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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

EXPRESSS FACTORIES GROUP FOR HOUSE HOLD ALEXANDRIA, ARAB REPUBLIC OF EGYPT

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

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CHAPTER 1
EXECUTIVE SUMMARY

A Rapid Pollution Prevention Diagnostic Assessment was conducted in September 1997 at Express Company The factory audited is located at Om Zeghew Road, El Agami, Alexandria, Egypt where powder coating and enamel coating is performed on various washing machines parts and some outside customer parts The coated parts vary greatly in size and configuration

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 Express on the environment is to decrease the drag-out in the conveyorized pre-treatment lines There will be estimated savings of 18,961 LE per year for these options (4 5 and 4 6) The capital cost is estimated to be no more than 5,050 LE Hence, a simple payback period of 3 2 months These two options alone will reduce by 784 Kg the annual chemical discharge of potentially metal bearing solution

If Options 4 2 through 4 6, highlighted in Table 1-1 are all implemented The estimated savings in raw materials will be 2,972 Kg per year for auxiliary chemicals consumption including salt, 867 Kg of degreasing solution, 1,222 Kg of pickling solution, 98 Kg of cleaning solution, and 785 Kg of phosphating chemicals If the Pollution Prevention Management System (Option 4 0) is implemented and the future pollution prevention options (Option 4 7) 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 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 114,250 LE per year for a cost of approximately 9,900 LE, yielding a simple payback period of less than 1 month

Table 1-1

Summary of Pollution Prevention Options

Chapter	Pollution Prevention Option	Environmental Benefits	Cost to Implement	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 Electrostatic Powder Coating Operation	Reduction in Powder Consumption of Approximately 20% or 92,000 LE	0	92000	Immediate
4 2	Degreasing Tank D1 Countercurrent Rinse Configuration for Zero Discharge	Reduction of Water Use by 63%, Reduction of Chemistry Losses by 68%	2350	1888	14 9
4 3	Pickling Tank D3 Countercurrent Rinse Configuration	Reduction of Chemistry Losses by 90%	2000	1142	21 0
4 4	Cleaner Tank D7 Spray Rinse Configuration	Reduction of Water Use by 82% Reduction of Chemistry Losses by 65%	500	260	23 1
4 5	Decrease Drag-Out in Conveyorized Pre Treatment Line 1	Reduction of Water Use by 87%, Reduction of Chemistry Losses by 45%	3800	12723	3 6
4 6	Decrease Drag-Out in Conveyorized Pre-Treatment Line 3	Reduction of Water Use by 91% Reduction of Chemistry Losses by 39%	1250	6238	2 4
4 7	Future Pollution Prevention Options	Investigate Ultrafiltration of Alkaline Cleaners	To be Determined	To be determined	--
	Total		9900	114251	Immediate

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

CHAPTER 3
BACKGROUND INFORMATION

3.1 Company Background

Express is located at Om Zeghew Road, El Agami, in the Greater Alexandria area Express's 240 employees work 1 shift, 280 days per year

Express's products are washing machines that are formed, assembled, powder coated, and/or enameled Express also powder coats aluminum and steel parts supplied by customers Table A1 in the Appendices Section summarizes the production of this factory for the year 1996 Table A2 is a summary of the raw materials used to make these products, and the quantities and prices of these raw materials

The following discussion of the Express facilities and products is divided into the five parts of the plant that we studied, washing machine powder coating line, customer powder coating line, enameling line, aluminum parts surface treatment, and utilities For an overall plant layout, please refer to Figure 3-1 in this section

3.2 Washing Machine Powder Coating Line

Washing machine body parts made of steel are powder coated on a dedicated line Parts are hung on an overhead conveyor that moves slowly through several process steps Parts are first pre-treated in a vertical spray unit, then dried in an oven, coated with epoxy powder coating, and heated in a curing oven Figure 3-2 provides a layout diagram of the entire line The following is a more detailed description of these four process steps

3 2 1 Pre-Treatment

The pre-treatment step occurs in a vertical spray unit divided into three sections, degreasing, rinsing, and passivation

3 2 1 1 Degreasing

The first section is used to degrease the steel Iron phosphate and detergent are used in this step, and the applied solution is heated to 65C by a Solar-fired heater The hot solution is contained in a tank

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under the spray unit, and the solution is sprayed on the parts as they pass through that section of the vertical spray unit The solution that drains off the parts falls into the tank under the spray unit and is recirculated by a pump

3 2 1 2 Rinsing

The second section is used to rinse the parts as they pass through that section The rinsing section also uses sprays and a recirculation tank Currently, municipal water is added to the tank, and the tank overflows

3 2 1 3 Passivation

Passivation of the metal surface is mostly done using hot water, however, sometimes a chromic acid solution is used This section is configured the same way as the preceding two sections The unit uses sprays and a recirculation tank

3.2.2 Drying

The conveyor carries the pre-treated parts into the same oven that is used for curing The estimated residence time of a part in the oven is approximately 20-30 minutes

3 2 3 Electrostatic Powder Coating

Epoxy powder coating is applied manually using high pressure, compressed air guns If the parts to be coated are cylindrical, two workers apply the coating, the first sprays the inside of the part at one spray booth, and the second worker sprays the outside of the part in a second spray booth that is connected to the first The parts are carried through the spray booths by the same conveyor that carries the parts through the other process steps

3 2 4 Curing

The conveyor moves the powder-coated parts into the vertical curing oven The estimated residence time of a part in the oven is 20-30 minutes The oven is fired by Solar

3.3 Customer Powder Coating Line

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The customer powder coating line operates in a similar fashion to the washing machine line That is, there is a vertical, spray unit for pre-treating the parts, a drying oven, a powder coating section, and a curing oven Both steel parts and this line handles aluminum parts, and the same chemistry is used Figure 3-3 provides a layout diagram of this line

3.3.1 Pre-Treatment

The pre-treatment step occurs in a vertical spray unit divided into three sections, de-greasing, rinsing, and passivation

3 3 1 1 Degreasing

The first section is used to degrease the parts Iron phosphate is used in this step, and a Solar-fired heater heats the applied solution The hot solution is contained in a tank under the spray unit, and the solution is sprayed on the parts as they pass through that section of the vertical spray unit The solution that drains off the parts falls into the tank under the spray unit and is recirculated by a pump

3 3 1 2 Rinsing

The second section is used to rinse the parts as they pass through that section The rinsing section also uses sprays and a recirculation tank Currently, municipal water is added to the tank, and the tank overflows

3 3 1 3 Passivation

Passivation of the metal surface is mostly done using hot water, however, sometimes a chromic acid solution is used This section is configured the same way as the preceding two sections The unit uses sprays and a recirculation tank

3 3 2 Drying

The conveyor carries the pre-treated parts into a drying oven that is fired by Solar The estimated residence time of a part in the oven is approximately 20-30 minutes

3.3 3 Electrostatic Powder Coating

Epoxy powder coating is applied manually using high pressure, compressed air guns There are a series of spray booths connected to each other, and one or more spray booths can be used by one or more workers, depending on the size and shape of the parts to be coated Parts are moved through these

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spray booths by a slow-moving conveyor There is a separate, stand-alone spray booth that is used for small batches or odd colors The in-line spray booths all have cyclones and bag-houses connected to the exhaust to capture overspray, and the stand-alone booth has a cyclone collector

3.3.4 Curing

The conveyor moves the powder-coated parts into the vertical curing oven The estimated residence time of a part in the oven is 20-30 minutes The oven is fired by Solar

3.4 Enameling Line

Enameling of steel parts is performed in a separate area from the powder coating lines The process consists of surface pre-treatment, spray coating, and curing

3.4.1 Surface Pre-Treatment

Surface pre-treatment of steel parts is conducted in a series of dip tanks Rectangular, steel frame baskets are used to hold the cylindrical parts, and a chain hoist is used to move the basket from tank to tank Figure 3-4 provides a layout diagram of this preparation step The five steps are as follows

3 4 1 1 Alkaline Degreasing

A heated (90°C) solution comprised of caustic soda, detergent, sodium silicate, and sodium carbonate is used to degrease the parts in a single-section, rectangular tank The heat is supplied by a Solar fired heater

3 4 1 2 Hot Rinse

A separate, double-section, rectangular tank is used to provide a hot rinse The two sections are connected so that the water flows freely between the sections The parts are dipped once in this tank The water is heated to 50°C

3 4 1 3 Pickling

Pickling is performed in a separate single-section rectangular tank using hydrochloric acid

3 4 1 4 Rinses

Parts are rinsed in cold (ambient temperature) water in a separate, double section, rectangular tank The parts are dipped twice, first in the first section, then in the second section

3 4.1 5 Passivation

Passivation is performed in a separate, single section, rectangular tank using sodium carbonate Sometimes borax is added to the tank contents The temperature is ambient

3.4 2 Drying

Parts are air-dried

3.4.3 Enameling

The enamel coating is applied in two steps, spray application and curing

3 4 3 1 Spray Application

Enamel coating is applied by high pressure air guns (non-electrostatic) in two spray booths The booths have exhaust fans, and the air is blown into the room without any control It appears that this exhaust system was once configured for a control system, but only the open ducts remain

Both black enamel and white enamel are used in an approximate ratio of 2 1 The outside of cylindrical parts are sprayed first with black enamel, then with white The inside of the parts are sprayed first with black enamel, then spattered with white enamel

3 4 3 2 Curing

A remote controlled oven is used to cure the enameled parts The sprayed parts are placed on a special pallet and are moved into the oven by a remote-controlled, electric powered unit The oven door also is opened and closed remotely

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3.5 Aluminum Parts Surface Treatment

Some aluminum parts are surface treated in a series of three dip tanks Figure 3-5 provides a layout diagram that illustrates this process The steps are cleaning, rinsing, and nitration The parts are moved in and out of the three tanks by hand

3.5 1 Cleaning

Cleaning is performed in a rectangular, stand-alone tank, using an sodium hydroxide based alkaline solution, heated at 70°C

3.5.2 Rinsing

Rinsing is performed in a rectangular, stand-alone static rinse tank City water at ambient temperature is used for make-up, and periodically replaced

3.5.3 Nitration

Nitration is performed in a rectangular, stand-alone tank using a mild solution of nitric acid No rinsing follows this step Parts are simply air-dried

3.6 Utility Information

Utilities at Express are comprised of water supply, heated water, electricity, fuel, and compressed air

3 6 1 Water Supply

The water is fed to the plant through the city network The total consumption was given as 120 m^3/day The annual consumption, based on an 8 hr/day, and 240 day/yr plant operations is 33,600 m^3 Water is distributed inside the plant without regulators or meters to indicate the consumption The price of the water is 0 90 LE/m^3 including wastewater fees (see Appendix 4, for more details on water supply and uses)

3 6 2 Heated Water

There is no boiler at Express Heated water is generated locally where needed by Solar-fired heaters

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3.6.3 Wastewater

Figure 3-6 is a schematic of the sewer system at the Express facility The Express plant does not have a wastewater treatment station for their industrial effluent Wastewater is collected in two main sewer lines in the plant The first line, designated by the plant as the "heavy" wastewater line, collects wastewater from the enameling preparation area, the washing machine powder coating line, and the vehicle parking area (where vehicle washing and maintenance occur) Also discharging into this sewer line are WC septic tank overflow, rainwater runoff, and the administration building WCs The second sewer line, designated the "light" wastewater line by the plant, collects wastewater from the customer powder coating line Also discharging into this line are the overflow from a WC septic system and rainwater runoff

Tank No T1 collects the "heavy" wastewater, and tank No T3 collects the "light" wastewater Tanks No T2 and T2 are percolation tanks (they have only stones at the bottom) Tank No T2 collects wastewater from both T1 and T3 A pump is connected to Tank T2 and periodically discharges wastewater from that tank into an injection well that is 64 meters deep The plant indicated that the pump operates when the level becomes too high in the wastewater tanks and the sewer lines

