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Prevention Project

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POLLUTION PREVENTION DIAGNOSTIC STUDY
COMANDARI S.A.
SANTIAGO, CHILE

Final Report

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The pollution prevention audit/assessment reported on herein was conducted by a team of EP3 and industry representatives. The primary purpose was to assist industry or facility management in creating a sustainable pollution prevention and waste minimization program. This report presents information from the first step in the process; a base line survey and a definition of actions which can be taken to prevent pollution, improve efficiency and pay back any required investments.

The overall EP3 program in the countries in which EP3 has activities includes a wide range of activities including audits/assessments, information dissemination, training and small scale demonstrations. These country programs are all designed to create the conditions in the country which will assure the continuation of urban and industrial pollution prevention and establish locally sustainable pollution prevention programs.

This report was prepared for RCG/Hagler Bailly, Inc. by Jorge Castillo, Environmental Engineering Consultant, Av. Blanco Encalada, 1975 Santiago, Chile.

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The principal opportunities for Comandari S.A. to reduce the plant's impact on the environment and reduce costs are summarized in Table 1. Changes that result in reduced energy use will avoid the release of 5.8 metric tons of air emissions each year in addition to unquantified reductions in the release of global warming gases and heavy metals. Water use can be reduced by 46,700 cubic meters per year. Chemical releases to the surface waters of Chile can also be reduced. The reductions in chemical releases require more research and development before they can be quantified.

Of the five opportunities recommended, the savings possible from implementing four have been quantified. These four recommendations, which include capturing the heat in wastewater, improving rinsing operation, reducing salt consumption, and recycling bleach rinse water, will reduce operating costs by about $15.47 million per year for an initial investment of $5.54 million. The simple payback period for heat recovery is 1.5 months and for salt use reduction is 3.5 months. $3.93 million in investments is required to implement first rinse bleach water reuse, savings potential of which is only $0.67 million per year, with a payback period of 5.9 years.

All savings and costs in this report are quoted in Chilean pesos (430 pesos per U.S. dollar).

Table 1
SUMMARY OF POLLUTION PREVENTION OPTIONS

Unit operations	Pollution prevention action	Implementation cost	Financial benefits	Environmental benefits	Payback period
Hot water discharges	Recovery of heat from effluent	$1,270,000	Reduction of fuel costs by estimated $10 million/year	Reduction of air emissions and wastewater temperature	1.5 months
Rinsing	Replace overflow rising by fill and dump rinsing and reduce fill volume	None	$3.8 million/year	Reduction of liquid wastes	
Waste water discharges	Use lint traps in effluent to reduce suspended solids and other contaminants	$50,000	Unquantified	reduce wastewater solids, sulfur and other pollutants.	
Softening	Reduce salt use by reuse of wash water	$290,000	To be determined. Estimated minimum of $1 million/year	reduce chlorides content in wastewater	3.5 months
Bleaching	Reuse of first bleach rinse water	$3,925,000	$670,560/year	reduce wastewater volume	5.9 years

CHAPTER 2: OBJECTIVE

The purpose of this study was to perform an environmental assessment of a textile dyeing plant and to propose a program of pollution prevention. The study was done under the Agency for International Development, Environmental Pollution Prevention Project (EP3) under the direction of AMCHAM - CHILE by RCG/Hagler Bailly, Inc. Mr. Jorge Castillo was the Industrial Pollution Prevention consultant to RCG/Hagler Bailly, Inc.

Comandari S. A. (Comandari) is a textile industry which produces mostly acrylic yarn and fabrics. The plant operates three eight-hour shifts, six days per week. Comandari typically wet-processes about 1,600 tons of yarn or fabric per year.

EP3 program personnel visited Comandari as part of a search for candidates who expressed an interest in pollution prevention. After obtaining a commitment from Comandari to make every effort to implement pollution prevention opportunities, a pollution prevention diagnostic study was commissioned. An initial interview was conducted to discuss what such a study would cover and what data would need to be collected. Attending this meeting were: John Stead Wells, Operations Manager of Comandari S. A.; Mauricio Roldán of AMCHAM Chile; Eduardo Maal, RCG/Hagler, Bailly; William Bilkovich, Industrial Pollution Prevention consultant; Maurice Knight, EP3/CIERA Technical Assistance Coordinator; and Jorge Castillo G., Chilean consultant.

After the initial briefing, Jorge Castillo spent several days retrieving information for the diagnostic study. In the middle of this process, preliminary findings were discussed in a meeting attended by John Stead Wells, William Bilkovich, Mauricio Roldán, and Jorge Castillo.

Section 4 consists of a detailed discussion of those recommendations. Section 5 details the time required to implement the recommendations and presents a budget for that implementation. Section 6 summarizes the effect that implementation will have on the environment. Following the report is Appendix A, an outline of the processes in the plant, which details water and chemical use for each process. The statement of work and industry agreement are included in Appendices A and B respectively.

4.1 Recovery of Heat from Effluent

Substantial amounts of money are expended by the industry to generate the heat required for most of the wet processes. Heated water or cooling water with an increased temperature are discharged to the sewer system containing about one third of the total heat that is generated by the boilers. Even though the 36°C estimated average temperature of the overall effluent slightly exceeds the Chilean effluent standard for temperature, 35°C, peak temperatures may be much greater than this value.

Calculations and Assumptions

Table 2 shows an estimation of the amounts of wastewater generated by the wet processes and the estimated average temperature of each effluent. Estimations are based on the process description data that is presented in Appendix A. Average temperature for each effluent was estimated by heat balance, assuming that hot effluents are mixed with 16°C cold water.

