5.3 Waste Stream Description and Current Waste Management Practices

Being an ISO 9001:2000 certified, PRII is committed to the protection of the environment and ensures the safety and health of its workers and the surrounding community. Aside from the personnel constantly updated safety training, existence of safety facilities and emergency response plans, PRII endeavors to continuously improve the safety and environmental performance of its production facility. Moreover, PRII is pro-active on projects on waste managements, greening of the environment, watershed rehabilitation, coastal care in the surrounding communities and information/awareness campaigns in conjunction with PRIIs community relations program.

Through the initial effort and awareness on health and safety, PRII management encouraged and obliged the workers to wear protective gadgets in the plant. Other good housekeeping measures have been implemented such as

Posting of signage about proper handling, storage, and disposal of hazardous substances and materials

Labeling of process chemicals and pipes;

Regular preventive maintenance and improved performance of equipments;

Proper ventilation in work areas to reduce exposure to high temperature conditions and toxic fumes;

Installation of VCM gas emission sensor within the facility

In line with this, PRII also requires workers to have an annual physical examination to track any health problems that might be associated with the production process.

Despite of these practices, minimum amount of wastes are still generated in the operation (see Figure 3). The succeeding sections discuss the various waste generated and how PRII is managing them.

◇ Solid Waste

The solid wastes generated are mostly from the polymerization process. All the used containers of raw materials are considered wastes. Currently, the company observes proper segregation/recycling system and disposal of these materials

The undersize and oversize PVC resin gathered in the process are classified as off-specification products while the sludge collected in the wastewater treatment facility is categorized as a low grade PVC resin and are not treated as wastes. These are sold directly to the low grade PVC user at lesser price.

In this activity, the company was able to reduce the volume of solid wastes generated from 1999-2002 as shown in the following Table 6.4. 29

Table 6.4. 29. PRII Solid Wastes Generated (1999-2002)

TYPE OF SOLID WASTE	1999 (Kilograms)	2000 (Kilograms)	2001 (Kilograms)	2002 (Kilograms)
a. CONTAINERS, JERRY CANS, CARBOYS	6,598	7,753	8,571	7,900
b. PVC SCALES, FLAKES and from SEWER	163,651	109,548	102,910	93,210
c. DOMESTIC WASTES	5,200	6,240	7,200	8,800
d. PAPER / CARTONS	763	1,678	1,472	1,600
e. SACKS	736	748	935	834
f. SLUDGE	121,550	134,870	97,150	74,335
TOTAL SOLID WASTE GENERATED	**298,498**	**260,837**	**235,836**	**186,679**
Total Solid Waste Recycled	***98.26%***	***97.61%***	***96.95%***	***95.29%***
Total Domestic Wastes Directly Disposed to Sanitary Landfill / Dumpsites	***1.74%***	***2.39%***	***3.05%***	***4.71%***

◇ Liquid Waste

Wastewater generated from decanter, scrubber, and cooling tower is pumped in the treatment facility. The treated water characteristics are shown in water quality monitoring data (see Table 2). In this process, low grade resins are recovered through coagulation and sedimentation processes. After passing through the system water is neutralized before discharging. The wastewater treatment facility has a capacity of 1,400 m^3/day.

◇ Air Emissions

In the production of PVC, the primary concern is the vinyl chloride monomer (VCM) because of its toxic nature. This material can be hazardous if improperly handled. It is normal in the polymerization reactor to have an unreacted VCM in minimal amount. In such way, the unreacted monomer is recovered and recycled back into the process. Most of the processes are interconnected in a VCM collector and recycled back in the process thus preventing possible escape of VCM.

Its noteworthy that PRII operates the Tosoh technology successfully. The plant uses a high performance closed-lid suspension-type reactor and high effective build-up suppressant which is coated in the inner walls and the internals of the reactor. The utilization of a highly efficient VCM stripping column technology and adoption of microprocessor-based distributed control system are part of the system. Latest technology for dust-free bagging and handling of the product are provided. The plant is also equipped with VCM gas emission sensor as a monitoring and alarm system for the workplace and routine measurement of worker exposure. This technology minimizes potential worker exposure, reduces environmental emissions, maximizes production efficiencies and produces a free residual VCM final product.

5.4 Recommendation Waste Minimization Options

The team is very grateful that PRII management is fully committed to excellence by way of responding to the needs and concerns of the community and the environment. Positive attitudes and skills spread to the workplace and full support from the management to implement measures that improve working conditions and reduce time lost to illness and injury are the most important principles adapted by the company as an indication of continuous improvement. For the WM assessment, the team focused on waste minimization options that would reduce or eliminate the possibility of VCM leaks at source and proper handling of materials as illustrated in the following Table 6.4. 30

Table 6.4. 30. Recommended Waste Minimization Options

Waste Minimization Options/Recommendation	Rationale	Expected Impact
Encapsulate the process equipments and piping system	Prevent any accidental or inadvertent discharges of toxic VCM.	Ensure safety of workers and improve production efficiency of the system.
Hazardous raw material containers must be lined with plastic material so that it can be rinsed and recycled (place into plastic bag first before in a rigid container). If possible return the containers to the supplier for proper disposal.	To properly manage hazardous wastes.	Reduce the volume of hazardous solid wastes to be generated in the plant.
Re-use of treated water in the process. Basically, the system is easy to handle because it does not contain much pollutants (see Table 3, water quality monitoring data) and upon further treatment it can be recycled as process water.	Reduce production cost and recovery of treated wastewater.	Lesser volume of wastewater will be generated in the process.

5.5 Future Waste Minimization Activities

◇ Organization of Waste Minimization Team

An in-house minimization team shall be organized to oversee all the activities in the implementation of the waste minimization program of the company. To generate a strong involvement among the personnel, team members must be selected from the different company's departments or processing sections. From among the team members, a coordinator will be appointed that will also serve as liaison officer between the management and the team. Overall, the waste minimization team will be responsible in organizing and implementing program of the company.

◇ Monitoring and Testing Requirements

To be able to track down the quality and quantity of wastes generated, the company shall conduct periodic monitoring. A source inventory of all types of wastes from the different processing areas through waste audit shall be done by composite sampling. By this way, the assessment team will be able to identify waste sources that are problematic and also they will be able to decide at what stage of the process waste minimization could be started. To know whether waste reduction has been achieved, measurement of water consumption and wastewater generation will be done regularly. Benchmarking on every process shall also be made in order to identify which process has not made any progress in the waste reduction effort of the team. To know the quality of wastewater generated, the following physico-chemical parameters will be determined: biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), alkalinity and pH. BOD, COD and TSS are measurements of the organic matter components of the wastewater. The greater the COD, BOD and TSS values, the higher is the pollutive property of the wastewater.

Also, for strict compliance to clean air act, much attention will be considered in monitoring the air emissions in the workplace.

5.6 Recommended Waste Minimization Activities

The future waste minimization activities of the company are summarized shown in Table 6.4. 31.

Table 6.4. 31. WM Future Activities

ACTIVITIES	TIME FRAME
1. Conduct in-house training	2 days
2. Organize in-house team	1 day
3. Facility walk through (for process validation)	2 days
4.Brainstorming and formulation of waste minimization options	1 day
5. Prioritization and Implementation of Options	Perpetual

6. Eldon Industrial Corp.

6.1 Facility Background and Location

The Eldon Industrial Corporation (EIC) was registered with the Securities and Exchange Commission in 1986 as a company engaged in the manufacture of aluminum pilfers proof caps, campaign pins, trays, novelty items, etc. In February 1997, under the EIC Group of Companies, Bounty Food Division was established which is involved in the production of ready to eat canned meat food products. It is located at Lot 1-A building, E Sunrise Village, Llano Road, Kalookan City, Metro Manila occupying a lot area of about 3,000 m^2. The plant has a production capacity of about 1000 cases (48,000 cans/case) per day operating for 8 hours per weeks on a 1 shift basis.

Most of its product lines are processed ethnic foods of beef, pork, chicken and beans which are exported to Hongkong, Taiwan and Middle East.

6.2 Facility Lay-out and Equipment

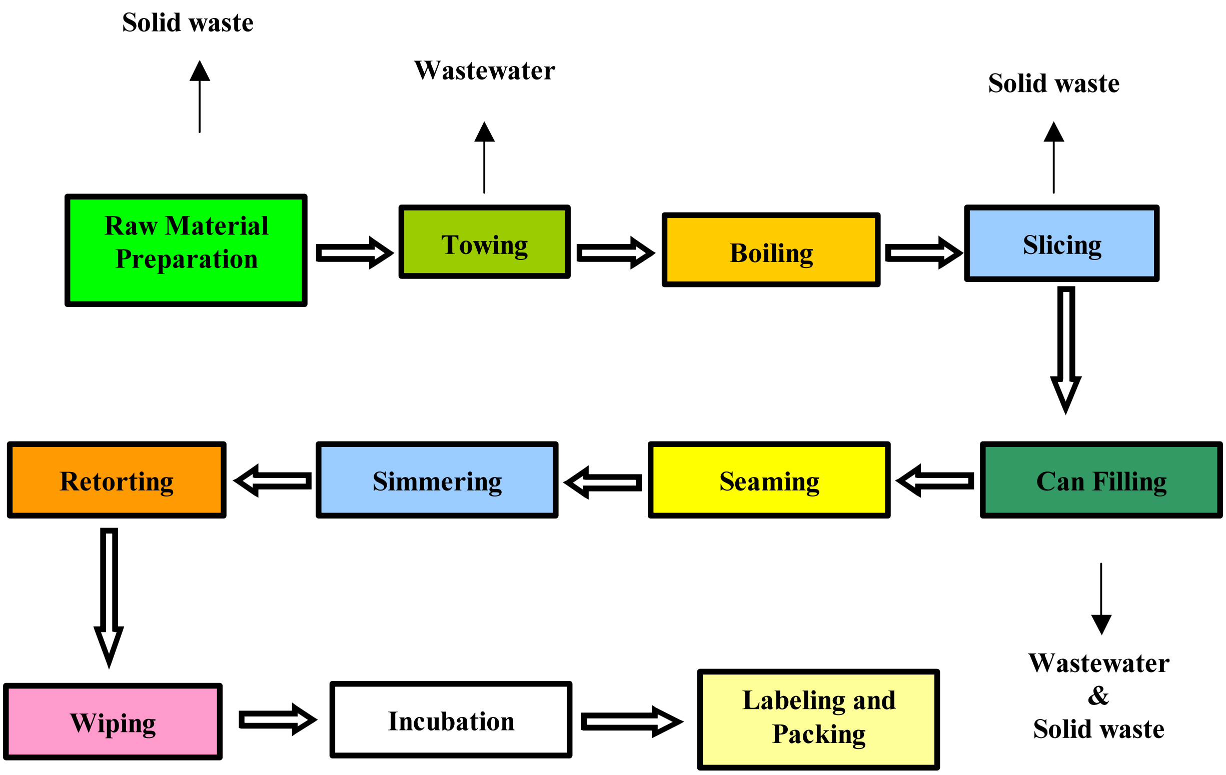
The entire plant house the 9 cold refrigerator vans, towing tank, boiling section, meat and sauce filling sections, retort equipment, and labeling and packing equipment. These various sections are strategically located within the plant to facilitate the easy transport and transfer of raw materials from one section to another.

