PN-ACC-474

Environmental Pollution Prevention Project

Report of the
Energy Conservation and Environmental Protection (ECEP) &
Environmental Pollution Prevention Project (EP3)
United States Agency for International Development (USAID)

Rapid Pollution Prevention Diagnostic Assessment

AL-AHRAM METAL WORKS
ALEXANDRIA, ARAB REPUBLIC OF EGYPT

Prepared for
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November 1997

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ACKNOWLEDGMENTS

This publication was made possible through support provided by the Office of Environment and Natural Resources, Global Programs Bureau, U S Agency for International Development, under the terms of Contract No PCE-5559-Q-00-3022-00 The opinions expressed herein are those of the author(s) and do not necessarily reflect the views of the U S Agency for International Development

A team of ECEP/EP3 and industry representatives conducted the pollution prevention audit/assessment reported on herein The primary purpose was to assist industry or facility management in creating a sustainable pollution prevention and waste minimization program

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We also wish to thank the management and employees of Al-Ahram Metal Works for their assistance and participation in the assessment of the facility In particular we wish to thank Mr Mohamed Ghanem, Chairman, Mr Mahmoud Ghanem, Managing Director, Eng Mohamed El-Morsy, Electroplating Manager

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CHAPTER 1
EXECUTIVE SUMMARY

A Rapid Pollution Prevention Diagnostic Assessment of Al Ahram was conducted in September 1997 Al Ahram is located at 423 Canal Mahmoudia St -Smouha, Alexandria, Egypt Al Ahram has two production lines, the first produces nails and drawn wire from steel wire stock, and the second produces electroplated wash basin handles

Table 1-1 outlines the principal pollution prevention opportunities identified during the assessment All savings and costs are quoted in Egyptian Pounds (LE) at a time when the exchange rate was 3 4 LE/US $ The principal opportunity to reduce the effect of Al Ahram on the environment is to decrease the discharge of chromium, copper cyanide, and nickel to the sewer There will be estimated savings of 58,425 LE per year for these options The capital cost is estimated to be no more than 35,300 LE Hence a simple payback period would be 7 2 months

If Options 4 1 through 4 6, highlighted in Table 1-1, are all implemented, the estimated savings in raw materials will be 2,583 Kg per year of chemicals consumption including salts, 529 Kg of degreasing solution, 11 Kg of acid dipping solution, 263 Kg of copper cyanide solution, and 208 Kg of copper activation, 800 Kg of nickel solution, and 772 Kg of chromic acid If the Pollution Prevention Management System (Option 4 0) is implemented and the future pollution prevention options (Option 4 8) are implemented, Best Industrial Practice values can be achieved for pollution generation, water use, and energy consumption per unit surface area metal pre-treated and painted

The combined effect of the implementation of these recommendations will be to

1 Reduce the chemical and heavy metal load in the wastewater stream
2 Reduce the wastewater flow rate
3 Increase the probability that the wastewater will meet the standards in the law
4 Reduce the operating capital and operating costs of a wastewater treatment plant if one is required

The combined savings of the options for which costs and savings were developed will be as much as 62 795 LE per year for a cost of approximately 99,300 LE, yielding a simple payback period of less than 19 months

Table 1-1

Summary of Pollution Prevention Options

Chapter	Pollution Prevention Option	Environmental Benefits	Cost to Implement in LE	Annual Financial Benefits in LE/year	Payback Period in Months
4 0	Implement a Pollution Prevention Management System	Pollution Prevention options will be implemented with the greatest environmental benefits	None	To be determined	--
4 1	Optimizing Degreasing by Reducing Drag Out & Flow Rate	Reduction of Chemistry Losses by 529 Kg/year Reduction of Water Usage by 555m3/year	2 500	3 724	8
4 2	Optimizing Acid Dipping by Reducing Drag Out and Rinse Flow Rate	Reduction of Chemistry Losses by 11 Kg/year Reduction of Water Usage by 568m3/year	0	647	Immediate
4 3	Optimizing Copper Cyanide for Zero Discharge Operation	Reduction of Chemistry Losses by 263 Kg/year Reduction of Water Usage by 690m3/year	28 600	11 626	30
4 4	Optimizing Copper Activation Operation	Reduction of Chemistry Losses by 208 Kg/year	0	1 702	Immediate
4 5	Optimizing Nickel Plating Operation	Reduction of Chemistry Losses by 800 Kg/year Reduction of Water Usage by 564 m3/year	1 000	13 628	Immediate
4 6	Optimizing Chromium Plating Operation	Reduction of Chemistry Losses by 772 Kg/year Reduction of Water Usage by 1649 m3/year	5 700	31,469	2
4 7	Water and Wastewater Batch Treatment System	Avoidance of a Full Scale Waste Treatment System Acquisition and Operating Cost	61 500	192 500 (avoided cost)	NA
4 8	Future Pollution Prevention Options	Investigate Ultrafiltration of Alkaline Cleaners	To be Determined	To be determined	--
	Total		99 300	62 795	19

CHAPTER 2
OBJECTIVES

2.1 The ECEP Project

The Energy Conservation and Environment Project (ECEP) is financed by the United States Agency for International Development (USAID) The Project's purpose is to encourage the Egyptian Industry to adopt technically advanced and financially viable management practices, including energy efficiency and pollution prevention Pollution prevention focuses on reducing pollution at the source as a way of avoiding costly treatment and reducing environmental liability and compliance costs

The Development Research and Technological Planning Center (DRTPC)/Cairo University is one of three different agencies that are assigned to implement ECEP practices ECEP/DRTPC is implementing in private sector industries

2.2 The EP3 Project

The Agency for International Development (AID) is implementing an environmental pollution prevention project (EP3) worldwide EP3 is designed to operate directly with industry groups to provide technical assistance in pollution prevention, waste minimization, and clean technologies Technical assistance is delivered in the form of 1) diagnostic studies of selected industries conducted by US and local experts, 2) recommendations on measures to minimize pollution through the use of clean technologies, 3) training and information on EP3 practices, 4) tours by local experts to the US to meet with their industrial counterparts that have successfully implemented pollution prevention measures, and 5) dissemination of effective experiences in the program

2.3 Alexandria Environmental Initiative

The objective of this assessment was to assist an industry in the Greater Alexandria area in reducing their impact on the environment while at the same time reducing costs Particular emphasis was placed upon wastes discharged to water but as with any integrated pollution prevention assessment, the impact of the facility on all media was considered

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CHAPTER 3
BACKGROUND INFORMATION

3.0 Company Background

Al Ahram is located at 423, Canal Mahmoudia St , 21131 Smouha, Alexandria Al Ahram's 250 employees work 2 shifts, 300 days per year

Al Ahram has two divisions, one that produces iron products and one that produces castings and electroplated products Table A1 summarizes the production of this factory for the year 1997 Table A2 summarizes the raw materials used to make these products, and the quantities and prices of these raw materials

The following discussion of the Al Ahram facilities and products is divided into three sections, iron products, castings and electroplated products, and utilities

3.1 Iron Products

Steel wire is first de-scaled, rinsed, and surface treated The wire is then used to make nails and is drawn into finer wire At the direction of the owner of Al Ahram, we did not put much emphasis on this portion of the manufacturing because the operation is not competitive

3 1 1 De-Scaling

The de-scaling operation occurs in an old, open, square tank made of bricks and cement Coiled steel wire is lowered into the tank filled with a sulfuric acid solution and is allowed to remain until the scale is removed The sulfuric acid bath is used for multiple coils of wire until the acid is spent The tank is then dumped to the sewer along with the scale

3 1 2 Rinsing

The coiled steel wire is removed from the sulfuric acid bath, placed on the floor, and hosed off The rinse water goes to the drain

3 1 3 Surface Treatment

The rinsed wire is lowered into a second brick and cement tank filled with a lime solution and allowed remaining for some period of time The wire is then removed and allowed to air dry

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3.1.4 Nail and Wire Manufacturing

The treated wire is drawn through dies to reduce the diameter and is either sold as finer wire or is made into nails

3.2 Castings and Electroplated Products

A variety of wash basin handles are produced in the factory The handles are first rough-formed by die-casting The castings are then polished, buffed, de-greased, and electroplated Zipper handles also are made by die casting They are then spray painted or electroplated
Figure 3-1 showing the electroplating flow diagram for nickel chrome plating
The following discussion focuses on the wash basin handles because those are the major products of the plant

3.2 1 Casting

The raw material used is Zamac, a zinc alloy There are six old die casting machines and one modern one The old machines are heated with Solar, and open flames were seen at the backs of the machines Both wash basin handles and zipper handles are cast in these machines The die casting operation was not studied in detail

3 2 2 Polishing and buffing

The cast parts are manually polished and buffed on a variety of buffing wheels and polishing belts The workers were not wearing any protective equipment (e g , safety glasses dust masks)

3 2 3 Initial Degreasing

The cast parts are placed on racks and lowered into a metallic, multi-section tank, filled with tetrachloroethylene (aka perchloroethylene or 'PERC'), a dry cleaning solvent They are then lowered into a tank in which vapor degreasing takes place, using the same solvent In the multi-section tank, the first compartment is heated to 80°C The second and third compartments are at ambient temperature A cooling coil surrounds the upper portion of the tank, above the level of the solvent, and act as a condensing coil reducing solvent vapor releases to the atmosphere However where workers stand directly in front of the tank and/or lean over it to move the racks a strong smell of solvent can be felt Improving this unit operation is considered in the future pollution prevention options of this report

3.2.3 Electroplating

Electroplating is performed in a modern, computer-controlled, electroplating line Two automatic gantry cranes move from tank to tank the part-carrying racks or barrels The tanks in the line are sequentially numbered, from through 41 The entire plating line is new (vintage 1993), extremely clean and well maintained Most plating processes feature automatic make-up units utilizing individual dosing pumps No chemical spills or leaks were observed in the entire plating department

The most common form of plating at Al Ahram is the classical copper-nickel-chrome combination (95% of Al hram's production) There are ten different shaped parts plated in this manner Limited quantities of parts are ass plated (some zipper handles), and other forms of plating are less commonly used Some parts that are destined for Europe are plated using cyanide copper, acid copper, nickel, and chrome Most parts are rack-ated (90%), the remainder are barrel plated Table A3 provides detailed information about the chemical onstituents of various process baths utilized for both surface preparation and electro-deposition Figure 3-1 showing the processes flow diagram

he following steps are used in a typical plating operation at this plant

2 3 1 Loading

Parts are loaded on racks or in barrels at a station designated "Tank No 1 "

3 2 3 2 Alkaline Degreasing

ank No 15 contains a solution of caustic soda at 50°C and is used to degrease parts Compressed air and mechanical agitation are used in the tank Tank 15 is dumped every two weeks

2 3 3 Rinsing

ank No 16 is a static rinse and is followed by Tank No 17, a flowing rinse Both rinse tanks operate at nbient temperature The flowing rinse is agitated using compressed air

2 3 4 Pickling

Tank No 18 is a static acid dip made-up of sulfuric acid and is operated at ambient temperature There is no gitation of the tank contents

3 2 3 5 Rinsing

ank No 19 is a static rinse and is followed by Tank No 20 which is a flowing rinse, both at ambient

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3 2 3 6 Cyanide Copper (Direct)

Tanks No 24 and 25 are used to plate copper The bath has 32 gm/l of copper and 31 gm/l of free cyanide at a temperature of 45°C Fumes are controlled by an air suction system with manifolds at opposite sides of the tanks The rack with the parts (the cathode) is mechanically moved back and forth in the bath

3 2 3 7 Rinsing

Tank No 23 is a static rinse and is followed by Tank No 22, which is a flowing rinse, both operate at ambient temperature The flowing rinse is agitated by compressed air

3 2 3 8 Nickel Activation

Tank No 33 is used for nickel activation The bath contains a solution of nickel salts and operates at ambient temperature

3 2 3 9 Rinsing

Tank No 32 is a static rinse and is followed by Tank No 31, a flowing rinse Both operate at ambient temperature

3 2 3 10 Bright Nickel Plating

Tanks No 40 and 41 are used for bright nickel plating (racks) Tanks No 38 and 39 are used for bright nickel plating (barrels) The plating baths are made-up with nickel sulfate at 300 gm/l, nickel chloride at 60 gm/l, and boric acid at 40 gm/l The operating temperature of each baths is 60°C and the racks/barrels containing the parts are mechanically moved back and forth during plating Fume emissions are controlled by air suction devices consisting of manifolds located at opposite sides of the tanks

3 2 3 11 Rinsing

Tank No 37 is a static rinse (drag-out tank) and is used for make-ups of the nickel plating solution This tank is followed by tank No 36 an air agitated flowing rinse Both rinse tanks operate at ambient temperature

3 2 3 12 Chrome Activation

Tank No 11 contains a solution of chromic acid operated at ambient temperature and is used for activation prior to chromium plating Fumes are controlled by an air suction system made of manifolds located at opposite sides of the tank

3 2 3 13 Chrome Plating

1

3 2.3 13 Chrome Plating

'ank No 10 contains a chromic acid plating solution at 300 gm/l and operates at 43°C It is used for decorative chrome plating Parts are mechanically agitated

›2 3 14 Rinsing

Tank No 9 is a static rinse (drag-out tank) and is used for make-ups of the chrome plating solution This tank is ollowed by tank No 8, a flowing rinse Both tanks operate at ambient temperature

ˆ 2 3 15 Chrome Reduction

ı ank No 7 is used for chromium reduction The parts are dipped in a dilute solution of sodium metabisulfite ·nd sulfuric acid operated at ambient temperature The function of this tank is to reduce the remaining traces of ıexavalent chromium to its trivalent form

ˆ 2 3 16 Rinsing

Tank No 6 is a flowing rinse operating at ambient temperature Its function is to remove the residual trivalent hromium from the parts Air agitation is used for improved rinsing efficiency, and a hot (50°C) static rinse ınk (No 5) conclude the wet process part of the plating operation