In 1993, fuel costs were $132.4 million plus an un-estimated cost fraction for wood consumption. Since the estimated steam production was 4.16 million kg/month, the fuel cost for producing 1 kg steam should be at least $2.7. Considering that 1 kg of steam can provide about 400 usable Kcal, unit cost of heat is about 0.0068 $/Kcal.

Assuming that cold water temperature is 16°C and considering that total effluent is estimated in 377,718 m^3/year at 36°C, total heat contained in wastewater is about $7.55 \cdot 10^9$ Kcal/year, about one third of the heat contained in the total steam produced. Recovering just one tenth of the heat contained in wastewater would make savings for $5 million/year. For evaluation purposes it will be assumed that 20% of the heat contained in the effluent can be recovered, thus reducing the average temperature of the overall effluent to 32 °C, and saving 10 million $/year.

Effluent from the fabric processing has a low average temperature, so heat transfer would be slow and inefficient in case it was recovered. The sewer line that lays under the passageway next to the cones and hanks dyeing rooms receives the effluents coming from hanks dyeing and cones bleach and dyeing. It is recommended that heat be recovered from the effluent that is disposed through this sewer line. The flow of this wastewater is 989 m^3/day and its average temperature is estimated at 36,6°C.

Effluent from hanks bleaching go to a sewer that runs parallel to the aforementioned one and also contains the wasted water from fabric processing. The average temperature of this effluent is only 31 °C.

Table 2
COMANDARI S. A.
Water Use and Effluent Temperature

Product	tons/year	m^3/ton	m^3/year	temper-ature
FABRICS				
wool 100%	45	144	6,489	39
wool acrylics	60	252	15,102	39
acrylic	10	146	1,462	37
polyester-rayon-linen	25	764	19,093	21
polyester	10	138	1,377	39
	150		53,180	31
YARN				
cones				
bleaching (20%)	60	53	3,174	51
dyeing (80%)	240	47	11,376	55
	300		18,360	54
Hanks				
bleaching (15%)	240	158	37,920	32
Dyeing (85%)				
acrylics (70%)	952	203	193,104	33
wool (5%)	68	178	12,070	35
cotton (10%)	136	178	24,181	46
other (15%)	204	317	64,758	40
	1,600		332,032	35
TOTAL	2,050		390,105	36

Heat can be transferred to cold soft water through a pipe coil exchanger submerged in a wastewater retention tank. Recovered heat should go to a storing warm water tank to feed the water that will be subsequently steam heated. The greater the volume of the wastewater retention tank the more heat will be recovered. However, since tank cost depends mostly in its capacity, an optimal volume should be calculated. For simplicity, it has been considered that, at least for an initial period, an existing tank at the end of the passage way, with a capacity of about 19 m^3 could be used.

The cost for this heat recovery alternative includes mostly the need for a warm water storage tank, heat exchange tubes, circulation pump, and diversion of waste waters to existing tanks. In the room where cones are dyed there exists a 13.5 m^3 steel tank which could be used for this purpose. The bottom of this tank is elevated, so warm water could feed machines by gravity. Eventually, warm water could be recycled to the exchange tank, to improve the transfer of heat.

Heat exchange tank not only will reduce the effluent temperature but also will regulate the wastewater flow, pollutants content, and pH, thus reducing peak values and making easier to comply with existing effluent standards.

Implementation of the heat recovery system requires a partial repiping of the sewer lines. Since there exists plans for repiping the whole sewer system of the plant, it would be advisable to insert this work in the overall plans for the plant.

Discussion of Obstacles to Implementation

The implementation of a heat recovery system will require an additional effort in terms of operation and maintenance. Workers in charge should be trained and become conscious of the importance of their work and the proper operation of the heat recovery system.

If lint is not removed as recommended in 4.3, it will settle in exchange tank, the cleaning of which will be made more difficult by the presence of the coil exchanger.

Another obstacle is the relatively low temperature of the effluent which makes heat transfer slow, so requiring more time and more tank volume. This obstacle could be overcome if temperature activated valves were installed to divert only hot water over a preset temperature to the heat exchange tank. However, this alternative would require a higher investment and additional control and maintenance. Recirculation of warm water to exchange tank would improve heat transfer.

Schedule of Implementation

To avoid or reduce the undesirable settling of lint or other materials in the heat exchange tank, it is advisable that heat recovery be implemented after the lint traps are installed as recommended in 4.3. It is required to start by evaluating the feasibility of this project and, in case it is feasible, do the engineering design for the system, repipe sewers, install exchanger, and install pipes, pumps and tank required for its proper operation.

Follow up Measurements

EP3 could provide advice for pipe layout, operation and evaluation of the system.

4.2 Modify Rinsing Processes

Whenever overflow or full tank batch rinsing is used it is possible to change to a more efficient use of rinse water that can result in a substantial reduction of its volume, without affecting the quality of the product. Continuous overflow rinsing is very inefficient in terms of water use and can always be replaced by a number of batch rinsing processes where tanks are filled and then dumped completely before refilling. Also, batch rinsing is more efficient if many small volume batches are used instead of a few full tank batches.

Specifically, it is proposed to change from overflow rinsing to fill and dump rinsing at rayon-linen fabric, acrylic hanks, and wool hanks dyeing and to change from full tank fill and dump rinsing to partial tank fill and dump rinsing in wool fabric and acrylic fabric.

