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POLLUTION PREVENTION ASSESSMENT
LA SOCIÉTÉ INDUSTRIELLE OLÉICOLE SFAXIÈNNE, SIOS-ZITEX
SFAX, TUNISIA

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 Alan J Gagnet, Hirschhorn & Associates, Inc., 4221 Forbes Boulevard , Suite 240, Lanham, MD 20706.

Other contributors include Timothy D. Gum, who served as the Oil-Seed Extraction and Refining Industry Expert on the Assessment Team. He provided guidance, analysis, and invaluable technical expertise to specify the extent and practicality of the various cost savings, process improvements, and strategies. Dr. Bechir N. Ouederni, EP3 Tunisia's Pollution Prevention Engineer managed the pre-assessment data gathering, identified pollution prevention options, and assisted in the assessment and analysis. Dr. Khaled Medhioub, director of the Regional Laboratory of Environmental Sciences (LARSEN) at the National School of Engineering in Sfax provided indispensable technical support and high quality laboratory services for the work at SIOS-ZITEX. The Assessment Team received the full support and assistance of Rachid Nafti, EP3 Tunisia's Office Director. Dr. Joel S. Hirschhorn assisted with the report preparation.

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The tightening of environmental standards, the increased costs for environmental controls, the need to be more competitive and expand into new markets, and the desire to maintain and improve upon the firm's reputation for high quality oil and soap motivated the owners of La Société Industrielle Oléicole Sfaxiènne (SIOS-ZITEX) to seek EP3 Tunisia's help in performing a pollution prevention assessment. Overall, the assessment identified 10 pollution prevention options that could provide first year savings of 442,165 TD for a one-time investment of 404,000 TD (the investment figure does not include any salary expenses, overhead, taxes or duties, and, as of May 1994, $1 US = 1.020 TD). If implemented, these pollution prevention improvements will: reduce hexane emissions to the atmosphere and to waste water by over 160,000 kilograms; significantly reduce waste water volume by 96,000 cubic meters per year and thereby reduce capital costs for a planned waste water treatment system; reduce particulate and NO_x emissions; reduce the risk of fire or explosion from hexane; and, improve productivity and product quality. The assessment identified four, no-low cost pollution prevention improvements that will save the company 25,000 TD for an investment of 11,000 TD. The assessment also identified six long-term, capital intensive pollution prevention changes that would cost 393,000 TD and could save as much as 417,165 TD upon implementation. The savings predicted for SIOS-ZITEX could rise dramatically by including the avoided capital costs for a waste water pre-treatment station designed for operating conditions before the assessment. Table 1 presents the assessment's findings in order of unit operation processes.

TABLE 1
SUMMARY OF POLLUTION PREVENTION OPTIONS

Unit Operation	Pollution Prevention Action	Health and Environmental Benefits	Cost to Implement TD	First Year Financial Benefits TD	Payback Period
Grignon Drying	Leave 12% residual moisture instead of the current level of 7%	Reduced hexane emissions from extraction and reduced particulate and NO_x emissions from boilers	0	Financial benefits not directly quantifiable	Not applicable
Grignon Drying	Purchase a steam tube dryer to eliminate direct contact between flue gas and grignon	Reduced hexane, particulate, and NO_x emissions as well as significantly reduced fire hazard	50,000	The cost of one fire or explosion	Not applicable
Oil Extraction: Hexane Washing	Purchase and install a heat exchanger to pre-heat the grignon and hexane to 60 C°	Reduced hexane emissions	12,000	219,300 combined	3 months
Oil Extraction: Hexane Distribution	Design, build, and install a hexane distribution manifold for each extractor	Reduced hexane emissions	25,000	219,300 combined	3 months
Oil Extraction: Control Hexane Feed Rate	Purchase and install flow meters for each extractor	Reduced hexane emissions	15,000	219,300 combined	3 months
Oil Extraction: Vapor Vent Condensing	Purchase a shell and tube condenser to maintain a negative pressure (vacuum) on the system	Reduced hexane emissions	7,000	219,300 combined	3 months
De-Solventizing Grignon: Steam Distribution	Design, build, and install a steam distribution manifold for each extractor	Reduced hexane emissions	25,000	21,465 combined	2 1/2 years combined

Unit Operation	Pollution Prevention Action	Health and Environmental Benefits	Cost to Implement TD	First Year Financial Benefits TD	Payback Period
De-Solventizing Grignon: Steam Measuring	Purchase and install flow meters and pressure gauges	Reduced hexane emissions	16,000	21,465 combined	2 1/2 years combined
De-Solventizing Grignon: Steam - Hexane Vapor Condensation	Purchase and install a shell and tube condenser to maintain a negative (vacuum) pressure on the system	Reduced hexane emissions	20,000	21,465 combined	2 1/2 years combined
Miscella Distillation: Hexane Evaporation	Purchase and install a heat exchanger to pre-heat the Miscella with the hot oil exiting the stripper	95% reduction of hexane contaminated waste water equivalent to 91,200 kilograms of hexane and 96,000 cubic meters of water per year; reduced hexane air emissions	8,000	166,400 combined	About 1 year
Miscella Distillation: Hexane Evaporation	Purchase and install two steam ejectors	Same as above	10,000 8,000	166,400 combined	About 1 year
Miscella Distillation: Vapor Condensation	Purchase and install two shell and tube condensers to maintain a negative (vacuum) pressure on the system	Same as above	27,000	166,4000 combined	About 1 year
Miscella Distillation: Water Cooling	Purchase and install an efficient cooling tower with a fan	Same as above	60,000	166,400 combined	About 1 year
Miscella Distillation: Hexane Vent Recovery	Purchase and install a mineral oil absorber	Same as above	60,000	166,400 combined	About 1 year

Unit Operation	Pollution Prevention Action	Health and Environmental Benefits	Cost to Implement TD	First Year Financial Benefits TD	Payback Period
Refining Oil: Neutralization Pre-Treatment Centrifuge	Purchase and install oil, acid, and caustic flow controllers and meters	Reduced oil loss to water stream	20,000	4,000	5 years
Refining Oil: Neutralization Wash Water Centrifuge	Purchase and install wash water flow controller and meter	Reduced waste water	4,000	6,000	9 months
Decolorization	Purchase and install a shell and tube heat exchanger to cool oil before storage	Reduced loading on decolorizing system, less waste	7,000	19,000 combined	Less than 5 months
Decolorization	Increase the holding time in the bleacher from 15 minutes to 30 minutes	Reduced operating wastes and costs in decolorization	0	19,000 combined	Immediate
Deodorization	Purchase and install two shell and tube vacuum condensers	Reduced fatty acids dumped into the sea	30,000	6,000	5 years

2.1 Assessment Objectives

The objective of the assessment was to identify pollution prevention options that would: reduce the quantity of toxics, raw materials, and energy used in the manufacturing process, and thereby, reduce industrial pollution and worker exposure to toxic chemicals; demonstrate the environmental and economic value of a focused pollution prevention assessment; improve manufacturing competitiveness and product quality; provide the foundation for a sustainable pollution prevention program at the company; and, reduce the costs associated with a waste water pre-treatment system. All of these objectives have been achieved.

The assessment focuses on the technical aspects of pollution prevention and is not intended to be a comprehensive evaluation of the safety and health impacts or considerations of the plant's operation. The assessment also does not address general business and management practices such as accounting procedures, data gathering, and data analysis.

The level of effort for this assessment, report development, and briefing and de-briefing meetings totalled 16 person days for US consultants. EP3 Tunisia provided approximately 12 person days on the project and local Tunisian consultants provided 6 person days.

This report provides the details on how to achieve and maintain pollution prevention changes at the facility and is intended to serve as a first step in developing a sustainable pollution prevention program at the facility; and, to provide information that will help similar oil extraction refining, and soap manufacturing facilities in Tunisia and other developing countries.

2.2 Report Organization

The remainder of this report is organized as follows: Chapter 3 presents background information on the SIOS-ZITEX oil extraction, refining, and soap manufacturing facility. Chapter 4 presents the conclusions and recommendations of this assessment, organized according to the processes used at the SIOS-ZITEX facility. Chapter 5 presents an approach for evaluating the present efficiency of SIOS-ZITEX's operations and improvements in the plant's performance as a result of implementing the recommendations contained in this report. Chapter 6 summarizes the principal conclusions of the assessment. The appendices include more detailed information and a glossary of terms.

3.1 Company Background

Located in Sfax, Tunisia, La Société Industrielle Oléicole Sfaxiènne, SIOS-ZITEX, extracts and refines oil from spent olive oil pressing waste (grignon) for sale as consumable oil. They also refine soy, olive, and rape seed oil for clients, including the Tunisian Ofice National de Huile (ONH). With any oils that cannot be used for consumption, they manufacture soap. Tables 2 and 3 list the principal inputs and outputs.

The firm was founded in 1926 and renovated in 1961. SIOS-ZITEX operates three, 8 hour shifts, with 80 permanent employees and 80 seasonal employees. Sales exceeded 2.7 million Tunisian Dinars during the 1992-1993 operating season. SIOS-ZITEX is the only company in the Sfax area that extracts olive oil from grignon. They represent approximately 30% of the national market for oil seed refining and sell about 15% of the nation's bar soap used primarily for clothes laundering. L ' Ofice National d' Assainissement (ONAS) has mandated that they purchase, install, and operate a waste water pre-treatment system before the end of 1994.

TABLE 2
PRINCIPAL RAW MATERIAL INPUTS

Description	Unit Cost TD per kilogram	Kilograms	Total Cost TD
Phosphoric Acid	1.068	8,800	9,395
Fresh Grignon	0.628	51,000,000	320,076
Hexane	0.641	393,228	252,023
Salt	0.074	358,850	26,554
Sodium Hydroxide	0.341	368,360	125,739
Bleaching Earth	0.528	123,127	65,067
TOTAL			798,856

TABLE 3
PRINCIPAL PRODUCT OUTPUTS

Description	Unit Cost TD per kilogram	Kilograms	Value TD
Extracted and Refined Olive Oil	0.430	3,800,000	1,634,000
Spent Grignon	0.867	3,276	28,400
Refined Acid Oil from ONH	0.670	1,000,000	670,000
Bar Soap	0.574	1,538,760	883,274
Soap Stock	0.230	208,690	47,998
TOTAL			3,263,673

3.2 Plant and Process Description: The plant has five main unit operations:

- Grignon drying
- Oil extraction
- Recovery of hexane
- Oil refining
- Soap making

On average, SIOS-ZITEX purchases 51,000 metric tons of grignon annually for a bit more than 6 TD per metric ton. The grignon contains between 8 - 11% olive oil and between 20 - 26% moisture (occasionally, grignon with 50 - 55% moisture is available for free, but they cannot dry it effectively). The grignon is piled up on the grounds of the facility as it awaits further processing. Each day, SIOS-ZITEX grinds raw grignon and then dries it in three large, hot-air rotary dryers to 7% moisture before the extraction process. After drying, the grignon is stored above the 12 large extraction vessels where the operators can gravity feed the oil extraction vessels.