Groundwater in the area of the plant is very high and is within approximately 1 meter of the ground inside the wastewater tanks Therefore, there is direct connection between the plant's wastewater and the groundwater

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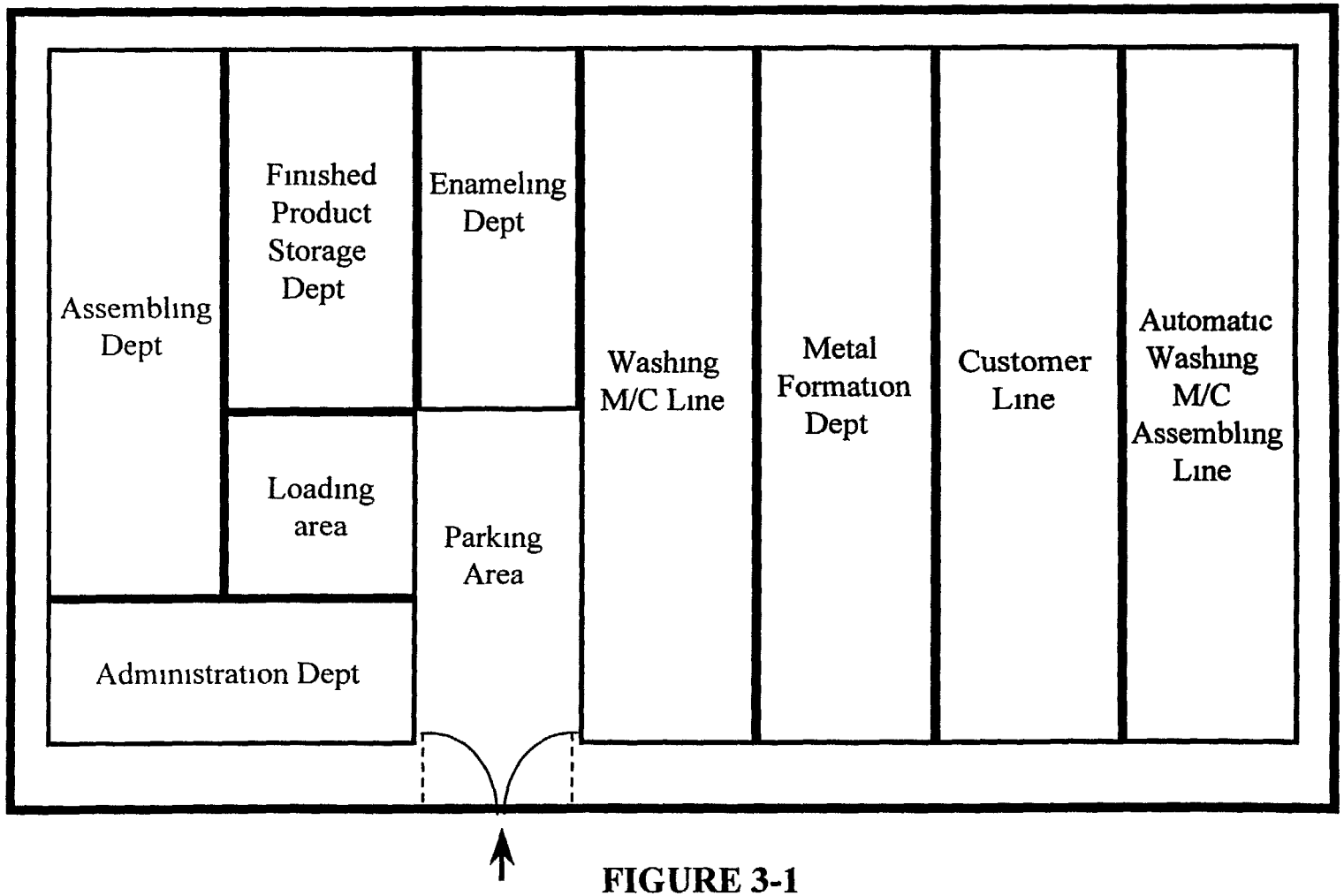

FIGURE 3-1
Express Company Layout

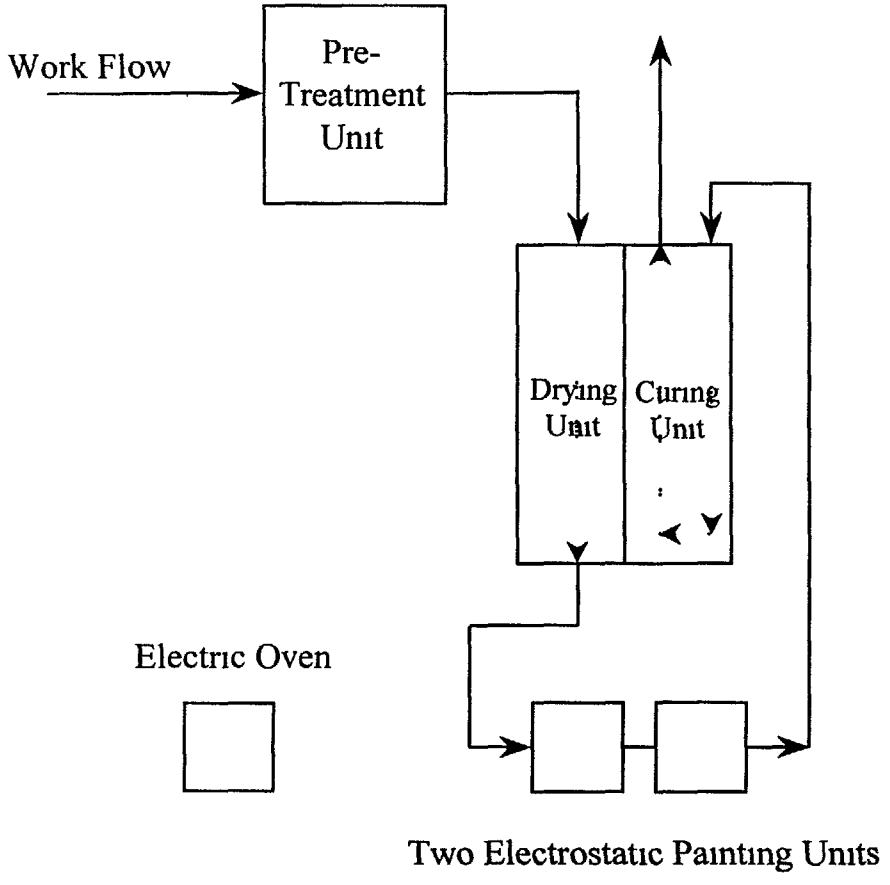

FIGURE 3-2
Layout Of The Powder Coating Line
For Washing Machines Parts

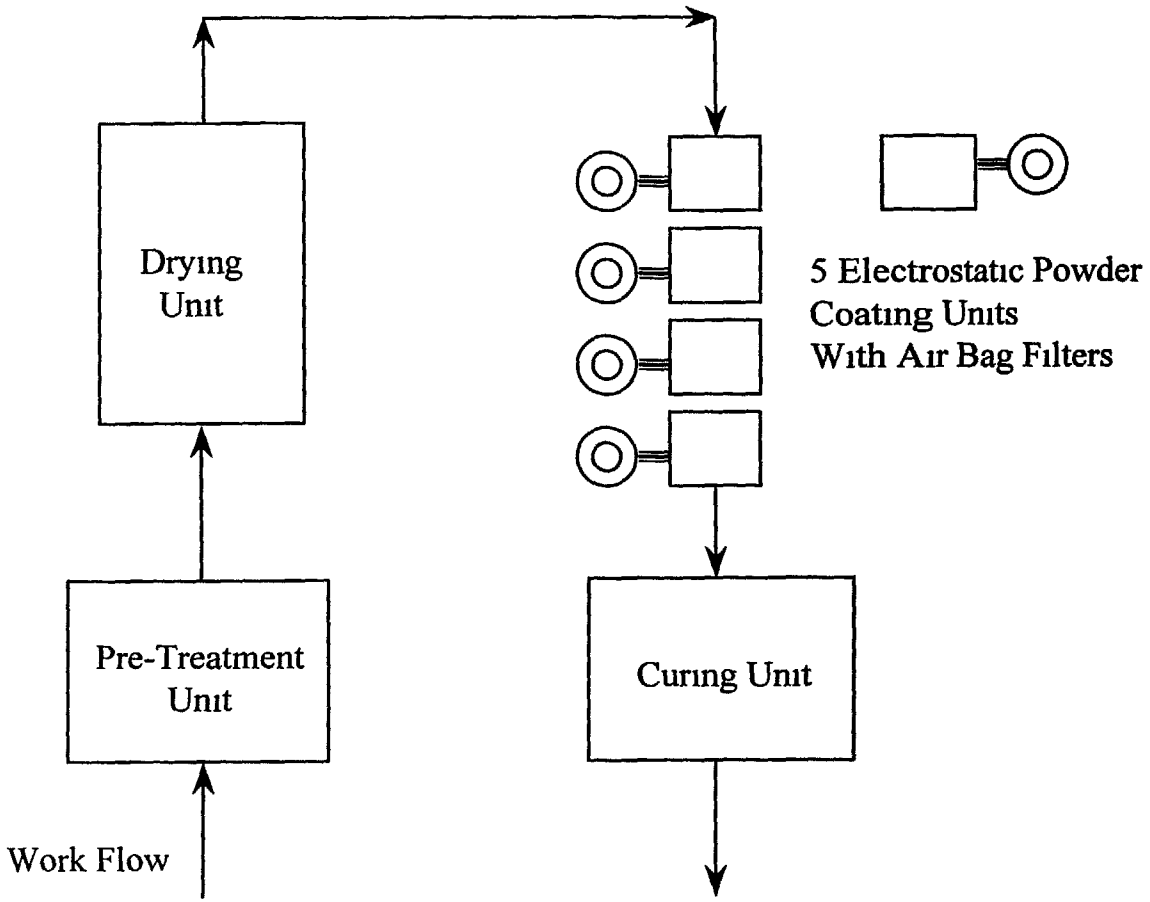

FIGURE 3-3
Layout Of Powder Coating Line For Customer Parts

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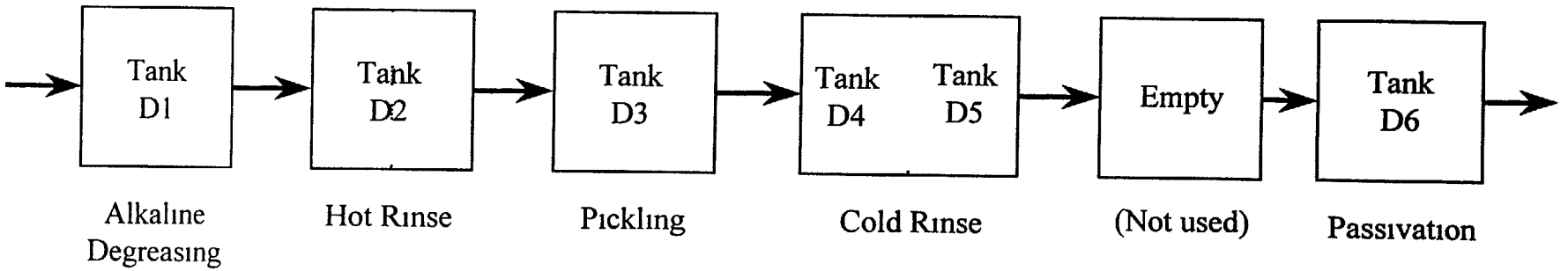