2 3 17 Drying

Tank No 4 is used to dry the parts using hot (55^0 C) air

ˇ 2 3 18 Unloading

he same station, "Tank No 1, that was used to load parts on racks or in barrels is used to unload the parts

³ 2 3 19 Acid Copper Plating

If acid copper plating is used, this step comes after cyanide copper plating Tanks No 28, 29, and 30 are used ·nd contain a solution of copper sulfate and sulfuric acid at ambient temperature The solution is air agitated

3 2 3 20 Bright Brass Plating

bright brass plating is used, this step comes after copper cyanide plating

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3.3 Wastewater

Figure 3-2 is a schematic of the sewer system at the Al Ahram facility The Al Ahram plant does not have wastewater treatment system for their industrial effluent

Wastewater from the iron parts production area are collected in separate sewers from the casting and electroplating production area However, both streams later combine before discharging to the AGOSD main sewer line Wastewater from the electroplating area is segregated and collected in two underground tanks One tank receives discharges from acidic and chromium processes, the other tank receives discharges from alkaline and cyanide processes This segregation was designed to facilitate operation of a traditional end-of-pipe wastewater treatment system

The following discussion pertains to the electroplating production area which was the main focus of this RPPDA

3 3 1 Acid/Chrome Underground Tank

The acid/chrome underground tank receives three sets of discharges, acid discharges, chromium discharges, and dilution water from an onsite well

a **Acid Discharges** Three separate acid sewer lines discharge to the acid/chrome underground tank One sewer line carries tank dumps and discharges from the acid copper process, nickel activation, and nickel plating The second line carries overflows from acid rinse tanks and nickel activation The third line carries discharges from the pickling process tanks

b **Chrome Discharges** Two separate chromium waste sewer lines also discharge to the acid/chrome underground tank The first line collects wastewater from chrome rinse tanks and from the passivation tank The second line collects wastewater from the hot air drying tank, the hot static rinse tank, the chrome reduction tank, the chrome drag out rinse tank the chrome activation tank and the passivation tank

c **Dilution Water** The plant pumps water from an on-site well into the acid/chrome underground tank to dilute the collected process wastewater at the point of discharge

3 3 2 Alkaline/Cyanide Underground Tank

a **Alkaline Discharges**

Two Alkaline sewer lines discharge to the Alkaline/Cyanide underground tank One sewer line collects process dumps and overflow discharges from the hot alkaline degreasing tank The second line includes discharges from the static and flowing rinses used after the alkaline degreasing bath

b Cyanide Discharges

Two Cyanide sewer lines discharged to the Alkaline/Cyanide underground tank One sewer line collects process dumps and overflow discharges from the cyanide bright copper, bright brass tanks The second line includes discharges from the static and flowing rinses after bright brass plating

c. Dilution Water The plant pumps water from an on-site well into the alkaline /cyanide underground tank to dilute the collected process wastewater at the point of discharge

Figure 3-3 illustrates the location of the major inputs to the wastewater flow diagram

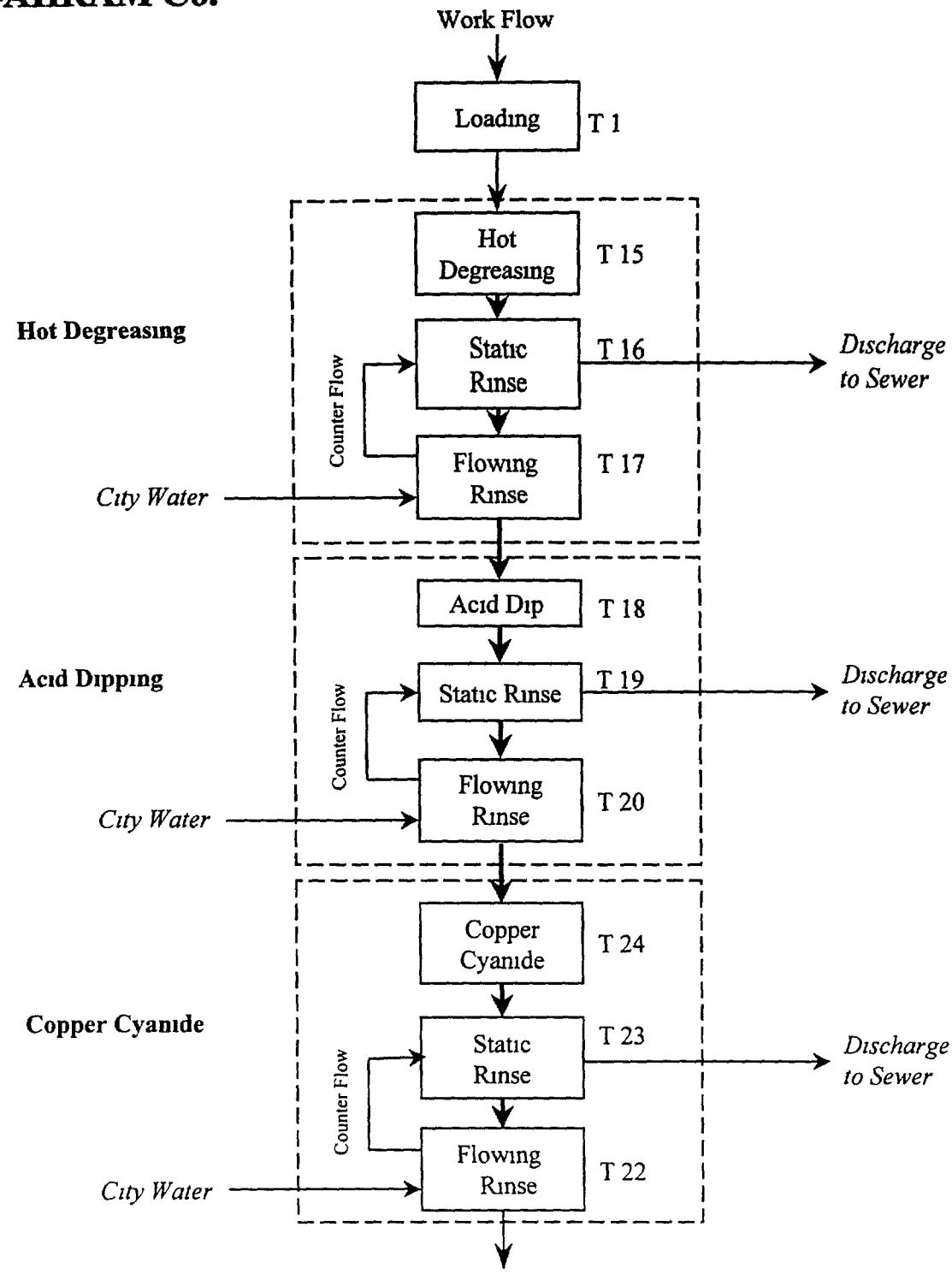

FIGURE 3-1: Flow Diagram of Nickel/Chrome Plating

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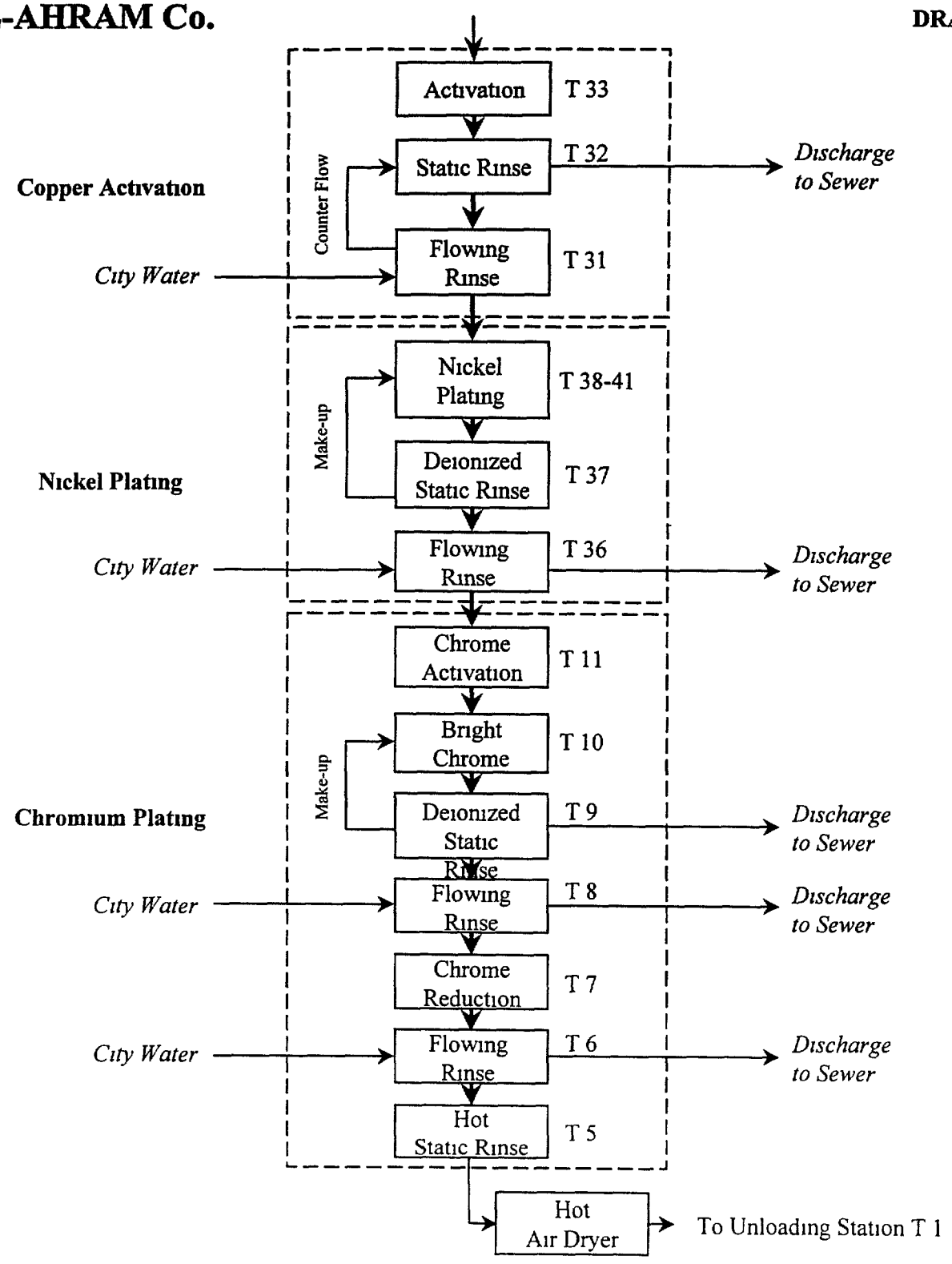

FIGURE 3-1 Flow Diagram of Nickel/Chrome Plating (continued)

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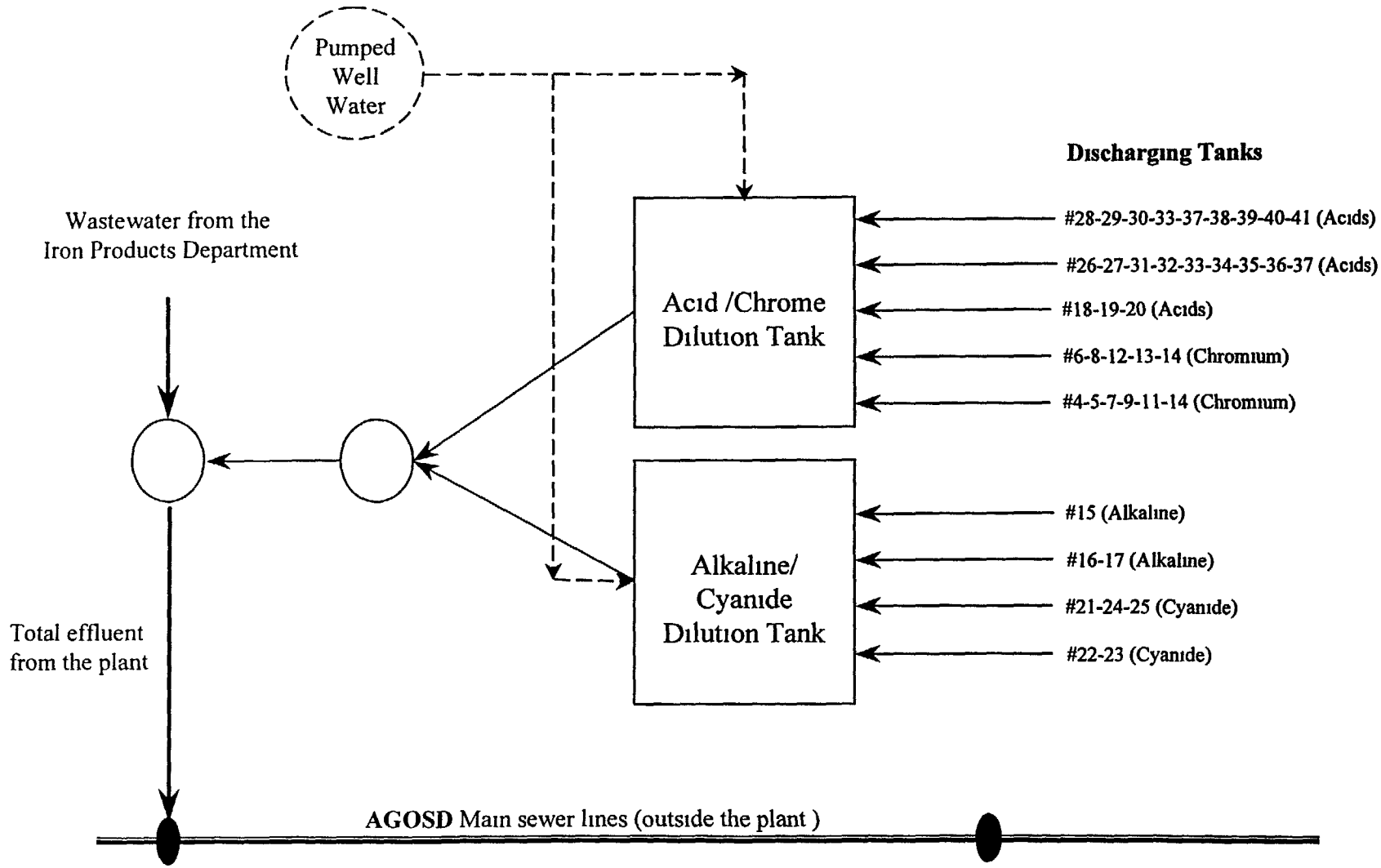
FIGURE 3-2
Wastewater Flow Diagram Showing Major Inputs