6.3 Process Description

During the waste assessment, the plant was not operating due to its yearly maintenance schedule except for the labeling and packing sections.

The process flow diagram in the production of processed foods is presented in Fig. 6.4. 23

Fig. 6.4. 23.Process Flow Diagram



◇ Towing and Boiling of Meat

About three (3) tons of meat are processed per day. The meat consists of beef, chicken, and pork which, are purchased at eighty pesos (P80.00), sixty pesos (P60.00) and one hundred pesos (P100.00) per kilogram, respectively, from local suppliers. On the other hand, the company used 1 ton of vegetable per day consisting of onions, long and bell peppers, carrots and potatoes. The purchase price of these items, ranged from twenty pesos (P20.00) to thirty pesos (P30.00) per kilogram.

Meat and vegetables are taken from one of the refrigerated vans in the storage area. These raw materials are brought to the preparation area where they are being towed inside a 500 liter capacity towing tank. After the towing period, the meat and vegetables are boiled and then brought to the slicing section. About 250 liters of water is used for towing of meat while 10 to 15 liters of water is utilized for washing of crates containing vegetables.

◇ Slicing and Filling

The meat and vegetables in this section are being sliced in standard sizes and then transferred manually to several cans.
During slicing and manual filling, lot of solids remained in the table and some are spilled on the floor.

◇ Filling of Sauce

The filled cans are brought to the filling sauce station through a sauce conveyor system where sauce is dispensed into each can. Batch filling is done from a 100 gallons capacity steam jacketed kettles.

◇ Seaming and Simmering

The canned products are then brought to the seaming and simmering section where it is immersed in a pool of water for sometimes.

◇ Retorting/Sterilization

The canned products are then placed inside a retorting equipment to undergo sterilization process for a period of 2 hours at 120°C. There are 5 cylindrical type retorts employed with each containing 3 baskets. Every basket contains 1,800 cans. After the sterilization period, the cans are cooled down overnight by washing with 2 m^3 of cooling water.

◇ Wiping

All the cans are wiped individually to remove the moisture from their surface. Cloth rugs are usually used in wiping the cans. About 10 kilograms of rugs are used during wiping.

◇ Incubation

After the wiping period, all the cans are incubated at room temperature for two (2) weeks. This process allows the absorption of the sauce by the meat.

◇ Quality Control Inspection

Random samplings of the canned product are done to determine the quality of the product during the production process. Laboratory analysis is being conducted on the presence of food contaminants that will affect the health and safety of the consumer.

◇ Labeling and Packing

Labeling is done by using a mechanized labeling machine. Then the products are packed manually in boxes.
During the labeling and packing process, destroyed labels and dented cans are produced. Undestroyed labels are re-used for the labeling of cans while the destroyed one are discharged into

the garbage for disposal. Dented cans are usually sold to the staff and workers at a lower price.

6.4 Waste Stream Description and Current Waste Management Practices

◇ Solid Waste

- Boxes/Cartons
  During the packing operation considerable number of cartons are being destroyed. About 1,200 kilograms of cartons are destroyed daily. These cartons are brought to a paper mill engaged in recycling of used papers.
- Vegetable Peels
  About 200 kilograms of vegetable peels are produced per week in the peeling section of the plant. These solid wastes are collected and disposed to a dumpsite by a local contractor.
- Plastics
  The company is generating 2 kilograms of plastic waste every two days. Vegetable peels are placed in these plastics for disposal.
- Solid Fats
  Solid fats are generated during the removal of the fatty portion of the meat. About 10 bags of solid fats are produced daily. Each bag contains about 10 kilograms of solid fats. All the bags are disposed into a dump- site by a private hauler.
- Spillage
  Meat and vegetable spills during the slicing and can filling process could also be one of the sources of solid wastes in the plant. These materials are usually collected in plastic bags for disposal into a dumpsite.

◇ Liquid Wastes

The company is consuming about 48 m^3 of water per day. Their water supply is being rationed by a private water delivery company. The various usage of water is presented in the Table 6.4. 32

Table 6.4. 32. The different usage of water by Eldon Industrial Company

Usage of Water	**Consumption Rate (m^3/d)**
Process Water	2
Cooling Water	10-15
Boiler Make-up Water	20-24
Wash Water and General Cleaning	5-10

- Towing, Washing and Cleaning
  About 18 m^3 of wastewater is generated daily during the towing, washing and cleaning of raw materials, equipment and floors in the plant. All the wastewater generated in these processes are conveyed to the wastewater treatment facility for treatment.
  There was no data available from the company regarding the quality of wastes generated in terms of BOD, COD, TSS, TSD and pH.

6.5 Current Waste Management Practices

The Eldon Industrial Corporation through its Bounty Food Division is committed to undertake environmental protection program by providing safe and healthful working environment for its employees and the surrounding community. Because of its policy, the company has embarked some waste management practices.

The plant is adopting a solid waste segregation program. Its segregated wastes were collected by a private contractor and transported into a dumpsite.

In the factory, workers were required to remove spilled solids from the floor before washing it with water to reduce water consumption.

Re-used of plastics bags for collection of solid waste.

Some of the good housekeeping practices as related and observed by the team are:

- Requiring workers to wear proper uniform during process operation. It minimizes food contamination.
- Working areas are kept clean and well organized.
- Equipment are properly in placed and well secured
- Cleaning and washing of meats and vegetables are done properly inside the tank to prevent spills and leaks.
- Vegetables are placed in plastic crates during washing to avoid spillage.
- Proper transport of food product to various process stations.
- Practice preventive maintenance on their equipment.

6.6 Recommended Waste Minimization Options

◇ Solid Waste

The different waste minimization options are presented in the following Table 6.4. 33.

Table 6.4. 33.Recommended waste minimization options

Waste Minimization Options	Rationale	Expected Impacts
Vegetable Peeling: Use vegetable peels as substrate for composting. Identify compost generators Use as animal feeds for piggeries.	Reduce the volume of solid waste disposed per week. Compost generators will be the one to collect the peels Peels are rich in carbohydrates	Lower the cost of solid waste transport and disposal every week. Help in prolonging the carrying capacity of the dump site.
Slicing and Filling Section: Manual removal of spilled solids on the floor prior to washing with high water nozzle spray.	Significantly reduce the volume of water for floor cleaning	Reduce cost in the consumption of water by saving water from floor cleaning. 20% of waste water is usually derived from floor cleaning.
Labeling and Packing Section: Fix destroyed labels for re-use. Re-use of dented cans during packing.	Reduction on the volume of destroyed labels during labeling. Disposing of dented can is minimized.	Reduce the volume of paper wastes for disposal. Selling the dented cans to the company staff/workers may reduce overhead cost of the company.
Replace all faucets with defective washer. Strategic installation of water meters in areas where water is constantly in use.	Prevent water leaks. Monitor water consumption.	Cost saving in water consumption. Company will know whether they are minimizing the use of water and also computation on how much savings can be made on the cost of water saved daily or monthly be known.

◇ Wastewater Treatment Options

The company has a wastewater treatment facility consisting of the following systems:

- Holding or equalization
- Chemical coagulation or flocculation
- Sedimentation
- Aeration

- Sand filtration
- Activated carbon
- Sludge drying bed.

The existing wastewater treatment facility has high treatment efficiency. Sand filters and activated carbon are considered as state of the art technologies in wastewater management because of its high treatment performance. In this connection, the operation of the sedimentation process could be disregarded without affecting the overall BOD reduction performance of the whole system. It will also lessen the operation cost of the facility.

6.7 Future Waste Minimization Activities

◇ Organization of Waste Minimization Team

An in-house minimization team shall be organized to oversee all the activities in the implementation of the waste minimization program of the company. To generate a strong involvement among the personnel, team members must be selected from the different company's departments or processing sections. From among the team members, a coordinator will be appointed that will also serve as liaison officer between the management and the team. Overall, the waste minimization team will be responsible in organizing and implementing the waste minimization program of the company.

◇ Monitoring and Testing Requirements

To be able to track down the quality and quantity of wastes generated, the company shall conduct periodic monitoring. A source inventory of all types of wastes from the different processing areas through waste audit shall be done by composite sampling.

In addition, the assessment team will be able to identify waste sources that are problematic and also they will be able to decide at what stage of the process waste minimization could be started. To know whether waste reduction has been achieved, measurement of water consumption and wastewater generation shall be done regularly. Benchmarking on every process shall also be made in order to identify which process has not made any progress in the waste reduction effort of the team. To know the quality of wastewater generated, the following physico-chemical parameters shall be determined: biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), alkalinity and pH. BOD, COD and TSS are measurements of the organic matter components of the wastewater. The greater the COD, BOD and TSS values, the higher is the pollutive property of the wastewater.

6.8 Recommended Waste Minimization Activities

The following Table 6.4. 34 shows the WM activities of the company.