FIGURE 3-4
Layout Of Enameling Preparation Line For Steel Parts

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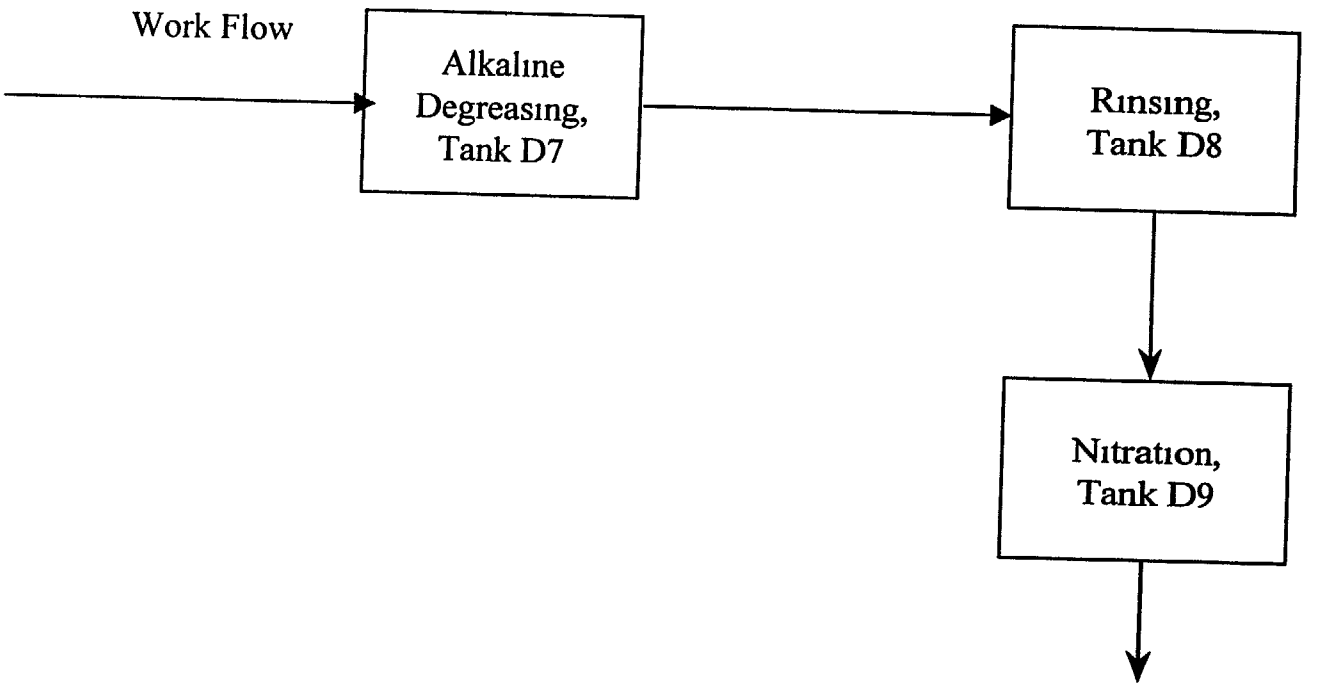

FIGURE 3-5
Layout Of Surface Pre-Treatment For Aluminum Parts

CHAPTER 4
ANALYSIS AND RECOMMENDATIONS

Introduction

This Rapid Pollution Prevention Diagnostic Assessment (RPPDA) was focused primarily on identifying processes and practices in the Express 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, option 4 1 presents a pollution prevention opportunity that can yield a high economic return, options 4 2 through 4 6 present opportunities for reduction of toxic and hazardous wastes, and option 4 7 deals with other 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 Optimize Electrostatic Powder Coating Operations
Pages 4-4 through 4-8

4.2 Degreasing Tank D1: Countercurrent Rinse Configuration
Pages 4-9 through 4-16

4 3 Pickling Tank D3: Countercurrent Rinse Configuration
Pages 4-17 through 4-24

4 4 Cleaner Tank D7. Spray Rinse Configuration
Pages 4-25 through 4-32

4 5 Conveyorized Pre-Treatment Line 1 Decrease Drag-Out Rate
Pages 4-33 through 4-40

4 6 Conveyorized Pre-Treatment Line 2 Decrease Drag-Out Rate
Pages 4-41 through 4-48

4 6 Future Pollution Prevention Options
Page 4-49

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4.0 Environmental Management System

An Environmental Management System is critical to the success of Express'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 Express 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 Express 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 Express 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 Use the guidelines in Appendix A for creating the Pollution Prevention Management System

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 an 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

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consideration of wastewater treatment investment and operating costs in the analysis of candidate options

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 Express 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 Express, several pollution prevention options have already been installed, and others are planned Express will benefit from these installed options, however we believe that formalizing the pollution prevention process at Express 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 Express, 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

4.1 Optimize Electrostatic Powder Coating Operations

Current situation In the electrostatic epoxy powder coating system, parts rely on good electrical grounding to rapidly and evenly attract the epoxy powder particles to all surfaces Electrostatic powder coating transfer efficiency can typically reach or even exceed 90 percent At Express, grounding of parts is compromised by a cured coating layer and oxidation on the surfaces of both conveyor racks and hanging wires For this reason, perhaps, the manual powder coating of parts does not achieve a sufficient thickness and additional manual powder coating is required before oven curing

Recommendation Improve parts grounding by an aggressive cleaning practice for conveyor

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racks and hanging wires Mechanical cleaning techniques are recommended to produce as clean a metal surface as reasonably possible Such techniques could include manual chipping of coating accumulations, drilling of coating accumulations from rack holes, and surface roughing by files or emery cloth The required cleaning frequency for each rack and hanging wire would be determined by experience Also, the conveyor system's ground connection should be improved by connecting a wire to a properly designed factory ground Connection to a nearby metallic water supply pipe could also offer a viable grounding

Improved parts grounding would increase the efficiency of the electrostatic powder coating process and result in a more uniform coating thickness Greater thickness uniformity means applying less epoxy powder to achieve the minimum thickness requirement

Results Savings in powder purchases of approximately 92,000 LE/year are achievable with no capital investment, and represent a reduction of 4,000 kg/year of powder consumption

While this option involves no directly measurable environmental benefit, improved transfer efficiency to the parts should result in 1) reduced loadings to the existing over spray collection system, 2) reduced potential for powder losses to the workplace atmosphere, and 3) energy savings from improved production efficiency

Input, assumptions and calculations During the Assessment, a simple volt-ohm meter (VOM or multi-tester) was used to measure resistance to ground of parts being electrostatically powder coated With uncleaned racks, the measured resistance was greater than one megohm (one million ohms) for all parts checked On a cleaner rack, resistance measurement indicated only 1,000 ohms More aggressive cleaning of the rack and wires would certainly reduce the resistance to ground even further

A second test was performed to determine the effect of high and low resistivity on the thickness of the finished powder coating A set of 10 parts of identical shapes were chosen to be suspended to the racks and manually grounded with an electrical wire while being processed Powder coating thickness was measured on this grounded set of parts and compared with a thickness measurement campaign performed on parts processed in the normal conditions Table # 4 1 1 & 4 1 2 show the results of thickness measurements for each set

For parts processed using the normal powder coating procedure, coating thickness ranged from 38 0 to 98 0 microns Thickness measurements averaged 62 6 microns
For parts processed using the "external ground arrangement", coating thickness ranged from 44 0 to 99 0 microns, with an average thickness of 73 5 microns

In this extremely limited test, the minimum thickness increased by 22% while the standard deviation decreased by 22%, when the grounding was improved These changes are important if savings in powder consumption are to be realized

The test results suggest that Express could continue to meet a given minimum coating thickness

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while applying a lower average thickness, and therefore obtaining a more even coating Because the test performed during the Assessment was so limited in scope, it is difficult to draw quantitative conclusions with certainty

It is assumed for the purpose of this analysis, that for a given minimum coating thickness, approximately 20 to 22% less powder could be applied onto the parts with an improved grounding This would directly translate into a reduction of approximately 20% of the average coating thickness for all production, and a corresponding reduction of powder consumption

Assuming an annual powder consumption of 20,000 Kg/year (epoxy) costing 23 LE/Kg the annual purchases amount to 460,000 LE/year

Savings of 20% would represent 92,000 LE/year

While there is no capital cost associated with this option, a labor charge that should incurred to implement the recommended aggressive rack/wire cleaning program It is not possible at this point to accurately predict the amount of labor required by this option

Obstacles to Implementation There are no technical or financial obstacles to implementing this option Any potential technical questions can be answered by inexpensive experiments Trial runs will allow the plant personnel to establish the minimum rack/wire cleaning requirements that would provide acceptable product coating uniformity
Upon implementation of the option, staff training and monitoring will be needed so that new procedures are properly adopted and consistently executed

Schedule of Implementation Since this option is only a procedural change option, implementation can be made promptly upon the conclusion of tests Establishing the minimum cleaning requirement and immediately implementing the changes could be completed in one to two weeks

Express Company

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Table	**4 1 1**
Topic	Thickness Test
Factory	Express Company
Process	Powder Coating
Line/Step	Washing Machines/Small Washer Coating
Condition	Uncleaned Racks and Hangers

Part \ Point	1	2	3	4	5	6	7	8	9	10	Average
1	48	41	48	50	43	47	52	52	50	48	**47 9**
2	36	68	65	62	64	66	69	58	52	62	**60 2**
3	58	49	57	55	45	46	51	52	50	66	**52 9**
4	62	68	54	52	41	48	45	56	42	60	**52 8**
5	55	68	59	66	54	64	51	52	50	54	**57 3**
6	53	58	38	42	43	42	41	36	59	53	**46 5**
7	49	60	70	60	39	46	51	58	42	57	**53 2**
8	71	76	70	61	67	60	56	57	59	59	**63 6**
9	58	50	53	58	56	56	52	57	48	51	**53 9**
10	59	62	64	52	53	51	67	72	62	63	**60 5**
11	86	82	93	80	73	75	87	83	87	83	**82 9**
12	81	78	73	90	72	77	66	63	82	52	**73 4**
13	82	70	84	70	80	69	84	71	82	55	**74 7**
14	75	79	75	98	76	69	90	90	47	78	**77 7**
15	96	87	80	90	73	84	80	85	77	64	**81 6**

Minimum Thickness	**36 microns**
Maximum Thickness	**98 microns**
Average Thickness	**62 6 microns**
Standard Deviation	**14 4 microns**

Express Company

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Table	**4 1 2**
Topic	Thickness Test
Factory	Express Company
Process	Powder Coating
Line/Step	Washing Machines/Small Washer Coating
Condition	Clean Racks and Hangers

Part \ Point	1	2	3	4	5	6	7	8	9	10	Average
1	63	72	60	56	65	94	64	65	75	73	**68 7**
2	44	47	75	85	66	73	63	70	62	77	**66 2**
3	64	58	80	72	84	75	76	83	75	89	**75 6**
4	67	61	83	86	73	86	80	96	81	88	**80 1**
5	88	54	59	69	68	67	79	62	83	75	**70 4**
6	61	77	77	87	85	86	68	77	69	60	**74 7**
7	80	73	88	51	68	83	75	81	74	77	**75**
8	64	57	95	84	74	75	99	57	77	69	**75 1**
9	71	66	79	82	79	88	86	81	96	76	**80 4**
10	52	63	58	68	80	69	67	77	71	82	**68 7**

Minimum Thickness	**44 microns**
Maximum Thickness	**99 microns**
Average Thickness	**73 5 microns**
Standard Deviation	**11 3 microns**

Summary

Table # 4 1 3	Case	Min	Max	Std Dev	Average
1 1	Uncleaned	36	98	14 4	62 6
1 2	Clean	44	99	11 3	73 5
Improvement %		**22%**	**1%**	**-22%**	**17%**

Conclusion *The experiment indicates that a 20% improvement in transfer efficiency could be expected from an operation with better part grounding*

Cost to Implement 0 *LE No significant capital investment is required to implement this option*