Calculations and Assumptions

It has been assumed that overflow rinsing water can be reduced at least by one third if replaced by a batch rinsing. Also, it has been assumed that batch rinsing water can also be reduced by one third if several smaller volume batch rinses are used instead of a few full tank batch rinses as it is performed at present. Table 3 shows the present amount of water estimated for each process, the resulting reduced volume where rinse modifications are applicable, and the resulting yearly water consumption. At present, water use is estimated as 390,105 m^3/year (table 2) and under the modified conditions water use would be 356,472 m^3/year, so saving 33,633 m^3/year.

Table 3
COMANDARI S. A.
Water Use Under Modified Rinsing

Product	tons/year	present m^3/ton	m^3/ton	m^3/year
FABRICS				
wool 100%	45	144	129	5,814
wool acrylics	60	252	222	13,302
acrylic	10	146	131	1,312
polyester-rayon-linen	25	764	560	13,993
polyester	10	138	138	1,377
	150		35,790	
YARN				
cones				
bleaching (20%)	60	53	53	3,174
dyeing (80%)	240	47	47	11,376
	300		14,550	
Hanks				
bleaching (15%)	240	158	158	37,920
Dyeing (85%)				
acrylics (70%)	952	203	177	168,923
wool (5%)	68	178	152	10,343
cotton (10%)	136	178	178	24,181
other (15%)	204	317	317	64,758
	1,600			306,124
TOTAL	2,050			356,472

Cost of Water

There are two deep wells, with pumps that theoretically supply 126 and 50 m^3/hour, with motors of 45 and 37 KW. According to the person in charge of maintenance, total production of water is about 60,000 m^3/month, which means that pumps should work at least 13.1 hours a day on the average. As shown by CHILECTRA invoices electrical energy costs $19.3 /KWH (plus AVT) and according to these figures water pumping costs $8.98/$m^3$.

Soft water is produced in 3 softeners with estimated capacities of 35, 40, and 65 m^3/hour. Each softener is regenerated about twice a day. Although at present none of the two existing flow meters are working (one for two softeners and one for the other) on the basis of readings done in the past, soft water production is estimated in 35,000 m^3/month.

According to the person in charge of maintenance, in each regeneration an average of 2.5 m^3 of saturated solution of sodium chloride is used, plus 8 to 10 m^3 of hard water. Purchases of sodium chloride in 1993 were 1,976,640 kg at 22 plus AVT $/kg, which is equivalent to $43.5 million a year (plus AVT), also equivalent to $103/$m^3$ of softened water. Since salt use has been reduced in the last months, possibly the actual cost is less than this value. For simplicity it will be assumed that softening cost is 80 $/$m^3$, a value found in similar industries.

Total cost of soft water production, including pumping energy and salt for resin regeneration, is 89 $/$m^3$. At this rate, the value of reducing water consumption in 33,633 m^3/year is equivalent to 3.0 million $/year

Discussion of obstacles to implementation

Since proposed changes modify the procedures that operators have applied for several years, a special effort is required to change their habits and to convince them that the proposed changes are required to reduce the effluent flow. Also, since operators have already developed a feeling to know, without any measurement, when the processes are finished, it may take some time to develop the same kind of sensitivity under the new conditions.

If less water is used, the system could be more sensible to small changes, therefore requiring more attention to ensure it operating properly.

Since the use of partially filled tanks could result in some kind of mechanical damage to fibers or fabric, special attention should be taken to the quality of the final product, when changes are being implemented.

Schedule of Implementation

The proposed changes only being operational, its implementation does not require changes to hardware. First, modification should be run and evaluated at an experimental level and then translated into systematic procedures to the operators. After changes are satisfactorily tested, operators should be trained and convinced of the convenience of implementing them.

Follow up Measurements

EP3 could help providing advice for the testing, implementation, and evaluation of the proposed changes.

4.3 Use of Lint Traps

At present, all the lint that is produced at the wet processes machines, goes to the sewer. Lint removal can be done very easily at the generation points by means of the use of grids or parallel bar screens. Lint removal will reduce solids content of effluent, reduce sulfur and other contaminants that can be generated from decomposition of natural fibers, reduce frequency of sewer obstructions, recover fiber that can be sold out, and will make it possible to detect abnormal fiber losses.

Solids are one of the beyond standard contaminants frequently found in textile industries effluents. Lint could be the main source of suspended solids and other contaminants, such as sulfur or nitrogen as by-products from decomposition of organic fibers. This process can occur under anaerobic conditions in sludge deposit in the sewer system.

Frequent sewer obstructions are attributed to the existence of roots inside the pipes. These, associated to the presence of lint in the effluent, can easily result in the formation of obstructing lint accumulations.

Waste fiber with commercial value can be obtained from periodic cleaning of grids and screens. The presence of abnormal amounts of lint trapped at the grid and screens could be a warning to indicate that other components of the system are working under abnormal conditions.

Places to Locate Screens:

Cones and hanks dyeing machines discharge to a channel that runs longitudinally in the bottom of a trench of about 1 m deep where the lower part of the machines themselves and its piping are accommodated. The trench is covered by a wooden platform at the floor level to allow circulation of operators. The channel ends in a short pipe which discharges to the nearer manhole in the passage way. Channel is corroded and needs to be rebuilt. From the point of

view of lint interception and screens cleaning, the best location for the screens seems to be inside the two manholes that receive the discharge pipes. The manhole that receives the outflow from the hank dyeing machines even has a built-in device to install a grid, which is not in use at present. If lint traps are installed in the locations recommended, cleaning operation would not interfere with the production process. The lint retention system should be a basquet type grid, with openings of 1 to 2 cm. Smaller openings would intercept more solids but would result in an excessive frequency of cleaning.