Table 6.4. 34. Waste Minimization Activities

Activities	Time Frame
1. Conduct in-house training	2 days
2. Organize in-house team	1 day
3. Facility walk through (for process validation)	2 days

4. Brainstorming and formulation of waste minimization options	1 day
5. Prioritization and implementation of options	Continuing

7. Aclem Paper Mills, Inc.

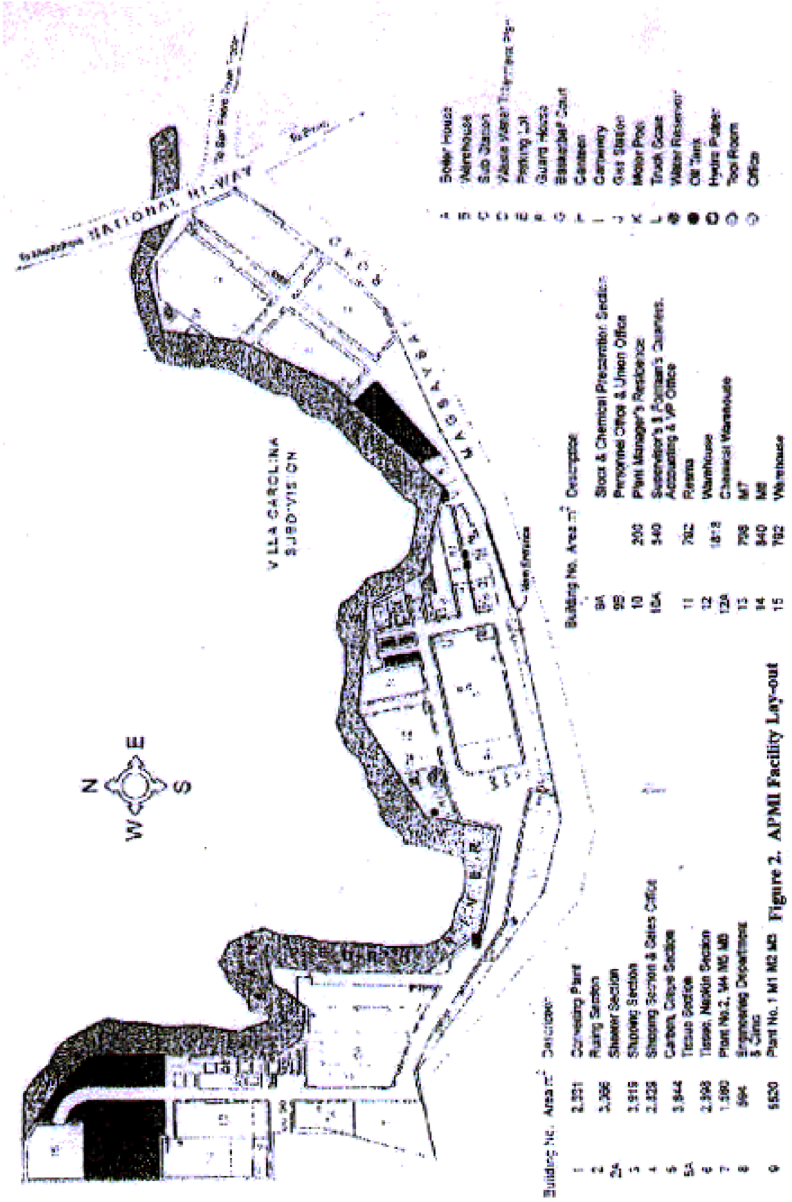
7.1 Facility Descriptions, Background and Location

Aclem Paper Mills Inc. (APMI) started its operations in 1962. It occupies a 5.5 hectare lot and is located at 2 Magsaysay Road, Barangay San Antonio, San Pedro, Laguna. *Figure 1* shows the vicinity map of APMI. It is managed by Engr. Robert C. Lim, Senior Vice President- Mill Manager. It has an actual production capacity of 80 tons/day and operates in 3 shifts for 24 hours per day for 300 days per year. It employs 800 staff and the average labor cost amounts to P450 per day. APMI manufactures various kinds of paper namely kraft paper, tissue paper, carbonizing paper, coupon bond, letter envelopes, crepe paper and Japanese paper. In the production of these papers, it also uses different chemicals.

7.2 Facility Lay-out and Equipment

Fig. 6.4. 24 illustrates the APMI facility lay-out which includes the converting plant, ruling section, sheeter section, shipping section, carbon and crepe section, tissue and napkin sections, plant no. 2, engineering department and clinic, plant no. 1, paper machines 1, 2 and 3, stock and chemical preparation section, personnel office and union office, plant manager’s residence, supervisor’s and foreman’s quarters, accounting and Office of the Vice President, chemical warehouse, paper machines 7 and 8, boiler house, carpentry section, water reservoir, hydra pulper, oil tank, office and tool room.

Fig. 6.4. 24. APMI Plant Layout



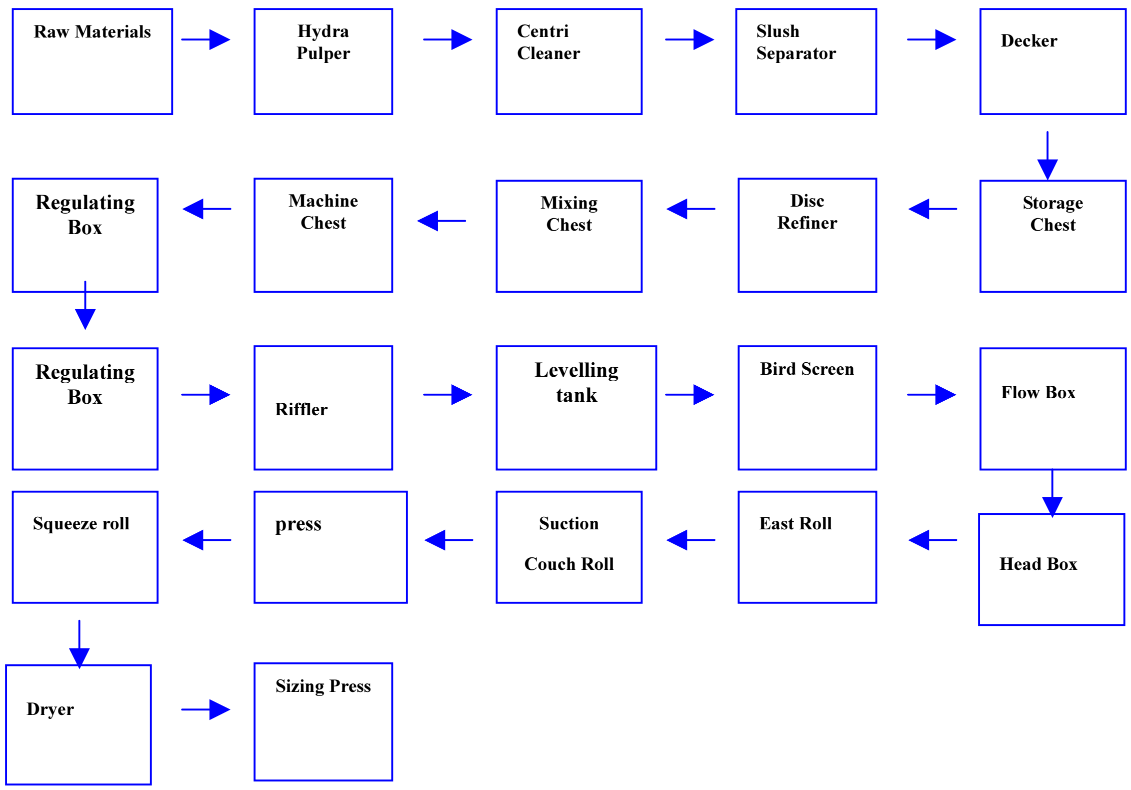
7.3 Process Flow

Fig. 6.4. 25 show the process flow diagram of APMI. Papermaking process can be briefly described as follows: Wastepapers as primary raw material for papermaking are conveyed into mechanical pulper, mixed with water or white water and disintegrated to form into pulp. The pulp with some foreign materials passes through coarse cleaners and liquid cyclones for initial segregation and cleaning. The pulp stock are then thickened, refined and further diluted with water for final fine screening process. Stock is added with chemicals and pumped to headbox for mat forming or for papermaking process.

The pulp at 4 to 6% consistency passes through a rotating endless wire mesh screen for mat forming and dewatering process. White water extracted are re-used in the process while the mat of fiber formed passes through a series of presses to reduce its water content prior to drying.

The sheets then passes through a series of cylindrical drums of dryers heated with steam from 105 to 170 degrees centigrade until dried up at moisture content between 4 to 6%. The sheet finally passes through calendar rolls and reeled in jumbo rolls before cutting into final form at the rewinder. Jumbo rolls are sent to winding section and cut into rolls or in sheets for final wrapping or baling and for storage.

Fig. 6.4. 25.Paper Production Process Flow Diagram



7.4 Raw Materials Used in Paper Production

The company utilizes the following raw materials with its consumption rates as shown in the following Table 6.4. 35

Table 6.4. 35. APMI raw materials and annual cost of raw materials

Raw Materials	Quantity of Raw Materials	Cost	Annual Cost
Bleached pulp	800 tons/annum	P25,200.00/ton	P20M
Hardwhite shaving	6,800 tons/annum	18,000.00/ton	P122.4M
Kraft cartons	1,300 tons/day	3,500.00/ton	4.5M
Process water	2,000 to 3,000 cubic meters/day		
Electricity	1.5 million kilowatt hour (KwH)/month	P4.50/KwH	

7.5 Waste Stream Description Waste Stream

The succeeding section describes the various wastes generated by APMI as part of its production/process.

◇ Sludge

APMI generates 1.5 tons per day of sludge, some of which are being recycled and the rest are brought to the landfill. Sludge disposal cost is only minimal. Water from the sludge is removed by the use of belt press and dried by open air drying.

◇ Wastewater

APMI generates 1,000 cubic meters (m^3) per day of wastewater from the different process operation. Portion of the wastewater is being recycled back into the system and the rest goes to the wastewater treatment facilities shown in Fig. 6.4. 26 and Fig. 6.4. 27. The company is spending 20 million pesos (P20M) per year in the annual operation of its existing waste treatment facility (WTF). Qualitative analysis of the wastewater is shown in *Annexes, which* indicate that APMI is able to comply with the standard set by the regulatory body.

◇ Gas Emissions

APMI generates sulfur oxide emissions (SOx) as a result of boiler operations. Intolerable smoke discharge from their boilers has been the subject of complaint among residents living in the vicinity of APMI. The company was notified of the complaint, and steps were made to further improve their emissions by upgrading their air pollution control devices.