SIOS-ZITEX operates two equal and independent systems of six, thirteen tonne extractor/de-solventizer vessels. Each system uses three tanks at a time in series for oil extraction. The operator adds an un-metered amount of hexane through the top of the first tank. It percolates to the bottom from where it flows to fill the second, overflows, and then pours into the third vessels to pick up more oil before going to temporary storage to await separation (the mixture of hexane and olive oil is called miscella). Another charge of fresh hexane is added to the

second tank from which it is pumped into the third tank, again, for more oil, and from there, into the fourth tank to begin the extraction process in the next series of three extractor vessels. New hexane washes the third tank and from there it goes to the fourth and fifth extraction vessels. The spent grignon, contains an unknown (last sampled over 2 years ago) amount of residual oil. SIOS-ZITEX believes that the spent grignon contains approximately 1 - 2% oil. The spent grignon is burned as fuel to dry the fresh grignon and for other energy needs at the plant.

Annual virgin hexane purchases amount to 252,000 TD, or just under the cost of the grignon raw material. To reuse the hexane as much as possible and to reduce fire and explosion hazard, SIOS-ZITEX steam purges the tanks after extraction. The hexane-steam mixture is condensed in locally fabricated, direct-contact cooling water condensers. Because only 9.5 X 10^{-4} grams of hexane will dissolve in 1 gram of water, they are able to separate most of the hexane from the water by gravity in settling tanks. The waste water from the separation process (over 500 cubic meters per day) combines with waste water streams from the rest of the plant and together, they collect in a ditch that empties directly to the sea 2 - 3 kilometers from the plant.

Miscella, the mixture of extracted oil and hexane, drains from the extractors into a 25 cubic meter tank from which it is pumped to the first of two evaporators. At SIOS-ZITEX, the miscella is reported to be 50% hexane and 50% oil. The evaporators use non-contact steam to evaporate the hexane from the mixture. The hexane vapors condense in a water-cooled shell and tube heat exchanger and two direct-contact water condensers connected in series. The condensate goes to one of five water/hexane separation tanks (totalling the above-mentioned 500 plus cubic meters per day of effluent) and the remaining hexane and steam vapors vent to the atmosphere. The oil-rich miscella enters a final vacuum/evaporator to evaporate the remaining hexane that condenses in shell and tube direct contact condensers that vent to the atmosphere. The oil exits the evaporator at 110 C° to two temporary storage tanks where the production is measured before sending it to a more permanent storage for refining. See Appendix B for the unit operations block flow diagrams.

The refinery process neutralizes the high pH oil, then washes, decolorizes, and deodorizes it. Concurrent with refining extracted olive oil for consumption, SIOS-ZITEX also refines approximately 1,000 metric tonnes annually of high-acid content olive oil from ONH (Ofice National d' Huile) for which they charge ONH approximately 60 TD per metric tonne. They also refine imported soybean oil for consumption.

The neutralization process adds phosphoric acid to the heated oil to eliminate the phospholipides. Then, they add an 18 - 20% solution of Sodium hydroxide. They centrifuge the mixture to separate the oil from the waste that is called "soap stock". The separated oil mixes with water for washing. The effluent, over 30 cubic meters per day, is waste water. The neutralized oil is ready for decolorizing.

SIOS-ZITEX uses over 120 metric tonnes a year of Bentonite Clay (bleaching earth) at a cost of over 65,000 TD to decolorize the oil. The oil mixes for 10 - 15 minutes at 80 - 100 C° with the clay after which they separate the oil from the clay by filtering.

A vacuum distillation step, aided by super-heated steam to drive off much of the remaining fatty acids, deodorizes the oil. Residual fatty-acids mix with the direct-contact cooling water and end up in the cooling water basin. The refined oil is sold for consumption.

Oil of insufficient quality for refining (as well as the soap stock from the neutralizing step in refining) is used as feed for soap making. In large, steam-heated cylindrical tanks, oil and/or soap stock mix with Sodium hydroxide, salt, and a variable amount of water to react to form a soap which floats on top of the tank. The waste water from the bottom moves to another tank where it again mixes with Sodium hydroxide and salt to make more soap. Subsequent steps include two salt water washes and multiple fresh water rinses.

The wet soap feeds by gravity to a small holding reservoir. From there it is filtered and steam heated to 75 C° in preparation for vacuum drying in an evaporation tower. The soap, now with approximately 20% moisture content, passes through a high-shear mixing machine to an extruder where it is cooled at the die head to below 20 C° and molded into a continuous rectangular solid. The continuous soap bar is cut, inspected, and placed into the dryer. After drying, the bars of soap are boxed for shipment.

4.1 Grignon Drying

Hexane extraction of oil is most efficient from oil seed cake that contains about 12% moisture. Consequently, SIOS-ZITEX should not dry the fresh grignon to its current target level of 7%. Any additional moisture removed from the grignon will be replaced with hexane during solvent extraction. SIOS-ZITEX cannot modify the process parameters to control the moisture content in the dried fresh grignon. The plant could experiment with periodically shutting off the hot air exhaust from the spent grignon boilers to increase the residual moisture.

The direct contact of the combustion gases from the spent grignon boilers is a serious fire hazard. After drying, the grignon is stored on a platform above the solvent extraction tanks. Any ember still present as the result of a process upset during the drying process could be catastrophic. SIOS-ZITEX should buy and install a sufficiently sized rotary-tube steam dryer with fans and cyclones for accurate moisture control.

Calculations and Assumptions: This recommendation is based on industrial experience with oil seed extraction using hexane. In the most modern, continuous solvent extraction plants, approximately 50% of the total hexane loss is in the extracted cake (spent grignon). The batch de-solventizing system does not allow for good distribution of the steam though the spent cake (see the Recommendation of Section 4.2.2), which causes an even greater hexane loss. Therefore, any change that limits the amount of hexane retained in the cake will reduce hexane emissions, reduce purchases, and save money.

Based on data from air samples that were included in the pre-assessment data package, shutting down the spent grignon rotary kiln heaters would significantly reduce visible dust emissions and other air pollutants.

Discussion of Obstacles to Implementation: The inability to accurately control the feed rate, residence time, and combustion parameters make it difficult to achieve the target moisture level of 12% consistently. But this will be no more of a problem than consistently achieving their current target moisture level of 7%. Since SIOS-ZITEX has no accurate means of measuring the residual amount of hexane in the extracted meal (spent grignon) they will not likely notice immediately measurable benefits from this change. The periodic hexane purchases are the only means of measuring results. Experimenting with the process will require prompt and accurate moisture analysis, an ability that SIOS-ZITEX currently lacks. Finally, the cost of a new steam dryer would be considerable.

Schedule of Implementation: Within four to six weeks, SIOS-ZITEX should specify the operating parameters for a rotary tube steam dryer (nominal moisture inlet, desired moisture outlet, and throughput rates). Once determined, responsible vendors could provide quotations within four to six more weeks. Once an order is placed, the dryer could be shipped within

four months. Installation and shakedown of the dryer can be done in two weeks. Assuming two months in transit and customs, the new drying system could be operational in about ten months. The recommendation for leaving more moisture in the fresh grignon can be immediately implemented once the dryer is in place. Or, perhaps sooner if they are able to somehow leave more moisture in the fresh grignon with their current system, which is recommended.

Follow Up Measurement: EP3 Tunisia should arrange for periodic moisture measurements in the fresh-dried grignon. Although hexane purchases and consumption can be monitored for overall reduction, it will be difficult to attribute the precise reduction connected to a higher moisture content in the feed.

4.2 Oil Extraction

4.2.1 Hexane Washing

Pre-heat the hexane and grignon to 60 C° before extraction. The hexane enters the top of each extraction tank at ambient temperature through a 50 millimeter diameter pipe. The washing efficiency can be improved by building and installing a distribution manifold in the top of each tank to help the hexane flow more evenly through the fresh grignon packed in the tanks.

Calculations and Assumptions: There are no assumptions for the recommendation to pre-heat the hexane and grignon, it is simply standard practice for oil seed extraction using hexane. SIOS-ZITEX has very able fabricators and technicians. It is assumed that they could build and install the required distribution manifold for the extraction tanks.

SIOS-ZITEX processes 51,000,000 kilograms of fresh grignon per year. The recommended improvements will allow them to extract an additional 1% of oil. At an assumed value of 0.430 TD per kilogram of oil, this will yield 219,300 TD.

Currently, a three tank cycle of extraction and purging takes approximately 14 hours. More efficient washing would provide some attractive options: (1) extract more oil in the same amount of time; (2) speed up the entire cycle by more efficient oil extraction and hexane recovery to run more cycles in a season; and, (3) extract the same amount of oil in less time and use the extra time for hexane recovery and thus reduce hexane losses. Greater production output from the first two improvements could be quantified independently.

Discussion of Obstacles to Implementation: There is limited space and time to work inside of the extraction tanks, as well as the danger of working in enclosed spaces that have recently been full of hexane. SIOS-ZITEX may have to wait until a plannedmaintenance shutdown to

safely install the hexane distribution manifolds. The proposed hexane distribution manifolds should not interfere with steam injection because of the recommendations in Section 4.2.2.

Schedule of Implementation: Local engineering experts can provide the design work needed for the SIOS-ZITEX fabricators to build and install the appropriate hexane distribution manifolds. Within four weeks, an engineering group could design the appropriate device, and the fabrication shop could build and install them in six to eight weeks.