Option # 4 2 Degreasing Tank D1 Countercurrent Rinse Configuration for Zero Dis

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
Current Configuration	112	100 73	1267 63	2665 19
Recommended Configuration	41	37 08	400 00	841 00
Reduction %	63%			68%
Annual Savings	71	64	868	1824

Total Savings 1888 LE/year

Summary of Capital Investments

	Capital Investment in LE
Modify Tank D2 to Counterflow Rinse	250 00
Drip Board	50 00
Counterflow Pipe	50 00
Filter System	1500 00
Agitate Tank D2	500 00
Total	2350 00

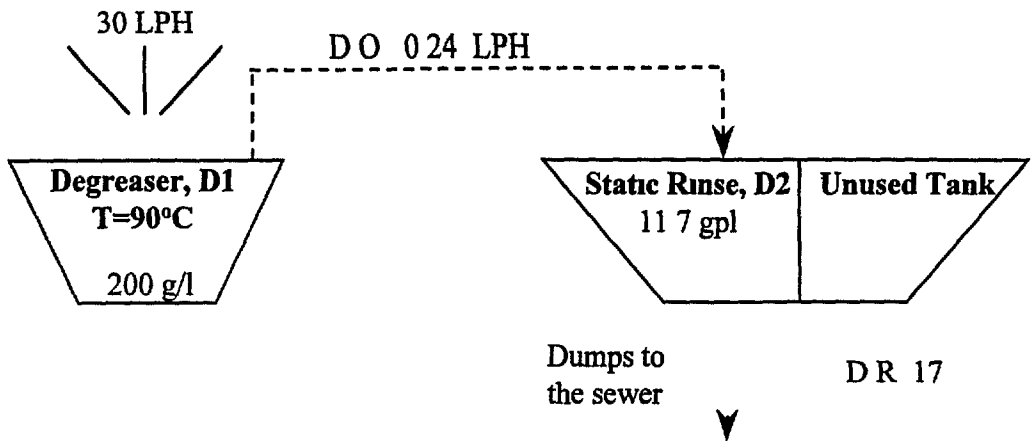
Investment 2350 LE

Payback Period· 1 2 years or 14 9 months

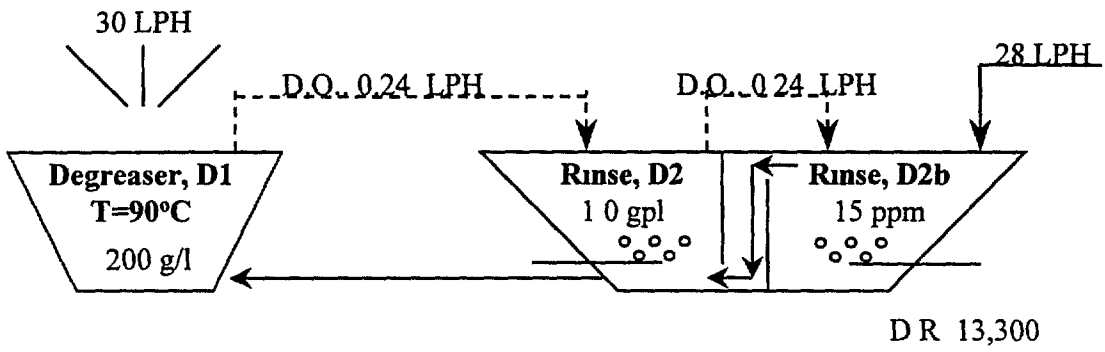
24

Figure 4-2 : WASHER LINE, DIP SURFACE PRE-TREATMENT TANKS #D1, D2 & D2b.

Current Configuration



Recommended Configuration



Zero Discharge

Summary

- Convert tank D2 to a 2-stage counter flowing rinse
- Add a drip board between tanks D1 & D2
- Counter flow rinse water from D2 to D1 (by gravity)
- Change dump schedule of tank D1 from 3 times a year to once a year
- Add agitation in rinses D2 and D2b
- Add continuous filtration system
- Eliminate dumps of tank D2

25

Current Situation **Tanks D1 & D2, Degreasing Step.**

The quality of the final rinse tank can be improved and drag-out to the next tank reduced The estimated dilution ratio of 17 0 clearly indicate an opportunity for process improvement while reducing the potential for wastewater pollution

Rinse tank #D2 is not agitated, and as a consequence, only floating solids are evacuated by overflowing to the sewer Solids heavier than water settle in the bottom of the tank necessitating frequent tank dumps for cleaning

A spare rinse tank is available after D2 Using it as an extra rinse step would allow better rinsing

Refer to Figure 4 2 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 improving the quality of rinse in the degreasing process while minimizing degreasing solution drag-out to the next process step, and accomplishing zero discharge operation

1. **Add a drip board between Tank D1 and D2** to allow for direct drag-out return to the process tank, while minimizing spills of chemicals onto the floor
2. **Convert tank D2 to a 2-stage counterflowing rinse**
3. **Change the dump schedule of tank D1** from 3 times per year to once a year
4. **Eliminate all dumps of tank D2**
5. **Add air agitation to tank D2 & D2b** to improve rinsing efficiency
6. **Add a continuous filtration system on tanks D1** operating even when the tank is cooled down over the week-end Such filtration should remove typical solids, and some oil and grease contaminants and therefore considerably extend the useful bath life

Results Figure 4-2 shows that under the above described operating conditions there would be a substantial improvement in rinse quality, with a dilution ratio increasing from 17 to 13 300

An estimated total savings of about 1,888 LE per year will be realized with a small capital investment of about 2,350 LE for tank modifications and the filter system The simple payback period of this capital cost will be approximately 1 2 year Contributing to the cost savings, there will be reductions of about

1. 870 Kg/year of degreasing solution currently discharged through drag-out losses (a 68% reduction)
2. 71 cubic meters per year of water consumption and discharge (a 63% reduction)

26

All savings in costs and consumption are based upon production rates provided by Express management for 1996, 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 24 liters per hour (LPH)
2 operator technique from parts transfer from one tank to another seemed adequate to minimize contamination of rinse and other process tanks
3 A dilution ratio of 1,000 provide the minimum rinse water quality acceptable for most processes

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*, a 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 Collaboration with a tank fabricator will allow staff to select the optimum tank design for counterflowing operation Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules, and use of tank covers) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately upon evaluation of the work required from the tank fabricator Installation of the air sparging devices and modification of counterflowing arrangements should require just a few weeks Depending on parts availability, 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

27

Table #	4.2.1
Topic:	Annual Water Cost Calculation (current)
Plant.	Express Company
Process.	Dip Surface Pre-Treatment, Washer Line
Line/Step.	Degreaser Tank # D1, D2 and D2b

Assumptions

Hours per shift	5	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	5	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	2	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*
D2	0	L	H	0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					0	0	0 00

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H S D M,W*	*Converted*			*LE/year*
D2	1	C	W	2 00	104 00		
D1	0 33	C	M	0 66	7 92		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					111 92		100 73

Rinse + Process Total	111 92	m3/year of water
Total Annual Cost	100 73	LE per year

28

Table #	4.2.2
Topic:	Annual Water Cost Calculation (recommended)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step:	Degreaser Tank # D1, D2 and D2b

Assumptions

Hours per shift	5	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	5	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	2	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*
D2	28	L	H	0 028	39 2	39 2	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					39 2	39 2	35 28

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H S,D M,W*	*Converted*			*LE/year*
D2	0	C	M	0 00	0 00		
D1	0 083	C	M	0 17	2 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					2 00		1 80

Rinse + Process Total	41 20	m3/year of water
Total Annual Cost	37 08	LE per year

29

Table #	4.2.3
Topic:	Drag-Out Estimation (current)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step:	Degreaser Tank # D1, D2 and D2b

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank to floating materials
Parts are very variable in shape and surface area
Virtually all the production is handled in large baskets
Drainage over the tank is allowed

Units Conversions

Gallons /	Sq Ft		Gal->Liter	Sq Ft ->M2	Liters/M2
8 3	1000		31 4155	92 90	0 3381536

Production Datas

Annual Production	Working Hours/year
1000 m2	1400

Drag-out Values in

Liters/hour		Liters per day		Liters/year	M3/year	Gal / hrs	Gal / day
0 24		2 05		338 15	0 34	0 06	0 54

Chemistry Losses

Bath TDS	200	grams per liter
Cost/Kg	2 10	LE/Kg
Chemical Loss	67 63	Kg/year
Annual Cost	142 19	LE/year

Cost of Process Dumps

Tank D1	is dumped	3	times/year
	and costs	2523	LE/year

Table #	4.2.4
Topic:	Drag-Out Estimation (recommended)
Plant	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step:	Degreaser Tank # D1, D2 and D2b

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area
Virtually all the production is handled in large baskets
Drainage over the tank is allowed

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
8 3	1000		31 4155	92 90	0 3381536

Production Datas

Annual Production		Working Hours/year
1000	m2	1400

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 24		2 05		338 15	0 34	0 06	0 54

Chemistry Losses

Bath TDS	200	grams per liter
Cost/Kg	2 10	LE/Kg
Chemical Loss	0 00	Kg/year
Annual Cost	0 00	LE/year

Cost of Process Dumps

Tank D1	is dumped		1 times/year
and costs		841	LE/year

31

Option # 4 3 Pickling Tank D3 Countercurrent Rinse Configuration

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
Current Configuration	54	48 60	1353 45	1353 45
Recommended Configuration	144	129 24	130 95	130 95
Reduction %	NA			90%
Annual Savings	-90	-81	1223	1223

Total Savings 1142 LE/year

Summary of Capital Investments

	Capital Investment in LE
Tank Covers	1500 00
Agitate D4 & D5	500 00
Total	2000 00

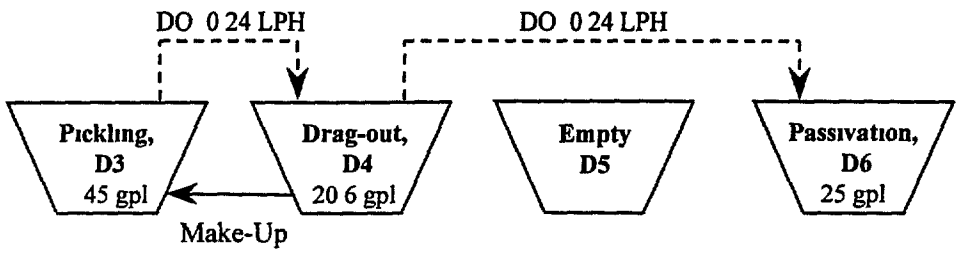
Investment 2000 LE

Payback Period 1 8 years or 21 0 months

32

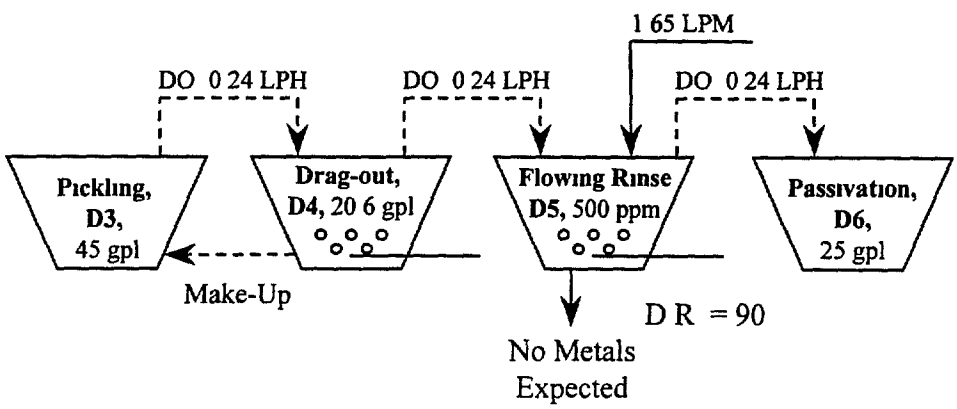
Figure 4-3 : WASHER LINE, DIP SURFACE PRE-TREATMENT TANKS D3, D4, D5 & D6