Since Fongs machines are located at floor level the depth of their discharge channel is only a few centimeters, being much more accessible than the discharge channels for cones and hank dyeing machines. The best location for a screen in this case is at the end of the channel, either inside or outside the dyeing room, just before the point the channel discharges to the manhole. This screen should be made of parallel bars inclined to about 60° to horizontal, with its bottom in the upflow end, with openings of about 1 or 2 cm. Parallel bar screens make possible an easy cleaning with a simple hand operated rack. Inclination makes that retained material moves up as flow passages through the screen.

Screens at fabric dyeing and hank bleaching rooms should be located at the end of collections channels at places where all water will pass through them, where it is easy to reach and clean them, and where cleaning operation does not interfere with production processes.

Calculations and Assumptions

There are no calculations for this recommendation.

Discussion of Obstacles to Implementation

Lint removal requires regular and frequent inspection and cleaning of lint traps. If personnel is not aware of the importance of removing lint before it goes to the sewer, it is possible that cleaning and maintenance of lint traps could be a second or third priority activity in the plant. It seems that lint traps existed once and were removed, possibly to avoid cleaning them.

Schedule of Implementation

Lint removal screen and grid can be made at mechanical shop existing in the industry. Its installation requires no more than one or two weeks.

Follow up Measurements

If needed, EP3 could provide advice on the design and installation of lint traps.

4.4 Reduction of Salt Consumption

Regeneration of each softener takes an average of 2.5 m^3 of saturated solution of sodium chloride plus 8 to 10 m^3 of hard water, used for backwashing the resin and rinsing the removed hardness and brine solution. Rinsing is considered complete when hardness of water is as low as 2 mg/l. In the period when rinse water hardness is between the same of untreated hard water from wells, of about 500 mg/l, an 2 mg/l, it still contains some of the salt excess that is being removed. If this water, which is low in hardness and high in salt concentration were used to prepare brine for the next regeneration, there would be an improvement in the regeneration process and the use of salt and water would be reduced. Water use reduction would be of 4,680 m^3/year.

Since softeners regeneration operation is performed with hard water, the production cost of which is only about 9 $/$m^3$, significant cost savings would come only from the reduced consumption of NaCl if the wash water contains a significant concentration of this salt. Additionally, if brine contains less hardness than hard water supplied from the wells, efficiency of regeneration would increase.

Calculations and Assumptions

Savings in terms of salt will depend on the amount of remaining NaCl in wash water. Since it is not possible to know what the NaCl concentration of the reused wash water would be without a measuring campaign, savings have been calculated as a function of salt concentration in recovered water. Table 4 shows yearly savings as a function of salt concentration in the recovered water. Calculation of savings has been done assuming that an average of 6 regenerations are done per day, each regeneration using 2,500 liters of brine at 209 gr/liter concentration (25°B). NaCl cost has been considered to be of $22/kg, based on the existing information.

Table 4
Yearly Savings as a Function of Salt Concentration

Salt concentration in recovered wash water (grams/liter)	Yearly savings (million $)
209	21.52
200	20.59
150	15.44
100	10.30
50	5.15
40	4.12
30	3.09
20	2.06
10	1.03

A simple way to recover wash water would consist in the use of a tank of at least 2.5 m^3 capacity to store water and a small pump to send it to the brine preparation tank. However, taking into account that 2.5 m^3 of brine are used in each regeneration, it is also possible to avoid using this storage tank if the recovered wash water is just pumped to refill the brine preparation tank.

Discussion of Obstacles to Implementation

Since the feasibility of the proposed method depends on the salt content of wash water when it reaches a hardness equivalent to well water, a special study is required to determine NaCl and hardness curves as a function of time in wash water. The cost of ten salt and hardness determinations using standard laboratory analytical procedures is $70,500.

Also, a simple method for testing hardness and salt content of wash water should be implemented. Hardness could be measured by the usual colorimetric method and salt content with a densimeter.

Since hardness and salinity should be evaluated before recovering wash water, the implementation of this prevention opportunity increases the complexity of softeners operation. Not being a current industrial practice, this prevention opportunity could be viewed with suspicion.

If wash water comes out of the softeners with low hardness and high salt content it could also mean that an excessive amount of brine is being used for regeneration. This suggests that salt consumption could be alternatively done just by reducing the amount of brine.

Schedule of Implementation

Implementation of this prevention opportunity requires conducting a study, evaluating its feasibility, evaluating easy means for determining salt and hardness content, testing of the proposed method and its alternative, installation of pump, and training of operators.

Follow up Measurements

EP3 could help in designing one or more experiments to evaluate project feasibility.

4.5 Reuse of Bleaching First Rinse Water

Bleach solutions can sometimes be recycled for further use in the same process, saving water and reactants. In the case of Comandari S. A. dye technicians think that it is not possible to reuse bleach solutions because they would be contaminated and with very low reactants concentration. However, first rinse water could be used to prepare a new bleaching solution, thus saving at least a significant amount of water.

Calculations and Assumptions

According to the available information on bleaching process, first rinse of cone bleaching contains acetic acid and first rinse in hanks bleaching contains a softener. Anyhow, reusable water would be 2,000 liters for every 150 kg, which is 13.3 liters/kilo for the cones, and 12,000 liters for every 380 kilos, which is 31.6 liters/kg. Considering that cones and hanks bleached are 60 and 240 tons a year, savings of soft water would be 798 and 7,584 m^3/year which totals 8,382 m^3/year with a cost of about $670,560/year, if it is assumed that soft water costs $80/$m^3$

Recycling of this water would require the use of a especial pipe system, a holding tank, and a recycling pump. Ideally holding tank should be below floor level to allow gravity discharge. Water should be pumped from this tank for reuse.