Follow Up Measurement: To expedite the manifold design, EP3 Tunisia may want to provide SIOS-ZITEX with a list of qualified engineers who would perform the necessary design work. Once the design work has been completed, EP3 Tunisia should then verify that the plant will authorize the building and installation of an in-tank distribution system. EP3 Tunisia should verify that the current cycle time is 14 hours and note changes, if any, in the cycle time after the manifold installation. Measuring any increase in oil extraction or reduction in hexane emissions can only be done over a period of three to six months, and only if SIOS-ZITEX implements several of the other recommendations of this report.

4.2.2 De-Solventizing Grignon

An unknown amount and quality of steam enters the extraction tanks from the top to strip the hexane from the meal. The de-solventizing continues until the sampled vapors pass the "smell test", i.e. the technician can no longer smell any hexane at an outlet at the bottom of the tank. Hexane is still present in meal even though one cannot smell it. SIOS-ZITEX must purchase and install the instrumentation to accurately measure the mass flow rate, temperature, and pressure of the steam used to strip hexane from the grignon. They should also re-plumb the tanks so that the steam enters the tanks from the bottom through a manifold, rather than through a single pipe at the top.

Calculations and Assumptions: Hexane is detectable by smell at a concentration of 10 parts per million. The de-solventizing process will be more efficient when the steam percolates upward from a distribution manifold in the bottom of each tank rather than forcing its way down through the meal.

Based on current operating practices, SIOS-ZITEX consumes 9 liters of hexane per metric tonne of fresh grignon processed. The recommendations in this report will allow them to cut overall use to 4 liters of hexane per metric tonne of fresh grignon. This is a savings of 5 liters per metric tonne, or 255,000 liters. The average cost per liter is 0.423 TD, for a total savings of 107,865 TD. However, in Section 4.3 that follows, the hexane loss to the water is calculated to be 86,400 TD. So the difference can be assumed to be lost to the atmosphere, 21,465 TD.

Discussion of Obstacles to Implementation: There is limited space and time to work inside of the extraction tanks, as well as the danger of working in enclosed spaces that have recently been full of hexane. SIOS-ZITEX may have to wait until a planned maintenance shutdown to safely install the steam distribution manifolds and re-plumb the steam inlets.

Schedule of Implementation: Local engineering experts can provide the design work needed for the SIOS-ZITEX fabricators to build and install the appropriate steam distribution manifolds and to re-plumb the steam line. Within four weeks, an engineering group could design the appropriate device, and the fabrication shop could build and install them in six to eight weeks.

Follow Up Measurement: To expedite this process, EP3 Tunisia may want to provide SIOS-ZITEX with a list of qualified engineers who would perform the necessary design work. Once the design work has been completed, EP3 Tunisia should then verify that the plant will authorize the building and installation of a steam distribution system. Measuring any reduction in hexane emissions can only be done over a period of three to six months, and only if SIOS-ZITEX implements several of the other recommendations of this report.

4.3 Hexane Recovery

Install a shell and tube heat exchanger that uses the hot oil leaving the stripper to pre-heat the miscella before it enters the first evaporator. Install a steam ejector capable of applying a vacuum of 600 millimeters of Hg (Mercury) to the first evaporator. The current evaporator operates at atmospheric pressure. Replace the present vacuum pump and condenser for the stripper with a larger condenser and steam ejector. Install a forced-draft cooling tower that will supply adequate cooling water even in the hottest months (within 5 C° of the ambient temperature). Install a mineral oil absorption system to extract the last of the hexane vapors from the vent system. See Appendix B for the block flow diagram with the recommended changes.

Calculations and Assumptions: The recommendations are based on best operating practices and expert experience in recovering hexane. Hexane is soluble in water only slightly, 0.00095 grams per milliliter. This inefficient direct contact cooling process wastes approximately 475 cubic meters of water per day more than is needed. This equates to over 450 kilograms or 683 liters of hexane per day. Assuming 300 operating days, almost 45% of the hexane purchased goes out in the water, totalling over 86,400 TD annually in hexane purchases. Without a firm quote for a waste water treatments system, we can assume a savings value based on other, similarly sized waste water treatment systems designed for Tunisia. Based on the cost for consumable chemicals alone for a recently designed 120 cubic meter per day system of 20,000 TD, the savings for these changes should be four times as large, or 80,000 TD. This equates to approximately 550 TD per 1,000 cubic meters of water in consumable costs. Also, the national water utility charges approximately 250 TD per 1,000

cubic meters of water (purchase price and sewer fees). Therefore, each cubic meter of water saved has a value of about 0.800 TD. This figure is used throughout the report.

Discussion of Obstacles to Implementation: There is a considerable cost to purchasing and installing these items. However, the current equipment is incapable of separating the hexane from the oil without significant hexane losses to the atmosphere and to the waste water. SIOS-ZITEX will have to get the cooperation and assistance of the equipment vendors to properly specify, size, and quote the right components and controls.

Schedule of Implementation: Once SIOS-ZITEX decides to move ahead with these recommendations, they should seek the assistance of selected equipment vendors. A typical analysis by a competent equipment manufacturer could take six to eight weeks. Once an order is placed, it could take four to five months before the equipment is shipped. Once received at the factory, installation and shakedown should only take two weeks if sufficient manpower and resources are applied to the task.

Follow Up Measurement: Verify that SIOS-ZITEX has formulated a modernization strategy and that they are making serious inquiries with equipment manufacturers.

4.4 Refining of Oil

4.4.1 Neutralization

The ability to precisely mix the raw materials for neutralization and washing (oil, phosphoric acid, sodium hydroxide, and water) greatly impacts the resultant oil quality, hazardous chemical usage, profitability, and waste generated. Install oil, acid, caustic, and wash water flow controllers and meters.

The leading refinery equipment manufacturers and industry experts recommend adding wash water in an amount equal to 10% of the weight of the oil being refined. That would equate to 4.5 to 5.5 cubic meters of water for the 50 to 60 metric tonnes of daily production from the refinery. Actual measurements from this process show a flow of above 30 cubic meters a day. Reduce the wash water flow to the recommended level of 10% of the weight of the oil being refined.

Calculations and Assumptions: It is assumed that the precise amount of feed stocks are not being added and that the product quality suffers and excessive waste is generated because of a lack of monitoring and control devices. For the savings calculation, it is assumed that this will save 10% of the annual purchases for the sodium hydroxide used in the refinery.

Discussion of Obstacles to Implementation: The variable acid level and quality of the incoming oil should encourage precision process control rather than discourage it. However,

SIOS-ZITEX may consider that the refinery process is more art than science and prefer to operate in their traditional manner. Even if they purchase and install this instrumentation, there will be no improvement unless top management supports the use of the instruments and utilizes the feedback from the instrumentation to continually control and improve the process.

Schedule of Implementation: With help from EP3 Tunisia's Information System, SIOS-ZITEX should be able to choose appropriate flow meters, flow controllers, and piping needed to issue an order. Once an order is placed, it could take up to one month before the equipment is shipped. Once received at the factory, installation and shakedown should take one week if sufficient manpower and resources are applied to the task.

Follow Up Measurement: Verify that SIOS-ZITEX has formulated equipment specifications and that they are making serious inquiries with equipment manufacturers. Once installed and operating, EP3 Tunisia should monitor the quantity of Sodium hydroxide, phosphoric acid, and wash water per metric tonne of oil processed and compare these values to the present values.

4.4.2 Decolorizing

Install a shell and tube heat exchanger to lower the temperature of the oil after it leaves the oil/hexane stripper on its way to the storage and measurement vessel. The oil currently enters the storage (and measurement) vessel at approximately 110 C°. Long storage periods at this elevated temperature will oxidize the oil and lower its quality. The oil will darken and need additional effort to decolorize. These two temporary storage tanks are really used to measure the amount of oil produced by extraction because the plant has no other means to accurately measure production. Install a totalizing, vortex-style flow meter downstream of the hexane/oil stripper to accurately measure daily (or other period) production.

Calculations and Assumptions: Each of the two storage vessels is approximately 28 cubic meters in volume. Company records for the period March 26, 1994 through April 29, 1994 indicate an average daily production just under 14 cubic meters of oil. Therefore, the oil could stay hot for up to 48 hours (or, even 96 hours if operators waited until both tanks were filled before sending the oil to the primary storage facility). It is assumed that cooling the oil to 45 C° before storage would reduce the use of bleaching earth (Bentonite Clay) by one-third, or 19,000 TD per year.

Discussion of Obstacles to Implementation: There is a considerable cost to purchasing and installing these items. SIOS-ZITEX will have to get the cooperation and assistance of the equipment vendors to properly specify, size, and quote the right components and controls.

Schedule of Implementation: Once SIOS-ZITEX decides to move ahead with these recommendations, they should seek the assistance of selected equipment vendors. A typical

analysis of this complexity by a competent equipment company could take two to three weeks. Once an order is placed, it could take two to three months before the equipment is shipped. Once received at the factory, installation and shakedown should only take two weeks if sufficient manpower and resources are applied to the task.

Follow Up Measurement: The appropriate measurements are: the exit temperature for the oil going to storage; and, the consumption of bleaching earth in the decolorization process per tonne of extracted and decolorized oil to compare to current values.

4.4.3 Deodorizing

Install shell and tube vacuum condensers to replace the direct-contact ejector steam vapor condensers. Continuously add a dilute caustic wash stream to the tubes of the condensers to eliminate any fatty acid build-up. Presently, SIOS-ZITEX must dump the 40 cubic meter cooling water basin every 21 days directly to the sea because of a build-up of fatty acids. These recommended additions to the system will remove the remaining fatty acids that can be added to the fatty acids that are already removed in the deodorizer vapor scrubber (which are collected and used as soap stock).

Calculations and Assumptions: Without specific sampling for fatty acid loading, it would be difficult to assign an economic benefit to the elimination of this dumping. Also, the cooling water comes from one of the wells on the property so there is no measurement or cost associated with its use. Recovered fatty acid has a value of about 250 millimes per kilogram when used as soap stock. It is assumed that daily fatty acid losses to the direct contact cooling water are 80 liters.

Discussion of Obstacles to Implementation: There is a considerable cost to purchasing and installing these items. However, the current equipment is incapable of effectively separating the fatty acids from the cooling water, and as a result, SIOS-ZITEX dumps their cooling water basin every 21 days to eliminate the build-up. SIOS-ZITEX will have to get the cooperation and assistance of the equipment vendors to properly specify, size, and quote the right components and controls.