Current Configuration



D R = 1 76

Recommended Configuration



Summary

- Use existing empty tank as a flowing rinse
- Cover all tanks when not in use
- Add air agitation in tank D4 & D5
- Reduce tank D3 dump schedule from twice a year to once a year
- Reduce tank D6 dump schedule from once a week to once every 3 months
- Add a continuous 1 65 LPM flow rate to the last rinse tank D5
- Add drip boards between all tanks

33

Current Situation Tanks D3, D4, D5, & D6, Pickling Step

The quality of the final rinse tank D4 can be improved and drag-out (contamination) into the next tank D6 reduced The estimated dilution ratio of less than 2 0 clearly indicate an opportunity for process improvement while reducing the potential for wastewater pollution

Rinse tank #D4 is a static drag-out tank with no agitation, and, as a consequence, high concentration of pickling solution accumulate and is subsequently dragged-out to the passivation process tank

A spare rinse tank is available after D4 Using it as an extra rinse step would allow better rinsing

Refer to Figure 4 3 for a schematic diagram of the pickling 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 improving rinsewater quality while minimizing solution drag-out to the next process step

1 **Add drip boards between each tank** to allow for direct drag-out return to the previous tank, while minimizing spills onto the floor
2 **Convert empty tank D5 to a rinse tank with 1 65 LPM city water overflow** and obtain a better dilution ratio in this final rinse
3 **Change tank D3 dump schedule** from twice a year to once a year
4 **Change tank D6 dump schedule** from once a week to 4 times a year
5 **Add air agitation to tanks D4 & D5** to improve rinsing efficiency
6 **Add covers to all tanks** when not in use to minimize dust contamination from the atmosphere

Results Figure 4-3 shows that under the above described operating conditions there would be a substantial improvement in rinse quality, with a dilution ratio increasing from 1 7 to 900

An estimated total savings of about 1,142 LE per year will be realized with a very small capital investment of about 530 LE for the tank modifications The simple payback period of this capital cost will be approximately 5 6 months Contributing to the cost savings, there will be reductions of about

1 1 223 Kg/year of degreasing solution currently discharged through drag-out losses (a 90% reduction)

All savings in costs and consumption are based upon production rates provided by Express management for 1996, during the data collection phase of the Assessment If needed, the

34

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 24 liters per hour (LPH)
2 operator technique from parts transfer from one tank to another seemed adequate to minimize contamination of rinse and other process tanks
3 A dilution ratio of about 900 provide the minimum rinse water quality acceptable for most processes

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*, a 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 Collaboration with a tank fabricator will allow staff to design easy to handle tank covers Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules, and use of tank covers) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately upon evaluation of the work required from the tank fabricator Installation of the air sparging devices should require just a few weeks Depending on parts availability, 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

35

Table #	4.3 1
Topic:	Annual Water Cost Calculation (current)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step.	Pickling Tank D3, D4, D5 and D6

Assumptions

Hours per shift	5	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	5	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	1	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*
D4	0	L	Mn	0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					0	0	0 00

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H,S,D,M,W*	*Converted*			*LE/year*
D3	0 17	C	M	0 17	2 00		
D4	0	C	D	0 00	0 00		
D5	0	C	W	0 00	0 00		
D6	1	C	W	1 00	52 00		
				0 00	0 00		
				0 00	0 00		
Process Total					54 00		48 60

Rinse + Process Total	54 00	m3/year of water
Total Annual Cost	48 60	LE per year

Table #	4.3.2
Topic:	Annual Water Cost Calculation (recommended)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step:	Pickling Tank D3, D4, D5 and D6

Assumptions

Hours per shift	5	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	5	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	1	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*
D5	1 65	L	Mn	0 00165	138 6	138 6	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					138 6	138 6	124 74

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H S,D,M,W*	*Converted*			*LE/year*
D3	0 083	C	M	0 08	1 00		
D4	0	C	M	0 00	0 00		
D5	0	C	M	0 00	0 00		
D6	0 333	C	M	0 33	4 00		
				0 00	0 00		
				0 00	0 00		
Process Total					5 00		4 50

Rinse + Process Total	143 60	m3/year of water
Total Annual Cost	129 24	LE per year

31

Table #	4.3.3
Topic:	Drag-Out Estimation (current)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step:	Pickling Tank D3, D4, D5 and D6

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area
Virtually all the production is handled in large baskets
Drainage over the tank is allowed

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
8 3	1000		31 4155	92 90	0 338154

Production Datas

Annual Production	Working Hours/year
1000 m2	1400

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 24		2 05		338 15	0 34	0 06	0 54

Chemistry Losses

Bath TDS	25	grams per liter
Cost/Kg	1	LE/Kg
Chemical Loss	8 45	Kg/year
Annual Cost	8 45	LE/year

Cost of Process Dumps

Tank D6	is dumped		52 times per year
and costs	1300	LE/year	
Tank D3	is dumped		2 times per year
and costs	45	LE/year	

Table #	4.3.4
Topic:	Drag-Out Estimation (recommended)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line
Line/Step:	Pickling Tank D3, D4, D5 and D6

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area
Virtually all the production is handled in large baskets
Drainage over the tank is allowed

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*		
8 3	1000		31 4155	*Sq Ft ->M2*	*Liters/M2*
				92 90	0 338154

Production Datas

Annual Production	Working Hours/year
1000 m2	1400

Drag-out Values in

Liters/hour		*Liters per day*					
0 24		2 05		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
				338 15	0 34	0 06	0 54

Chemistry Losses

Bath TDS	25	grams per liter
Cost/Kg	1	LE/Kg
Chemical Loss	8 45	Kg/year
Annual Cost	8 45	LE/year

Cost of Process Dumps

Tank D6	is dumped		4 times per year
and costs	100	LE/year	
Tank D3	is dumped		1 times per year
and costs	22 5	LE/year	

79

Option # 4 4 Cleaner Tank D7 Spray Rinse Configuration

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
Current Configuration	71	63 89	160 87	321 74
Recommended Configuration	13	11 46	63 30	114 05
Reduction %	82%			65%
Annual Savings	58	52	98	208

Total Savings 260 LE/year

Summary of Capital Investments

	Capital Investment in LE
Covers & Drip Boards	100 00
Drain Bar Over D7 D8 & D9	150 00
Spray Gun	50 00
Agitation D8 and D8	200 00
Total	500 00

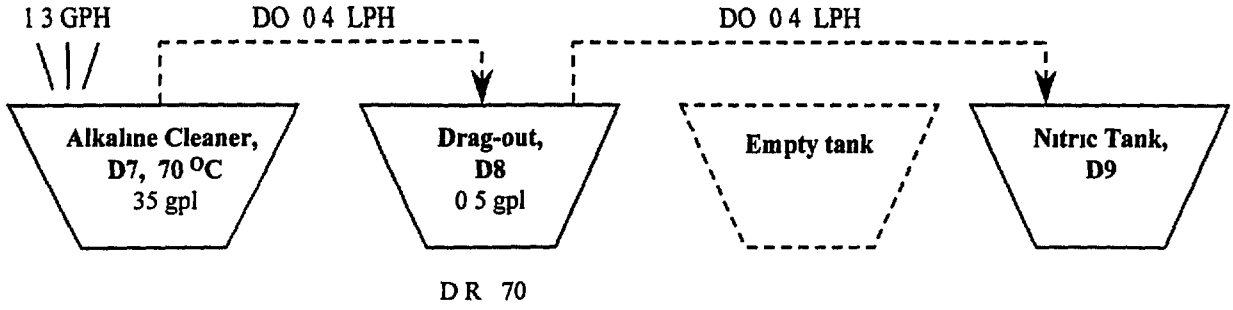
Investment 500 LE

Payback Period 1 9 years or 23 1 months

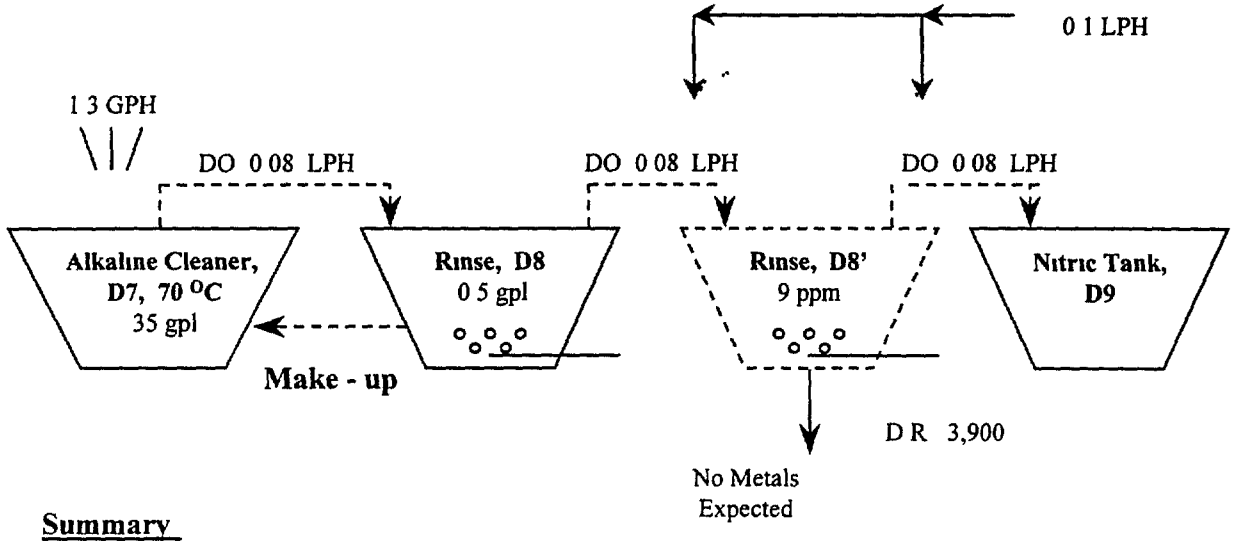
40

Figure 4-4: WASHER LINE, DIP SURFACE PRE-TREATMENT TANKS # D7 & D8

Current Configuration



Recommended Configuration



Summary

- Reduce drag-out by 80% using a drip bar over tank D7
- Convert existing empty tank to a spray rinse using approx 0 1 LPH
- Reduce tank D8 dump schedule from once a day to 4 times per year
- Add tank covers (when not in use) and drip boards between tanks
- Add air agitation in tanks D8 & D8'
- Reduce tank D9 dump schedule from once a month to twice a year

41

Current Situation **Tanks D7, D8, D8' & D9, Cleaning Step·**

The quality of the final rinse tank can be improved and drag-out to the next tank reduced The estimated dilution ratio of 70 clearly indicate an opportunity for process improvement while reducing the potential for wastewater pollution

No time is allowed for drainage over each tank Operator□s technique is the main component driving the rate of plating solution dragged-out of the cleaning tank to the rinse tank and subsequent processes

Rinse tank D8 is a static drag-out tank with no agitation, and as a consequence, high concentration of cleaning solution accumulate and is subsequently dragged-out to the nitration process tank

A spare rinse tank is available after D8 Using it as an extra rinse step would allow better rinsing

Refer to Figure 4 4 for a schematic diagram of the cleaning 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 improving rinsewater quality in the cleaning process while minimizing cleaning solution drag-out to the next process step

1 **Add drip boards between each tanks** to allow for direct drag-out return to the process tank, while minimizing spills onto the floor
2 **Convert empty tank D8' to a spray rinse** using approximately 0 1 LPH and therefore improve the dilution ratio in the final rinse tank
3 **Reduce tank D8 dump schedule** from once a day to 4 times a year
4 **Add air agitation to tanks D8 & D8'** to improve rinsing efficiency
5 **Add covers on all tanks** when not in use to minimize dust contamination from the atmosphere

