32	Electricty Heavy Diesel Furnace Oil	150433 kwh 788 ltr 2909 ltr	1.7 kwh	240000 Small Amt. 0.03 ltr	2.75	Wash water containing acid Al- scraps

Table 7 BC

Waste			Chemical		Size of Industry		Opportunities	Recycling
Volume			C					
For total Production L/M	For Unit Prod'tion L	Receiving body of Effluent	Type	Am't Kg/M	No:	c l a s s	For	
50 ltr	1ltr	Dandugama stream	Zn- Salt NaCN HCl acid Zn chromate salt Nitric acid	1 1 1 1 1	2.00	S	House keeping Chemical losses New building Improved rinsing	Water
1300.00 15 kg	2.6 ltr 0.03 kg	Kalu river	Cu-Salt Ni-Salt NaCN HCl	10 6 8 6	10.00	S	Reduction of chemical losses Improved rinsing	Reuse of M/Steel wire water
12,000 ltr 700 kg 150 kg	0.12 ltr 70.007 kg 0.001 kg	Kirula canal	NH4Cl HCl Chromic acid	800 500 1	25.00	M	acid pickle & flux recovery	reuse Zn dross & metal scraps
23000 ltr 2570 kg	0.17 ltr 0.019 kg	Kelani river	Zn phosphate Sodium nitrate Chromic acid NaOH Red oxide Thinner Paint Zn cyanide Sodium cyanide HCl	473 75 2 83 184 281 419 4072	150	L	reduced over spray, heat loss recovery Improved rinsing Reduction of steel waste, Sequential plating line	Recycling of water & heat
4900 kg 2000 ltr	0.49 kg 22 ltr	Bolgoda Lake	Paints Solvents Cu-salt Ni-salt Nitric acid NaCN	5400 300 27 22 20 20	150	L	Processes improve-ments, waste min., piants, solvents, reduce film waste/ solvent waste, replace I.P.A.	Recycling polyethene
980000 ltr 3900 kg	123.90 0.49 kg	Bolgoda lake	Sulphuric acid Phosphating solu. Paints Thinner	4880 465 16681 3625	500	L	Sequential line improvements, waste min. on piants, rinse improv., paint waste reduc.	Reuse of scrap metals Recycling of water
709 kg 200000 ltr	0.18 kg 51.6 ltr	Kalu river	Nickle chloride Revelux 630 Watting agent Chromium salt Boric acid Sulphuric acid NaOH Surclean EC 504 Nickel conc. Lubricating oil	18 7 2 4 7 10 8 6 4	49.00	M	Process improvements, House keeping, maintenance, impr., oil reduction, scrap reduction, sequential plating line	Reuse of cut pieces recycling water
430,000 ltr 12,000 kg 2,500 kg	1.48 ltr 0.04 kg 0.01 kg	Bolgoda lake	Amonium chloride HCl Zn - chloride NH4Cl NaCl	2666 1660 150 150 150	80.00	L	Seqential line, Flux recovery, Reduction in heat loss	Resale metal scraps, Re-use Zn-dross
230,000 ltr 28,000 kg	2.3 ltr 0.32 kg	Kelani river	HNO3 NaOH H2SO4 NiSO4 SnSO4 Cresol Sulphate Almeco 46 Nalco	1340 235 4713 243 98 37 200 1234	100	L	Minimizing offcuts, recovery of caustic etch, furnace heat recovery, improved cooling efficiency, improved annealing furnace	Reuse Al billets Scraps & recycling of water

Table 8 A

Company Name	Processes Involved	Equipment	Production			
			Category	Capacity (nt)	Quantity /M	Type
M. A. V. Aluminium Industry 23/13, 1st Lane Galpattha Rd., Nawala	* Manufacturing * Moulding * Polishing	* Forming mach. * Blower, mould * Burner	Kitchen Eqp set	4000	2000	Al- sheet
Amico Industries (Cey) Ltd., No. 503 Kandawala Rd Ratmalana	* Manufacturing * Polishing	* Polishing & bending machine, blower with burner, oven	Aluminium closure caps Printed sheets	2200 800	1500 500	Al -sheet Brass sheet

Table 8 B

aterial			Energy		Water used		
Amount		Type	Amount				Type
For total Prodtion Kg/M	For Unit Prodtion Kg		For total Production /M	For Unit Production	For total Production L/M	For Unit Prodtion L	
4200	2.10	Electricity Furnance oil	700 kwh 14000 ltr	0.35 kwh 7 ltr	20500	10.25	Al - scraps wash water
1800	1.20	Electricity	6500 kwh	4.3 kwh	3250	2.17	wash water Al scraps
60	0.12	Electricity	2100 kwh	4.2 kwh	520	1.04	wash water Brass dross

Table 5 C

Waste			Chemical		Size of Industry		Opportunities For	Recycling
Volume For total Production L/M	For Unit Prod'tion L	Receiving body of Effluent	Type	Am't Kg/M	No:	c l a s s		
225 kg 15000 ltr	0.11 kg 75 ltr	Kelani river	Amonium sulphate	9600	720	L	Waste minimization of chemicals	Reuse of Al scraps & recycling of water
2500 ltr 210 kg 450 ltr 12 kg	1.67 ltr 0.12 kg 0.9 ltr 0.024 kg	Bolgoda Lake	Methyl ethyl ketone Methyl alcohol Butyl glycol Ethyl glycol Di- aceton alcohol Propyl alcohol Solvesso	5 5 7 7 2 2 10	150	L	Extend life of polishing mop Improve polishing efficieny	Reuse Brass dross & Al scraps