Fig. 6.4. 26. Wastewater Treatment Flow Diagram at Plant #1

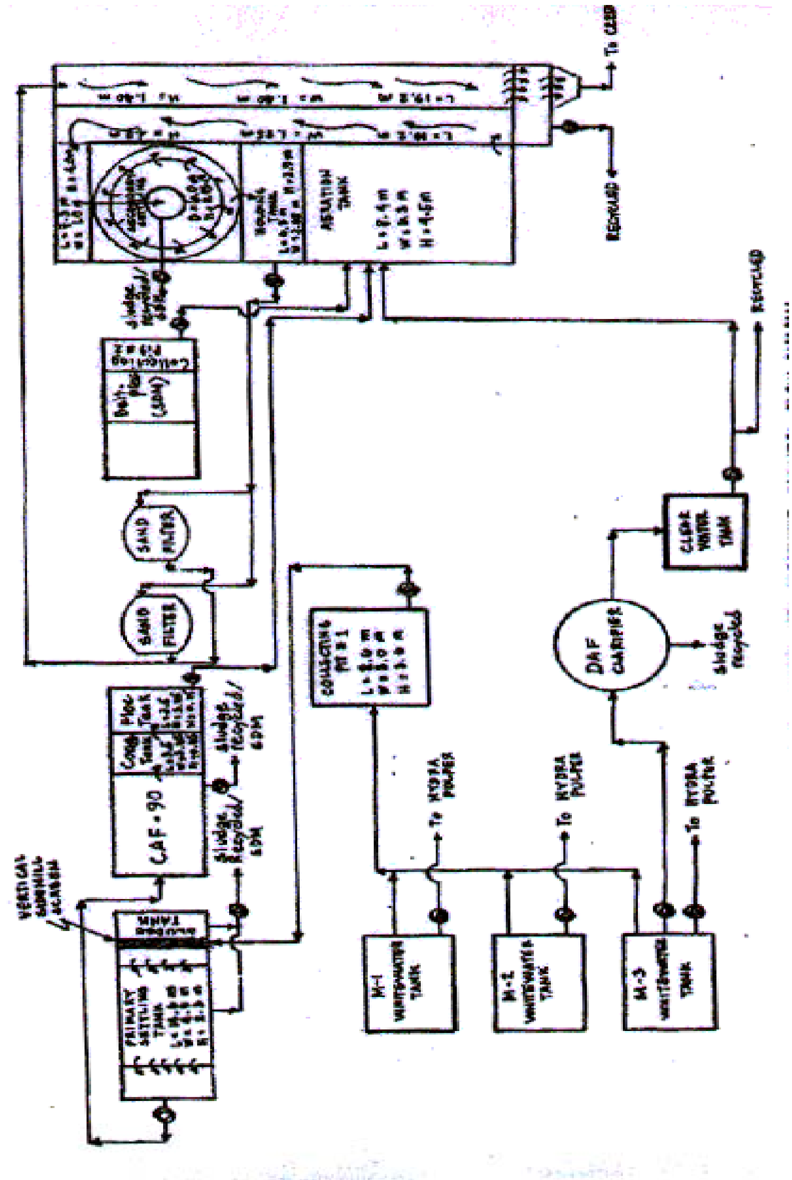
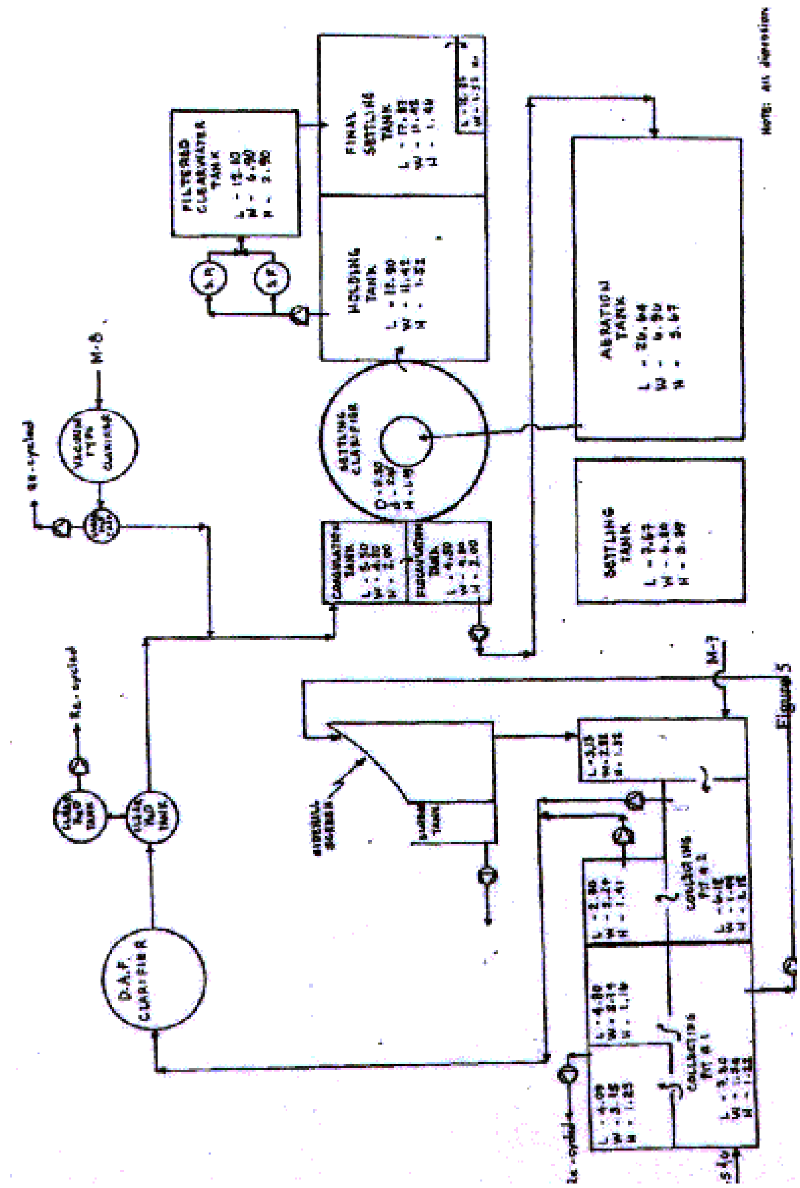


Fig. 6.4. 27 Wastewater Treatment Flow Diagram at Plant #2



7.6 Current Waste Management Practices

APMI observes several waste management practices such as:

- The company conserves water by using white water for breaking and pulping wastepaper and board to reduce water consumption.
- It also uses white water to dilute rejects in tank in the first step of cleaning to reduce water consumption.
- It replaces leaking valves, pumps and seals.
- It uses kerosene to clean machinery and prevent contamination of other materials.
- Utilization of minimal amount of printing ink in closed leak-proof containers.
- Use of condensed water from dryers

- Prohibition on the use of fresh water to clean chests.
- Use of synthetic rosin instead of soap rosin as sizing agent. It is added to paper to improve resistance to penetration by liquids.
- Addition of denatured starch to increase retention of fines and fillers and to reduce solids content in white water.
- Direct back feed of water from vacuum pump to white water. Efficiency of screen is improved and a fiber loss is reduced.
- Addition of Polymer to improve efficiency of air floatation.
- Use of plastic wire instead of bronze wire.
- Use of high pressure water to wash wire and reduce water consumption. The company considers this practice very helpful because water overflows when using low-pressure water.
- Efficient scheduling of production and reduction of repeated starts and stops.
- Use of warm air hood and heat pump to reduce steam consumption. Secondary fines are recycled through a strainer or filtration unit. Saveall operations are improved and fibers are reused in paper manufacturing, thereby lowering sludge production.
- Recycling of used heated water through a multiple pass system instead of a single pass system to reduce fuel consumption and the amount of water treated.
- Recycling boxes, paper bags and newsprint when allowed by product quality and cost considerations.

7.7 Recommended Waste Minimization Options

Waste minimization options as show in the Table 6.4. 36 were identified to reduce pollution load and comply with DENR effluent regulations. Based on the rapid waste assessment conducted, the WM Team generated the following options:

Table 6.4. 36Waste Minimization Options, Rationale and Expected Impact

WASTE MINIMIZATION OPTIONS	RATIONALE	EXPECTED IMPACT
Install measuring equipment for the machine which the company is using most of the time, test run it for 2 to 3 months then later test other machines to measure steam consumption	To monitor the steam consumption of machine	Improved maintenance of equipment
WASTE MINIMIZATION OPTIONS	RATIONALE	EXPECTED IMPACT
Put on the machine one at a time till it reaches a desired level of electric consumption	To reduce electric consumption and costs	Reduction of electric power consumption and costs
Conduct regular inspection, monitoring and maintenance of company's paper machines, water valves and other sources of leakages	To reduce company costs	Less operating and maintenance costs
Install additional aeration and sedimentation tanks in company's wastewater treatment facility	To increase/improve efficiency of its wastewater treatment facility	Reduction of pollution load of company wastewater
Conduct regular monitoring of its wastewater	To keep track of company wastewater characteristics	Reduction of BOD, COD, TSS values in wastewater and compliance to effluent standards
Upgrade air pollution control devices	To control sulfur oxide emissions	Air pollution control and improvement of environment conditions

◇ Recommended WM Activities

The following Table 6.4. 37 summarizes the recommended activities for the EMPOWER WM project.

Table 6.4. 37.Recommended Activities for the EMPOWER Waste Minimization Project

ACTIVITIES	TIME FRAME
1. In-depth assessment of paper model company	3 months
2. In-house training	2 days
3. Organize in-house team	1 day
4. Facility walk through (for process validation)	2 days
5. Brainstorming and formulation of waste minimization options	1 day
6. Prioritization and implementation of options	Perpetual

◇ Organization of Waste Minimization Team

An in-house minimization team shall be organized to oversee all the activities in the implementation of the waste minimization program of the company. To generate a strong involvement among the personnel, team members must be selected from the different company's departments or processing sections. In this regard, the JICA-PBE-ITDI team will conduct an in-house seminar to discuss on how waste minimization program will be set-up in the company.