CHAPTER 4
ANALYSIS AND RECOMMENDATIONS

Introduction

This Rapid Pollution Prevention Diagnostic Assessment (RPPDA) was focused primarily on identifying processes and practices in the Al Ahram facility where pollution prevention can reduce toxic and hazardous waste and can yield large economic savings This chapter contains an explanation of those pollution prevention opportunities and an explanation of how the implementation of those opportunities will benefit the plant The chapter also contains a discussion of the costs, benefits, obstacles, and other issues that are related to implementation of the opportunities

This chapter is organized in the following order Option 4 0 is concerned with overall environmental management in the plant Options 4 1 through 4 6 present opportunities for reduction of toxic and hazardous wastes Option 4 7 presents the avoided cost of wastewater treatment, and option 4 8 deals with future pollution prevention opportunities

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Pollution Prevention Options:

4 0 **Implement a Pollution Prevention Management System**
Pages 4-3 through 4-4

4 1 **Optimizing Degreasing by Reducing Drag-Out and Rinse Flow Rate**
Pages 4-5 through 4-12

4 2 **Optimizing Acid Dipping by Reducing Drag-Out and Rinse Flow Rate**
Pages 4-13 through 4-20

4 3 **Optimizing Copper Cyanide for Zero Discharge Operation**
Pages 4-21 through 4-28

4 4 **Optimizing Activation Operation**
Pages 4-29 through 4-36

4 5 **Optimizing Nickel Plating Operation**
Pages 4-37 through 4-44

4 6 **Optimizing Chromium Plating Operation**
Pages 4-45 through 4-52

4 7 **Water and Wastewater Batch Treatment Systems**
Page 4-53 through 4-56

4 8 **Future Pollution Prevention Options**
Page 4-57

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4.0 Environmental Management System

An Environmental Management System is critical to the success of Al Ahram's efforts to comply with the law and to continue to comply with the law in the future A Pollution Prevention Management System is part of the overall EMS and is the single most important pollution prevention opportunity that a plant can implement Therefore, this option is placed ahead of all other discussions in this report

Current Situation Law 4 of 1994, Law 93 of 1962, and Law 48 of 1982 contain wastewater and emission standards that must be met by March 1998 Al Ahram is subject to both Law 4 and Law 48 and may be subject to Law 93 when the plant is connected to a sewer system

The laws do not specify what methods a company must use to comply Traditional methods of compliance include construction and operation of wastewater treatment plants and gas cleaning devices

Law 4 requires companies to write and implement a Compliance Action Plan (CAP) that specifies how the company will comply with the requirements of the laws Al Ahram has not yet written a CAP Samples of the company's wastewater were taken to check if the plant effluent meets all of the requirements of the laws Al Ahram is under pressure to come into compliance with wastewater and other discharge standards, and both local deadlines and Law 4 deadlines are demanding action now

Recommendations Implement a Pollution Prevention Management System before investing money in wastewater treatment systems, or considering any one-pollution prevention option Pollution prevention offers an excellent approach to meeting wastewater and emission standards Properly designed pollution prevention projects reduce discharges and emissions while paying for themselves in a relatively short period of time The projects then continue to show cost savings after the payback period

Begin implementing the Pollution Prevention Management System immediately because pollution prevention is often the best way to move toward meeting environmental standards Make the Pollution Prevention Management System the basis of a Compliance Action Plan (CAP) for the plant

It makes good financial sense for a company to incorporate pollution prevention methods into its CAP Pollution prevention measures can help reduce the capital and operating costs of a treatment plant and can further help the plant meet the discharge standards

Use the Pollution Prevention Management System as the process by which information needed for a CAP is developed and organized Begin the planning process of the CAP with consideration of pollution prevention options After measurement and determination of current conditions implement a selected series of promising pollution prevention options Include consideration of wastewater treatment investment and operating costs in the analysis of candidate options

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Results Implementing a Pollution Prevention Management System should result in a continuing series of improvements in plant operating practices that achieve reductions in waste discharges while paying back investments within a reasonable period of time

Inputs, Assumptions, and Calculations Assuming Al Ahram accepts our recommendation and uses the guidelines provided in Appendix A, the plant's pollution prevention task force will make assumptions and perform calculations for benefits, costs, and payback period

Obstacles to Implementation The pollution prevention approach to reducing waste problems is new to most Egyptian companies At Al Ahram, several pollution prevention options have already been installed, and others are planned Al Ahram will benefit from these installed options, however we believe that formalizing the pollution prevention process at Al Ahram will result in far more benefits

Some difficulties may be experienced in implementing a formalized pollution prevention program, including possible resistance to the idea of having employees participate actively in the process We believe that, with time, both management and staff personnel will become accustomed to this way of working, and the company ultimately will profit from the changes

The key to overcoming any potential resistance is strong and continuing management commitment We're convinced that with the enlightened management that is present at Al Ahram, this action will occur, and a successful program will result

Schedule of Implementation Formation of a pollution prevention task force can begin immediately Writing a corporate environmental policy could take one to three weeks The pollution prevention task force will establish its own schedule of implementation for all of the activities to which it is assigned

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Option # 4 1 Optimizing Degreasing by Reducing Drag-Out & Flow Rate

Summary of Annual Savings

	Annual Water Use in m3	Annual Water Cost in LE	Annual Losses of Chemistries in Kg	Annual Cost of Chemistry Losses in LE	Annual Cost of Wastewater Treatment
Current Configuration	675	607 50	1057 28	6449 41	0 00
Recommended Configuration	120	108 00	528 69	3225 00	0 00
Reduction %	82%			50%	
Annual Savings	555	500	529	3224	0

Total Savings 3724 LE/year

Summary of Capital Investments

	Capital Investment in LE	Operating Cost in LE per year
Filter System	2500 00	0 00
Total	2500 00	0 00

Investment 2500 LE

Net Savings 3724 LE/year

Payback Period 0 7 years or 8.1 months

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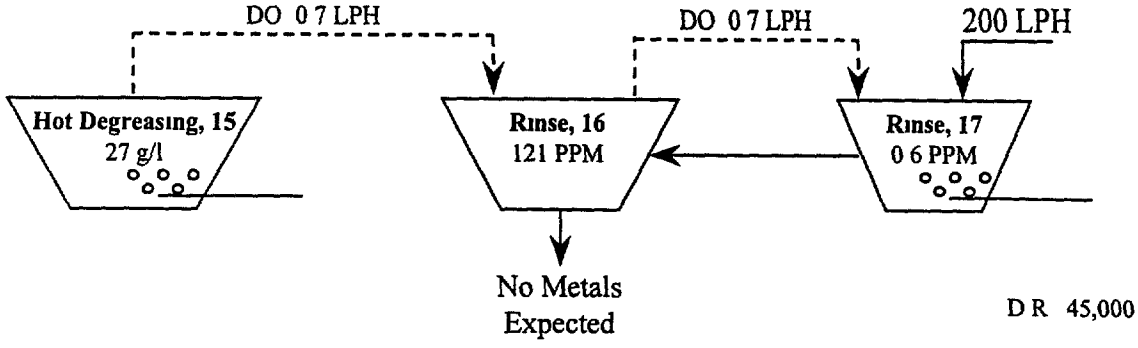
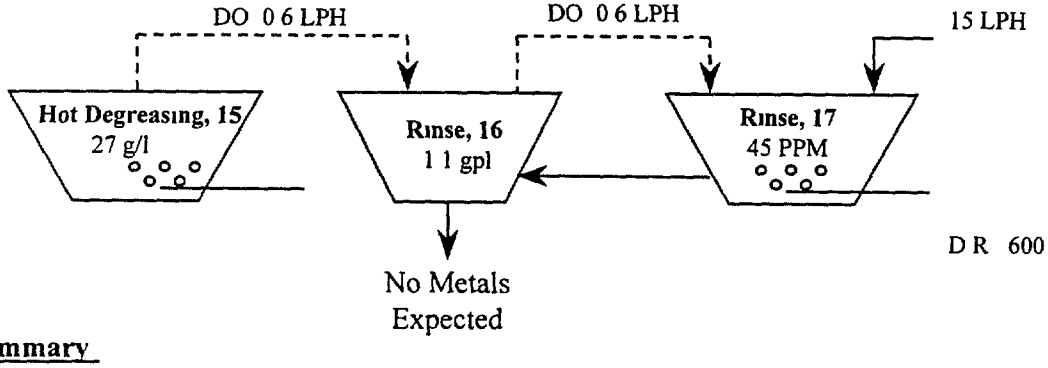
Figure 4-1 : COPPER, NICKEL, CHROME PLATING HOT DEGREASING TANK# 15, 16 & 17

Current Configuration



Recommended Configuration



Summary

-Reduce Drag-out by 15%
-Reduce Rinse Flow Rate to 15 LPH
-Reduce Tank #15 Dumps From 1D/2Weeks to 1D/1 5Month
-Reduce Tank #16 Dumps From 1D/2Weeks to 1D/1 Month
-Reduce Tank #17 Dumps From 1D/2Weeks to 1D/1 Month
- Add filter on the recirculation system

Current Situation (Tanks #15, 16 & 17, Degreasing Step) Hot degreasing takes place in a fully automatic plating line equipped with a computer-controlled overhead hoist system Metal parts to be plated are loaded onto racks (95% of the production) or barrels (5% of the production) The hot degreasing step is followed by a 2-stage countercurrent rinse series receiving a city water flow rate of 200 liters per hour (LPH)

The quality of the final rinse is satisfactory but water consumption can be decreased Adding filtration on-line with the existing recirculation pump can reduce dump schedules

Refer to Figure 4-1 for a schematic diagram of the degreasing step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations

The recommendations below aim at reducing water use and dump schedules

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Reduce rinse water flow rate** to 15 liters per hour (LPH) in tank #17
3 **Reduce tank #15 dump schedule** from once every 2 weeks to twice every 3 months
4 **Reduce tank #16 dump schedule** from once every 2 weeks to once a month
5 **Reduce tank #17 dump schedule** from once every 2 weeks to once a month
6 **Add a filter cartridge** on line with the existing recirculation pump to extend the degreasing bath life

Results Figure 4-1 shows that under the above described operating conditions there would be a substantial reduction of water use since rinse water flow rate could be reduced from 200 LPH down to 15 LPH

An estimated total saving of about 3,724 LE per year will be realized with a very small capital investment of about 2,500 LE for the filter cartridge The simple payback period of this capital cost will be approximately 8 1 months Contributing to the cost savings, there will be reductions of about

1 529 Kg/year of degreasing solution currently discharged through drag-out losses (a 50% reduction)
2 555 cubic meters per year of water consumption and discharge (an 82% reduction)

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram management for 1997 during the data collection phase of the Assessment If needed the company can adjust these figures to reflect more recent production rates

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Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables, are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)
2 by reducing the parts withdrawal speed it is expected that the overall drag-out value will decrease by 15%
3 A dilution ratio of 600 provides a rinse water quality acceptable for this type of process

See also tables 4 1 1 through 4 1 4 for additional assumptions and calculations in the following pages The detail of drag-out estimations used for these calculations is presented in Appendix A5

Note Figure 4-1 contains results of calculations performed with *Rinsecalc*, specialized software developed by CAI Engineering in May 1995 *Rinsecalc* calculates rinse water usage including evaporation for various rinsing configurations, based on inputs of drag-out rate, chemical concentration, temperature, volume and open surface area of the process tank, and the target drag-out concentration in the last (cleanest) rinse In addition to rinse water requirements, *Rinsecalc* calculates chemical losses and expected concentrations

Obstacles to Implementation There is no significant financial obstacle to implementing these recommendations Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Tests and trials will allow the staff to validate the optimized configuration allowing a 15% reduction of drag-out rate Collaboration with a filter system supplier will allow staff to select the optimum filter design for proper operation Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately upon selection of the filter system Installation of the filtration device should require just a few weeks Depending on parts availability, full implementation of the recommendations should take about 2-3 weeks Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

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Table #	4.1.1
Topic:	Annual Water Cost Calculation (current)
Plant:	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Hot Degreasing Tanks # 15, 16 and 17

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	1 5	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	*Flow*	*Unit per*	*Unit*	*M3*	*M3/Year*	*Adjusted for*	*Water Cost*
		L,M3	*Mn,H*	*Converted*		*Intermittent*	*LE/year*
16	200	L	H	0 2	600	600	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					600	600	540 00

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H,S D,M W*	*Converted*			*LE/year*
15	0 5	C	W	0 75	37 50		
16	0 25	C	W	0 38	18 75		
17	0 25	C	W	0 38	18 75		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					75 00		67 50

Rinse + Process Total	675 00	m3/year of water
Total Annual Cost	607 50	LE per year

22

Table #	**4.1.2**
Topic:	**Annual Water Cost Calculation (recommended)**
Plant:	**Al Ahram Co**
Process:	**Copper, Nickel, Chrome Plating**
Line/Step:	**Hot Degreasing Tanks # 15, 16 and 17**

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	1 5	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	*Flow*	*Unit per*	*Unit*	*M3*	*M3/Year*	*Adjusted for*	*Water Cost*
		L,M3	*Mn,H*	*Converted*		*Intermittent*	*LE/year*
16	15	L	H	0 015	45	45	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					45	45	40 50