Results Figure 4-4 shows that under the above described operating conditions there would be a substantial improvement in rinse quality, with a dilution ratio increasing from 70 to 3,888

An estimated total savings of about 260 LE per year will be realized with a very small capital investment of about 500 LE for the tank modifications The simple payback period of this capital cost will be approximately 1 9 years Contributing to the cost savings, there will be reductions of about

1 98 Kg/year of degreasing solution currently discharged through drag-out losses (a 65% reduction)

2 58 cubic meters per year of water consumption and discharge (a 82% reduction)

All savings in costs and consumption are based upon production rates provided by Express management for 1996, 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 4 liters per hour (LPH)
2 operator technique from parts transfer from one tank to can be improved to minimize contamination of rinse and other process tanks
3 A dilution ratio of 1,000 provide the minimum rinse water quality acceptable for most processes

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*, a 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 Collaboration with a tank fabricator will allow staff to design easy to handle tank covers Upon implementation of the recommendations, staff training and monitoring will be needed so that new procedures (reduced dump schedules, and use of tank covers) are properly adopted and consistently executed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately upon evaluation of the work required from the tank fabricator Installation of the air sparging devices should require just a few weeks Depending on parts availability, 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 #	4.4.1
Topic:	Annual Water Cost Calculation (current)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line, Aluminum Parts
Line/Step:	Alkaline Cleaner

Assumptions

Hours per shift	8	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	8	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	0 25	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*
		L	Mn	0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					0	0	0 00

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H,S,D,M W*	*Converted*			*LE/year*
D7	0 33	C	M	0 08	0 99		
D8	1	C	D	0 25	70 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					70 99		63 89

Rinse + Process Total	70 99	m3/year of water
Total Annual Cost	63 89	LE per year

44

Table #	4.4.2
Topic.	Annual Water Cost Calculation (recommended)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line, Aluminum Parts
Line/Step:	Alkaline Cleaner

Assumptions

Hours per shift	8	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	8	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	0 25	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*
D8'	0 08	L	Mn	0 00008	10 752	10 752	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					10 752	10 752	9 68

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H S D,M,W*	*Converted*			*LE/year*
D7	0 33	C	M	0 08	0 99		
D8	0 33	C	M	0 08	0 99		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					1 98		1 78

Rinse + Process Total	12 73	m3/year of water
Total Annual Cost	11 46	LE per year

45

Table #	4.4.3
Topic:	Drag-Out Estimation (current)
Plant:	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line, Aluminum Parts
Line/Step:	Alkaline Cleaner

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank to floating materials
Parts are very variable in shape and surface area
Virtually all the production is handled in large baskets
No drainage over the tank is allowed

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
22	1000		83 27	92 90	0 8963108

Production Datas

Annual Production		Working Hours/year
1000	m2	2240

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
0 40		3 40		896 31	0 90	0 11	0 90

Chemistry Losses

Bath TDS	35	grams per liter
Cost/Kg	2	LE/Kg
Chemical Loss	31 37	Kg/year
Annual Cost	62 74	LE/year

Cost of Process Dumps

Tank D7	is dumped		4 times per year
and costs		70 LE/year	
Tank D9	is dumped		12 times per year
and costs		189 LE/year	

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Table #	4.4.4
Topic:	Drag-Out Estimation (recommended)
Plant.	Express Company
Process:	Dip Surface Pre-Treatment, Washer Line, Aluminum Parts
Line/Step:	Alkaline Cleaner

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area
Virtually all the production is handled in large baskets
No drainage over the tank is allowed

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*		
4 4	1000		16 654	*Sq Ft ->M2*	*Liters/M2*
				92 90	0 1792622

Production Datas

Annual Production	Working Hours/year
1000 m2	2240

Drag-out Values in

Liters/hour		*Liters per day*					
0 08		0 68		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
				179 26	0 18	0 02	0 18

Chemistry Losses

Bath TDS	35	grams per liter
Cost/Kg	2	LE/Kg
Chemical Loss	6 27	Kg/year
Annual Cost	12 55	LE/year

Cost of Process Dumps

Tank D7	is dumped		4 times per year
and costs		70 LE/year	
Tank D9	is dumped		2 times per year
and costs		31 5 LE/year	

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Option # 4 5 Decrease Drag-Out in Conveyorized Pre-Treatment Line 1

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
Current Configuration	7403	6663 06	1273 20	15278 45
Recommended Configuration	926	833 44	698 75	8385 00
Reduction %	87%			45%
Annual Savings	6477	5830	574	6893

Total Savings 12723 LE/year

Summary of Capital Investments

	Capital Investment in LE
New Nozzles	1000 00
Baffles	1000 00
Drip Separations	600 00
Small Transfer Pump & Piping	1200 00
Total	3800 00

Investment 3800 LE

Payback Period 0 3 years or 3 6 months

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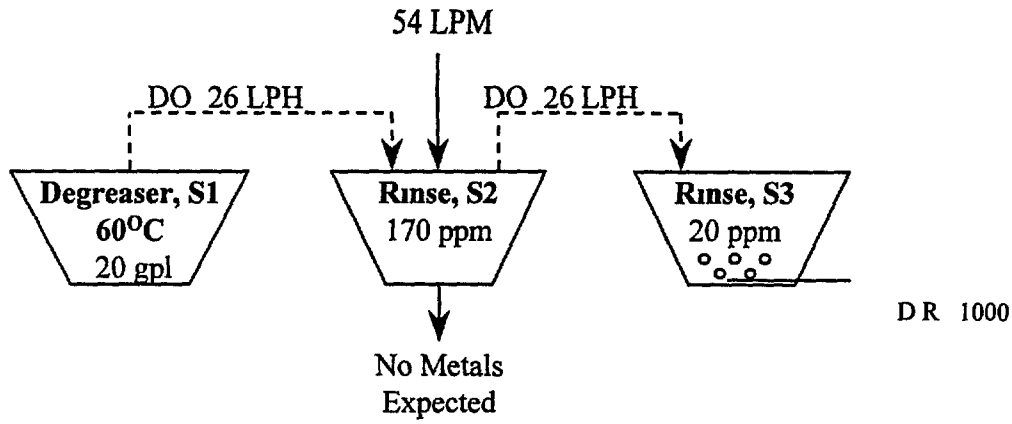
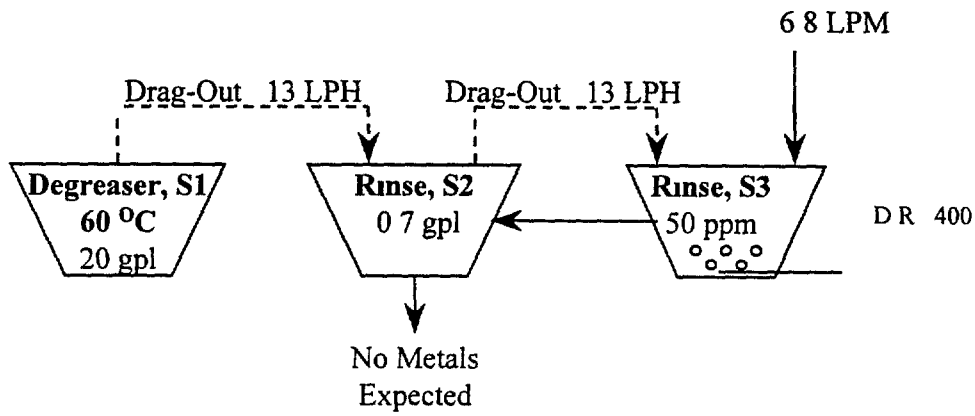
Figure 4-5 : WASHER LINE, CONVEYORIZED SURFACE PRE-TREATMENT, TANKS S1, S2 AND S3

Current Configuration



Recommended Configuration



Summary

-Reduce drag-out to 13 LPH, by using new spray nozzles, baffles, and drip separations
-Reduce rinsewater flow rate to 6 8 LPM
-Re-use overflow from tank S3 to tank S2
-Eliminate tank S2 dump schedule

49

Current Situation Tanks S1, S2 & S3, Degreasing Step·

Even though this pre-treatment line includes spray application of the cleaning chemicals, a very high drag-out rate was estimated during normal operation This high rate is due to insufficient separation devices between the spray chambers

Refer to Figure 4 5 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 maintaining the quality of rinse in the degreasing process, while minimizing water use and chemicals losses by drag-out to the next spray chamber

1 **Replace existing spray nozzles by more directional ones** to reduce overspray around the parts
2 **Add baffles that create separations between the chambers** to minimize direct spraying into the next chamber
3 **Add bottom separations** to allow direct return of drips to the sump tank
4 **Counter flow rinse water from collection tank S3 to collection tank S2** to improve water use efficiency
5 **Eliminate tank S2 dump schedule** to minimize water use

Results Figure 4-5 shows that under the above described operating conditions there would be a substantial reduction of rinse water use from 7,403 to 926 m3/year

An estimated total saving of about 12,723 LE per year will be realized with a very small capital investment of about 3,800 LE for the chamber modifications The simple payback period of this capital cost will be approximately 3 6 months Contributing to the cost savings, there will be reductions of about

1 574 Kg/year of degreasing solution currently discharged through drag-out losses (a 45% reduction)
2 6,477 cubic meters per year of water consumption and discharge (a 87% reduction)

All savings in costs and consumptions are based upon production rates provided by Express management for 1996, 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

50

1 drag-out tests performed on site led to an estimated value of 54 0 liters per hour (LPH)
2 A dilution ratio of approximately 500 provide the minimum rinse water quality acceptable for most spray rinse processes
3 drag-out can be reduced by 50% using the chamber separation fixtures

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*, a 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 Collaboration with a plastic fabricator will allow staff to select the optimum chamber separation designs Upon implementation of the recommendations, process monitoring will be needed so that the efficiency of the new fixtures can be properly assessed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately upon evaluation of the work required from the plastic fabricator Installation of the chamber separation fixtures should require just a few weeks Depending on parts and fabricators availability, full implementation of the recommendations should take about 2-3 months Assistance from ECEP-EP3 during initial trials, installation start-up and staff training can ease any implementation concerns

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Table #	4.5.1
Topic:	Annual Water Cost Calculation (current)
Plant:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Washer Line
Line/Step:	Degreasing Tank S1, S2 and S3

Assumptions

Hours per shift	8	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	8	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	2 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*
S2	54	L	Mn	0 054	7257 6	7257 6	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					7257 6	7257 6	6531 84

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H S,D,M,W*	*Converted*			*LE/year*
S1	0 17	C	M	0 45	5 40		
S2	0	C	M	0 00	0 00		
S3	1	C	W	2 70	140 40		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					145 80		131 22

Rinse + Process Total	7403 40	m3/year of water
Total Annual Cost	6663 06	LE per year

52

Table #	4.5.2
Topic:	Annual Water Cost Calculation (recommended)
Plant.	Express Company
Process.	Conveyorized Surface Pre-Treatment, Washer Line
Line/Step:	Degreasing Tank S1, S2 and S3

Assumptions

Hours per shift	8	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	8	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	2 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*
S3	6 85	L	Mn	0 00685	920 64	920 64	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					920 64	920 64	828 58

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H,S,D M,W*	*Converted*			*LE/year*
S1	0 1666667	C	M	0 45	5 40		
S2	0	C	W	0 00	0 00		
S3	0	C	M	0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					5 40		4 86

Rinse + Process Total	926 04	m3/year of water
Total Annual Cost	833 44	LE per year

53

Table #	4.5.3
Topic:	Drag-Out Estimation (current)
Plant:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Washer Line
Line/Step:	Degreasing Tank S1, S2 and S3

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
143	1000		541 255	92 90	5 82602

Production Datas

Annual Production	Working Hours/year
10000 m2	2240

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
26 01		221 08		58260 20	58 26	6 87	58 41