7.8 Monitoring and Testing Requirement

To be able to track down the quality and quantity of wastes generated, the company shall conduct periodic monitoring. A source inventory of all types of wastes from the different processing areas through waste audit shall be done by composite sampling. By this way, the assessment team will be able to identify waste sources that are problematic and also they will be able to decide at what stage of the process waste minimization could be started. To know whether waste reduction has been achieved, measurement of water consumption and wastewater generation shall be done regularly. Benchmarking on every process shall also be made in order to identify which process has not made any progress in the waste reduction effort of the team. To know the quality of wastewater generated, the following physico-chemical parameters shall be determined: biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), alkalinity and pH. BOD, COD and TSS are measurements of the organic matter components of the wastewater. The greater the COD, BOD and TSS values, the higher are the pollutive property of the wastewater. Also, analysis of SOx emissions from boilers must be monitored regularly so that appropriate remedial action can be done in case it exceeds the standard limits set by the Department of Environment and Natural Resources (DENR).

8. Mabuhay Vinyl

8.1 Facility Background and Location

Mabuhay Vinyl Corporation (MVC) is the first and largest chlor-alkali producer in the Philippines. It manufactures caustic soda, hydrochloric acid, liquid chlorine, and sodium hypochlorite. Its plants are located in Iligan City, Lanao del Norte and Sta. Rosa, Laguna. MVC was incorporated and duly registered with the Philippine Securities and Exchange Commission as a rubber shoe manufacturer on July 20, 1934 and subsequently reorganized in 1963 to engage in chemical and resin manufacturing. The corporate name of Mabuhay Vinyl Corporation was adopted in 1966.

Today, MVC is the biggest domestic producer and importer of caustic soda and enjoys a dominant position in the hydrochloric acid and chlorine markets. The company is backed by a team of technically skilled managers with long and extensive experience in the field of chlor-alkali production. The company is also engaged in the trading activities of caustic soda pearls, industrial salt, and Asahi-brand PVC valves.

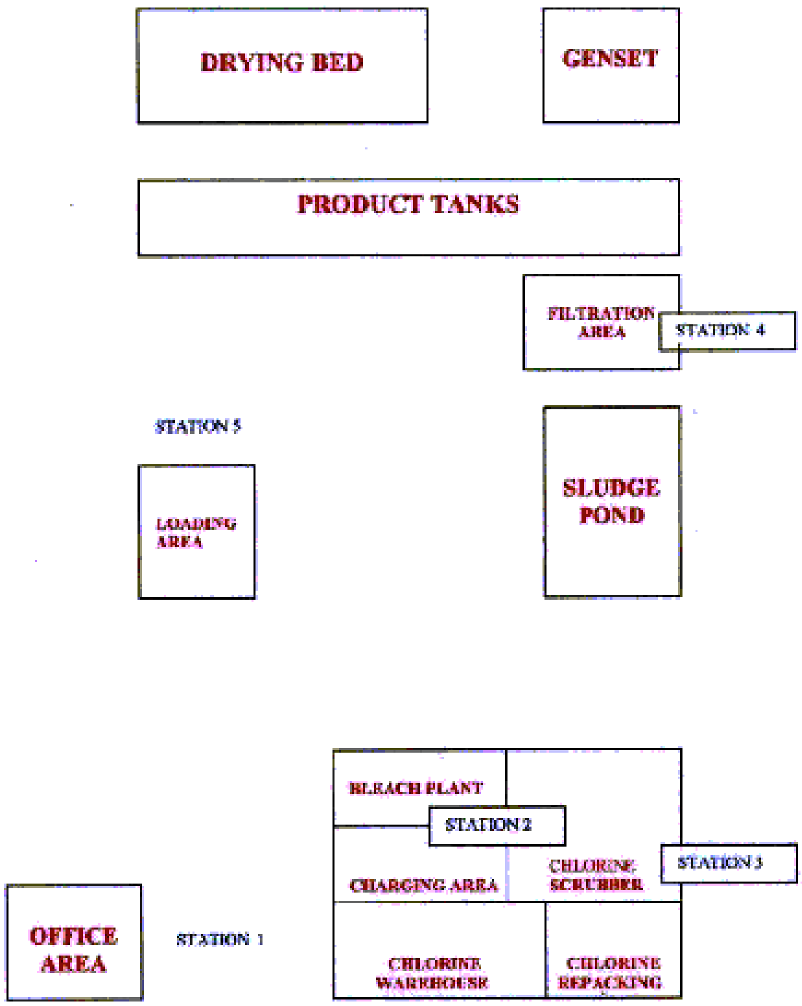
MVC in Sta. Rosa, Laguna also known as Mabuhay Vinyl Corporation-Premium Bleach Plant (MPBP) is solely dedicated to the production of sodium hypochlorite. The project was initiated by marketing department in 1991 as a means of recovering left over chlorine in one ton cylinders before returning to Iligan. The recovered chlorine is used as raw material in the production of sodium hypochlorite (NaOCl). In January 1994 the plant was fine tuned for commercial production, capable of producing 50 metric tons of 8% to 18% NaOCl per 8-hr shift operation or 150MT per 24-hr operation.

In April 1995, MPBP was awarded the ISO 9002 1994 certificate, the only ISO certified bleach plant in the Philippines and the third in Asia (next to Australia and New Zealand).
The plant is operated by only three personnel from 1994-2001 with one shift of operation. Now, the plant started its 68kg chlorine repacking and operating in 2 shifts with an additional of three personnel.

8.2 Facility Layout and Equipment

Fig. 6.4. 28 shows the layout of the plant and the sampling stations for ambient and source monitoring of vapor emissions. Different types of equipment are also presented in the layout including the waste treatment facility.

Fig. 6.4. 28. Plant Layout



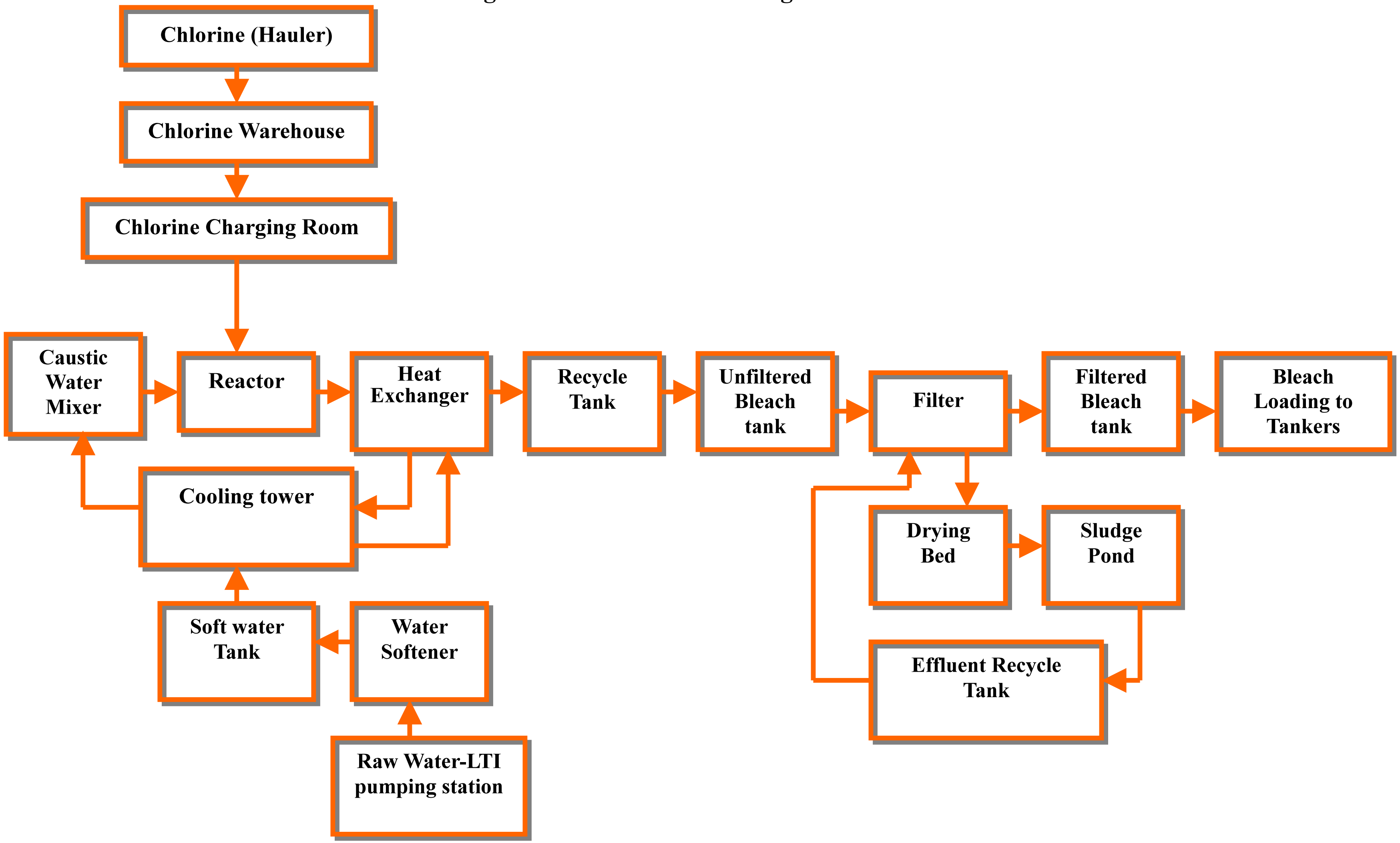
8.3 Process Description

To manufacture sodium hypochlorite with greater efficiency and higher quality, MPBP is using the Powell Sodium Hypochlorite Process System. The basic raw materials are chlorine and sodium hydroxide (caustic soda). The 4 metric tons cylinders with liquid chlorine are batch operated and properly mounted and connected to the process pipeline at the chlorination room. The plant started its operation when the process water and caustic soda systems are ready. The water and caustic soda mixture passes through an on line pipe mixer then chlorinated in a packed reactor. Due to heat of reaction and dilution, the hot product is cooled down to 35°C through a plate heat exchanger prior to storage. The cooling water that passed through the heat exchanger is being recycled and circulated in the cooling tower. Part of the product is also recycled and circulated in the cooling tower. The concentration of excess sodium hydroxide is adjusted between 0.28-0.35%. The precision of the ORP and the ratio controller is checked every batch operation by laboratory analysis of the bleach product.