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H,S D,M,W*	*Converted*			*LE/year*
15	0 5	C	W	0 75	37 50		
16	0 25	C	W	0 38	18 75		
17	0 25	C	W	0 38	18 75		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					75 00		67 50

Rinse + Process Total	120 00	m3/year of water
Total Annual Cost	108 00	LE per year

23

Table #	4.1.3
Topic:	Drag-Out Estimation (current)
Plant:	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Hot Degreasing Tanks # 15, 16 and 17

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in barrels and 5% in racks

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
2 2	1000		8 21	92 90	0 09

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 7		6 09		2148 00	2 15	0 19	1 61

Chemistry Losses

Bath TDS	26 67	grams per liter
Cost/Kg	6 10	LE/Kg
Chemical Loss	57 28	Kg/year
Annual Cost	349 41	LE/year

Cost of Process Dumps

Tank 15	is dumped	25	times/year
	and costs	6100	LE/year

WWT OPERATING COSTS					
	121	TDS in ppm	1057	Kg ->in lbs	LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

24

Table #	4.1.4
Topic:	Drag-Out Estimation (recommended)
Plant:	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Hot Degreasing Tanks # 15, 16 and 17

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in barrels and 5% in racks

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
1 8	1000		6 98	92 90	0 08

15% Drag-Out Reduction

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 6		5 17		1825 80	1 83	0 16	1 37

Chemistry Losses

Bath TDS	26 67	grams per liter
Cost/Kg	6 10	LE/Kg
Chemical Loss	48 69	Kg/year
Annual Cost	297 00	LE/year

Cost of Process Dumps

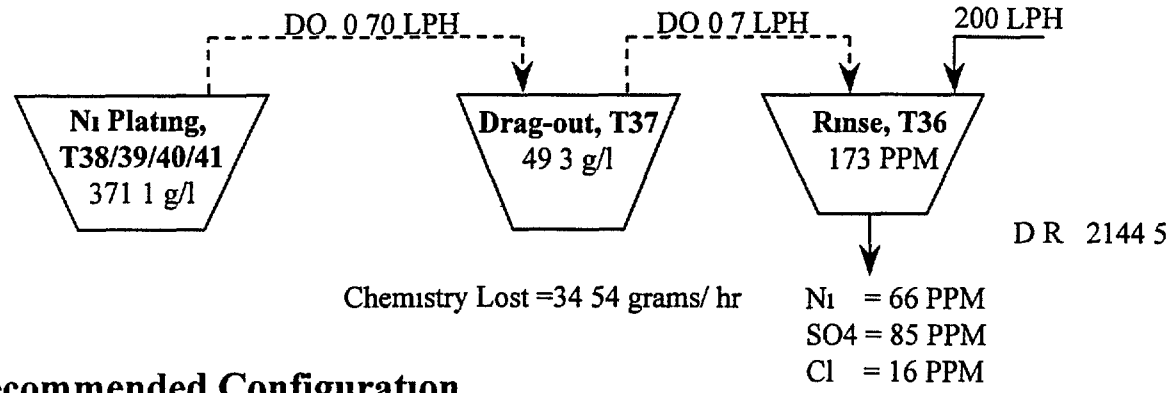
Tank 15 is dumped 12 times/year
and costs 2928 LE/year

WWT OPERATING COSTS					
	1100	TDS in ppm	529	Kg ->in lbs	LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

25

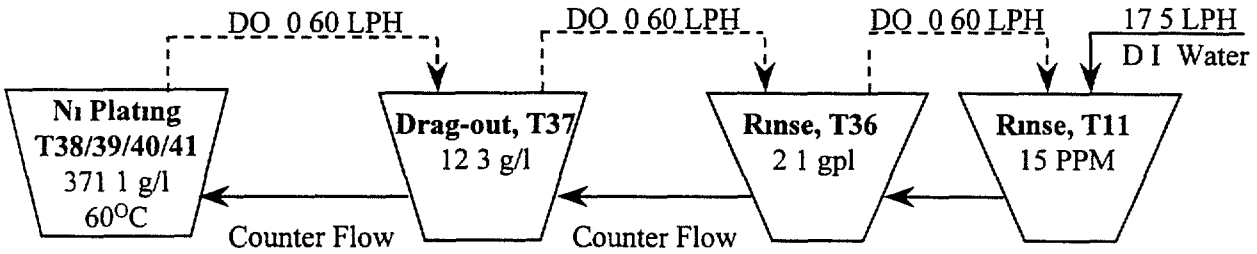
Figure 4-5: COPPER, NICKEL, CHROME PLATING NICKEL PLATING, TANK# 38/39/40/41,37&36

Current Configuration



Recommended Configuration

Natural Evaporation 18 LPH



Summary **Zero Discharge** D R 24,740

- Reduce Drag-out by 15%
- Reduce rinse flow rate to 17 5 LPM
- Counter current flow rinse water to plating tank
- Use D I water for rinse make-up in tank 11
- Use tank 11 as additional rinse tank
- Eliminate tank 36 dumps
- Dump and waste treat tank 37 once a year

26

Current Situation (Tanks #38-41, 37 & 36,-Nickel Plating Step) The nickel plating step takes place in a fully automatic plating line equipped with an overhead hoist system Metal parts to be plated are loaded onto racks or barrels A drag-out tank (#37) and a flowing rinse receiving 200 LPH of city water follow the nickel-plating step

Discharging rinse tank 37 contains levels of nickel, sulfates and chloride ions expected to be above discharge limits

Refer to Figure 4-5 for a schematic diagram of the nickel-plating step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations. In order to comply with the current discharge standards, the recommendations described below aim at eliminating the discharge of nickel, sulfates and chloride ions from the flowing rinse tank, while also reducing water use

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Use tank 11 as additional rinse tank** in a 4-stage countercurrent rinse series
3 **Reduce rinse water flow rate** to 17 5 liters per hour in tank 11
4 **Use DI water** for rinse water feed in tank 11
5 **Dump and waste treat (batch) tank 37** once a year
6 **Eliminate dumps** for tank 36

Results Figure 4-5 shows that under the above described operating conditions there would be a substantial water use since rinse water flow rate could be reduced from 200 LPH down to 17 5 LPH

An estimated total saving of about 13,628 LE per year will be realized with a very small capital investment of 1,000 LE The simple payback period of this option will be approximately 1 month Contributing to the cost savings, there will be reductions of about

1 800 Kg/year of nickel plating solution in the final effluent that would otherwise have to be treated (a 100% reduction)
2 564 cubic meters per year of water consumption and discharge (a 91% reduction)

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram management for 1997, during the data collection phase of the Assessment If needed the company can adjust these figures to reflect more recent production rates

Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)

27

Option # 4 2 Optimizing Acid Dipping by Reducing Drag-Out and Rinse Flow Rate

Summary of Annual Savings

	Annual Water Use in m3	Annual Water Cost in LE	Annual Losses of Chemistries in Kg	Annual Cost of Chemistry Losses in LE	Annual Cost of Wastewater Treatment
Current Configuration	625	562 68	26 37	316 44	0 00
Recommended Configuration	58	51 84	15 06	180 77	0 00
Reduction %	91%			43%	
Annual Savings	568	511	11	136	0

Total Savings 647 LE/year

Summary of Capital Investments

	Capital Investment in LE	Operating Cost in LE per year
1	0 00	0 00
2	0 00	0 00
Total	0 00	0 00

Investment 0 LE

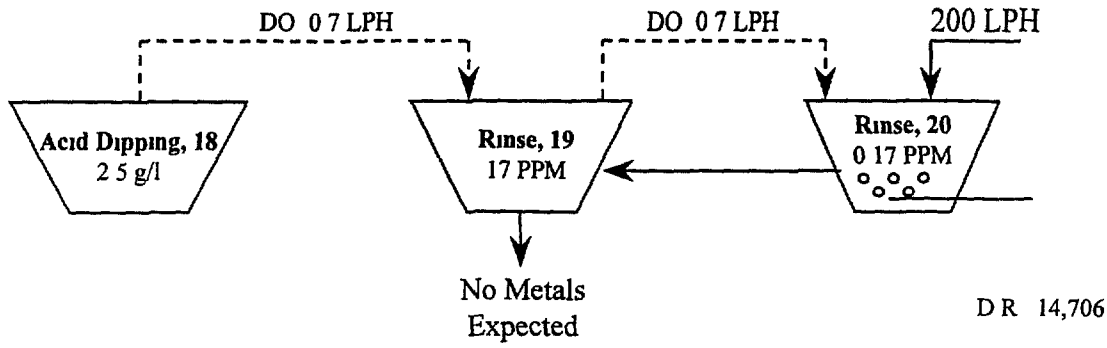
Net Savings 647 LE/year

Payback Period 0 0 years or 0 0 months

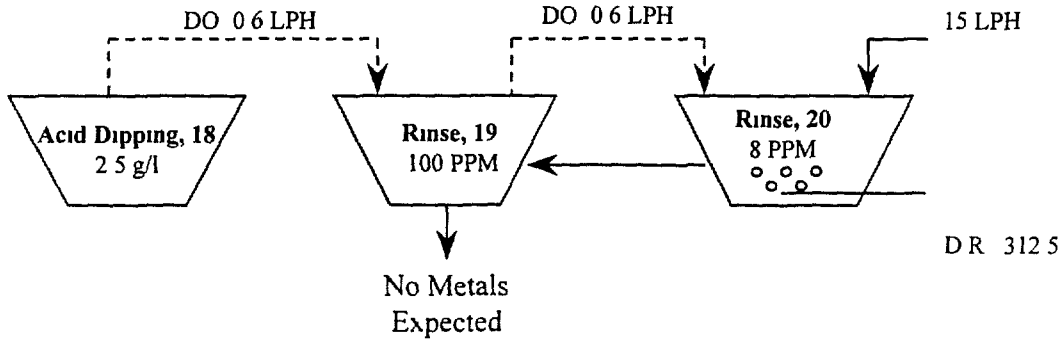
28

Figure 4-2 : COPPER, NICKEL, CHROME PLATING ACID DIP TANK# 18,19 & 20

Current Configuration



Recommended Configuration



Summary

-Reduce Drag-out by 15%
-Reduce Rinse Flow Rate
-Reduce Tank #18 Dumps From 1D/1 Month to 1D/2 Month
-Reduce Tank #19 Dumps From 1D/1 Month to 1D/2 Month
-Reduce Tank #20 Dumps From 1D/1 Month to 1D/2 Month

29

Current Situation (Tanks #18, 19, & 20, Acid Dipping Step) Acid dipping takes place in a fully automatic plating line equipped with a computer-controlled overhead hoist system Metal parts to be plated are loaded onto racks (95% of the production) or barrels (5% of the production) The acid dipping step is followed by a 2-stage countercurrent rinse series receiving a city water flow rate of 200 liters per hour (LPH)

The quality of the final rinse is satisfactory but water consumption can be decreased Performing analysis rather than following a systematic dump routine can reduce dump schedules

Refer to Figure 4 2 for a schematic diagram of the acid-dipping step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations The recommendations below aim at reducing water use in the acid dipping process while keeping solution drag-out to the next process step, to a minimum

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Reduce rinse water flow rate** to 15 liters per hour (LPH) in tank #20
3 **Reduce tank #18 dump schedule** from once a month to once every 2 months
4 **Reduce tank #19 dump schedule** from once a month to once every 2 months
5 **Reduce tank #20 dump schedule** from once a month to once every 2 months

Results Figure 4-2 shows that under the above described operating conditions there would be a substantial water use since rinse water flow rate could be reduced from 200 LPH down to 15 LPH

An estimated total saving of about 647 LE per year will be realized with no capital investment The simple payback period of this option will be immediate Contributing to the cost savings, there will be reductions of about

1 11 Kg/year of degreasing solution currently discharged through drag-out losses (a 43% reduction)
2 568 cubic meters per year of water consumption and discharge (a 91% reduction)

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram management for 1997, during the data collection phase of the Assessment If needed, the company can adjust these figures to reflect more recent production rates

Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)
2 by reducing the parts withdrawal speed it is expected that the overall drag-out value will

30

decrease by 15%

3 A dilution ratio of 300 provides a rinse water quality acceptable for this process

See also tables 4 2 1 through 4 2 4 for additional assumptions and calculations in the following pages

Note Figure 4-2 contains results of calculations performed with *Rinsecalc*, specialized software developed by CAI Engineering in May 1995 *Rinsecalc* calculates rinse water usage including evaporation for various rinsing configurations, based on inputs of drag-out rate, chemical concentration, temperature, volume and open surface area of the process tank, and the target drag-out concentration in the last (cleanest) rinse In addition to rinse water requirements, *Rinsecalc* calculates chemical losses and expected concentrations

Obstacles to Implementation There is no significant financial obstacle to implementing these recommendations Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Tests and trials will allow the staff to validate the optimized configuration allowing a 15% reduction of drag-out rate Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately Full implementation of the recommendations should take about 1-2 weeks Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

Table #	4.2.1
Topic:	Annual Water Cost Calculation (current)
Plant:	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Acid Dip Tanks #18, 19, and 20

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	0 7	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	*Flow*	*Unit per*	*Unit*	*M3*	*M3/Year*	*Adjusted for*	*Water Cost*
		L,M3	*Mn,H*	*Converted*		*Intermittent*	*LE/year*
19	200	L	H	0 2	600	600	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					600	600	540 00

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H S D,M,W*	*Converted*			*LE/year*
18	1	C	M	0 70	8 40		
19	1	C	M	0 70	8 40		
20	1	C	M	0 70	8 40		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					25 20		22 68

Rinse + Process Total	625 20	m3/year of water
Total Annual Cost	562 68	LE per year

32

Table #	4.2.2
Topic:	Annual Water Cost Calculation (recommended)
Plant	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step:	Acid Dip Tanks #18, 19, and 20