Cones bleaching is done only in THEN N°1, with a volume of 2,000 liters, and hanks bleaching in tanks N° 5, 6, and 7, with a total capacity of 12,000. Assuming that hanks bleaching machines will work in parallel, a 2,000 liters holding tank is required for recycling the cones bleach rinse and a 12,000 liters tank for hank bleach rinses. Pumps should be able to recycle at a flow rate similar to the one that can be obtained from the pipe system, of about 2 l/s.

Discussion of Obstacles to Implementation

Since savings arising from this prevention opportunity are low there will probably be resistance to implementation of the proposed changes. Experiments should be run before final implementation to ensure that recycling is feasible from the technical point of view and that the quality of the product is not impaired or that the impairment risk is not excessive.

Recycling of bleach rinse water requires the operators to be especially careful. They should be able to discriminate whether each water should be discharged through the usual way or to the holding tank. Also, operators should be aware that only bleach rinse waters should be sent to the holding tank, but not other wastewaters.

Schedule of Implementation

Implementation of this prevention opportunity requires that experiments be run in the first place to ensure recycling feasiblility. Should it be feasible, tanks, pumps, and all necessary piping and valves should be installed. Operators should receive special training to be aware of the importance of the operational changes and to feel involved in the project.

Follow up Measurements

EP3 could assist, upon request, in designing experiments, suggesting tanks and piping lay out, and providing training to operators.

Table 5 presents a schedule of implementation, subject to the availability of personnel and capital, for the five recommendations made in this report. One of them can be implemented with no capital investment. For those projects that do require expenditures, the approximate amount of the required investment appears in the shaded window which shows the time required for implementation. Many projects can be implemented in less than six months. Most of those projects are not dependent upon other projects for their initiation. Instead of specifying the order in which these short projects should be done, the table places the start date for all of them in week one.

TABLE 5
Schedule of Implementation and Capital Budget

PROJECT	WEEK												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Recovery of heat from effluent (4.1)													
Feasibility analysis													
Engineering design													
Sewer repiping						120,000							
Exchanger installation								500,000					
Piping, pump, and tank installation											650,000		
Modify rinsing processes (4.2)													
Run experimental test													
Prepare procedures for operators													
Operators training													
Use lint traps (4.3)													
Prepare screens	50,000												

TABLE 5
Schedule of Implementation and Capital Budget

PROJECT	WEEK												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Installation													
Reduction of salt consumption (4.4)													
Determine NaCl and hardness curves	70,000												
Implement simple measuring procedures													
Install pipes and pump				220,000									
Reuse of bleaching rinse water (4.5)													
Evaluate detailed feasibility													
Install tanks, pipes, and pumps			3,925,000										

Implementing the recommendations in this report will lower operating costs for Comandari by $15.5 million per year. Just as important, these projects will reduce the impact that the operation of the plant has on the environment. This section summarizes those environmental benefits.

6.1 Air Emissions

One of the proposed changes will reduce steam consumption, lower fuel use and thereby reduce air emissions. Only the savings that can be gained through recovering the heat from effluent have been quantified. Recapturing the heat from effluent should reduce fuel consumption by 7.5% or 189 metric tons of Number 180 oil per year. Number 180 is an intermediate fuel between Number 5 and Number 6.

Using USEPA document AP-42 and assuming that Number 180 oil emissions are similar to Number 5 oil emissions, the effect of reducing consumption in a commercial steam boiler by 189 metric tons of Number 180 oil can be estimated. Table 6 presents the expected reductions. They total about 5.8 metric tons of air pollutants avoided each year. Not included in these figures are reductions in carbon dioxide emissions which reduce the plant's contribution to global warming. Heavy metal emissions will also be reduced, but cannot be quantified without fuel analysis.

TABLE 6
Reductions in Air Emissions

POLLUTANT	AP-42 EMISSION FACTOR in KILOGRAMS per METRIC TON of #5 OIL BURNED	YEARLY REDUCTION FROM BURNING 189 FEWER TONS OF #5 OIL
Particulate Matter (All)	2.14 kg/MT	404 kg
Sulfur Oxides	20.62 kg/MT	3,897 kg
Nitrogen Oxides	7.15 kg/MT	1,351 kg
VOCs	0.036 kg/MT	6.8 kg
Carbon Monoxide	0.65 kg/MT	123 kg
Lead	0.00055 kg/MT	0.1 kg

6.2 Liquid Wastes

Heat recovery from effluent would reduce the average effluent temperature from 36°C to 32°C or less, depending on the amount recovered, and will also distribute it more evenly in time. Even though effluent temperature of the industry is not a problem on average, being

slightly over 35°C, the maximum allowable temperature according to Chilean standards, the heat recovery system will be more effective in reducing the temperature precisely when it is at the higher levels.

If rinse water reduction, reuse of resin regeneration wash water, and reuse of bleach rinse water projects are implemented, Comandari S. A. could consume 46,700 m^3/year less water than it now does. A certain chemical use decline could take place if bleach chemicals contained in rinse water allow for a reduction of the doses applied at present.

Removal of lint at the source points will reduce solids content of effluent, reduce sulfur and other contaminants that can be generated from anaerobic decomposition of natural fibers, and also reduce frequency of sewer obstructions. Recovered fibers will increase the amount of solid wastes unless they can be reused or sold.