The unfiltered product is treated with magnesium chloride and soda ash to precipitate trace metals, then filtered and stored in the filtered product tank.

The end of bleach operation is signaled by low chlorination line pressure buzzer which is confirmed by freezing cooled chlorine lines. The chlorine lines and cylinders are then purged with air which is bubbled and reacted to the scrubber solution in the scrubber tank. Then the cylinders are removed from the chlorination room. The manufacturing process of MPBP is fully automated.

Fig. 6.4. 29. Process Flow Diagram



8.4 Waste Stream Description and Current Waste Management Practices

MPBP has improved its facility to a safer and environment-friendly manufacturing industry. Since the plant is quite small and the system is fully automated, less risk of chemical spills and accidents can be expected. The good housekeeping practices that are strictly observed are:

- Labeling of process chemicals and pipes
- Keeping liquid chlorine storage and work areas clean and well organized
- Maintaining accurate records of inventory
- Reusing of residual sample in the maintenance of equipment
- Improving maintenance and performance of equipment

The team has observed few lapses in their in-house practices such as:

- No designated storage area for some chemicals and tanks.
- Sludge pond contains a lot of dry leaves and other dirts on the surface.
- Accumulated amount of solid wastes in the treatment facility

The management of waste occurs at different stages during production process. Much attention is focused on vapors that might escape in the system during reaction and the use of filter precoat material which contains impurities such as nickel, copper, iron, and other metals. Corresponding waste management practices are implemented in compliance with regulations set by the regulating body.

◇ Solid Waste

The accumulated solid waste in the wastewater treatment facility primarily consists of filter precoat material and traces of metals. This waste is dried and drained to at least 30% moisture content prior to treatment. The solid waste is transported to DENR accredited waste treater.

◇ Liquid Waste

The different sources of liquid wastes are from the truck lorry cleaning, product tank cleaning, and sudden chemical spills. Wastewater generated from the backwashing of the filter is loaded in the treatment facility. Parameters such as BOD, COD, TSS, chlorides, sulfates, and temperature are closely examined. Any residual bleach & caustic soda obtain from sampling, line and tank repair is recovered and transferred to unfiltered bleach tank. Residual samples from unfiltered bleach tank are placed in the cooling tower for controlling the algae growth that is part of the equipment maintenance schedule. Filter washings is collected and reuse for another washing activity.

◇ Air Emission

The plant is equipped with two chlorine leak detector located in the charging room and in the repacking area within the chlorine warehouse. The detectors are interlock to the scrubber which operates automatically if any leaks occur. The standby chlorine scrubber is designed to absorb one metric ton chlorine leak and regular monitoring on the parameters such as concentration and level of scrubber solution, chlorine leak detector, and chlorine scrubber vent leak test is conducted.

Ambient monitoring of free chlorine and source monitoring of stack gases such as nitrogen oxides, sulfur dioxide, particulate matter and carbon monoxide are conducted annually in 6 stations. Sampling is carried out by the external laboratory during plant operation mode. The following stations are:

- Office, warehouse, and repacking area
- Charging room beside bleach plant
- Scrubber Vent (roof deck)
- Back right corner near the sludge pond
- Center besides loading area, filtration area and product tank
- Back left corner near the drying bed

In addition, the company plans to conduct a study in the treatment and re-use of softener wastewater in bleach process; recovery of 1,500 liters regeneration discharges; and search for a neutralization process for laboratory wastewater.

8.5 Recommended Waste Minimization Options

The source reduction measures that must be prioritized by the plant in order to achieve outstanding environmental performance and quality excellence are presented in the following Table 6.4. 38.

Table 6.4. 38Recommended Waste Minimization Options

Waste Minimization Options/Recommendation	Rationale	Expected Impact
Establish a leak detection program for all valves, pipes, pumps and seals.	To avoid chemical spills and fugitive emissions of toxic and hazardous gases.	Prevent inadvertent spills and emissions of toxic and hazardous chemicals.
Recycle back chemicals into process or use appropriate clean up method. If water is use as cleaning agent, employ a spray or jets of water to clean tanks and contaminated area.	Material recovery and reduce the amount of water consumption	Lesser volume and concentration of wastewater will be generated
Eliminate the use of precoat materials (diatomaceous earth and fiber) in the filtration process, instead use a filter membrane	Improve the production process.	No solid waste will be generated in this process.
Cover the sludge pond with net	To prevent dry leaves and other dirts to come in the system.	Lesser volume of solid waste will be generated and reduce treatment cost.
Provide designated storage area for other chemicals and tanks. It should have a band walls and provisions to contain chemical spills.	Compliance to DAO 29	To properly manage potential spills of hazardous chemicals.

8.6 Future Waste Minimization Activities

The future waste minimization activities of the company are summarized in the following Table 6.4. 39.

Table 6.4. 39.Future WM Activities

ACTIVITIES	TIME FRAME
1. In-house training	2 days
2. Organize in-house team	1 day
3. Facility walk through (for process validation)	2 days
4. Brainstorming and formulation of waste minimization options	1 day
5. Prioritization and Implementation of Options	Perpetual

◇ Organization of Waste Minimization Team

An in-house minimization team will be organized to oversee all the activities in the implementation of the waste minimization program of the company. To generate a strong involvement among the personnel, team members must be selected from the different company's departments or processing sections.

◇ Monitoring and Testing Requirements

To be able to track down the quality and quantity of wastes generated, the company will conduct periodic monitoring. A source inventory of all types of wastes from the different processing areas through waste audit will be done by composite sampling. By this way, the assessment team will be able to identify waste sources that are problematic and also they will be able to decide at what stage of the process waste minimization could be started. To know whether waste reduction has been achieved, measurement of water consumption and wastewater generation will be done regularly. Benchmarking on every process will also be made in order to identify which process has not made any progress in the waste reduction effort of the team. To know the quality of wastewater generated, the following physico-chemical parameters will be determined: biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), alkalinity and pH. BOD, COD and TSS are measurements of the organic matter components of the wastewater. The greater the COD, BOD and TSS value, the higher is the pollutive property of the wastewater.

Also, for strict compliance to clean air act, much attention will be considered in monitoring the air emissions in the workplace.

9. Jo-na's International Phils.

9.1 Facility Background and Location

Jo-na's International Philippines, Inc. is a food processing company producing about 520 tons/month of a wide variety of the following products at various seasons of the year:

- Bottled preserved fruits/jams
- Frozen fruits, vegetables, and delicacies
- Sweet red and white beans
- Sweet chick peas
  Pickles
  Noodles
  Sauces/condiments
  Seasoning Products
  Canned fruits
  Snack food (banana and corn chips)
  Mixes
  Frozen fresh fishes
  Smoked fishes
- Dried fishes
  Coconut products

These products are shown in detail in the attached list. Among these products, the major products of the company are shown in the following Table 6.4. 40:

Table 6.4. 40.Production Capacity

Product	Production
Nata de coco	130-150 tons/month
Kaong	48- 60 tons/month
Suga	30- 40 tons/month

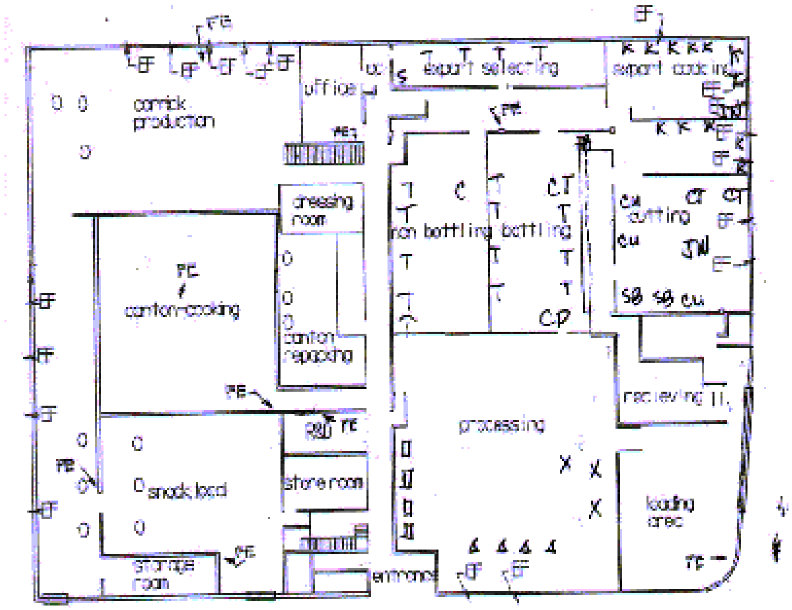
Among these major products, only nata de coco and kaong are processed in the plant. About 70% of the total production of Jo-na's is nata de coco, thus, the assessment will be focused on this product. The processing of kaong is similar to that of nata and the same production area is used. Sugar is repacked only, thus, this will not be discussed further. A more detailed listing of the products of Jo-na's and their packaging are shown in Attachment A. Most of these products are exported to various countries, such as United States, Canada, Japan, England, and other European countries.

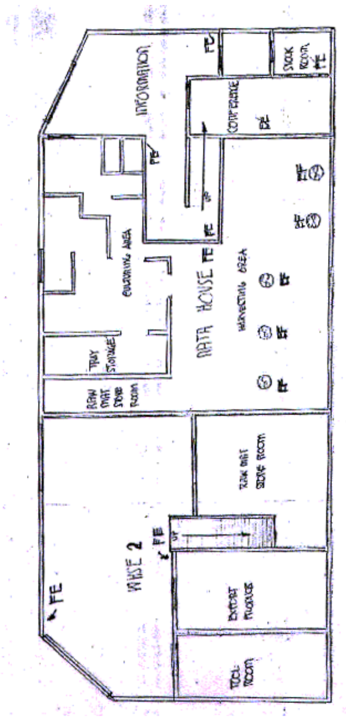
The office, plant, and warehouses of the company occupy a land area of 3,000 m^2 and about 226 workers are employed in the production area.