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	0 7	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	*Flow*	*Unit per*	*Unit*	*M3*	*M3/Year*	*Adjusted for*	*Water Cost*
		L M3	*Mn,H*	*Converted*		*Intermittent*	*LE/year*
19	15	L	H	0 015	45	45	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					45	45	40 50

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H S,D,M,W*	*Converted*			*LE/year*
18	0 5	C	M	0 35	4 20		
19	0 5	C	M	0 35	4 20		
20	0 5	C	M	0 35	4 20		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					12 60		11 34

Rinse + Process Total	57 60	m3/year of water
Total Annual Cost	51 84	LE per year

Table #	4.2.3
Topic:	Drag-Out Estimation (current)
Plant	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Acid Dip Tanks #18, 19, and 20

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks, and 5% in barrels

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
2 2	1000		8 21	92 90	0 09

Production Datas

Annual Production		Working Hours/year
24317	m2	3000

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 7		6 09		2148 00	2 15	0 19	1 61

Chemistry Losses

Bath TDS	2 5	grams per liter
Cost/Kg	12 00	LE/Kg
Chemical Loss	5 37	Kg/year
Annual Cost	64 44	LE/year

Cost of Process Dumps

Tank 18	is dumped	12	times/year
	and costs	252	LE/year

WWT OPERATING COSTS					
	17	TDS in ppm	26	Kg ->in lbs	LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

34

Table #	4.2.4
Topic:	Drag-Out Estimation (recommended)
Plant	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Acid Dip Tanks #18, 19, and 20

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
1 8	1000		6 98	92 90	0 08

15% Drag-Out Reduction

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 6		5 17		1825 80	1 83	0 16	1 37

Chemistry Losses

Bath TDS	2 5	grams per liter
Cost/Kg	12 00	LE/Kg
Chemical Loss	4 56	Kg/year
Annual Cost	54 77	LE/year

Cost of Process Dumps

Tank 18	is dumped		6 times/year
and costs		126	LE/year

WWT OPERATING COSTS					
	100	TDS in ppm	15	Kg ->in lbs	LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

35

DRAFT

Al Ahram Co

Option # 4 3 Optimizing Copper Cyanide for Zero Discharge Operation

Summary of Annual Savings

	Annual Water Use in m3	Annual Water Cost in LE	Annual Losses of Chemistries in Kg	Annual Cost of Chemistry Losses in LE	Annual Cost of Wastewater Treatment
Current Configuration	767	690 12	263 13	10348 18	5578 47
Recommended Configuration	77	69 12	0 00	0 00	0 00
Reduction %	82%			100%	100%
Annual Savings	690	621	263	10348	5578

Total Savings 16548 LE/year

Summary of Capital Investments

	Capital Investment in LE	Operating Cost in LE per year
Evaporator	20000 00	0 00
Heater 28 Kw	7000 00	4922 06
Counterflow to Tank #24	600 00	0 00
Installation	1000 00	0 00
Total	28600 00	4922 06

Investment 28600 LE

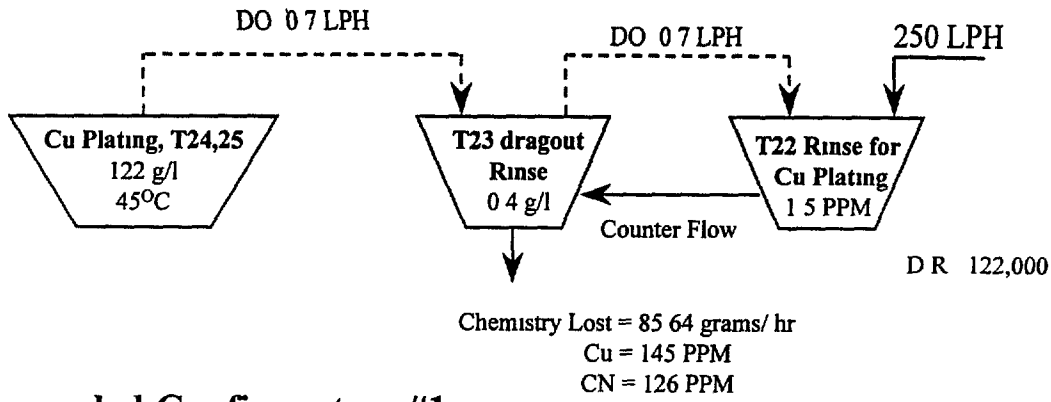
Net Savings 11626 LE/year

Payback Period 2 5 years or 29 5 months

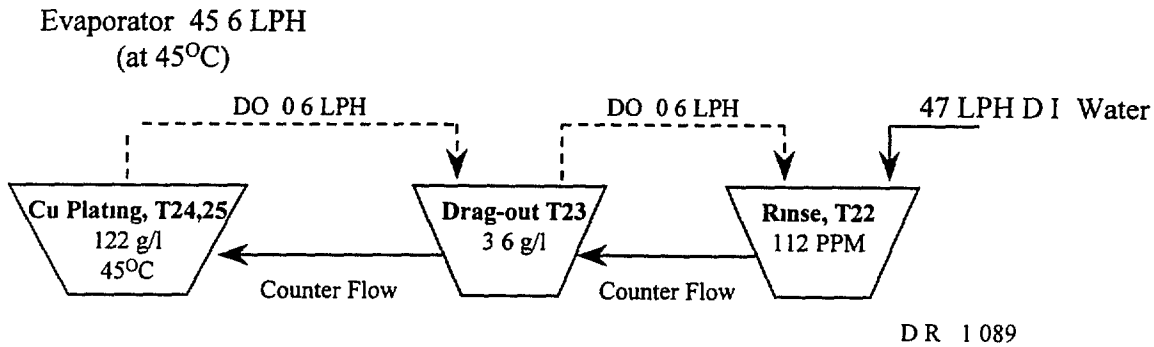
36

Figure 4-3: COPPER, NICKEL, CHROME PLATING COPPER CYANIDE, TANK 22, 23 &24

Current Configuration



Recommended Configuration #1



Zero Discharge

Summary

-Reduce Drag-out by 15%
-Add evaporator
-Reduce rinse flow rate to 0 784 LPM
-Counter current flow rinse water to plating tank
-Use D I water for rinse make-up
-Eliminate dumps of the tanks

37

Current Situation (Tanks #24/25, 23 & 22 Copper Cyanide Plating Step) Copper cyanide plating takes place in a fully automatic plating line equipped with a computer-controlled overhead hoist system Metal parts to be plated are loaded onto racks (95% of the production) or barrels (5% of the production) The Copper-plating step is followed by a 2-stage countercurrent rinse series receiving a city water flow rate of 250 liters per hour (LPH)

The discharging rinse tank 23 contains levels of copper and cyanide ions expected to be above discharge limits

Refer to Figure 4-3 for a schematic diagram of the copper cyanide-plating step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations In order to comply with the current discharge standards, the recommendations described below aim at eliminating the discharge of copper and cyanide from the flowing rinse tank, while also reducing water use

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Use DI water** for rinse water feed
3 **Counter current flow rinse water from tank 23** to tank 24/25 for zero discharge operation, using a dosing pump
4 **Add an atmospheric evaporator** on tank 24/25
5 **Reduce rinse water flow rate** to 47 LPH
6 **Eliminate dumps** of tanks 23 and 22

Results Figure 4-3 shows that under the above described operating conditions there would be no cyanide or copper discharged in the wastewater from this plating operation
An estimated total saving of about 16,548 LE per year will be realized with a capital investment of about 28 600 LE for reconfiguration The simple payback period of this capital cost will be approximately 2 5 years or 29 5 months Even though the payback period is relatively long this tank represent an excellent opportunity to significantly reduce environmental impact with little capital investment Significant environmental impact reductions include

1 96 Kg/year of cyanide in the final effluent that would otherwise have to be treated (a 100% reduction)
2 148 Kg/year of copper in the final effluent that would otherwise have to be treated (a 100% reduction)
3 690 cubic meters per year of water consumption and discharge (an 82% reduction)

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram s management in 1997 during the data collection phase of the Pre Assessment If needed the company can adjust these figures to reflect current production rates

Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)
2 by reducing the parts withdrawal speed it is expected that the overall drag-out value will decrease by 15%
3 A dilution ratio of 1,000 provides a rinse water quality acceptable for this process

See also tables 4 3 1 through 4 3 4 for additional assumptions and calculations in the following pages

Note Figure 4-3 contains results of calculations performed with *Rinsecalc*, specialized software developed by CAI Engineering in May 1995 *Rinsecalc* calculates rinse water usage including evaporation for various rinsing configurations, based on inputs of drag-out rate, chemical concentration, temperature, volume and open surface area of the process tank, and the target drag-out concentration in the last (cleanest) rinse In addition to rinse water requirements, *Rinsecalc* calculates chemical losses and expected concentrations

Obstacles to Implementation There is no financial obstacle to implementing this option Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Tests and trials will allow the staff to validate the optimized configuration allowing a 15% reduction of drag-out rate Upon implementation of the recommendations staff training and monitoring will be needed to become familiar with the added equipment

Schedule of Implementation Additional drag-out reduction techniques can be implemented quickly and monitored for optimization Installation of the dosing pump should require just a few days Depending on parts availability, full implementation of the new equipment should take about 1-2 months Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

39

Table #	4 3 1
Topic	Annual Water Cost Calculation (current)
Plant	Al Ahram Co
Process	Copper, Nickel Chrome Plating
Line/Step	Copper Cyanide Plating, Tanks 24 23 and 22

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	0 7	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	Flo	Unit per L M3	Unit Min H	M3 Converted	M3 Year	Adjusted for Intermittent	Water Cost LE Year
23	250	L	H	0 25	750	750	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					750	750	675 00

Process Tanks	Dumps	Unit per C M3	Unit H S D M W	M3 Converted	M3 Year		Water Cost LE
24	0	C	M	0 00	00		
23	1	C	M	0 70	140		
22	1	C	M	0 70	140		
				0 00	00		
				0 00	00		
				0 00	00		
Process Total					280		

Rinse + Process Total 766 80 m3/year of water

Total Annual Cost [illegible] LE per year

40

Table #	4 3 2
Topic	Annual Water Cost Calculation (recommended)
Plant	Al Ahram Co
Process	Copper Nickel, Chrome Plating
Line/Step	Copper Cyanide Plating, Tanks 24, 23 and 22

Assumptions

Hours per shift	12 Hours
Shifts per day	1 Shift
Day per Year	250 Days
Intermittent Value	12 Hours ON per day
Month per year	12 Month
Weeks pe year	50 Weeks
Tank Capacity	0 7 M3
Cost of water	0 9 LE/M3

Calculations

Flowing Tanks	Flow	Unit per	Unit	M3	M3/Year	Adjusted for	Water Cost
		L M3	M H	Converted		Intermittent	LE/year
23	20	L	H	0 02	60	60	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					60	60	54 00

Process Tanks	Dumps	Unit per	Unit	m3	m3/Year		Water Cost
		C M3	H	Converted			LE/year
[illegible]	0	[illegible]	[illegible]	0 00	0 00		
[illegible]	1		M	[illegible]	8 40		
[illegible]	1	[illegible]	M	0 70	8 40		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					16 80		1[illegible]

Rinse + Process Total 76 80 m3 year of water

Total [illegible] Cost [illegible] LE [illegible]

41

Table #	4.3.3
Topic.	Drag-Out Estimation (current)
Plant:	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Copper Cyanide Plating, Tanks 24, 23 and 22

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
90% of production is processed in racks and 10% in barrels

Units Conversions

Gallons /	Sq Ft		Gal->Liter	Sq Ft ->M2	Liters/M2
2 2	1000		8 21	92 90	0 09

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		Liters per day		Liters/year	M3/year	Gal / hrs	Gal / day
0 7		6 09		2148 00	2 15	0 19	1 61

Chemistry Losses

Bath TDS	122 50	grams per liter
Cost/Kg	39 33	LE/Kg
Chemical Loss	263 13	Kg/year
Annual Cost	10348 18	LE/year

Cost of Process Dumps

Tank 24 is dumped 0 times per year
and costs 0 LE/year

WWT OPERATING COSTS					
	400	TDS in ppm	263	Kg ->in lbs	LE/year
Metal	0	49%	128	282	953
Cr	0	0%	0	0	0
CN	0	32%	83	183	4626
Total					5578

42

Table #	4.3 4
Topic	Drag-Out Estimation (recommended)
Plant:	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step:	Copper Cyanide Plating, Tanks 24, 23 and 22

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
90% of production is processed in racks and 10% in barrels

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
1 8	1000		6 975468049	92 90	0 08

15% Drag-Out Reduction

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 6		5 17		1825 80	1 83	0 16	1 37

Chemistry Losses

Bath TDS	122 5	grams per liter
Cost/Kg	39 33	LE/Kg
Chemical Loss	0 00	Kg/year
Annual Cost	0 00	LE/year

Cost of Process Dumps

Tank 24 is dumped 0 times per year
223 66 and costs 0 LE/year

WWT OPERATING COSTS					
	1800	TDS in ppm		0 Kg	>in lbs LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

EVAPORATION		LE/KWh		0 18 LE	
LPH	>	KW	Hrs/Day	Days/year >	Cost/year
15		9 115	12	250	4922
GPH					
3 963					

Option # 4 4 Optimizing Copper Activation Operation

Summary of Annual Savings

	Annual Water Use in m3	Annual Water Cost in LE	Annual Losses of Chemistries in Kg	Annual Cost of Chemistry Losses in LE	Annual Cost of Wastewater Treatment
Current Configuration	625	562 79	472 05	5082 40	0 00
Recommended Configuration	1220	1098 20	264 22	2844 74	0 00
Reduction %	-95%			44%	
Annual Savings	-595	-535	208	2238	0

Total Savings 1702 LE/year

Summary of Capital Investments

	Capital Investment in LE	Operating Cost in LE per year
1	0 00	0 00
Total	0 00	0 00