Reuse of regeneration wash water will reduce chlorides content in water. If 1993 salt consumption, of about 2 million kg/year, and total annual water use, of 720,000 m^3/year, are considered, the resulting average concentration of chlorides is 1,600 mg/l. Even though chlorides concentration is not limited by the Chilean liquid effluent standard, this concentration is very high and should be reduced.

APPENDIX A

Industry Agreement

CONTRATO DE MUTUA COOPERACION
ENTRE
El Programa EP3 Y (EMPRESA)

Se celebra el presente Contrato con fecha 09 de Marzo de 1994, por y entre El Programa de Prevención de Contaminación (en lo sucesivo denominado "El Programa EP3") financiado por la Agencia de los Estados Unidos para el Desarrollo Internacional, (en lo sucesivo denominado como "USAID") en Chile, y que cuenta con el respaldo de la Cámara Chilena Norteamericana de Comercio A.G. (en lo sucesivo denominado como "AMCHAM"), y que recibirá asistencia técnica de RCG/Hagler, Bailly, Inc. como Contratista Principal (en lo sucesivo denominado como "EP3-HBI"), con sus oficinas situadas en la Cámara Chilena Norteamericana de Comercio A.G., Avenida Américo Vespucio Sur 80, piso 9, Casilla 82, Santiago 34, Chile, por una parte; y por la otra parte Industria Textil COMANDARI SA. (en lo sucesivo denominado "EMPRESA"); domiciliada en Avda, Carlos Valdovinos 420, San Joaquín, Santiago, Chile;

Y

POR CUANTO "EP3-HBI" ha sido contratado por la Agencia de los Estados Unidos para el Desarrollo Internacional para que le proporcione al Programa EP3 servicios de administración y apoyo técnico;

Y

POR CUANTO la EMPRESA manifestó su deseo de participar en El Programa EP3, de ejecutar un Estudio de Diagnóstico de Prevención de Contaminación y de implementar sus recomendaciones;

LAS PARTES VIENEN, EN VIRTUD DE LO EXPUESTO, A CONVENIR LO SIGUIENTE:

1.0 <u>RESPONSABILIDADES DEL PROGRAMA EP3</u>

1.1 El Programa EP3 y EP3-HBI ejecutarán directamente y/o contratarán (sin costo para la EMPRESA) un análisis diagnostico de prevención de contaminación que será hecho por técnicos/expertos Chilenos asistidos por técnicos/expertos extranjeros, cuando sea necesario. Entre la primeras actividades del estudio diagnostico será establecer una base de referencia de las composiciones actuales de los efluentes de la EMPRESA.

1.2 El Programa EP3 y EP3-HBI le enviarán a la EMPRESA, para su respectiva aprobación y consentimiento, un Alcance de trabajo recomendado para la EMPRESA.

1.9 El Programa EP3 designa aquí al señor Mauricio Roldán como Coordinador del Proyecto, quien asume una responsabilidad contractual y operativa directa en virtud del presente Contrato.

El señor Roldán será también responsable de verificar el cumplimiento de las condiciones del presente Contrato.

2.0 RESPONSABILIDADES DE LA EMPRESA

2.1 La EMPRESA cooperará con los técnicos del Programa EP3, suministrará las informaciones técnicas, administrativas y contables, relacionadas a los procesos de fabricación necesarias para analizar los sistemas de producción. El objetivo de esto es identificar posibles cambios en ellos, en las materias primas (si es posible), en los productos químicos, en los controles de producción, y en otros variables para reducir la emisión de contaminantes, y que incidirá en el mejoramiento de la productividad y la rentabilidad operacional.

2.2 La EMPRESA también proveerá a los técnicos del Programa EP3 las informaciones, mediciones o datos relacionados a las actuales composiciones de los efluentes de nuestra EMPRESA y sobre proyectos de mejoramiento ambiental en ejecución o en planificación. En caso que no tengamos datos cuantitativos sobre la composición actual de efluentes, permitiremos que El Programa EP3 directamente o usando sub-contratistas de USA o Chilenos tome mediciones cuantitativas sobre la composición de los efluentes como parte del estudio diagnostico de prevención de contaminación.

2.3 La EMPRESA requiere que todos los datos confidenciales de procesos de propiedad de la EMPRESA, o datos relacionados a composición de efluentes que suministre, o cualquier información operacional o comercial que obtengan los técnicos del Programa EP3 en la EMPRESA, serán tratados con máxima confidencialidad, y que no serán divulgados a ninguna entidad Publica o Privada sin previa aprobación por escrito por parte de la EMPRESA.

2.4 La EMPRESA tendrá la última decisión y aprobación de cualquiera recomendación que haga el programa EP3, y por ende, la EMPRESA releva al Programa EP3 de toda responsabilidad legal relacionada a la implementación de las recomendaciones del Programa EP3 o de sus resultados.

2.5 La EMPRESA está de acuerdo con que el Programa EP3 inicialmente, tratará de identificar modificaciones que no impliquen mayores inversiones o costos.

2.6 La EMPRESA implementará las modificaciones identificadas y recomendadas por El Programa EP3, siempre y cuando estas, según evaluación de la EMPRESA, no sean perjudiciales a los productos, a los sistemas de producción, ni a las prácticas comerciales y de ventas.