Chemistry Losses

Bath TDS	20	grams per liter
Cost/Kg	12	LE/Kg
Chemical Loss	1165 20	Kg/year
Annual Cost	13982 45	LE/year

Cost of Process Dumps

Tank S1 is dumped 2 times per year
and costs 1296 LE/year

54

Table #	**4 5.4**
Topic:	Drag-Out Estimation (recommended)
Plant:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Washer Line
Line/Step:	Degreasing Tank S1, S2 and S3

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
72 5	1000		274 4125	92 90	2 953752

Production Datas

Annual Production		Working Hours/year
10000	m2	2240

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
13 19		112 08		29537 52	29 54	3 48	29 61

Chemistry Losses

Bath TDS	20	grams per liter
Cost/Kg	12	LE/Kg
Chemical Loss	590 75	Kg/year
Annual Cost	7089 00	LE/year

Cost of Process Dumps

Tank S1 is dumped 2 times per year
and costs 1296 LE/year

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Option # 4 6 Decrease Drag-Out in Conveyorized Pre-Treatment Line 3

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
Current Configuration	4542	4087 80	540 06	6480 69
Recommended Configuration	412	370 44	329 98	3959 77
Reduction %	91%			39%
Annual Savings	4130	3717	210	2521

Total Savings 6238 LE/year

Summary of Capital Investments

	Capital Investment in LE
Modify Tank D5 to Counterflow Rinse	250 00
Add a Dosing Pump	1000 00
Total	1250 00

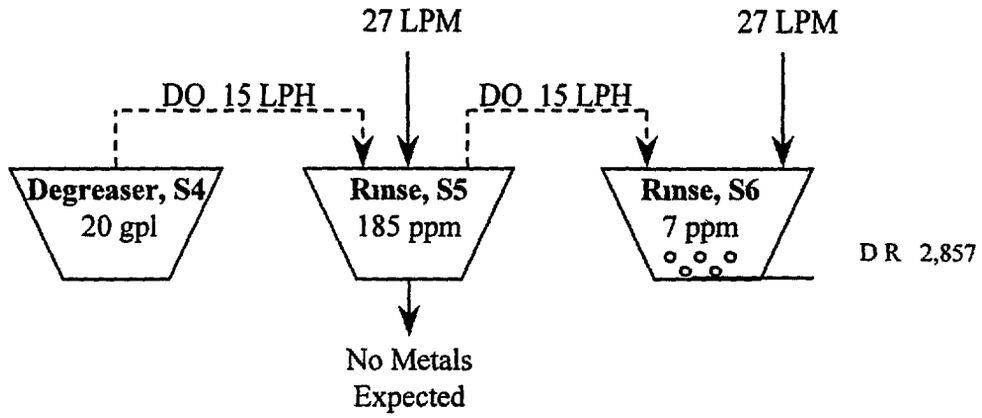
Investment 1250 LE

Payback Period 0 2 years or 2 4 months

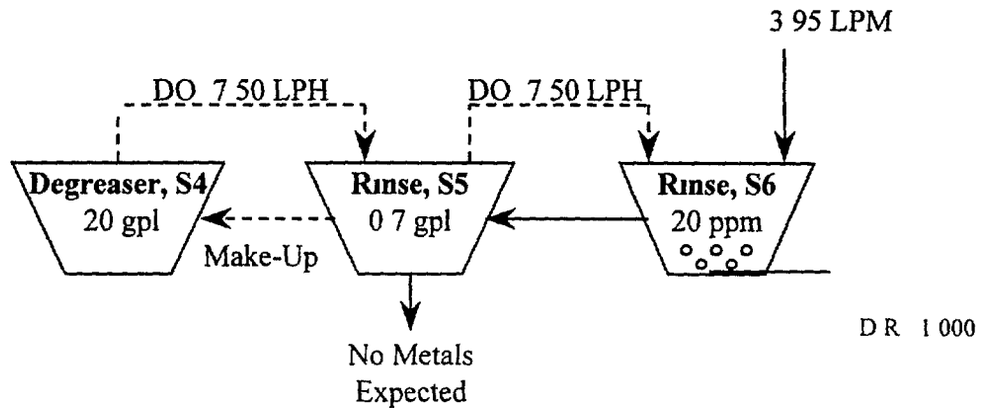
56

Figure 4-6 : WASHER LINE, CONVEYORIZED SURFACE PRE-TREATMENT, TANKS S4, S5 AND S6

Current Configuration



Recommended Configuration



Summary

-Reduce drag-out to 7 50 LPH, by using new spray nozzles, baffles, and drip separations
- Reduce rinsewater flow rate to 3 95 LPM
- Re-use overflow from tank S6 to tank S5

51

Current Situation: Tanks S4, S5 & S6, Degreasing Step:

Even though this pre-treatment line includes spray application of the cleaning chemicals, a very high drag-out rate was estimated during normal operation This high rate is due to insufficient separation devices between the spray chambers, therefore allowing a high drag-out

Refer to Figure 4 6 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 maintaining the quality of rinse in the degreasing process, while minimizing water use and chemicals losses by drag-out to the next spray chamber

1 **Replace existing spray nozzles by more directional ones** to reduce over spray around the parts
2 **Add baffles that create separations between the chambers** to minimize direct spraying into the next chamber
3 **Add bottom separations** to allow direct return of drips to the sump tank
4 **Counter flow rinse water from collection tank S6 to collection tank S5** to improve water use efficiency

Results Figure 4-6 shows that under the above described operating conditions there would be a substantial reduction of rinse water use from 4,542 to 412 m3/year

An estimated total saving of about 6,238 LE per year will be realized with a very small capital investment of about 1,250 LE for the chamber modifications The simple payback period of this capital cost will be approximately 2 4 months Contributing to the cost savings, there will be reductions of about

1 210 Kg/year of degreasing solution currently discharged through drag-out losses (a 39% reduction)
2 4,130 cubic meters per year of water consumption and discharge (an 91% reduction)

All savings in costs and consumption are based upon production rates provided by Express management for 1996, 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

58

the engineering spreadsheets tables, are as follows

1 Drag-out tests performed on site led to an estimated value of 27 0 liters per hour (LPH)
2 A dilution ratio of approximately 500 provide the minimum rinse water quality acceptable for most spray rinse processes
3 drag-out can be reduced by 50% using the chamber separation fixtures

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*, a 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 Collaboration with a plastic fabricator will allow staff to select the optimum chamber separation designs Upon implementation of the recommendations, process monitoring will be needed so that the efficiency of the new fixtures can be properly assessed

Schedule of Implementation All recommendations listed for this process step can be implemented immediately upon evaluation of the work required from the plastic fabricator Installation of the chamber separation fixtures should require just a few weeks Depending on parts and fabricators availability, full implementation of the recommendations should take about 2-3 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:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Aluminum Parts
Line/Step.	Degreasing Tank S4, S5 and S6

Assumptions

Hours per shift	5	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	5	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	3	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*
S5	27	L	Mn	0 027	2268	2268	
S6	27	L	Mn	0 027	2268	2268	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					4536	4536	4082 40

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C,M3	*H,S,D,M,W*	*Converted*			*LE/year*
S4	0 1666667	C	M	0 50	6 00		
S5	0	C	M	0 00	0 00		
S6	0	C	M	0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					6 00		5 40

Rinse + Process Total	4542 00	m3/year of water
Total Annual Cost	4087 80	LE per year

60

Table #	**4 6.2**
Topic:	Annual Water Cost Calculation (recommended)
Plant:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Aluminum Parts
Line/Step:	Degreasing Tank S4, S5 and S6

Assumptions

Hours per shift	5	Hours
Shifts per day	1	Shift
Day per Year	280	Days
Intermittent Value	5	Hours ON per day
Month per year	12	Month
Weeks per year	52	Weeks
Tank Capacity	3	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*
S6	3 9	L	Mn	0 0039	327 6	327 6	
				0	0	0	
				0	0	0	
				0	0	0	
				0	0	0	
Rinse Total					327 6	327 6	294 84

Process Tanks	*Dumps*	*Unit per*	*Unit*	*m3*	*m3/Year*		*Water Cost*
		C M3	*H,S,D,M,W*	*Converted*			*LE/year*
S4	0 17	C	M	0 50	6 00		
S5	0 5	C	W	1 50	78 00		
S6	0	C	M	0 00	0 00		
				0 00	0 00		
				0 00	0 00		
				0 00	0 00		
Process Total					84 00		75 60

Rinse + Process Total	411 60	m3/year of water
Total Annual Cost	370 44	LE per year

Table #	4.6.3
Topic:	Drag-Out Estimation (current)
Plant:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Aluminum Parts
Line/Step:	Degreasing Tank S4, S5 and S6

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank, to floating materials
Parts are very variable in shape and surface area

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
51 55	1000		195 11675	92 90	2 100219

Production Datas

Annual Production		Working Hours/year
10000	m2	1400

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
15 00		127 52		21002 88	21 00	3 96	33 69

Chemistry Losses

Bath TDS	20	grams per liter
Cost/Kg	12	LE/Kg
Chemical Loss	420 06	Kg/year
Annual Cost	5040 69	LE/year

Cost of Process Dumps

Tank S4 is dumped 2 times per year
and costs 1440 LE/year

Table #	**4.6.4**
Topic:	Drag-Out Estimation (recommended)
Plant:	Express Company
Process:	Conveyorized Surface Pre-Treatment, Aluminum Parts
Line/Step:	Degreasing Tank S4, S5 and S6

Assumptions
Rinse waters show evidence of impurities ranging from deposit in the bottom of the tank to floating materials
Parts are very variable in shape and surface area

Units Conversions

Gallons /	*Sq Ft*		*Gal->Liter*	*Sq Ft ->M2*	*Liters/M2*
25 77	1000		97 53945	92 90	1 049906

Production Datas

Annual Production	Working Hours/year
10000 m2	1400

Drag-out Values in

Liters/hour		*Liters per day*		*Liters/year*	*M3/year*	*Gal / hrs*	*Gal / day*
7 50		63 74		10499 06	10 50	1 98	16 84

Chemistry Losses

Bath TDS	20	grams per liter
Cost/Kg	12	LE/Kg
Chemical Loss	209 98	Kg/year
Annual Cost	2519 77	LE/year

Cost of Process Dumps

Tank S4 is dumped 2 times per year
and costs 1440 LE/year

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4.7 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

Alkaline Cleaners Investigate Ultrafiltration
While no heavy metals are typically expected in theses 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 ultra filtration, 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

Express 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 Express'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 retarders, 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

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CHAPTER 5
CRITICAL RATIO ANALYSIS

Critical Ratio analysis offers a way of examining the efficiency of a unit operation or an entire production process A Critical Ratio expresses material or energy used per unit of manufacture It can be used to compare the efficiency of the plant being assessed with those of other facilities in the same industrial sector Management can compare Critical Ratio to help reveal those unit operations which have a good potential for improvements through Pollution Prevention measures A smaller numerical value of a Critical Ratio indicates a more efficient operation.

Even if there is no pub,ished data (such as values for Best Industrial Practice or Standard Industrial Practice) that can be used for such comparisons, the Critical Ratio is still a valuable tool It provides management a numerical baseline by which to gauge the impact of improvements made to a process

For metal finishing facilities, no Best Industrial Practice or Standard Industrial Practice values are available because of the huge number of process variations from facilities to facilities Therefore, only Achievable Industrial Practice (AIP) values can be used AIP values are calculated below based upon what can be achieved if the recommendations of Chapter 4 are implemented The AIP values provide near-term goals or targets With a on-going Pollution Prevention Program, management at Express Company can set longer term target values that are lower than the AIP values that follow

5 1 Pre-Treatment Wastewater Flow Critical Ratios

A **Before implementation**

Annual production (surface area) 5,302 m2/year
Pre-Treatment wastewater flow 12,182 m3/year

Critical Ratio #1 =	2 30	m3 of water/m2 of parts produced

or

the plant currently discharges *2298 liters of waste water per m2 of parts produced*

B After implementation

Wastewater will be reduced to 1 535 m3/year

Critical Ratio #2 =	0 29	m3 of water/m2 of parts produced

or

the plant will discharge *290 liters of waste water per m2 of parts produced*

Critical Ratio #2, represents the AIP value for wastewater discharge from the Pre-Treatment line.