Investment 0 LE/year

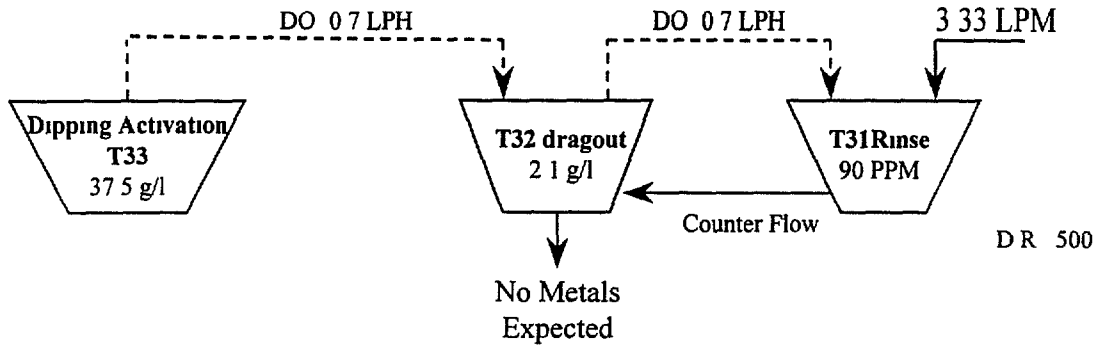
Net Savings 1702 LE/year

Payback Period 0 0 years or 0 0 months

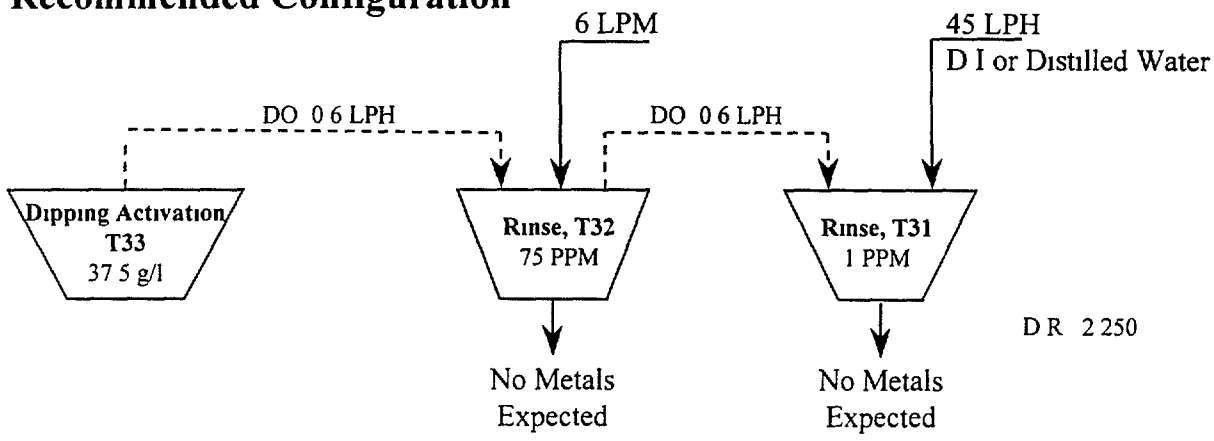
44

Figure 4-4: COPPER, NICKEL, CHROME PLATING ACTIVATION LINE, TANK# 31, 32, & 33

Current Configuration



Recommended Configuration



Summary

- Reduce Drag-out by 15%
-Eliminate dump for tanks 32 & 31
-Eliminate Counter Flowing rinse arrangement
-Adjust rinse water flow rate to 6 LPM in tank 32 and 45 LPH in tank 31
-Use D I water in tank 31
-Reduce dump schedule for tank 33 from 1D/1Month to 1D/2Months

45

Current Situation (Tank #33, 32, & 31, Activation Step) The activation step takes place in a fully automatic plating line equipped with a computer-controlled overhead hoist system Metal parts to be plated are loaded onto racks (95% of the production) or barrels (5% of the production) The activation step is followed by a 2-stage countercurrent rinse series receiving a city water flow rate of 3 3 liters per minute (LPM)

The quality of the final rinse is satisfactory but water consumption can be decreased Performing analysis rather than following a systematic dump routine can reduce dump schedules

Refer to Figure 4-4 for a schematic diagram of the activation step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations The recommendations below aim at reducing solution losses by drag-out and minimizing contamination of the next process step (nickel plating)

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Eliminate the counter current flowing rinse arrangement** to increase final rinse quality
3 **Adjust rinse water flow rate** to 6 0 liters per minute for tank 32 and 45 liters per hour for tank 31
4 **Use DI water** for rinse water feed in tank 31
5 **Reduce tank #33 dump schedule** from once a month to once every 2 months
6 **Eliminate dumps** for tanks 32 & 31

Results Figure 4-4 shows that under the above described operating conditions there would be a substantial drag-out loss reduction from 5082 to 2845 Kg of activation solution per year

An estimated total saving of about 1,702 LE per year will be realized with no capital investment The simple payback period of this option will be immediate

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram management for 1997, during the data collection phase of the Assessment If needed, the company can adjust these figures to reflect more recent production rates

Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)
2 by reducing the parts withdrawal speed it is expected that the overall drag-out value will decrease by 15%
3 A dilution ratio of 2 000 provides a rinse water quality acceptable for this process

46

See also tables 4 4 1 through 4 4 4 for additional assumptions and calculations in the following pages

Note Figure 4-4 contains results of calculations performed with *Rinsecalc*, specialized software developed by CAI Engineering in May 1995 *Rinsecalc* calculates rinse water usage including evaporation for various rinsing configurations, based on inputs of drag-out rate, chemical concentration, temperature, volume and open surface area of the process tank, and the target drag-out concentration in the last (cleanest) rinse In addition to rinse water requirements, *Rinsecalc* calculates chemical losses and expected concentrations

Obstacles to Implementation There is no significant financial obstacle to implementing these recommendations Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Tests and trials will allow the staff to validate the optimized configuration allowing a 15% reduction of drag-out rate Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately Full implementation of the recommendations should take about 1-2 weeks Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

47

Table #	4 4 1
Topic	Annual Water Cost Calculation (current)
Plant	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step	Activation Tanks #33, 32 and 31

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	0 87	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	Flow	Unit per	Unit	M3	M3/Year	Adjusted for	Water Cost
		L M3	Min H	Converted		Intermittent	LE/year
32	3 3	L	Mn	0 0033	594	594	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					594	594	534 60

Process Tanks	Pumps	Unit per	Unit	m3	m3 Year		Water Cos
		C M3	H S D M W	Converted			LE/yea
32	1	C	M	0 8[illegible]	10 44		
[illegible]	1		M	0 8[illegible]	10 44		
	1	C	M	1 8[illegible]	10 44		
				0 00	0 00		
				0	0 00		
				0 00	0 00		
Process Total					31 32		28 19

Rinse + Process Total 625 32 m3/year of water

Total Annual Cost [illegible] LE per year

48

Table #	4 4 2
Topic.	Annual Water Cost Calculation (recommended)
Plant	Al Ahram Co
Process·	Copper, Nickel, Chrome Plating
Line/Step	Activation Tanks #33, 32 and 31

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	0 87	M3
Cost of water	0 9	LE/M3

Calculations

Flowing Tanks	*Flow*	*Unit per*	*Unit*	*M3*	*M3/Year*	*Adjusted for*	*Water Cost*
		L M3	*Mn H*	*Converted*		*Intermittent*	*LE/year*
32	6	L	Mn	0 006	1080	1080	
31	45	L	H	0 045	135	135	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					1215	1215	1093 50

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H S D M W*	*Converted*			*LE/year*
33	0 5	C	M	0 44	5 22		
32	0	C	M	0 00	0 00		
31	0	C	M	0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					5 22		4 70

Rinse + Process Total	1220 22	m3/year of water
Total Annual Cost	1098 20	LE per year

49

Table #	4.4.3
Topic:	Drag-Out Estimation (current)
Plant:	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step:	Activation Tanks #33, 32 and 31

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
2 2	1000		8 21	92 90	0 09

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 7		6 09		2148 00	2 15	0 19	1 61

Chemistry Losses

Bath TDS	37 5	grams per liter
Cost/Kg	10 77	LE/Kg
Chemical Loss	80 55	Kg/year
Annual Cost	867 25	LE/year

Cost of Process Dumps

Tank 33 is dumped 12 times per year
and costs 4215 15 LE/year

WWT OPERATING COSTS					
	2100	TDS in ppm	472	Kg >in lbs	LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

50

Table #	4 4.4
Topic:	Drag-Out Estimation (recommended)
Plant·	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step:	Activation Tanks #33, 32 and 31

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	Sq Ft		Gal->Liter	Sq Ft ->M2	Liters/M2
1 8	1000		6 98	92 90	0 08

15% Drag-Out Reduction

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		Liters per day		Liters/year	M3/year	Gal / hrs	Gal / day
0 6		5 17		1825 80	1 83	0 16	1 37

Chemistry Losses

Bath TDS	37 5	grams per liter
Cost/Kg	10 77	LE/Kg
Chemical Loss	68 47	Kg/year
Annual Cost	737 17	LE/year

Cost of Process Dumps

Tank 33 is dumped 6 times per year
and costs 2107 575 LE/year

WWT OPERATING COSTS					
	75	TDS in ppm	264	Kg ->in lbs	LE/year
Metal	0	0%	0	0	0
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					0

51

Option # 4 5 Optimizing Nickel Plating Operation

Summary of Annual Savings

	Annual Water Use in m3	Annual Water Cost in LE	Annual Losses of Chemistries in Kg	Annual Cost of Chemistry Losses in LE	Annual Cost of Wastewater Treatment
Current Configuration	618	556 20	800 24	10864 13	2262 52
Recommended Configuration	54	48 60	0 41	5 50	1 15
Reduction %	91%			100%	100%
Annual Savings	564	508	800	10859	2261

Total Savings 13628 LE/year

Summary of Capital Investments

	Capital Investment in LE	Operating Cost in LE per year
Counterflow to Tank #38	1000 00	0 00
Total	1000 00	0 00

Investment 1000 LE

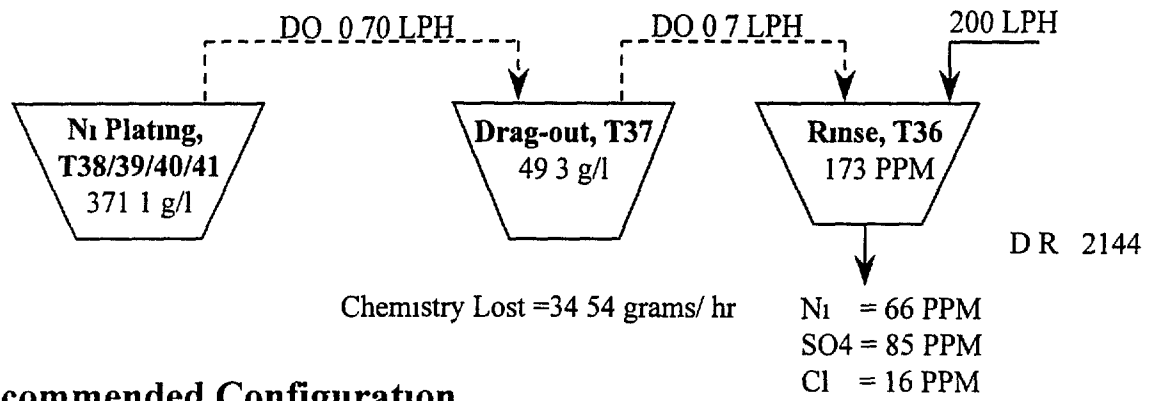
Net Savings 13628 LE/year

Payback Period 0 1 years or 0 9 months

52

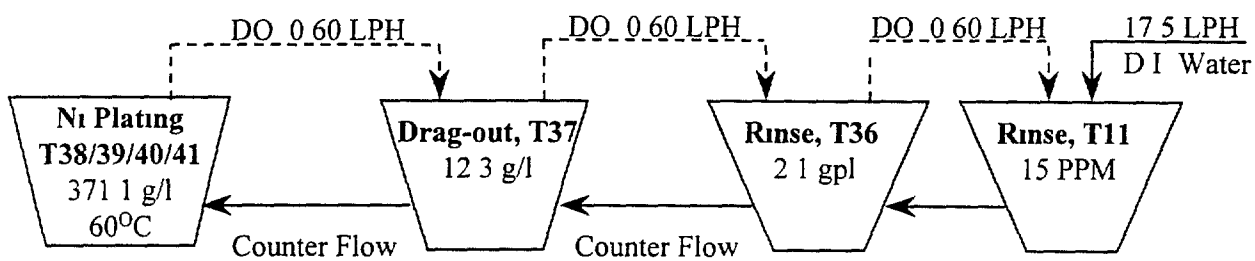
Figure 4-5: COPPER, NICKEL, CHROME PLATING NICKEL PLATING, TANK# 38/39/40/41,37&36

Current Configuration



Recommended Configuration

Natural Evaporation 18 LPH



Summary **Zero Discharge** D R 24 740

- Reduce Drag-out by 15%
- Reduce rinse flow rate to 17 5 LPM
- Counter current flow rinse water to plating tank
- Use D I water for rinse make-up in tank 11
  Use tank 11 as additional rinse tank
- Eliminate tank 36 dumps
- Dump and waste treat tank 37 once a year

53

Current Situation (Tanks #38-41, 37 & 36,-Nickel Plating Step) The nickel plating step takes place in a fully automatic plating line equipped with an overhead hoist system Metal parts to be plated are loaded onto racks or barrels A drag-out tank (#37) and a flowing rinse receiving 200 LPH of city water follow the nickel-plating step

Discharging rinse tank 37 contains levels of nickel, sulfates and chloride ions expected to be above discharge limits

Refer to Figure 4-5 for a schematic diagram of the nickel-plating step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations In order to comply with the current discharge standards, the recommendations described below aim at eliminating the discharge of nickel, sulfates and chloride ions from the flowing rinse tank, while also reducing water use