2.7 La EMPRESA permitirá que El Programa EP3 le de publicidad a los resultados de las innovaciones recomendadas por el Programa EP3, y permitirá que otras industrias con procesos similares se beneficien de las experiencias de nuestra EMPRESA, siempre y cuando esto no involucre procesos de propiedad de la EMPRESA, y que se puedan transferir a otras industrias del sector. Los resultados no serán divulgados a ninguna entidad Publica o Privada sin previa aprobación por escrito por parte de la EMPRESA. Esta divulgación de resultados se podrá hacer durante los dos (2) primeros años siguientes a la puesta en marcha e iniciación operativa de las modificaciones o aplicaciones, de forma que otras empresas puedan observar las tecnologías en operación. Estas visitas serán aprobadas por el Gerente de Proyecto de la EMPRESA, y se programarán de forma tal de minimizar perturbaciones en las operaciones de la EMPRESA.

2.8 La EMPRESA obtendrá también las licencias, permisos y otros documentos oficiales que puedan requerirse. La EMPRESA se encargará del pago de cargos locales. La EMPRESA será responsable del almacenamiento y de la seguridad de todos los instrumentos y/o equipos de los técnicos del Programa EP3 desde su llegada a ésta.

2.9 La EMPRESA se compromete a pagar los costos de implementación de la recomendaciones del Programa EP3 que sean aceptadas por la EMPRESA.

2.10 La EMPRESA accede a proporcionar personal operativo y de mantenimiento que esté capacitado para recibir entrenamiento para la Operación y Mantenimiento de los equipos, instrumentos o recomendaciones operacionales según lo soliciten El Programa EP3 y EP3-HBI o el consultor/contratista local que contrate El Programa EP3 para el Programa EP3. La EMPRESA tambien se compromete a promocionar una ética de Prevención de Contaminación que adoptará e implementará la siguiente politica ambiental formalizada, que incluirá a todo su personal:

> "Para la EMPRESA, la protección del medio ambiente tendrá máxima prioridad. Nuestro compromiso será eliminar o reducir la utilización de sustancias tóxicas y reducir al mínimo el uso de la energía y la generación de todo tipo de desechos, siempre que sea posible. Preferimos prevenir la contaminación en la fuente que controlarla y/o tratarla al final del proceso industrial. En los casos que no se puede evitar que haya desechos, trataremos de reciclar, de tratar o eliminar desechos por medios que reduzcan al mínimo los efectos nocivos para la atmósfera, las aguas y la tierra."

2.12 La EMPRESA proporcionará personal con capacidades técnicas suficientes para ejecutar las funciones de verificación o implementación que identifique El Programa EP3. Se le proporcionará toda la información disponible a Programa EP3 que sea necesaria para formular sus recomendaciones.

2.13 Luego de la ejecución del presente Contrato, el personal técnico de la EMPRESA y del Programa EP3 realizarán conjuntamente el seguimiento de los resultados. Se registrarán toda medida y parámetros necesarios, como ser las emisiones y los efluentes, para verificar la reducción de los efluentes y de las emisiones.

2.14 La EMPRESA designa al Señor John Stead como su Gerente de Proyecto, quien asumirá las responsabilidades de revisión técnica de la EMPRESA en relación a la implementación del Programa EP3. El Gerente de Proyecto actuará también como enlace entre la EMPRESA y El Programa EP3/EP3-HBI y/o con los consultores/contratistas extranjeros o Chileno, que contrate El Programa EP3 para este Proyecto.

2.15 La EMPRESA le proporcionará espacio de trabajo a los representantes del Programa EP3 cuando éstos se hallen en la EMPRESA durante las fases de medición, implementación de las recomendaciones, y puesta en marcha de operaciones, y también durante el seguimiento de las implementaciones de las recomendaciones y las evaluaciones y/o mediciones de los resultados.

2.16 La EMPRESA conviene en participar, con otras firmas y con El Programa EP3, en la promoción de la "aplicación de tecnologías de prevención de contaminación", asistiendo a seminarios y talleres.

2.17 La EMPRESA declara que ni El Programa EP3 ni USAID ni EP3-HBI ni sus respectivos contratistas y sub-contratistas, serán responsables por ningún daño directo o indirecto, especial o consecuencial; incluyendo, sin que esta enumeración sea limitante, pérdida de energía, costo de reponer energía, imposibilidad de uso o pérdida de ganancias que pudiesen resultar de la implementación de recomendaciones emanadas de los Estudios Diagnósticos de Prevención de Contaminación o de cualesquier otros servicios prestados por El Programa EP3, por USAID o por EP3-HBI o por sus respectivos contratistas y sub-contratistas en virtud de este Contrato.

2.18 La EMPRESA declara que ni El Programa EP3 ni USAID ni EP3-HBI ni sus respectivos contratistas y sub-contratistas, serán responsable por daños personales, pérdidas o daños a la propiedad que pudiesen resultar de la Aplicaciones Técnicas descritas en este documento. La EMPRESA se compromete a indemnizar, a defender y a mantener libre de perjuicio al Programa EP3, a USAID y a EP3-HBI y a sus respectivos contratistas y sub-contratista por y ante cualesquier demandas, juicios o procedimientos provocadas por o relacionadas con cualquier acto o emisión en relación con la ejecución de los servicios objeto del presente Contrato.

2.19 Queda convenido que la EMPRESA procurará sus propios seguros como única medida paliativa ante daños personales, pérdidas o daños a la propiedad o ante cualquier otra pérdida o daño resultantes de o relacionados con la prestación de los servicios ejecutados por El Programa EP3, por USAID y por EP3-HBI y por sus respectivos contratistas y sub-contratistas en el cumplimiento del presente Contrato. La EMPRESA acepta liberar, por el presente instrumento, al Programa EP3, a USAID y a EP3-HBI y a sus respectivos contratistas y sub-contratistas, de responsabilidad por cualesquier pérdidas o daños que pudiese sufrir la EMPRESA por razones de cualquier clase que sean, en este respecto.