9.2 Facility Lay-Out

The layout of these equipment/facilities are shown in the sketch of the First Floor, Office, Nata House and Warehouse 2 and First Floor, Jo-na's Production Area are shown in the following Fig. 6.4. 30 and Fig. 6.4. 31

Fig. 6.4. 30. Plant Layout 1st Floor **Fig. 6.4. 31.Plant Layout2nd Floor**





9.3 Equipment

◇ Nata de Coco Production
The following major equipment are used in the production of nata de coco:
- Bubblebath
- Slabbing machine
- Cutter
- Jet washer x 2
- Centrifuge
- Bubblebath (for rehydration)
- Kettle (cooking vessel for nata de coco)
- Kettle (for syruping)
- Retort (for pasteurization)
- Cooling tank

◇ Preserved sweet kaong Production
The following equipment/facilities are used for the production of preserved sweet kaong:
- Washing tanks x 2
- Bubble bath (for deacidification)
- Kettle (for cooking and blanching)
- Soaking vat
- Bottling facility
- Kettle (for syruping)
- Retort (for steaming)
- Cooling tank

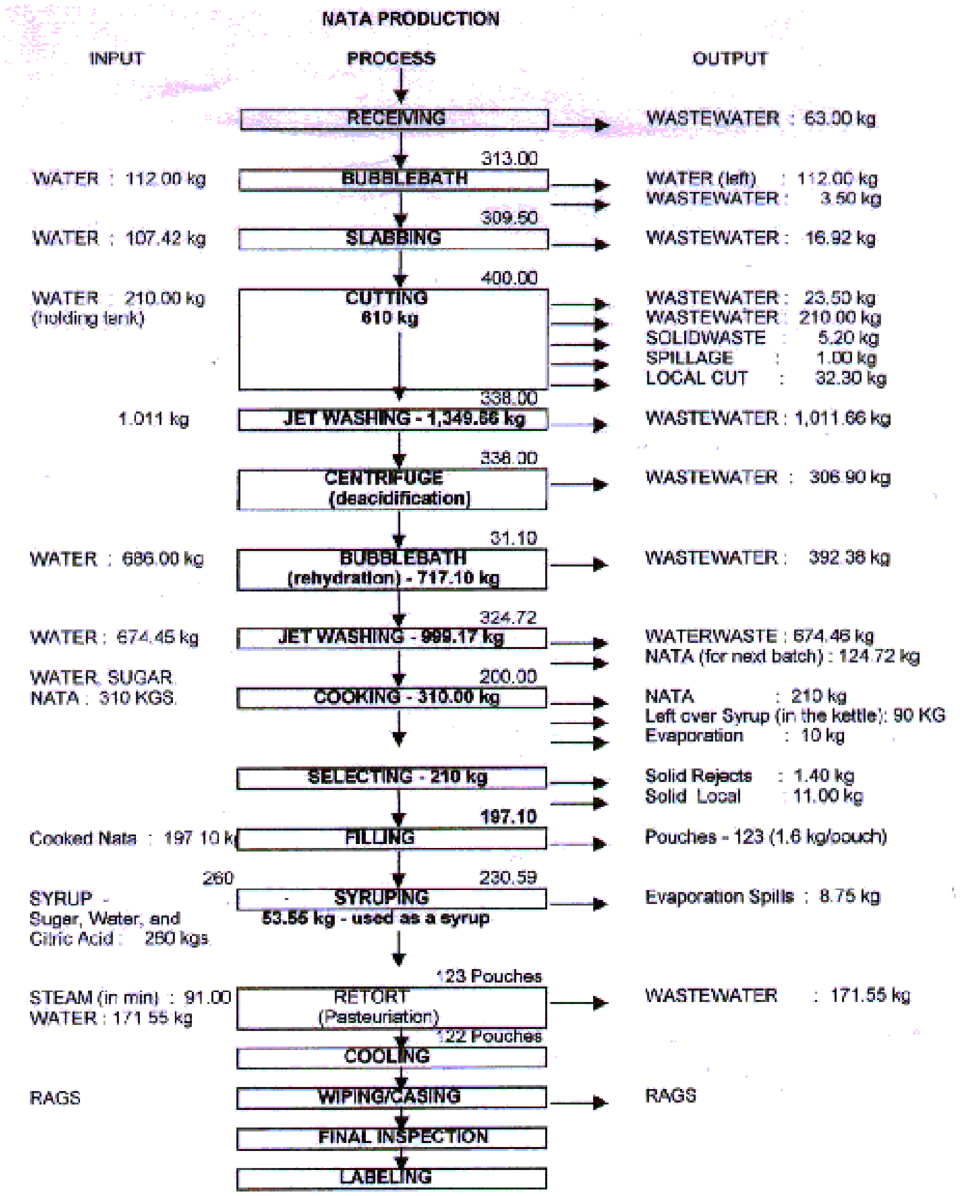
The same production area used in the processing of nata de coco is utilized for the processing of kaong.

9.4 Process Description

Nata de coco from suppliers are delivered to the plant and placed in bubblebaths. The bubblebaths are filled with water and bubbled with air. The bubblebath restores the plumpness of the product. The nata de coco does not have uniform thickness, thus, it is passed through a slabbing machine to slice off the excess thickness. Then, the nata de coco slabs are cut into cubes in the cutting machine. The cubes are washed with water in the jet washing machine. The dirt goes with the water while the cubes are collected in another container. The water from the jet washer is filtered and recycled. The cubes are transferred to the centrifuge. The centrifuge removes the remaining acid from the nata de coco. Then nata is transferred to the bubblebath, added with water for the rehydration of the cubes and bubbled with air. The cubes are washed again in the jet washing machine and cooked in the kettle. Sugar is added to sweeten the nata de coco. After cooking, the rejects are selected and taken out. Pouches are filled with nata de coco. Each pouch contains 1.6 kg of product. The pouches are filled with syrup and pasteurized in a retort. The pasteurized products are cooled in cooling tanks with water after which the pouches are wiped with rags and subjected to final inspection. The pouches are labeled ready for marketing.

The process flow diagram for the production of nata de coco is shown in Fig. 6.4. 32.

Fig. 6.4. 32. Nata de Coco Production Process



9.5 Waste Stream Description and Current Waste Management Practices

◇ Solid Wastes

Solid wastes are generated during the production of nata de coco. Thin slices of nata de coco are produced during slabbing. About 5.2 kg/batch are off sizes and 1.0 kg/batch of nata are wasted through spillage during cutting. About 1.4 kg/batch of nata de coco are rejected during selection. The plant processes about 20-30 batches of nata de coco everyday. The clean solid wastes are sold for P5.00-6.00/kg and are utilized for making candies or confectioneries.

◇ Liquid Wastes

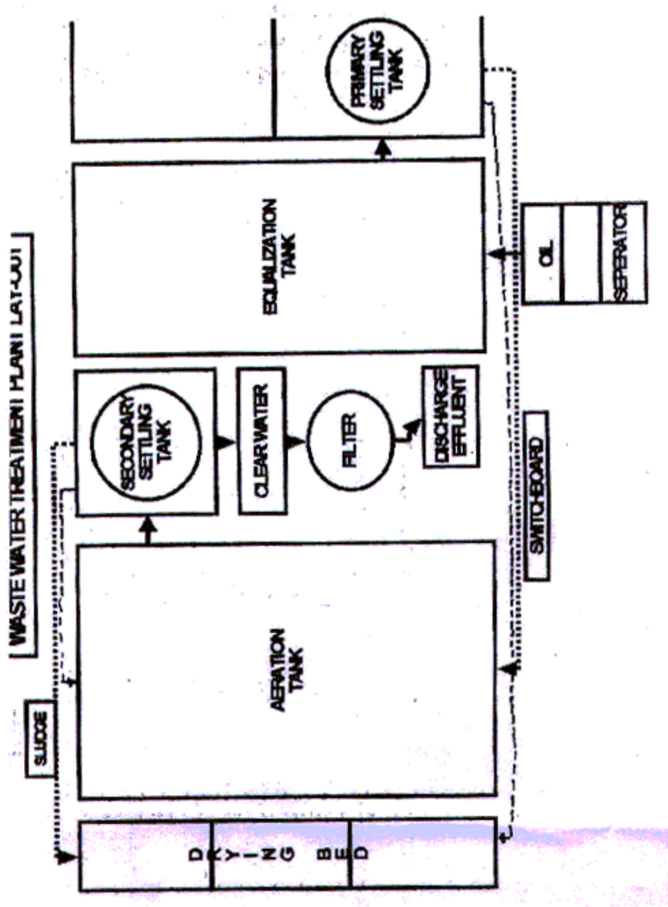
The following quantities of wastewater as shown in the Table 6.4. 41is generated from the corresponding processing of nata de coco:

Table 6.4. 41.Wastewater generated during the production of nata de coco

EQUIPMENT/PROCESS	QUANTITY OF WASTEWATER GENERATED (Kg/batch)
Receiving Vat	63
Bubblebath	3.5
Slabbing	16.92
Cutting	233.5
Jet washing	1,011.66
Centrifuge	306.9
Bubblebath (rehydration)	392.38
Jet washing	674.46
Retort/Pasteurization	171.55
Cooling water, m^3/day	10

The diagram of the wastewater treatment facility is shown in Fig. 6.4. 33.

Fig. 6.4. 33. wastewater treatment facility



◇ Air Emission

The air emissions released during the production of nata de coco is from the boiler used for producing steam for the pasteurization process. The boiler consumes 33,000 – 40,000 liters bunker fuel per month. Bunker costs P11.50/liter.

9.6 Current Waste Management Practices

The wastewater from the receiving vat, bubblebath, slabbing, cutting, bubblebath for rehydration are discharged and flows directly to the wastewater treatment facility. The water from the jet washing equipment are filtered and recycled 2 – 3 times only, after which, the wastewater is discharged to the wastewater treatment facility. At the end of each working day, the 10 m^3 water from the cooler is discharged and flows to the wastewater treatment facility. The wastewater streams coming from various processes are not segregrated. Not all of the wastewater needs treatment.

Waste plastics, pouches, and other packing materials are disposed by selling. Waste oil are also sold. Trimmings and off-spec cubes from the cutting process are utilized for making candies or confectioneries.

9.7 Waste Minimization Options

The following Table 6.4. 42 shows waste minimization options are recommended for Jo-na's International Philippines, Inc.