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Use tank 11 as additional rinse tank** in a 4-stage countercurrent rinse series
3 **Reduce rinse water flow rate** to 17 5 liters per hour in tank 11
4 **Use DI water** for rinse water feed in tank 11
5 **Dump and waste treat (batch) tank 37** once a year
6 **Eliminate dumps** for tank 36

Results Figure 4-5 shows that under the above described operating conditions there would be a substantial water use since rinse water flow rate could be reduced from 200 LPH down to 17 5 LPH

An estimated total saving of about 13 628 LE per year will be realized with a very small capital investment of 1,000 LE The simple payback period of this option will be approximately 1 month Contributing to the cost savings there will be reductions of about

1 800 Kg/year of nickel plating solution in the final effluent that would otherwise have to be treated (a 100% reduction)
2 564 cubic meters per year of water consumption and discharge (a 91% reduction)

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram management for 1997 during the data collection phase of the Assessment If needed the company can adjust these figures to reflect more recent production rates

Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)

54

2 by reducing the parts withdrawal speed it is expected that the overall drag-out value will decrease by 15%
3 A dilution ratio of 24,000 provides a water quality acceptable for this process

See also tables 4 5 1 through 4 5 4 for additional assumptions and calculations in the following pages

Note Figure 4-5 contains results of calculations performed with *Rinsecalc*, specialized software developed by CAI Engineering in May 1995 *Rinsecalc* calculates rinse water usage including evaporation for various rinsing configurations, based on inputs of drag-out rate, chemical concentration, temperature, volume and open surface area of the process tank, and the target drag-out concentration in the last (cleanest) rinse In addition to rinse water requirements *Rinsecalc* calculates chemical losses and expected concentrations

Obstacles to Implementation There is no significant financial obstacle to implementing these recommendations Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Tests and trials will allow the staff to validate the optimized configuration allowing a 15% reduction of drag-out rate Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately Full implementation of the recommendations should take about 1-2 weeks Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

55

Table #	4 5 1
Topic	Annual Water Cost Calculation (current)
Plant	Al Ahram Co
Process	Copper Nickel, Chrome Plating
Line/Step	Nickel Plating Tanks #38-41, 37 and 36

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON pe day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	1 5	M3
Cost of ater	0 9	LE/M3

Calculations

Fo[illegible] Tanks	Flo[illegible]	Unit per	Unit	M3	M3/Year	Adjusted for	Wa[illegible]e Cos
		L M3	Mn H	Converted		Intermittent	LE ear
[illegible]c	200	L	H	0 2	600	600	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	(	
Rinse [illegible]al					600	60 1	540 00

P[illegible] Tanks	Dumps	Unit pe	Unit	m3	m3/Year		Wa[illegible]e os
		C M3	H S D M	Converted			LE
[illegible]	1	C	M	1 50	18 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Proce[illegible]a					18 00		[illegible]

Rinse Process Total 618 00 m3/year of water

[illegible] 5[illegible] per year

56

Table #	4 5 2
Topic	Annual Water Cost Calculation (recommended)
Plant	Al Ahram Co
Process	Copper Nickel Chrome Plating
Line/Step	Nickel Plating Tanks #38-41, 37 and 36

Assumptions

Hours per shift	12 Hours
Shifts per day	1 Shift
Day per Year	250 Days
Intermittent Value	12 Hours ON per day
Month per year	12 Month
Weeks per year	52 Weeks
Tank Capacity	1 5 M3
Cost of water	[illegible] /M3

Calculations

Rinsing Tanks	Flow	Type	Unit	M3	M3/Year	Adjustment for Intermittent	Water Cost LE/year
		L/Min	Min/H	Converted			
36	0	L	Min	0	0	0	
11	17.5	L	H	0.0175	52.5	52.5	
				0	0	0	
				0	0	0	
				0		0	
Rinse Total					52.5	[illegible]	[illegible]

Process Tanks	Flow	Type	Unit	M3	M3/Year	Adjustment for Intermittent	Water Cost LE/year
				Converted			
[illegible]				0.01	[illegible]		
	0.0			0.1			
				0			
				[illegible]			
				0			
				[illegible]	[illegible]		
[illegible]					[illegible]		

Rinse + Process Total [illegible]

51

Table #	4.5.3
Topic:	Drag-Out Estimation (current)
Plant:	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step	Nickel Plating Tanks #38-41, 37 and 36

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
2 2	1000		8 21	92 90	0 09

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 7		6 09		2148 00	2 15	0 19	1 61

Chemistry Losses

Bath TDS	371 1	grams per liter
Cost/Kg	13 58	LE/Kg
Chemical Loss	797 12	Kg/year
Annual Cost	10821 86	LE/year

Cost of Process Dumps

Tank 36 is dumped 12 times per year
and costs 42 28 LE/year

WWT OPERATING COSTS					
	173	TDS in ppr	800	Kg >in lbs	LE/year
Metal	0	38%	304	669	2263
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					2263

58

Table #	4.5 4
Topic:	Drag-Out Estimation (recommended)
Plant	Al Ahram Co
Process:	Copper, Nickel, Chrome Plating
Line/Step	Nickel Plating Tanks #38-41, 37 and 36

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	Sq Ft		Gal->Liter	Sq Ft ->M2	Liters/M2
1 8	1000		6 98	92 90	0 08

15% Drag-Out Reduction

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		Liters per day		Liters/year	M3/year	Gal / hrs	Gal / day
0 6		5 17		1825 80	1 83	0 16	1 37

Chemistry Losses

Bath TDS	0	grams per liter
Cost/Kg	13 58	LE/Kg
Chemical Loss	0 00	Kg/year
Annual Cost	0 00	LE/year

Cost of Process Dumps

Tank 36 is dumped 6 times per year
and costs 5 50 LE/year

WWT OPERATING COSTS					
	15	TDS in ppr	0	Kg >in lbs	LE/year
Metal	0	38%	0	0	1
Cr	0	0%	0	0	0
CN	0	0%	0	0	0
Total					1

59

Option # 4 6	Optimizing Chromium Plating Operation

Summary of Annual Savings

	Annual Water Use in m3	Annual Water Cost in LE	Annual Losses of Chemistries in Kg	Annual Cost of Chemistry Losses in LE	Annual Cost of Wastewater Treatment
Current Configuration	1700	1530 36	793 81	18855 04	13678 99
Recommended Configuration	52	46 44	21 69	515 19	393 43
Reduction %	97%			97%	97%
Annual Savings	1649	1484	772	18340	13286

Total Savings 33109 LE/year

Summary of Capital Investments

	Capital Investment in LE	Operating Cost in LE per year
Heater 3 KW	3500	1640 69
Counterflow	1200 00	0 00
Agitation Tank 9	1000 00	0 00
Total	5700 00	1640 69

Investment 5700 LE

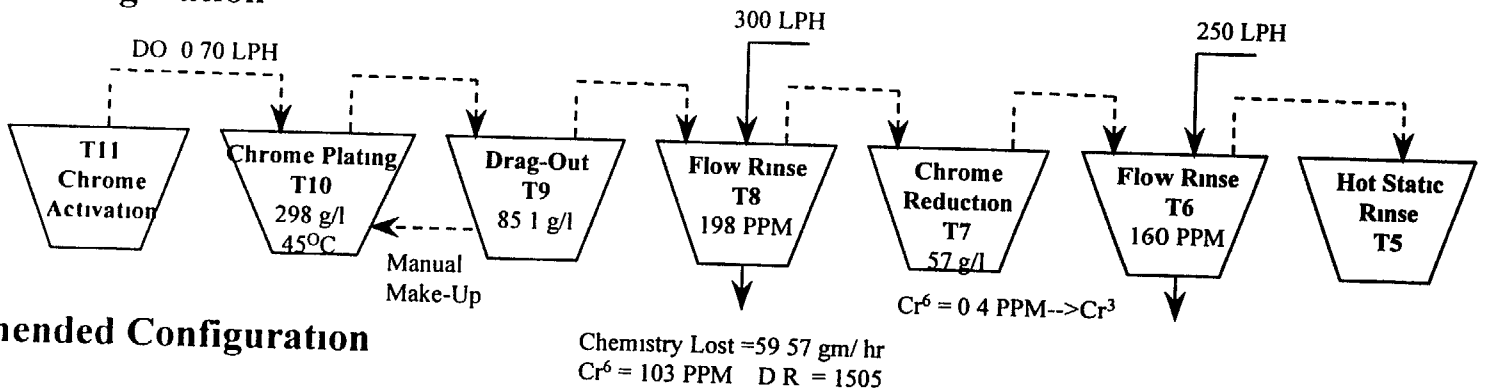
Net Savings 31469 LE/year

Payback Period	0 2	years or	2 2	months

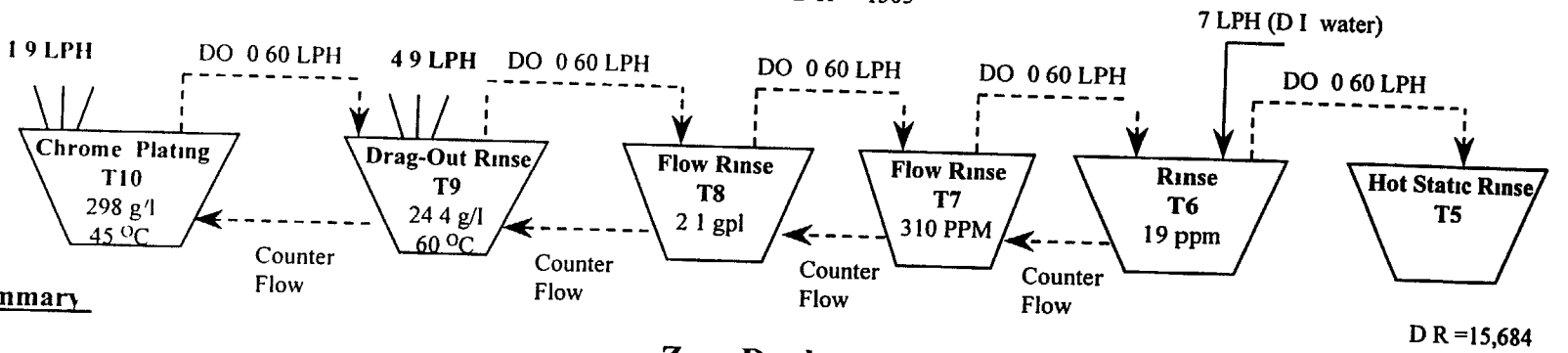
60

Figure 4-6: NICKEL CHROME PLATING LINE CHROMIUM PLATING, TANK#11-5

Current Configuration



Recommended Configuration



Zero Discharge

Summary

- Reduce Drag-out by 15%
- Add Agitation and Heater on T9
- Add Dosing Pump(s) to counter flow rinsewater
- Eliminate Chrome Activation and Chrome Reduction Processes
- Counter Flow rinses to Tank #10 for Zero Discharge
- Reduce Rinse Flow Rate to 37 LPH instead of 550 LPH, use D I water

Current Situation (Tanks #5 through 11, Chromium Plating Step) The chromium plating step takes place in a fully automatic plating line equipped with an overhead hoist system Metal parts to be plated are loaded onto racks or barrels The chromium plating step is preceded by a chromium activation step tank 11 and a followed by drag-out tank 9 and flowing rinse tank 8 receiving 300 LPH of city water Tank 7 contains a chromium reduction solution and is followed by rinse tank 6 receiving 250 LPH of city water, and finally the parts are dipped into hot static rinse tank 5 before exiting the plating line

Discharging rinse tank 8 contains levels of hexavalent chromium expected to be above discharge limits

Dumps of tank 11 contain high levels of hexavalent chromium also expected to be above discharge limits

Even though containing a less toxic form of chromium (trivalent chromium), tanks 7 and 6 are also expected to contribute to the heavy metal load in the final effluent

Refer to Figure 4-6 for a schematic diagram of the chromium-plating step The diagram depicts the current and recommended configurations for this step, and provides information on chemical concentrations and water flow rates

Recommendations In order to comply with the current discharge standards, the recommendations described below aim at eliminating the discharge of both hexavalent and trivalent chromium ions from the flowing rinse tanks, while also reducing water use

1 **Reduce parts withdrawal speed** to reduce drag-out
2 **Eliminate the chromium activation step** and use tank 11 as a rinse tank after nickel
3 **Eliminate the chromium reduction step** and use tank 7 as a rinse tank after chromium
4 **Use tanks 6 through 9 as a 4-stage countercurrent rinse series** to achieve zero discharge
5 **Reduce rinse water flow rate in tank 6** to 7 LPH
6 **Eliminate water flow rate** in tank 8
7 **Use DI water** for rinse water feed in tank 6
8 **Dump and waste treat (batch) tanks 7, 8 & 9** every 2 months
9 **Use dosing pumps** for tank counter current flowing arrangement
10 **Add agitation and a 3 kW heater in tank 9** to evaporate excess water

Results Figure 4-6 shows that under the above described operating conditions there would be a substantial water use reduction since rinse water flow rate could be reduced from 550 LPH down to 7 LPH

An estimated total saving of about 33 109 LE per year will be realized with a very small capital investment of 5 700 LE The simple payback period of this option will be approximately 2 2 months Contributing to the cost savings there will be reductions of about

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1 772 Kg/year of chromium plating solution in the final effluent that would otherwise have to be treated (a 97% reduction)
2 1,649 cubic meters per year of water consumption and discharge (a 97% reduction)

All savings in operating costs and raw material consumption are based upon production rates provided by Al Ahram management for 1997, during the data collection phase of the Assessment If needed, the company can adjust these figures to reflect more recent production rates

Input, assumptions and calculations Assumptions used to perform calculations contained in the engineering spreadsheets tables, are as follows

1 drag-out tests performed on site led to an estimated value of 0 7 liters per hour (LPH)
2 by reducing the parts withdrawal speed it is expected that the overall drag-out value will decrease by 15%
3 A dilution ratio of 15,000 provides a rinse water quality acceptable for this process