2.20 Se espera que la EMPRESA proporcione indemnización o cobertura a su propio sub-contratista, si lo hubiese, sobre cualquier equipo o instalación de instrumentos en el transcurso de sus prácticas normales de contratación, y que tales medidas puedan incluir cualesquier fuerzas mayores, retrasos, daños liquidados o garantías de cumplimiento que la EMPRESA pueda desear, pero se entiende también que tales medidas no involucrarán en forma alguna los resultados de cualesquier actos u omisiones del Programa EP3 ni de EP3-HBI ni de ninguno de sus contratistas y sub-contratistas.

3.0 <u>OBLIGACIONES FINANCIERAS DE AMBAS PARTES</u>

3.1 El Programa EP3/EP3-HBI o el consultor/contratistas extranjeros o Chilenos contratados por El Programa EP3 para este Proyecto, no tienen obligación financiera alguna para con la EMPRESA. En igual forma, la EMPRESA no tiene obligación financiera alguna para con el Programa EP3/EP3-HBI o el consultor/contratistas extranjeros o Chilenos contratados por El Programa EP3 para este Proyecto.

4.0 DURACION DE ESTE CONTRATO

4.1 Este contrato tendrá una duracion suficiente para efectuar los estudios diagnósticos descritos anteriormente, y para implementar las recomendaciones del Programa EP3, pero en ningún caso será mayor de un (1) año a partir de la fecha de la firma de este contrato. El período de duracion solamente podrá ser modificado por medio de un acuerdo formal por escrito, entre las dos partes.

5.0 DISPOSICIONES GENERALES

5.1 Honorarios Eventuales

A) La EMPRESA garantiza que no ha empleado ni le ha pagado a ninguna persona ni agente de ventas para que solicite u obtenga este Contrato en base a un contrato de entendimiento por comisión, porcentaje, corretaje u honorarios anticipados; a excepción de empleados de buena fe o de agencias comerciales o de venta establecidas que la EMPRESA mantenga para efectos de procurar negocios.

B) En caso de infringimiento o violación del presente Contrato, El Programa EP3 tendrá el derecho de detener todas las actividades sin contraer responsabilidad por ello.

5.2 Efecto Legal de la Aprobación y Decisión de USAID

Las Partes suscritas manifiestan entender que el presente Contrato reserva ciertos derechos para USAID, tales como (pero no limitándose a): el derecho de aprobar las condiciones del presente Contrato, y también la EMPRESA y cualesquier otras industrias, los informes, las especificaciones, los sub-contratos, los documentos de licitación, los planos u otros documentos relacionados con el presente Contrato, como también el Proyecto del que este Contrato forma parte. Las partes suscritas declaran también entender y aceptar que USAID, al reservarse cualesquiera o todos los derechos de aprobación mencionados, actúa únicamente como una entidad financiera para asegurar el uso adecuado de los fondos del gobierno de los Estados Unidos, y que cualquier decisión que USAID tome de ejercer o de abstenerse de ejercer tales derechos de aprobación, será en cuanto parte financiante en el curso del financiamiento de este Proyecto, no significando que USAID entre a ser una parte del presente Contrato.

Las Partes suscritas declaran entender y aceptar que USAID puede, de vez en cuando, ejercer los derechos de aprobación mencionados, o bien discutir materias relacionadas con tales derechos y con el Proyecto, ya sea con las partes en conjunto o separadamente, sin que por ello incurra en responsabilidad alguna ante las partes, ni en conjunto ni en forma separada. Cualquier aprobación (u omisión de aprobar) por parte de USAID no privará al Programa EP3 ni a EP3-HBI ni a USAID de ejercer sus derechos, ni liberará a la EMPRESA de ninguna responsabilidad que ésta pudiese tener, de no haber mediado tal ejercicio, ante El Programa EP3, ante EP3-HBI o ante USAID.

5.3 Inspección

La EMPRESA consiente en permitir acceso a los representantes autorizados del Programa EP3 y de USAID, en cualquier momento razonable, para que inspeccionen las instalaciones, las actividades y el trabajo relacionado con este Contrato, y también para que adopten medidas de trabajo y realicen pruebas durante la vigencia del presente Contrato.

5.4 Notificaciones

Cualquier notificación que entregue al Programa EP3/EP3-HBI tendrá validez y efectividad solamente si se emite por escrito y se entrega al coordinador del Programa EP3 o a la EMPRESA en las direcciones consignadas en este Contrato. Las notificaciones entrarán en vigencia al momento de su entrega o a la fecha consignada como efectiva, lo que ocurra primero.

5.5 Ley que Regirá

El presente Contrato se interpretará de acuerdo con las leyes de la República de Chile, y en caso de litigio, este se tramitará en la ciudad de Santiago.

6.0 COPIAS DE ESTE CONTRATO

6.1 Este documento se hará en cuatro originales, uno para el Programa EP3, uno para la EMPRESA, uno para AMCHAM y uno para EP3-HBI.

Se declara que las partes, por medio de sus representantes debidamente autorizados, están de acuerdo con las cláusulas de este contrato.

Por la EMPRESA

Nombre: John Stead

Cargo: Gerente Operaciones

Firma:

Fecha: 15 Marzo.1994

Por el Programa EP3

Nombre: Eduardo S. Maal

Cargo: DEPUTY DIRECTOR

Firma:

Fecha: 3/17/94