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C Conclusion

When comparing Critical Ratios #1 and #2, we see a reduction in wastewater of 87 4%

This 87% reduction in wastewater flow per unit area plated will be achieved mainly by modifying rinse configurations

5 2 Pre-Treatment Heavy Metals: Critical Ratios

A. Before implementation

Annual production (surface area) 5,302 m2/year
Pre-Treatment Heavy Metals (Cr6) 11,000 grams/Year

Critical Ratio #3 =	2 07	grams Cr6/m2 of parts produced

or

the plant currently discharges 2 grams of Cr6 per m2 of parts produced

B After implementation

Cr6 discharge will be reduced to 0 0 grams/year

Critical Ratio #4 =	0 00	m3 of water/m2 of parts produced

or

the plant will discharge 0 grams of Cr6 per m2 of parts produced

Critical Ratio #4 represents the AIP value for wastewater discharge from the Pre-Treatment line

C Conclusion

When comparing Critical Ratios #3 and #4, we see a reduction in Cr6 discharge of 100 0%

This 100% reduction in Cr6 discharge per unit area Pre-Treated will be achieved by eliminating the use of chromium as a passivation chemical

CHAPTER 6
CONCLUDING REMARKS

6.1 Environmental Issues

At Express, significant pollution prevention opportunities exist which would result in improved product quality, economic benefit, worker health, and environmental quality Implementing the recommended options, and/or other options that the plant pursues on its own, will reduce the contaminant levels in the plant wastewater so that the treatment plant operates more efficiently, and there is an improved probability that the treatment plant discharge will meet the law's standards

This report has been focused mainly on wastewater issues However, implementation of the recommended options also will lead to improvement in air quality and some lowering of solid waste generation

6.2 Constraints

Potential obstacles to successful implementation of options have been discussed in Chapter 4 under each option for which calculations have been done These potential obstacles are not serious enough to prevent implementation of the options

6.3 Implementation

The heart of the pollution prevention project is implementation Implementing the options will demonstrate real money savings and real reductions in pollution To focus its efforts for implementation, and to ensure success in implementing options, the plant, with help from ECEP/DRTPC and ECEP/EP3, should prepare an implementation plan Considerable design work and strategic negotiations are involved in the successful implementation of the proposed plan, so delay is discouraged

Physical-Chemical Analysis of Samples Collected on September 17 1997 from Express Company

Sample Type Parameters	Unit	Pump effluent 1	Heavy ww Tank T1 2	Light ww tank T3 3	Raw Water 4	Law 48/1982	Law 93/1962
Temprature	Cent	29		28	30	35	40
pH	Value	7 2	6 7	7	7	6 - 9	6 - 10
Colour		Dark Gray	Black	Light Gray	Free	Free	
BOD	mg/l	120		105	8	20	400
COD	mg/l	154		173	15	30	700
Total disolved solids	mg/l	692		645	388	800	2000
Ashes of dissolved solids	mg/l	NA	NA	NA	NA	700	
Suspended solids	mg/l	60		26	3	30	500
Ashes of suspended solids	mg/l	NA	NA	NA	NA	20	
Sulphides	mg/l	NA	NA	NA	NA	1	10
Lipids fats and resins	mg/l	12	332 644	35	ND	5	100
Inorganic phosphates	mg/l	2 7	1 7	3 6	0 09	1	5
Nitrates (NO3)	mg/l	0 12		0 04	0 16	30	30
Finol	mg/l	NA	NA	NA	NA	0 001	0 005
Florides	mg/l	NA	NA	NA	NA	0 5	1
The remaining chlorine	mg/l	160	100	140	50	1	10
Total heavy metals	mg/l					1	10(Q< 50m3), 5 (Q>50M3)
Mercury	mg/l	NA	NA	NA	NA	0 001	sum of Ag+Hg <1
Silver	mg/l	NA	NA	NA	NA	0 5	sum of Ag+Hg <1
Lead	mg/l	NA	NA	NA	NA	0 05	
Chadmium	mg/l					0 01	
Arsric	mg/l	NA	NA	NA	NA	0 05	
Chromium hexa valent	mg/l					0 05	
Copper	mg/l					1	
Nickle	mg/l					0 1	
Iron	mg/l	NA	NA	NA	NA	1	
Manganese	mg/l	NA	NA	NA	NA	0 5	
Zinc	mg/l					1	
Industrial Detergents	mg/l	NA	NA	NA	NA	1 5	

* NA Not analyized
** ND Not Detected

Noted that for Sample number 2 it was not possible by the lab To determine the rest of the parameters because of the high concentration of oils and grease

Appendices Section

- A1: Production Rates for 1996
- A2: Raw Material Consumption for 1996
- A3: Baths Characterization
- A4: Sources of Wastewater
- A5: Chemistry Losses Through Drag-Out

Table #	**A1**
Topic	Production Rates for 1996
Plant	Express Company

No	Name	Number of units per year	Unit Surface Area m^2	Surface Area/Year in m2	Type of paint
1	Cylindrical Washers	3056	1 22	3742 1	Electrostatic Powder
2	Vertical Washers	97	1 22	118 0	Electrostatic Powder
3	Medium Washers	176	1 17	205 6	Electrostatic Powder
4	Small Washers (1)	753	0 60	448 2	Electrostatic Powder
5	Square Washers	484	1 56	755 0	Electrostatic Powder
6	Small Washers (2)	55	0 60	32 7	Enamel
Total				5301 6	

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Table #.	**A2**
Topic:	Raw Material Consumption for 1996
Plant·	Express Company

No	Name	Consumption kg/yr	Conc %	Price LE/Kg	Annual Cost in LE
1	Sodium Silicate	42	40	2 00	84 00
2	Caustic Soda	60	98	2 50	150 00
3	Sodium Carbonate	400	98	1 00	400 00
4	Detergent	42	Liquid	0 60	25 20
5	Sodium Tri Phosphate	60	95	4 00	240 00
6	Iron Phosphate	1,970	Mix	10 50	20685 00
7	Nitric Acid	240	60	2 00	480 00
8	Chromic Acid	20	60	7 00	140 00
9	Hydrochloric Acid	1,000	30	0 60	600 00
10	Electrostatic Painting Powder	20,000	Powder	23 00	460000 00
11	Enamel	1,000	Powder	4 50	4500 00
12	Water	33,600	NA	0 59	19824 00
Total					487304 20

Painting for Others (Aluminum only)

Production	60	tons of Aluminum parts per year
Powder Consumption	67 5	kg per ton of Aluminum parts
Powder Consumption	4050	kg per year

Note The above mentioned powder consumption for Painting for Others is included in the annual consumption in Table A2

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Table #:	A3
Topic	Baths Characterization
Plant:	Express Company
Process.	Surface Pre-Treatment Department
Line/Step:	All

Composition of the Degreaser
Tank Volume 2000 liters
Mixing Volume 2000 liters

Components	Conc GPL	Price/Kg or Liter
Detergent	30	0 60
Sodium Silicate	30	2 00
Sodium TnPhos	45	4 00
Sodium Hydrox	45	2 50
Sodium Carbon	50	1 00
TDS	200	
Total (in GPL)		
Total as % TDS		
Average LE/Kg		2 10

Composition of the Passivation
Tank Volume 2000 liters
Mixing Volume 2000 liters

Components	Conc GPL	Cr GPL	Price/Kg or Liter
CrO3	0 19	0 11	7 00
TDS	0 19		
Total (in GPL)		0 11	
Total as % TDS		55%	
Average LE/Kg			7 00

Note
The Chromic acid concentration is averaged as a component of the chemistry
Chromic acid passivation is used only a few times a year and the
average represents this practice

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Table #:	A4
Topic.	Sources of Wastewater
Plant	Express Company

1. Breakdown of the Sources of Wastewater for the Current Operation

Total Water Consumption	120 m3/day	or	**33,600** m3/year
From Option #	4 2		111 9 m3/year
From Option #	4 3		54 0 m3/year
From Option #	4 4		71 0 m3/year
From Option #	4 5		7,403 4 m3/year
From Option #	4 6		4,542 0 m3/year
Total Wastewater from Surface-Pretreatment			**12,182** m3/year
Percentage of Total Water Consumption			*36 3%*
Wastewater from Other Sources			**21,418** m3/year
Percentage of Total Water Consumption			*63 7%*

2 Breakdown of the Sources of Wastewater for the Recommended Operation

				Change after Implementation
Total Water Consumption	82 0 m3/day	or	**22,953** m3/year	*-31 7%*
From Option #	4 2		41 2 m3/year	
From Option #	4 3		143 6 m3/year	
From Option #	4 4		12 7 m3/year	
From Option #	4 5		926 0 m3/year	
From Option #	4 6		411 6 m3/year	
Total Wastewater from Pre-Treatment			**1,535** m3/year	*-87 4%*
Percentage of Total Water Consumption			*6 7%*	
Wastewater from Other Sources			**21,418** m3/year	*0 0%*
Percentage of Total Water Consumption			*93 3%*	

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Table #.	A4
Topic	Sources of Wastewater
Plant:	Express Company

1 Breakdown of the Sources of Wastewater for the Current Operation

Total Water Consumption	120 m3/day	or	**33,600** m3/year
From Option #	4 2		111 9 m3/year
From Option #	4 3		54 0 m3/year
From Option #	4 4		71 0 m3/year
From Option #	4 5		7,403 4 m3/year
From Option #	4 6		4,542 0 m3/year
Total Wastewater from Surface-Pretreatment			**12,182** m3/year
Percentage of Total Water Consumption			*36 3%*
Wastewater from Other Sources			**21,418** m3/year
Percentage of Total Water Consumption			*63 7%*

2 Breakdown of the Sources of Wastewater for the Recommended Operation

				Change after Implementation
Total Water Consumption	82 0 m3/day	or	**22,953** m3/year	*-31 7%*
From Option #	4 2		41 2 m3/year	
From Option #	4 3		143 6 m3/year	
From Option #	4 4		12 7 m3/year	
From Option #	4 5		926 0 m3/year	
From Option #	4 6		411 6 m3/year	
Total Wastewater from Pre-Treatment			**1,535** m3/year	*-87 4%*
Percentage of Total Water Consumption			*6 7%*	
Wastewater from Other Sources			**21,418** m3/year	*0 0%*
Percentage of Total Water Consumption			*93 3%*	

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Table #:	A5
Topic:	Chemistry Losses Through Drag-Out
Plant:	Express Company

1 **Breakdown of Chemistry Losses through Drag-Out for the Current Operation**

From	Option #	4 2	1,267 6 Kg/year
From	Option #	4 3	1,353 5 Kg/year
From	Option #	4 4	160 9 Kg/year
From	Option #	4 5	1,273 2 Kg/year
From	Option #	4 6	540 1 Kg/year
Total Chemistry Losses			**4,595 Kg/year**

2 **Breakdown of Chemistry Losses through Drag-Out for the Recommended Operation**

				Change after Implementation
From	Option #	4 2	400 0 Kg/year	*68 4%*
From	Option #	4 3	131 0 Kg/year	*90 3%*
From	Option #	4 4	63 3 Kg/year	*60 7%*
From	Option #	4 5	698 8 Kg/year	*45 1%*
From	Option #	4 6	330 0 Kg/year	*38 9%*
Total Chemistry Losses			**1,623 Kg/year**	*-64 7%*

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