Schedule of Implementation: Once SIOS-ZITEX decides to move ahead with these recommendations, they should seek the assistance of selected equipment vendors. A typical analysis by a competent equipment company could take four to six weeks. Once an order is placed, it could take up to two months before the equipment is shipped. Once received at the factory, installation and shakedown should only take two weeks if sufficient manpower and resources are applied to the task.

Follow Up Measurement: Verify that SIOS-ZITEX has formulated equipment specifications and that they are making serious inquiries with equipment manufacturers. Once installed and

operating, EP3 Tunisia should monitor the increase in fatty acid recovery and the reduction in the concentration of fatty acid in the cooling water basin. Also, quantify the frequency (if at all) of the dumping of the water in the cooling water basin.

4.5 Soap Making

This process takes waste material from other higher value processes and makes a salable product that accounts for approximately 40% of the company's gross income. The general quality and acid level of the soap stock varies greatly and this impacts its ability to react and form soap. The batch process to make soap at SIOS-ZITEX employs few, if any precision measurements or quality controls. Operators add variable amounts of water and chemicals to the soap kettles. The amounts reported are determined by feel, and are not measured by calibrated, precision instruments. Specific recommendations would require accurate numerical data, something not available for this soap making process.

The soap making process generates an undetermined volume of waste water. Estimates range from 8 to 24 cubic meters per day. Waste water from the soap making process leaves the plant at irregular intervals and is very difficult to measure without devoting full time to monitoring the process outfalls to determine a weighted average.

Glycerine is a by-product of the reaction that forms soap. It is the contaminant that keeps most of the waste water from being recycled back into the process. Glycerine is worth approximately 2 TD per kilogram. There is a method to recover the glycerine and reuse the water in the soap manufacturing process, but it involves treatment. It may be possible to use waste water treatment technologies to recover soap stock quality oil from the oil/water emulsion created in the refinery process. Along with the valuable soap stock, the treatment creates a low pH waste water stream that could be used to replace one of the many steps in the recovery of glycerine from the soap making process. But the rest of the process steps needed to recover glycerine use a considerable amount of energy and shift the environmental impacts and risks elsewhere. Therefore, there are no pollution prevention options for soap making that we can recommend at this time.

A methodology for measuring and tracking pollution prevention performance has been developed elsewhere for the EP3 project by Hirschhorn & Associates, Inc.. The approach is based on using simple but critical ratios so that facility data can be normalized in a way that facilitates comparisons among different facilities in the same industrial sector. Critical ratios are defined so that decreasing their numerical value indicates pollution prevention progress.

Because of the lack of useful and verifiable data, the assessment identified only one critical ratio: liters of hexane purchased per metric tonne of grignon processed. This is ratio is defined for oil extraction using hexane, for which current and best industrial performance (BIP) values can be obtained by comparison to the most efficient oil seed extraction processes in the US. Facilities should strive to lower their critical ratios to reach the BIP values, which themselves may decrease over time as new technologies or materials are commercialized.

5.1 Hexane Purchases per Metric Tonne of Grignon Processed

The critical ratio is: liters of purchased hexane/metric tonne of grignon processed.
The amount of hexane consumed and lost should be minimized to generate less waste.

The current value of this ratio is 9 liters of hexane purchased/metric tonne of processed grignon. The Best Industrial Practice (BIP) is 4 liters of hexane purchased/metric tonne of processed grignon (based on experience at modern, well-managed extraction plants).

6.1 Product Quality and Competitiveness

The pollution prevention strategy is premised on the belief that technological changes that address the sources of wastes and pollutants will also improve the economic health of companies. Although much of the emphasis in pollution prevention work is on reductions in operating costs, which several of the recommendations in this report will yield, it is also important to examine impacts on product quality. For many years, people in industry feared negative impacts on products from making changes in production, especially ones driven by environmental considerations. However, it has become clearer over time that many pollution prevention actions actually improve product quality. That is the case for SIOS-ZITEX, because the recommendations listed below produce superior oil for consumption. The pollution prevention actions that improve product quality are:

- cooling the oil from the oil/hexane stripper
- adding process flow meters and controls in the refining stage
- equipment upgrades in the deodorizing process

The recommendations in this report will help SIOS-ZITEX to improve its competitiveness in the domestic and export markets. This ability to retain and even expand local and export market shares is an extremely important benefit of this pollution prevention program. It is a benefit that will prove itself over time, but that cannot be quantified at this time.

6.2 Less End-of-Pipe Investment

One of the traditional benefits cited for pollution prevention is the avoided costs of using end-of-pipe pollution control equipment that only adds to a plant's capital and operating costs without any return on investment. This is clearly the case for SIOS-ZITEX. They face a legal requirement for installing an on-site waste water treatment facility to treat approximately 1,000 cubic meters of water per day if they choose not to implement the pollution prevention recommendations of this assessment. While it is not practical to totally eliminate the need for some waste water treatment, several of the recommendations in this report will sharply reduce waste water volume by almost 50%. They will also lower the COD level, the hydrocarbon loading, and the amount of solids in the waste water.

6.3 Financial Significance

SIOS-ZITEX, which already is already financially successful, will reach a higher level of financial performance as a result of implementing the report's pollution prevention recommendations.

6.3.1 Improved Worker Productivity

The major environmental issues for SIOS-ZITEX are: releases of hexane (a highly toxic substance with a TLV of 50 ppm in air) into the workplace environment; losses of hexane to the waste water; the very real danger of fire and explosion; and, dust and NO_x emissions from burning spent grignon as fuel. The report's recommendations impact each of these problem areas. By implementing the pollution prevention changes in the report, SIOS-ZITEX will improve the work environment and consequently, worker productivity.

6.4 Diversification and Technology Transfer

SIOS-ZITEX may want to take advantage of their experience and market strength to diversify into new oil markets (oil extraction directly from soy beans or other oil seeds such as: sunflower seeds; canola seeds; or, rape seeds). A new 1,200 tonne/day soybean extraction plant in the United States would cost from 30-35 million TD. This price estimate would include the cost for soybean receiving, storage, and preparation prior to extraction. In good market conditions, soybean meal can sell for as much as 275 TD per tonne, almost offsetting the estimated delivered cost of the beans (300 TD per tonne). If there were a local or regional market for the soybean meal after extraction, such diversification may look more attractive.

Such a system would also allow SIOS-ZITEX to greatly expand their processing of grignon. If the strategy was to only expand the grignon capacity, the cost for a modern plant would be considerably less because grignon does not require nearly as much preparation equipment. Increasing grignon capacity would make sense for SIOS-ZITEX if they were able to process the grignon before the residual oil becomes too acidic, thus, making it unfit for refining for consumption. If the increase capacity only gave them more oil for soap making, then such an expansion for grignon alone might be questionable.

Prior to obtaining bids from the equipment suppliers it is critical that SIOS-ZITEX decide on the oil seed or seeds that they intend to use as well as the daily capacity. The most profitable oil companies in the United States run no more than two different types of oil seeds. And, in those relatively rare instances when a company extracts oil from two oil seeds, they do so with dedicated equipment. Each different oil seed requires unique preparation, processing, and extraction residence time. Each of these variables effect the size, configuration, and throughput of the equipment. Therefore, SIOS-ZITEX should develop a sharply focused plan of action, perhaps supported by further study to clarify their options and potential.

APPENDIX A

Glossary of Terms, Definitions, Abbreviations, and Acronyms

APPENDIX A: GLOSSARY OF TERMS, DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

ABSORB - The penetration of one substance into the inner structure of another.

ANPE - Agence National de Protection de L' Environnement, it is the Tunisian agency with environmental enforcement responsibilities

BLEACHING EARTH - A fine white clay (Bentonite is the typical trade name) which brightens the refined oil

BOD_5 - Biochemical Oxygen Demand, 5 Days.

BIOCHEMICAL OXYGEN DEMAND, 5 DAYS - A standardized means of estimating the degree of contamination of water supplies, especially those which receive contamination from sewage and industrial wastes. It is expressed as the quantity of dissolved oxygen (in milligrams per Liter) required during stabilization for the decomposable organic matter by aerobic biochemical action.

COD - Chemical Oxygen Demand.

CHEMICAL OXYGEN DEMAND - A measure of the oxidizable components present in water. Since the carbon and hydrogen, but not the nitrogen, in organic matter are oxidized by chemical oxidants, the oxygen consumed is a measure only of the chemically oxidizable components and is dependent upon the oxidant, structure of the organic compound, and manipulative procedure.

CO-GENERATION - Producing steam with a boiler at a pressure and volume sufficient to operate a steam turbine for generation of electric power. The low pressure steam from the turbine is used for heat within the plant processes while any excess power generated not used within the plant process usually is sold to the local electric utility or to neighboring industrial users.

CONDENSING - Changing a substance from the gaseous or vapor state to the liquid state by cooling (usually with cold water).

CONTINUOUS EXTRACTION - Separating oil from an oil seed cake using equipment designed to receive and discharge a continuous flow of product.

DIRECT CONTACT CONDENSER - A condenser using a spray of water which comes in direct contact with the vapor being condensed. The water and vapors are not separated by plates or tubing.

DT - De-Solventizer Toaster

APPENDIX A: GLOSSARY OF TERMS, DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

DE-SOLVENTIZER TOASTER - A unit designed to separate hexane from meal or cake after solvent extraction using direct and indirect steam. In the heating process the meal is also toasted to improve is use as an animal feed.

EVAPORATOR - A shell and tube heat exchanger which heats an oil and hexane mixture (miscella) while under a vacuum. The vacuum speeds the evaporation of the hexane from the mixture.

FIRST YEAR SAVINGS - This is a column heading in Table 1 Summary of Pollution Prevention Options. To calculate this number, sum the increase in revenues and the decrease in expenses and subtract the cost to make the change. For example, sum the first year monies from increased production or the sale of unnecessary production equipment, reductions in capital costs for end-of-pipe equipment and facilities not purchased, reductions in raw material purchases, reductions in direct labor costs, reductions in indirect labor and expenses, and reductions in other intangible costs. Then, subtract the first year capital costs of any necessary acquisitions, new raw materials, new labor and training costs, and increases in indirect labor and expenses.

GRIGNON - The cake remaining from the virgin olive oil extraction process (mechanical pressing). It is a mixture or crushed seeds and pulp.