See also tables 4 6 1 through 4 6 4 for additional assumptions and calculations in the following pages

Note Figure 4-6 contains results of calculations performed with *Rinsecalc*, specialized software developed by CAI Engineering in May 1995 *Rinsecalc* calculates rinse water usage including evaporation for various rinsing configurations, based on inputs of drag-out rate, chemical concentration, temperature, volume and open surface area of the process tank, and the target drag-out concentration in the last (cleanest) rinse In addition to rinse water requirements, *Rinsecalc* calculates chemical losses and expected concentrations

Obstacles to Implementation There is no significant financial obstacle to implementing these recommendations Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Tests and trials will allow the staff to validate the optimized configuration allowing a 15% reduction of drag-out rate Upon implementation of the recommendations staff training and monitoring will be needed so that new procedures (reduced dump schedules) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately Full implementation of the recommendations should take about 1-2 months Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

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Table #	4 6 1
Topic:	Annual Water Cost Calculation (current)
Plant	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step.	Chromium Plating Tanks #11 - 5

Assumptions

Hours per shift	12	Hours
Shifts per day	1	Shift
Day per Year	250	Days
Intermittent Value	12	Hours ON per day
Month per year	12	Month
Weeks per year	50	Weeks
Tank Capacity	1 5	M3
Cost of water	0 9	LE/M3

Calculations

[illegible] ng Tanks	Flow	U[illegible] per	Unit	M3	M3/Yea	Adjusted for	[illegible] Cos
		L M3	M H	Converted		Intermittent	LE ear
6	250	L	H	0 25	750	750	
8	300	L	H	0 3	900	900	
				0	0	0	
				0	0	0	
				0	0	0	
[illegible] Total					1650	1650	1485 00

[illegible] Tanks	Dumps	[illegible]	Unit	m3	m3 Yea		[illegible]
		C M3	[illegible] M H	Converted			LE
	0 5	C	M	0 75	[illegible]		
	0	C	M	0 00	0 00		
8	[illegible]	[illegible]	M	0 75	9		
[illegible]	0	C	M	0 75	9		
	0		M	1 05	12		
[illegible]	0 [illegible]	[illegible]	M	0 90	[illegible]		
[illegible]					[illegible]		[illegible]

Pr[illegible] Process Total 1700 4 [illegible] car of water

[illegible] year

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Table #	4.6 2
Topic	Annual Water Cost Calculation (recommended)
Plant	Al Ahram Co
Process	Copper, Nickel, Chrome Plating
Line/Step	Chromium Plating, Tanks #11 - 5

Assumptions

Hours per shift	12 Hours
Shifts per day	1 Shift
Day per Year	250 Days
Intermittent Value	12 Hours ON per day
Month per year	12 Month
Weeks per year	50 Weeks
Tank Capacity	1 5 M3
Cost of water	0 9 LE/M3

Calculations

Flowing Tanks	Flow	Unit per L M3	Unit Mn H	M3 Converted	M3/Year	Adjusted for Intermittent	Water Cost LE/year
6	7	L	H	0 007	21	21	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					21	21	18 90

Process Tanks	Dumps	Unit per C M3	Unit H S D M W	m3 Converted	m3/Year		Water Cos LE/year
				0 03	0 00		
9	0	C	M	0 00	0 00		
8	0 5	C	M	0 75	9 00		
7	0 5	C	M	0 75	9 00		
6	0 7	C	M	1 05	12 60		
				0 01	0 00		
Process Total					30 60		27 54

Rinse + Process Total	51 60 m3/year of water
Total Annual Cost	46 44 LE per year

Table #	4.6.3
Topic·	Drag-Out Estimation (current)
Plant	Al Ahram Co
Process.	Copper, Nickel, Chrome Plating
Line/Step	Chromium Plating, Tanks #11 - 5

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	Sq Ft		Gal->Liter	Sq Ft ->M2	Liters/M2
2 2	1000		8 21	92 90	0 09

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		Liters per day		Liters/year	M3/year	Gal / hrs	Gal / day
0 7		6 09		2148 07	2 15	0 19	1 61

Chemistry Losses

Bath TDS	298 20	grams per liter
Cost/Kg	23 75	LE/Kg
Chemical Loss	640 55	Kg/year
Annual Cost	15214 75	LE/year

Cost of Process Dumps

Tank 10	is dumped		0 times per year
and costs	0	LE/year	
Tank 11	is dumped		6 times per year
and costs	1068 86	LE/year	
Tank 7	is dumped		6 times per year
and costs	2571 43	LE/year	

WWT OPERATING COSTS					
	179	TDS in ppm	794	Kg >in lbs	LE/year
Metal	0	52%	391	859	2904
Cr	0	52%	391	859	10775
CN	0	0%	0	0	0
Total					13679

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Table #	4.6.4
Topic·	Drag-Out Estimation (recommended)
Plant	Al Ahram Co
Process.	Copper, Nickel, Chrome Plating
Line/Step	Chromium Plating, Tanks #11 - 5

Assumptions

Parts vary from Cup-Shaped to Vertical Flat and Cylindrical Shape and include barrel Plating
95% of production is processed in racks and 5% in barrels

Units Conversions

Gallons /	Sq Ft		Gal->Liter	Sq Ft ->M2	Liters/M2
1 8	1000		6 98	92 90	0 08

15% Drag-Out Reduction

Production Datas

Annual Production	Working Hours/year
24317 m2	3000

Drag-out Values in

Liters/hour		Liters per day		Liters/year	M3/year	Gal / hrs	Gal / day
0 6		5 17		1825 80	1 83	0 16	1 37

Chemistry Losses

Bath TDS	298 2	grams per liter
Cost/Kg	23 75	LE/Kg
Chemical Loss	0 00	Kg/year
Annual Cost	0 00	LE/year

Cost of Process Dumps

Tank 10	is dumped	0 times per year	544 45	and costs 0 LE/year
Tank 8	is dumped	6 times per year		and costs 448 92 LE/year
Tank 7	is dumped	6 times per year		and costs 66 27 LE/year

WWT OPERATING COSTS		19 TDS in ppm		22 Kg >in lbs	LE/year
Metal	0	52%	11	25	84
Cr	0	52%	11	25	310
CN	0	0%	0	0	0
Total					393

EVAPORATION		LE/KWh	0 18 LE	
LPH	KW	Hrs/Day >	Days/year >	Cost/year
5	3 038	12	250	1641
GPH 1 321				

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4.7 Water and Wastewater Batch Treatment Systems

Summary of Savings

	Capital Investment in LE
Conventional configuration	192,500
Recommended Configuration[1]	61,500
Cost Avoidance	131,000

Savings 131,000 LE on the capital investment

Note The annual operating cost of the waste treatment system is already factored in the per tank calculations (see also in the Appendices Section, Tables A7 & A8)

Payback Period· not relevant to this option

[1] This cost includes the purchase of a 34 000 LE deionizer to be used with the closed loop arrangements recommended

Conventional Waste Treatment Systems Conventional waste treatment systems involve the use of chemicals to produce insoluble by-product precipitants Precipitated pollutants are further removed by physical separation using clarification or filtration technologies The presence of wastewater containing hexavalent chromium and cyanide ions would require Al Ahram to include an hexavalent chromium reduction unit as well as a 1 or 2 stage cyanide oxidation system Additionally, these steps would be followed by a chemical precipitation occurring in a neutralization tank Finally, clarification and filtration would complete the process, prior to discharge of the treated wastewater Various chemicals would need to be purchased and stored for each steps of the process, including

Sodium Metabisulfite for hexavalent chromium reduction
Sodium Hypochlorite for cyanide oxidation
Calcium Hydroxide for metals precipitation
Sodium Hydroxide for chemical pH adjustment
Coagulation/Flocculation Agents

Annual consumption of chemicals is a major contributor to the total operating cost of a waste treatment system

The size and capital investment required for a conventional waste treatment system depend on the maximum instantaneous flow rate to be handled

Other considerations related to conventional waste treatment systems include space requirements, the need for segregated plumbing, sludge handling and disposal costs

Recommendations Implementation of the pollution prevention recommendations made in the previous paragraphs, will eliminate the need for waste treatment of flowing rinse water from the electroplating department However, regular dumps from the tanks listed below will require batch treatment using conventional chemical precipitation techniques

Electroplating Department

Tank #06	Dumps of the last rinse tank after chrome
Tank #07	Dumps of the third rinse tank after chrome
Tank #08	Dumps of the second rinse tank after chrome
Tank #22	Dumps of the last rinse tank after copper
Tank #23	Dumps of the first rinse tank after copper
Tank #36	Dumps of the second rinse tank after nickel
Tank #37	Dumps of the first rinse tank after nickel

Results

Conventional Waste Treatment System

The technology is expected to achieve the discharge limits currently imposed on Al Ahram for Metals facility

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However, the presence of complexing agents, often found in bath brighteners and alkaline cleaners, seriously impedes precipitation of the pollutants Specific procedures might be required, depending upon the type and strength of the complexer Common complexers include, ethylene diamine tetra acetic acid (EDTA), nitrilotriacetic acid (NTA), quadrol, glucconates, glutamates, ammonia and various amines

Batch Waste Treatment System
The technology is also expected to achieve the discharge limits currently imposed on Al Ahram The presence of complexing agents might also require, specific procedures or the use of non-conventional chemicals Since the system is to handle a relatively low volume of wastewater, the option to proceed with a partial off-site disposal of UN-treated solution can be used when treatment difficulties are encountered

Input, assumptions and calculations

Conventional Waste Treatment System
A combined waste stream of 35 liters per minute LPM has been used with a maximum flow rate of 70 LPM, of which 0 5 LPM contain hexavalent chromium and 8 5 LPM contain cyanide complexes These parameters provided a capital investment estimate of approximately 192,500 LE, including installation cost[2] The associated operating expense including chemicals needs, labor costs and sludge disposal costs are presented on a per tank basis under each recommendation
See also Table A7 for additional details on calculations and hypotheses

Batch Waste Treatment System
A combined batch volume of 177 m3/year can be treated in static tanks, utilizing proper portable pH and ORP instrumentation The total capital investment required for the tanks, mixers and instrumentation was estimated at 27,500 LE
Since most dumps occur only once a month, ample time is available for proper processing of the batches
Operating costs were estimated on a per tank basis under each recommendation

Zero discharge rinse configurations generally require the use of deionized (DI) water as make-up in the final rinse tank Presently the electroplating department at Al Ahram uses distilled water from a boiler The highest quality water should be used in closed-loop arrangements Therefore as part of the water treatment recommendation it is suggested that a deionizing unit be used The unit should be capable of supplying the amount of deionized water required for an un-interrupted 12-hour operation 5 days per week For the purpose of our calculation a nominal flow rate of 3 0 liters per minute was chosen and an associated capital investment of 34 000 LE included in the cost of water treatment

The total capital investment of the water treatment recommendation is 61 500 LE

[2] This estimate is based on equipment prices in the United States of America

See also Table A8 for additional details on calculations and hypotheses

Obstacles to Implementation There is no significant financial obstacle to implementing the batch waste treatment system recommendations Some unused tanks, mixers or instrumentation already available in the facilities, might be useful in helping to reduce the acquisition cost Technical questions can be answered by experiments and by technical assistance from ECEP/EP3 Trials and collaboration with chemistry vendors will allow staff to select satisfactory reagents for the solutions to be treated Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures are properly adopted and consistently executed

Schedule of Implementation Installation and set-up of the batch waste treatment system should only require a few weeks Depending on parts and information availability, full implementation of the system should take about 3-6 months Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

4.8 Future Pollution Prevention Opportunities

An effective Pollution Prevention program is a continuing series of 1) assessment of various options, and 2) implementation of options found to be cost-effective and environmentally beneficial Successful implementation of the options proposed above may encourage management to also consider the following recommended options

Solvent Degreasing Investigate 2 or 3-stage alkaline cleaning combined with ultrasonic cleaning

The current solvent cleaning operation produces VOC emissions that could be eliminated by switching to an alkaline cleaning line Such operation would totally eliminate the use of solvent-based chemistry, and capital investment would be lower than an enclosed vapor degreasing system When well designed, cleaning performance of an alkaline cleaning line can equal the solvent-based operation Necessary tank space and possible automation for handling of the parts should be investigated carefully

Alkaline Cleaners Investigate Ultrafiltration

While no heavy metals are typically expected in thesis processes, they contribute to high TDS in a plant□s final effluent Depending upon local discharge guidelines, alkaline cleaners can also cause problems meeting requirements for organic content The technology of choice is ultrafiltration, whereby the life of the bath can be extended virtually forever, reducing the cost of cleaner purchases and labor required for regular dumps Additionally, a steady state condition of the cleaner improves the quality of the process A mobile unit could be used at ABB Arab to service multiple tanks

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General Pollution Prevention Opportunities for Reducing Toxic and Hazardous Wastes

Al Ahram generates several toxic and hazardous substances in its process wastes These substances are primarily contained in the plant wastewater, however some are contained in air emissions as well as in solid wastes

Wastes can be classified according to their level of toxicity and their hazardous nature The discussion of Al Ahram's wastes will refer to the following classification

Class 1 - Relatively harmless inorganic pollutants, such as alkalis, mineral acids, and most oxidizes agents

Class 2 - Readily biodegradable, with moderate to high BOD, such as starch, biodegradable surfactant, most organic acids, and biodegradable vegetable oils

Class 3 - Nonmetallic and nontoxic dyes and polymers difficult to biodegrade

Class 4 - Difficult to biodegrade, high toxicity but treatable in conventional biological waste treatment facilities to meet typical effluent standards, such as non-biodegradable anionic and nonionic detergents

Class 5 - Unsuitable for conventional waste treatment facilities These are chemicals such as formaldehyde, chlorinated solvents and carriers, cationic retards, cationic softeners, biocides, sequestering agents, heavy metals, and heavy metal salts They must have special treatment such as ion exchange, reverse osmosis, etc that is very expensive