HEXANE - (n - HEXANE) CAS Number 100-54-3. $CH_3(CH_2)_4CH_3$. Properties: Colorless, volatile liquid with a faint odor. Density 0.66 kilograms per liter. Boiling point 68.7 C°, freezing point -95 C°, flash point -22.7 C°, auto-ignite temperature. It is soluble in alcohol, acetone, and ether; insoluble in water.

MEAT - Ministère de L' Environnement et de L' Amènagement du Territoire, this is the highest level environmental body in Tunisia.

MINERAL OIL ABSORPTION - The use of mineral oil to absorb the hexane from vent gases leaving an extraction plant. The mineral oil evenly distributed over a packed column of saddles which exposes it to a countercurrent flow of the vent gases. The mineral oil is heated with steam to recover the absorbed hexane.

MISCELLA - A mixture of vegetable oil and hexane. In a well-managed extraction process, the mixture is typically 30% oil and 70% hexane.

ONAS - Office National de L' Assainissement, the agency responsible for waste water standards, compliance, and enforcement.

APPENDIX A: GLOSSARY OF TERMS, DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

ONH - Office National de Huile, the agency responsible for national standards and quality for oil from oil seeds.

PACKED COLUMN - A cylinder, typically full of small, regular-shaped surfaces which significantly increase the contact surface area for reaction or transfer between one substance with another.

SADDLES - A specific type and shape of packing.

SAFETY BOILER - A tank where the water leaving the water/hexane separation tank is heated with steam to a temperature of 90-95 C°prior to discharge as effluent. The tank is vented to a condenser for recovery of the steam and any hexane vapor. The effluent water should not contain any hexane under normal operations of the plant.

SHELL AND TUBE HEAT EXCHANGER - A cylindrical shell with a bundle of tubes (pipe segments) aligned along the axis of the cylinder and fixed at both ends. In most cases, the product to be heated to or cooled flows through the tubes and the heating (steam) or cooling medium (water) is in the shell.

TLV - Threshold Limit Value

THRESHOLD LIMIT VALUE - A set of standards established by the American Conference of Governmental Industrial Hygienists for concentrations of airborne substances in workroom air. They are time-weighted averages based on conditions which it is believed that workers may be repeatedly exposed to day after day without adverse effects. The TLV values are revised annually and provide the basis for US Government safety regulations. The are intended to serve as guide in control of health hazards, rather than definitive marks between safe and dangerous concentration.

VENT SYSTEM - The combination of condensers and mineral oil absorption system designed to maintain a negative (sucking) pressure on all of the equipment used in meal de-solventizing and miscella distillation

WASH WATER - Softened water used to mix with refinery oil prior to entering the washing centrifuge.

APPENDIX B

Unit Operation Diagrams

SIOS – ZITEX
DISTILLATION – DESOLVENTIZING
PROPOSED RECOMMANDATIONS

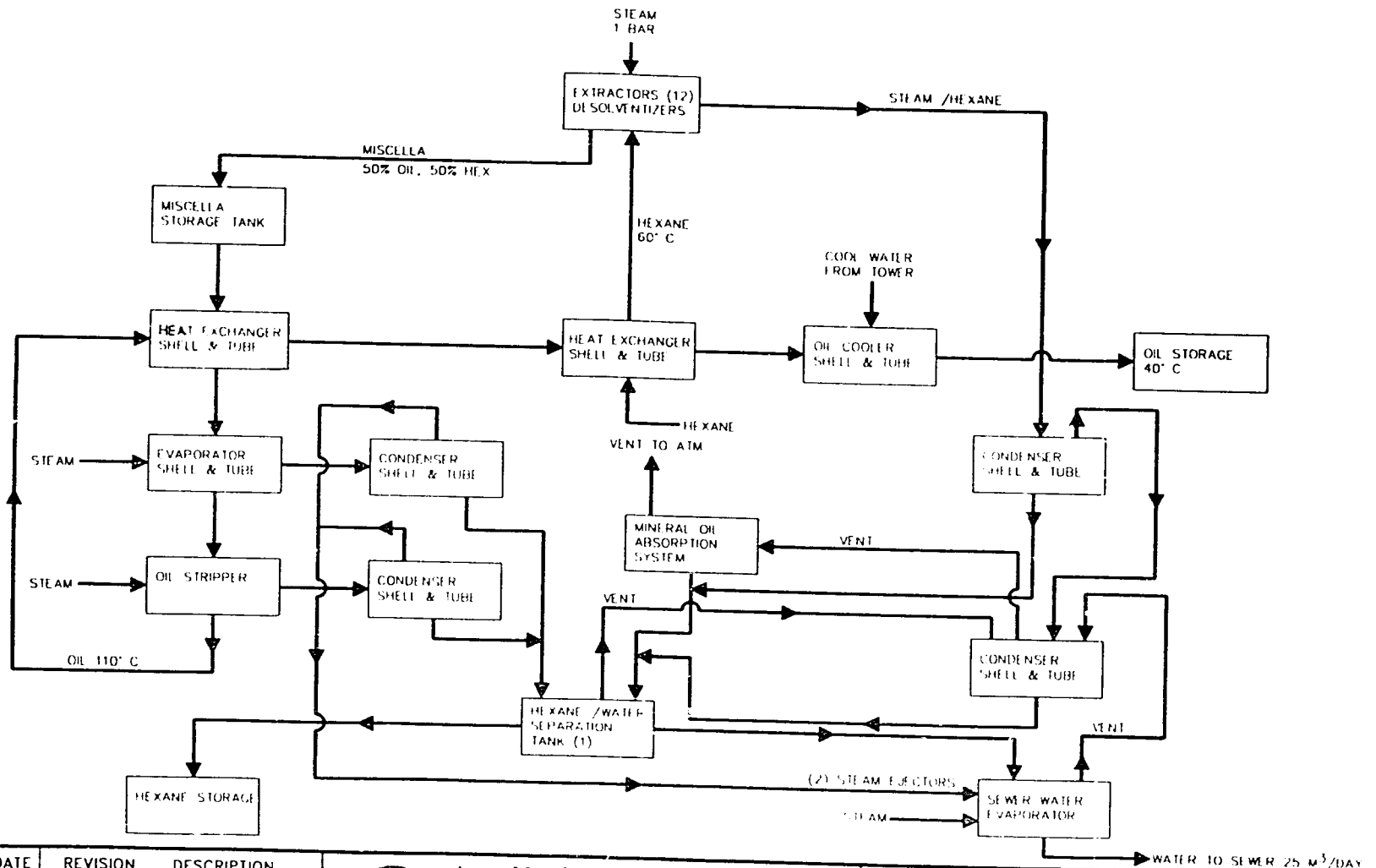


FIGURE 3

SCALE	NO.	DATE	REVISION	DESCRIPTION
DWN BY GOE				
CHK'D BY KMK				
APPR BY TG				

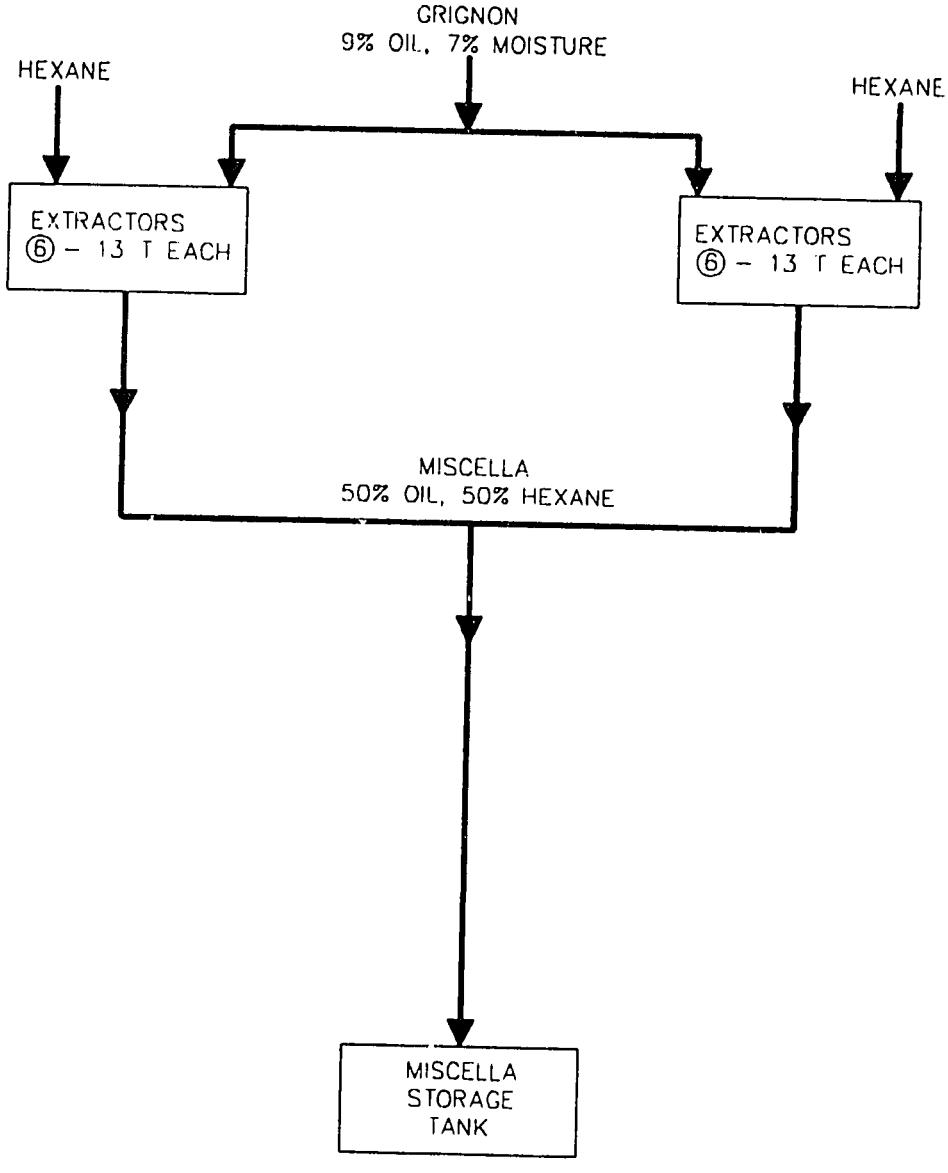
Applied Engineering & Science — Atlanta Georgia

PROPOSED RECOMMENDATIONS
DISTILLATION & DESOLVENTIZING
EP3 AID PROJECT, TUNISIA

DATE MAY, 1994
DWG NO 4340A003
SHEET NO. 3

4340A003.DWG

SIOS – ZITEX
SOLVENT EXTRACTION
PRESENT



CALE --	Applied Engineering & Science	PRESENT SOLVENT EXTRACTION EP3 AID PROJECT TUNIS'A	FIGURE 4
WN. BY GOE			DATE MAY, 1994
HK'D. BY KMK			DWG. NO. 4340A004
PR. BY TG			SHEET NO. 2
4340A004.DWG			

SIOS – ZITEX
DESOLVENTIZING – HEXANE RECOVERY
PRESENT

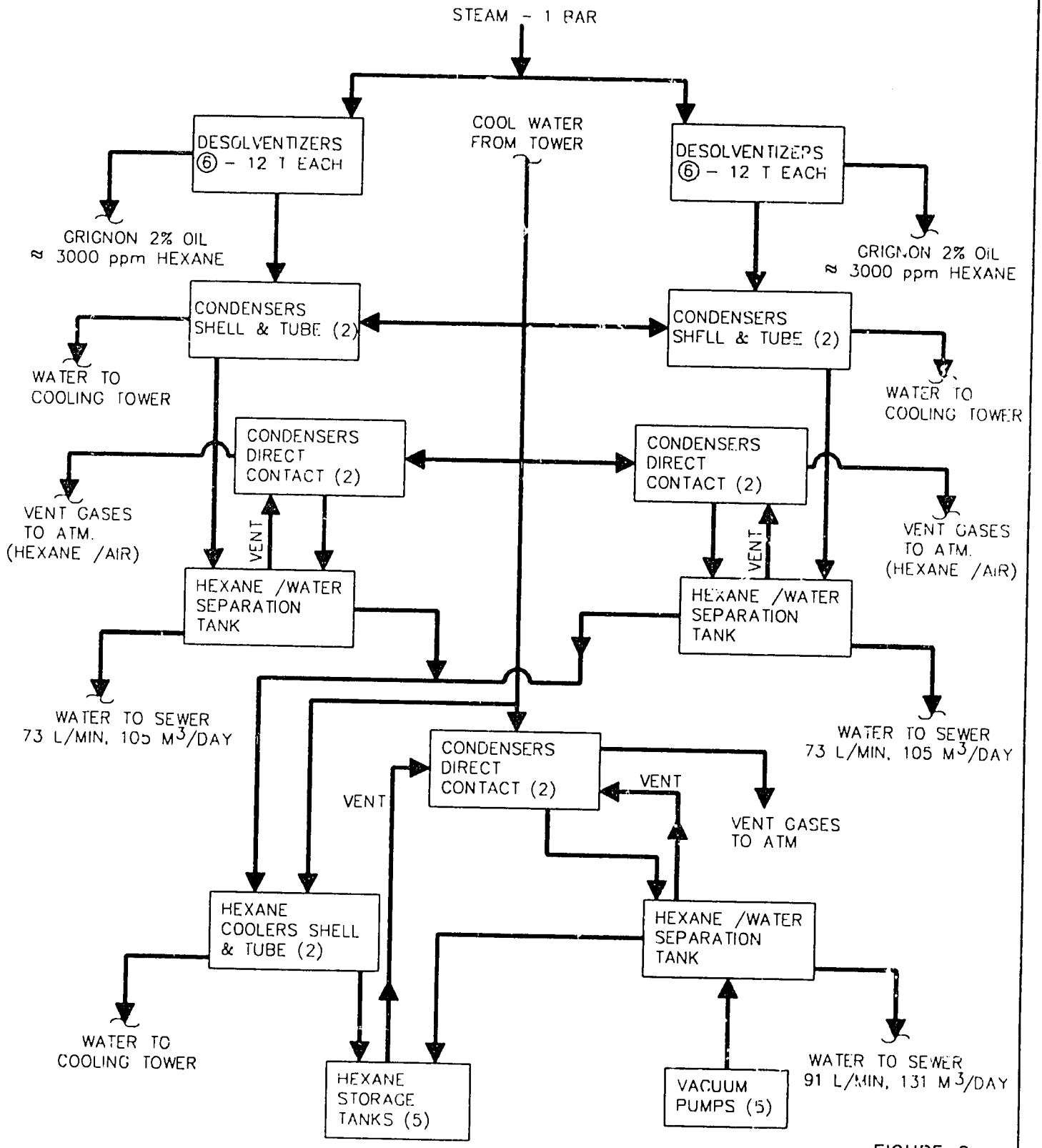


FIGURE 2

SCALE --	Applied Engineering & Science	PRESENT DESOLVENTIZING HEXANE RECOVERY EP3 AID PROJECT TUNISIA	DATE MAY, 1994
DWN. BY GOE			DWG. NO. 4340A002
CHK'D. BY KMK			SHEET NO. 2
APPR. BY TG			

4340A002.DWG

SIOS – ZITEX

MISCELLA DISTILLATION – HEXANE RECOVERY

PRESENT

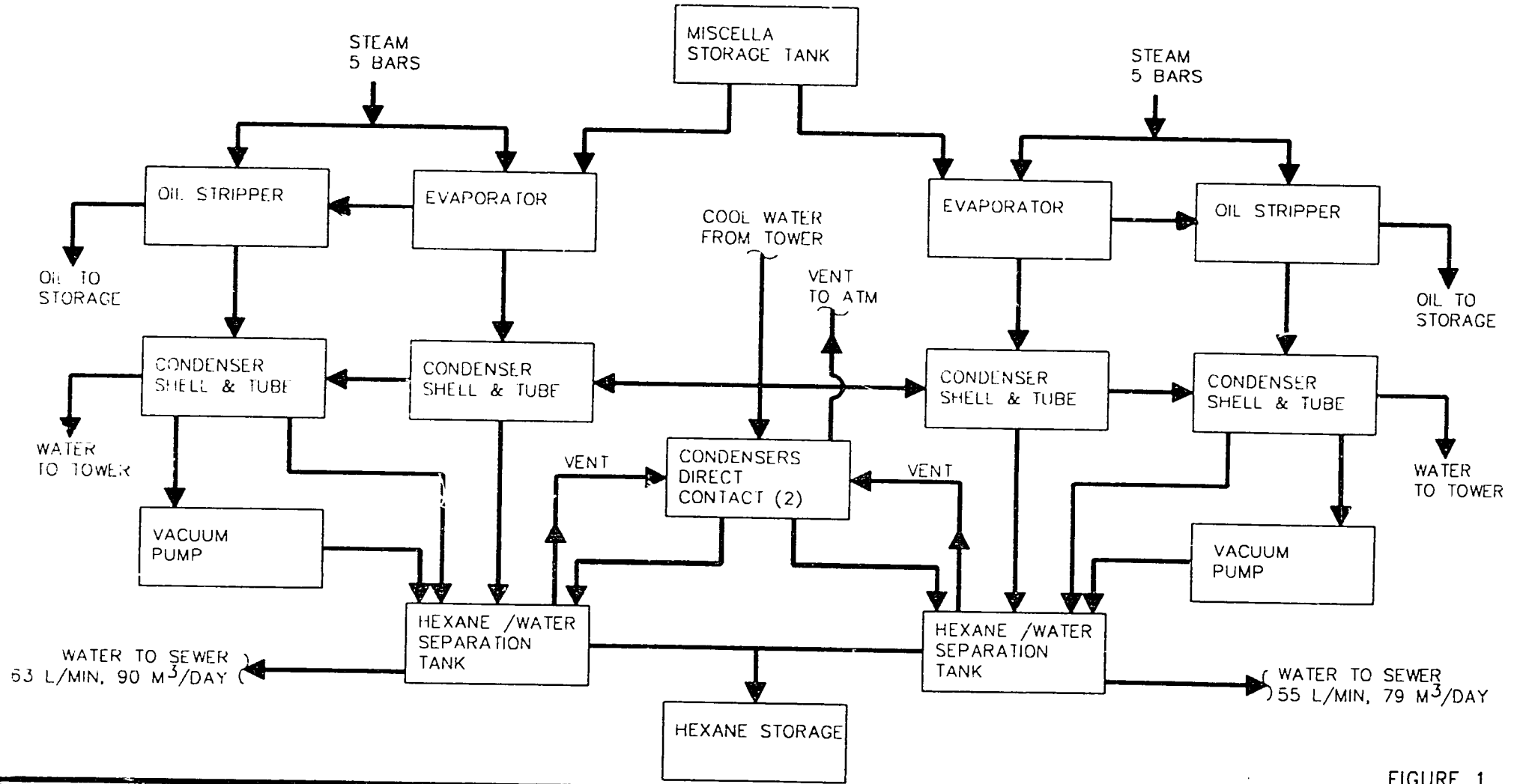


FIGURE 1

SCALE --	Applied Engineering & Science	EP3 AID PROJECT TUNISIA	PRESENT MISCELLA DISTILLATION HEXANE RECOVERY	DATE MAY, 1994
DWN. BY GOE				DWG. NO. 4340A001
CHK'D. BY KMK				SHEET NO. 1
APPR. BY TG				

4340A001.DWG

APPENDIX C

Units of Measure

APPENDIX C: UNITS OF MEASURE

All financial data in the report is in terms of the Tunisian Dinar. The exchange rate during the assessment and report writing was $1 US = $1.025 TD. The assessment report uses the International system with standard units of meter, kilogram, and second. Some convenient conversion factors are: 1 M = 39.37 Inches; 1 Kg = 2.205 Pounds; 1 M^3 = 1,000 Liters or 264 Gallons.

APPENDIX D

U.S. Sources of Equipment

APPENDIX D: U.S. SOURCES OF EQUIPMENT

Solvent Extraction/Refining/Decolorization/Deodorizaton/Drying equipment:

Crown Iron Works Company
PO Box 1364
Minneapolis, Minnesota 55440-1364 USA
Phone: 612-639-8900
Fax: 612-639-8051
VP Sales, Mr. Jeffery Scott

De Smet Process and Technology
2839 Paces Ferry Road
Suite 880
Atlanta, Ga. 30339 USA
Phone: 404-436-0061
Fax: 404-434-5188
Executive Vice President, Mr. Philip VanDo

AES, Inc.
2261 Perimeter Park Drive
Suite 1
Atlanta, Georgia 30341 USA
Phone 404-454-1810
Fax 404-454-1816
President, Mr. Michael Boyer

Louisville Drying Machinery
232 East Main Street
Louisville, Kentucky 40202 USA
Phone 502-969-3535
Fax 502-969-9028
Mr. Bob McAdams, Sales Engineer

PERSTORP, Division of NIR Systems
12101 Tech Road
Silver Spring, Maryland 20904 USA
Phone 301-680-9600
Fax 301-236-0134
Ms. Debbie Chapman, Sales Engineer

APPENDIX E

Statement of Work

EP3 ACTIVITY INITIATION BRIEF (Q)

SPLTHRDA.041
4702-007

TITLE: May 1994 PPDA Support for EP3/Tunisia
COUNTRY: Tunisia
START DATE: 4/20/94 **COMPLETION DATE:** 6/15/94

ACTIVITY DESCRIPTION:

Background:

EP3 Tunisia has collected general and technical information on the processes, raw materials used, and wastes generated at two soap manufacturing plants and two leather tanneries in Sfax, Tunisia. A team of three experts from the U.S. will assist EP3 Tunisia in conducting detailed pollution prevention diagnostic assessments at these four facilities.

Objective:

Complete pollution prevention assessments and prepare draft and final assessment reports for two soap manufacturing plants in Sfax, Tunisia, and assist in conducting and finalizing reports for two pollution prevention assessments at two leather tanneries in Sfax, Tunisia.

Scope of Work (Gagnet, Hirschhorn, & Gum):

This Scope of Work (SOW) covers activities that will be performed primarily by two individuals: Alan Gagnet, a pollution prevention generalist, and Timothy Gum, a soap manufacturing expert. Both of these individuals are being provided by Hirschhorn & Associates and are referred to as "the team" throughout this document. (A separate SOW applies to the activities of the leather tanning expert.) In addition, Joel Hirschhorn will assist in finalizing the four audit reports. Jim Westfield, a member of the EP3 Core staff, will also participate in the audits. Mr. Westfield's travel and time will be covered under the EP3 Core contract. All team members will work a six-day work week while in Tunisia.

Mr. Gum and Mr. Gagnet will be responsible for conducting audits and preparing draft and final audit reports for the two soap manufacturing plants. In addition, Mr. Gagnet will support the efforts of the leather tanning expert in conducting audits of two leather tanneries and preparing and finalizing audit reports for these facilities. The team will review baseline data collected by the EP3 Tunisia Office, collect additional information on process flows, raw materials used, and wastes generated, identify and evaluate opportunities for employing pollution prevention techniques, and recommend options, as appropriate, for implementation by the facilities.

A total of 8 tasks will be conducted, for a total of 19 days for Mr. Gagnet, 17 days for Mr. Gum, and 4 days for Dr. Hirschhorn. (The total for Gagnet includes two travel days and the total for Gum includes four travel days). Tasks 1, 6 and 7 take place in the U.S. Tasks 2 through 5 take place in Tunisia. Of the six days assigned to Mr. Gagnet for Task 8, four will take place in Tunisia, and the other two, which pertain to finalizing the draft tannery reports, will take place in the U.S.

Task 1: Pre-trip Preparation. A briefing for all participants in the Sfax audits has been scheduled for April 22, 1994. The meeting will take place at EP3's office in Rosslyn, Virginia, from 9:00 to 3:00 PM. At the briefing, EP3 core staff will provide team members with an overview of the project, describe the program that has been set up in Tunisia, and outline the purpose and scope of the audits to be conducted. This will provide an opportunity for team members to ask questions about the nature of this assignment and to clarify their roles and responsibilities on the audit team.

Task 2: Meet with EP3 Tunisia Staff and Plant Managers. A similar meeting will take place in Tunisia. At this meeting, EP3 Tunisia staff will describe in greater detail the scope of the audits and outline their expectations for the audit and the audit team. Before beginning Task 3, the team also will meet with the managers of the plants being audited to brief them on the team's activities and discuss their expectations and needs.

Task 3: Conduct In-Plant Assessment Work at Two Soap Manufacturing Plants. The in-plant assessments will consist of two steps and will take from two to four days to complete at each facility:

-- First, the team will verify technical and financial data collected by EP3 Tunisia and obtain additional detailed information on process flows. The team will then develop process flow diagrams and material and energy balances for each facility's operations.

-- Once all processes are understood and quantified as much as possible, the team will identify and analyze pollution prevention options that could be applied to the production processes. The team should look for options that are "no- or low-cost" as well as options that may require some capital investment. The team should emphasize options that are economically and environmentally important rather than identifying many a large number of minor actions.

Task 4: Develop In-Country "Draft" Reports. Once options have been identified, the team will begin preparing draft reports that thoroughly analyze all options identified, including their technical feasibility, environmental benefits, cost to implement, "payback periods," net economic benefits, and implementability.

The draft reports should be based on the format provided by EP3 Washington. However, EP3 invites team members to suggest improvements to the format provided. The reports must: describe the plant's production processes; clearly describe options; identify first, second, etc. priority options; and outline an implementation schedule for recommended options. The reports should suggest followup actions for both facilities to guide them in project implementation and measurement.

A copy of the draft reports must be left with EP3 Tunisia before the team returns to the U.S. A second copy must be provided to EP3 Washington upon returning to the U.S.

Task 5: Conduct Exit Interviews with EP3 Tunisia, plant managers, and AID. The team should present its findings orally to the managers of all facilities, EP3 Tunisia and AID before leaving Tunisia.

Task 6: Brief EP3 Washington Staff and AID. Approximately two weeks after returning to the U.S., the team will brief EP3 Washington staff and AID on the results of the audits. This will be an opportunity for EP3 Washington staff to provide oral comments on the draft reports and to learn from the audit team's experience.

Task 7: Complete Reports. Following the U.S. debriefing and based on comments received from EP3 Washington, EP3 Tunisia, and AID, the team will finalize its reports on the two soap manufacturing plants and submit final reports in hard copy and on disk to EP3 within two weeks following the U.S. debriefing.

Task 8: Assist with the Tannery Audits. Mr. Gagnet will also work with the leather tanning expert to conduct audits at two leather tanneries and will play a key role in identifying and evaluating pollution prevention options. Mr. Gagnet will review the assessment report developed by the leather tanning expert and provide feedback and guidance, as appropriate. Hirschhorn and Associates will also review and finalize the reports for the leather tanneries and complete the final reports for the tanneries. Of the six days assigned to Mr. Gagnet for this task, four days will take place in Tunisia, and the other two, which pertain

to finalizing the draft tannery reports, will take place in the U.S. All of Dr. Hirschhorn's time on this task will be spent in the U.S.

The table below illustrates a suggested level of effort for each task.

Name	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Task 8	Travel Days	Total
Gagnet	0	1	4	2	1	1	2	6	2	19
Gum	1	1	5	3	1	1	1	0	4	17
Hirschhorn	0	0	0	0	0	0	2	2	0	4
Total	1	2	9	5	2	2	5	8	6	40

DELIVERABLES and SCHEDULE:

-- Debriefing in Tunisia: On or about May 6

-- Detailed assessment reports using the format provided by EP3 as a starting point. The final report should provide a model for future pollution prevention assessments.
- Draft reports for two soap manufacturing plants (one copy provided to EP3 Tunisia and one copy provided to EP3 Washington): May 7
- Final reports for two soap manufacturing plants and two leather tanneries incorporating comments: two weeks following the U.S. debriefing

-- Debriefing in U.S. on or about May 23

KEY PERSONNEL:

Alan Gagnet, Timothy Gum, and Joel Hirschhorn

Scope of Work (Webster):

This Scope of Work (SOW) covers activities that will be performed by George Webster, one member of the three-person audit team. Mr. Webster has expertise in leather tanning and will be responsible for conducting a pollution prevention diagnostic assessment and preparing draft and final audit reports for two leather tanneries in Sfax, Tunisia. He will be supported and guided by a pollution prevention generalist, one of the other members of the audit team. Jim Westfield, a member of the EP3 Core staff, will also participate in the audits. Mr. Westfield's travel and time will be covered under the EP3 Core contract. All team members will work a six-day work week while in Tunisia.

To complete the audit, Mr. Webster will review baseline data collected by the EP3 Tunisia Office, collect additional information on process flows, raw materials used, and wastes generated, identify and evaluate opportunities for employing pollution prevention techniques, and recommend options, as appropriate, for implementation by the facilities.

A total of 7 tasks will be conducted for a total of 18 days, including 4 travel days. Tasks 1, 6, and 7 take place in the U.S. Tasks 2 through 5 take place in Tunisia.

Task 1: Pre-trip Preparation. A briefing for all participants in the Sfax audits has been scheduled for April 22, 1994. The meeting will take place at EP3's office in Rosslyn, Virginia, from 9:00 to 3:00. At the briefing, EP3 core staff will provide team members with an overview of the project, describe the program that has been set up in Tunisia, and outline the purpose and scope of the audits to be conducted. This will provide an opportunity for team members to ask questions about the nature of this assignment and to clarify their roles and responsibilities on the audit team.

Task 2: Meet with EP3 Tunisia and Plant Managers. A similar meeting will take place in Tunisia. At this meeting, EP3 Tunisia staff will describe in greater detail the scope of the audits and outline their expectations for the audit and the audit team. Before beginning Task 3, the team also will meet with the managers of the plants being audited to brief them on the team's activities and discuss their expectations and needs.

Task 3: Conduct In-Plant Assessment Work at Two Leather Tanneries. The in-plant assessment will consist of two steps and will take from two to four days to complete at each facility:

-- Verify technical and financial data collected by EP3 Tunisia and obtain additional detailed information on process flows. Develop process flow diagrams and material and energy balances for each facility's operations.

-- Once all processes are understood and quantified as much as possible, identify and analyze pollution prevention options that could be applied to the production processes. Look for options that are "no- or low-cost" as well as options that may require some capital investment. Emphasize options that individually result in economically and environmentally important results rather than a large number of minor actions that individually have low impact.

Mr. Webster will be supported in conducting these audits by Mr. Alan Gagnet, of Hirschhorn & Associates.

Task 4: Develop In-Country "Draft" Reports. Once options have been identified, the tannery expert will begin preparing draft reports that thoroughly analyze all options identified, including their technical feasibility, cost to implement, "payback periods," net economic benefits, and implementability.

Draft reports should be based on the format provided by EP3 Washington. However, EP3 invites team members to suggest improvements to the format provided. The reports must: describe the plant's production processes; clearly describe options; identify first, second, etc. priority options; and outline an implementation schedule for recommended options. The reports should suggest followup actions for both facilities to guide them in project implementation and measurement.

A copy of the draft reports must be left with EP3 Tunisia before the expert returns to the U.S. A second copy of the reports must be provided to EP3 Washington upon returning to the U.S.

Task 5: Conduct Exit Interviews with EP3 Tunisia, plant managers, and AID. The expert should present its findings orally to the managers of all facilities, EP3 Tunisia and AID before leaving Tunisia.

Task 6: Brief EP3 Washington Staff and AID. Approximately two weeks after returning to the U.S., the expert and other members of the audit team will brief EP3 Washington staff and AID on the results of the audits. This will be an opportunity for EP3 Washington staff to provide oral comments on the draft report and to learn from the audit team's experience.

Task 7: Complete Report. Following the U.S. debriefing, Mr. Webster will incorporate comments received from EP3 Washington, EP3 Tunisia, and AID. Mr. Webster will submit a final draft report to EP3 one week after the U.S. debriefing.

The table below illustrates a suggested level of effort for each task.

Name	T 1	T 2	T 3	T 4	T 5	T 6	T 7	Travel Days	Total
Webster	1	1	5	4	1	1	1	4	18

DELIVERABLES and SCHEDULE:

-- Debriefing in Tunisia: On or about May 6

-- Detailed assessment reports using the format provided by EP3 as a starting point. The final report should provide a model for future pollution prevention assessments.
- Draft reports for two leather tanneries (one copy provided to EP3 Tunisia and one copy provided to EP3 Washington): May 7
- Final draft reports for two leather tanneries incorporating comments: two weeks following the U.S. debriefing

-- Debriefing in U.S. on or about May 23

KEY PERSONNEL:

George R. Webster

APPENDIX F

Industry Agreement

CONVENTION

ENTRE LES SOUSSIGNES,

EP3 Tunisie/RCG Hagler Bailly Inc. (dénommée ci-après EP3/HBI), financé par l'agence des états Unis d'Amérique pour le développement international (dénommée ci-après USAID),

D'UNE PART,

ET,

La société SIOS - ZITEX, fabriquant de savon domestique à partir des huiles végétales et partenaire industriel, domiciliée à: Z.I., route de Gabès, Sfax, Tunisie,

D'AUTRE PART,

La présente convention est conclue en vue de la réalisation du programme qui jouit de l'appui du ministère de l'environnement et de l'aménagement du territoire et de l'union Tunisienne de l'industrie, du commerce, et de l'artisanat et sera exécutée par le principal contractant, RCG/Hagler Bailly, Inc, et le Directeur de Programme, EP3 Tunisie, domicilié au 75, avenue Mohamed V, 1002 Tunis-Belvédère.

EN FOI DE QUOI :

Concidérant que le Gouvernement de Tunisie a donné son aval au objectifs du programme de prévention de la pollution (EP3) qui sont d'encourager la prévention de la pollution par les établissements industriels dans les secteurs privé et public, et que EP3/HBI a conclu un contrat avec l'USAID pour la prestation du soutien technique et de gestion nécessaire.

Considérant que SIOS-ZITEX désire participer avec EP3/HBI à la conception d'un programme de prévention de la pollution et de contribuer à une étude diagnostique de la prévention de la pollution qui sera réalisée par EP3/HBI, des experts américains, le personnel de SIOS-ZITEX, et des experts Tunisiens, et que l'un des principaux objectifs de ce programme de prévention de la pollution avec SIOS-ZITEX est de rationnaliser la consommation de matières premières, de ressources naturelles et d'énergie afin de réduire les investissement dans le procédé (surtouts pour des installations nouvelles), de comprimer les coûts d'exploitation, et d'alléger les exigences sur le dimensionnement des stations de pré-traitement des eaux usées ou de dépollution atmosphérique si encore nécessaire,

IL A ETE CONVENU ET ARRETE ce qui suit entre les parties contractantes :

Obligations de EP3-Tunisie

EP3 réalisera, à sa charge, une étude diagnostique de la prévention de la pollution avec le concours d'experts Tunisiens et étrangers, pour SIOS-ZITEX.

EP3/HBI soumettra à l'approbation et l'accord de SIOS-ZITEX, les rapports d'avancement et recommandations, et ce suivant un calendrier approuvé par les deux parties.

EP3/HBI nomme M. Rachid Nafti, Directeur de EP3 Tunisie, pour assumer la principale responsabilité contractuelle et opérationnelle au vu de la présente convention. Il est également chargé de veiller au respect des termes de la présente convention.

EP3/HBI ne publiera aucune information considérée comme confidentielle ou exclusive, ou que, de bonne foi, tout homme/femme d'affaire rationnel jugerait comme telle, relative à des procédés et pratiques appartenant à SIOS-ZITEX.

Obligations de SIOS-ZITEX :

SIOS-ZITEX s'engage à inaugurer un programme de prévention de la pollution dans son établissement avec l'objectif de réduire, dans la mesure du possible, la consommation de produits chimiques et d'énergie et l'exploitation de ressources naturelles. SIOS-ZITEX s'engage tout particulièrement à: fournir des informations correctes et régulières sur les quantités et coûts des matières premières, et toutes les autres informations utiles à l'étude diagnostique; et à assurer tout le soutien, l'orientation et la reconnaissance au sein de l'entreprise qui permettront à EP3/HBI, et à tout expert étranger employé par elle, de réussir dans cette étude diagnostique.

SIOS-ZITEX s'engage à payer, au besoin, tous les frais, en monnaie locale, d'analyse des échantillons prélevés pour évaluer le procédé; ainsi que toute pièce d'équipement inprévue recommandée pour améliorer le procédé et réduire ses coûts opératoires.

SIOS-ZITEX dotera le personnel des moyens techniques qui permettront de contribuer et exécuter les fonctions de contrôle décelées au cours de l'évaluation.

Les techniciens de SIOS-ZITEX et de EP3/HBI assureront le suivi des résultats de tests, expériences et autres collectes de données. Tous les paramètres et quantités à calculer pour l'étude, tels que émissions, déchets et effluents, seront mesurés sur la base de leur valeur par rapport à une unité de production donnée afin de vérifier les estimations de réduction

d'émissions, de déchets et d'effluents, ainsi que des économies potentielles d'argent.

SIOS-ZITEX s'engage à nommer un Directeur de projet qui sera responsable du suivi technique et de l'assistance dans toute autre activité connexe du projet. Ce Directeur sera également chargé de la coordination entre SIOS-ZITEX, et EP3/HBI et/ou le consultant/contractant engagé par EP3/HBI pour ledit projet.

La direction de SIOS-ZITEX autorisera le libre accès à l'usine, au cours des deux premières années du projet, à des Sociétés privées, agences publiques et experts étrangers, préalablement agréés par EP3 et SIOS-ZITEX, afin d'observer les technologies propres (non-polluantes) appliquées. EP3/HBI organisera de telles visites des lieux, après autorisation préalable de SIOS-ZITEX. Dès qu'elles auront été autorisées, ces visites seront coordonnées par le Directeur de projet prédesigné, et seront programmées de manière à gêner le moins possible le déroulement des activités en cours.

SIOS-ZITEX s'engage à ne pas tenir pour responsable EP3/HBI et ses contractants et sous-traitants de toute lésion corporelle, perte ou dommage matériel qui pourrait émaner de l'étude de diagnostic de la pollution sus-mentionnée.

Il est entendu que SIOS-ZITEX s'engage à assurer l'indemnisation ou la couverture de ses propres sous-traitants, s'il en existe, pour tout équipement ou installation d'instruments au respect de ses pratiques contractuelles courantes, et à ce que ces dispositions tiennent compte de toutes les garanties requises en cas de force majeure, de retard, de dommages liquidés ou d'éxécution que SIOS-ZITEX puisse demander.

Obligation financières des deux parties

EP3/HBI ou des consultants ou contractants engagé sur place par EP3/HBI dans le cadre du présent projet ne sont liès par aucune obligation financière vis-à-vis de SIOS-ZITEX ou un quelconque de ses employés, agents ou représentants.

Dispositions générales

Il est entendu que toutes les informations concernant les procédés ou produits qui sont propriétés de la SIOS-ZITEX, ainsi que toutes les données relatives aux quantités et qualités des effluents et les données opérationnelles et commerciales qu'elle fournit à EP3 /Tunisie, à ces sous-traitants ou experts soient traitées dans la plus stricte confidalité, et qu'elle ne soient transmises à aucune entité/autorité publique ou privée sans avoir l'accord préalable de la SIOS-ZITEX.

En cas de violation de la présente convention. Les parties se réservent le droit de mettre fin à tout moment, sans encourir de responsabilité et sans que l'autre partie ne puisse se prévaloir d'une indemnisation ou remboursement.

Effet juridique de l'aval et des décisions de l'USAID

La présente convention ne sera valable qu'aprés sa ratification par USAID.

L'USAID a un droit de supervision sur l'exécution du programme et sur l'utilisation des fonds octroyés.

Préavis

Il est entendu que tout préavis donné par l'une ou l'autre des parties ne peut être valable et prendre effet que s'il est donné par écrit et remis au Directeur du co-contractant dont l'adresse est fournie par la présente convention.

De la compétence

En cas de litige quant à l'interprétation ou l'éxcution de la présente convention seuls les tribunaux de Tunisie seront compétent, et seule la législation Tunisienne sera applicable.

Copies de la convention

La présente convention sera signée en trois exemplaires, dont un original pour chacun des : EP3/HBI, SIOS-ZITEX, et USAID Tunisie.

En foi de quoi, les parties, par leurs représentants dûment autorisés, conviennent des dispositions de la présente convention.

Pour SIOS - ZITEX

Mohamed CHAARI

Directeur Général

Signature: .....

Date: 21/04/94

Pour EP3/HBI

Rachid Nafti

Directeur de EP3 Tunisie

Signature.....

Date: 22/4/94