Table 6.4. 42.Waste Minimization Options

6.4.6. **Options**	**Rationale**	**Expected Impact**
1. Utilize the thin slices of nata de coco from the slabbing process for candies or confectioneries. Study also its utilization for medical purposes.	Waste utilization eliminates waste. Additional income can be generated by producing saleable by-products.	Reduce solid wastes Save on disposal costs Increase income
2. Study the utilization of spilled and rejected nata de coco for animal feed	Waste utilization eliminates waste and additional income can be generated from saleable by-products	Reduce solid waste Save on disposal costs Increase income
3. Determine the optimum time for the centrifuge of nata de coco	Energy can be saved if equipment are operated at the shortest possible time but still attain the required product quality.	Savings on power/energy
4. Study the energy consumed in each process/operation. Make an energy audit.	Energy audit can determine where savings on power/fuel can be made	Savings on power/energy/fuel
5. Install heaters to pre-heat the fuel for boilers and furnaces and reduce fuel feeding	Pre-heating of fuel will save energy.	Savings on fuel and costs
6. Improve or change the jet washing equipment. Increase the size of the catch basin. Increase the number of times the recycling of water.	The jet washing equipment keeps on running but the output is very small (inefficient). Plenty of water is also spilled because the catch basin for water is small.	.Increase efficiency of equipment Save on power/energy Save on water consumption and avoid spillage. Reduce wastewater. Reduce costs on wastewater treatment and disposal.

9.8 Wastewater Treatment Options

The following Table 6.4. 43 shows wastewater treatment options are recommended for Jo-na's International Philippines, Inc.

Table 6.4. 43.Wastewater Treatment Options

6.4.7. **Options**	**Rationale**	**Expected Impact**
1. Ask nata suppliers to rinse the nata de coco at least one more time	Additional rinsing will reduce the acid and oil from nata.	Reduce wastewater from washing of nata and save on

6.4.7. **Options**	**Rationale**	**Expected Impact**
before transporting the nata.		chemicals used for the neutralization of wastewater in treatment facility.
2.Monitor the pH and/or characteristics of the wastewater from various processes.	Knowing the characteristics of the wastewater is important to determine whether the wastewater can be recycled, reused, treated or disposed	Save on water consumption, treatment, and costs.
3. Consider removing the acid from nata de coco by centrifuge in the earlier stage of the process.	The early removal of the acid can reduce the need to change the water in the following processes and the water in following processes can be reused or recycled.	Save on water consumption and costs.
4.Segregate the flow of wastewater from various processes.	Not all of the wastewater require treatment in all systems in the wastewater treatment facility. Clear but acidic water may require neutralization only prior to disposal.	Save on wastewater treatment costs. Save on water consumption and costs.
5. Find use for cooling water	Cooling water may not need treatment (depending on contamination) but cooling only and can be reused or recycled.	Save water and costs. Save on wastewater treatment and costs
6. Experiment on putting off 1 or 2 aeration pumps	If the production plant is not operating at full capacity and waste minimizations options had been implemented, less wastewater is generated and treatment may not need the full operation of the wastewater treatment facility. The hydraulic retention time is also increased so that the pollutants has more time for biodegradation.	Save on energy and costs.

9.9 Future Waste Minimization Activities

◇ Waste Minimization Team Organization

An in-house minimization team will be organized to oversee all the activities in the implementation of the waste minimization program of the company. To generate a strong involvement among the personnel, team members will be selected from the different company's departments or processing sections. A brainstorming session among team members will be organized to formulate waste minimization options.

◇ Monitoring and Testing Requirements

To be able to track down the quality and quantity of wastes generated, the company will conduct periodic monitoring. A source inventory of all types of wastes from the different processing areas through waste audit will be done by composite sampling. In this way, the assessment team will be able to identify waste sources that are problematic and also they will be able to decide at what stage of the process waste minimization could be started. To know whether waste reduction has been achieved, measurement of water consumption and wastewater generation will be done regularly. Benchmarking on every process will also be made in order to identify which process did not make any progress in the waste reduction effort of the team. To know the quality of wastewater generated, the following physico-chemical parameters will be determined: biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), alkalinity and pH. BOD, COD, and TSS are measurements of the organic matter components of the wastewater. The greater the COD, BOD and TSS values, the higher are the pollutive property of the wastewater.

The following future WM activities as shown in the Table 6.4. 44are recommended:

Table 6.4. 44.Future Waste Minimization Activities

ACTIVITIES	TIME FRAME
In-house training	2 days
Organize in-house team	1 day
Facility walk through (for process validation)	2 days
Brainstorming and formulation of waste minimization options	1 day
Prioritization and implementation of options	Perpetual

ANNEX 6.5

6.5 Preparation Process of Company - wide Waste Minimization Action Plan

1. Obtain Strong Management Commitment

The very first step in establishing a pollution prevention /waste minimization program is to obtain management support and commit all members of the organization to the concept of waste minimization. Organizational commitment and management support are paramount factors in the program's success. The company top management is the best place to start the waste minimization program. Company top management will support a waste minimization program if it is convinced that the benefits of such a program will outweigh the costs. From the business standpoint, these benefits include at least the following:

- Ease of doing business. Environmentally responsible companies will find it easier to do business with their neighbors and regulators;
- Internal pride and external respect. Environmentally responsible companies will find their employees to have pride in their company and gain respect with the public;
- Influence on public policies. Environmentally responsible firms are often invited to participate in environmental debates and to help set agendas on environmental issues; and
- New value added products. Environmentally responsible companies may develop new markets and new products, such as environmental services and licensing.

2. Establishment of Waste Minimization Program

- **Organization of planning/implementing team**

The commitment from all employees to implement a waste minimization program starts before any assessment or evaluations are performed. It is measured as the time and effort needed to raise employee awareness, establish a cohesive waste minimization team and begin to incorporate the program's ideas into the company's day-to-day operations. Waste minimization is a team effort. While the program needs top-down support and commitment, it also needs bottom-up input and implementation. This means that teamwork and participation for all levels within the company are essential. A key element for success is to find a good advocate and coordinator. To start a waste minimization program, the program coordinator may act as a liaison and/or catalyst to promote the idea of pollution prevention to senior management. Cooperation from all parties involved is imperative to the success of the program. Keeping all parties involved helps overcome organizational barriers and ensure smooth implementation of the program. It is therefore necessary to assemble a waste minimization planning team that should include members of any group or department that will be effected in the program.

- **Develop employee awareness**

One method of increasing knowledge of waste minimization is through corporate/facility awareness training. Supervisors should discuss the status of waste minimization at regular meetings. They should encourage employees to bring ideas to them so that they can forward them to facility planning team meetings. The waste minimization team should include the following aspects in developing their awareness programs:

- ❑ Provide definition and explanation of the primary components of waste

minimization source reduction and in-process recycling;
- Clearly state company policies and guidelines;
- Identify company goals to reduce waste generation and to improve operations;
- Stress that waste minimization is not only essential but also beneficial;
- Encourage employee participation as extremely important to improve facility and environmental condition;
- Make management and waste minimization planning team members available to employee suggestions and new ideas;
- Present facts on safety improvement that occurs when a waste minimization program is implemented;
- Stress the relationship between the cost of generating waste to company competitiveness;
- Equate savings from waste minimization with the company's fiscal health and employees' job security.

Waste minimization suggestions can be solicited from employees. Establish suggestion system for waste minimization activities such as standard idea form and electronic procedure for submission. Suggestions should be reviewed and evaluated fairly by an independent department/division. Four types of communication tools are commonly used to promote employee awareness and involvement: posters, newsletters, videos and company annual reports. Newsletters dedicated to waste minimization and specific to the company and various facilities will be most useful to energize employee enthusiasm. Contests can create employee interest in waste minimization if the prizes are worthy of the expected accomplishments. Specialized waste minimization training programs tailored for management and line and maintenance staff should be incorporated into company procedures. Employees will need thorough training on any new technologies or techniques added to unit processes. Another option is to have employee performance evaluation systems revised to reflect their responsibilities in waste minimization.

- **Set program goals**

Every program needs a goal and waste minimization is no exception. The program coordinator will need to establish goals that state the long-term direction for the waste minimization program. Well-defined goals will help to focus effort and build consensus. Goals should be consistent with the company's waste minimization policy and in fact, may have been stated in general terms in the policy statement.

Goal-setting will involve the planning team and company management. Goals need to be challenging enough to motivate but not unreasonable or impractical. Waste minimization goals can be qualitative, such as, "achieve a significant reduction of toxic substance emissions to the environment". However, quantifiable goals, which are preferred, establish a clear guide as to the degree of success expected of the program. For example, a 5% waste reduction per year can be incorporated in the policy statement. Finally, goals should be flexible and adaptable.

- **Write waste minimization plan**

After the planning team is organized, developing a written plan should be the first official task of the team. The waste minimization plan should be action-oriented with clearly defined objectives. As a first step, this plan should include all the ideas developed by the team such as the statement of support from management; the team's structure; organizational guidelines; the methods for fostering participation of all employees; the company's general waste minimization goals; and provisions of employee training.

The plan should be presented and agreed to by management so that they understand how the team will proceed and what resources/support will be required from them. The plan should be further developed once the manufacturing processes and potential organizational obstacles are assessed, and the waste minimization program schedule is established. The plan should be also modified on an annual basis as experience is gained and goals are reached.

3. Waste Assessment/Audit

- **Characterize unit processes**

To effectively implement a program, it is important to understand the various unit processes and where in these unit processes the waste is being generated. An extensive amount of data gathering maybe necessary in this step in order to achieve a complete process characterization. The steps involved in process characterization include gathering background information, defining a production unit, assessing unit processes and completing a material balance. The first step toward characterizing processes and waste generation is gathering background information on the facility. This allows for the accurate determination on the type and quantity of wastes generated. The waste minimization team should divide up the responsibilities for obtaining this information. A time frame should be established for assembling the data and presenting it to the team. To obtain data, employees can be interviewed to determine how the processes are run; what type of raw materials, cleaning agents, lubricants, etc. are used; how frequent and what types of wastes are generated and how it is handled; what other types of records are kept; and what information is not recorded on a regular basis. Once this information is assembled, the general process can be characterized.

- **Develop process flow diagrams**

By assembling background information, process flow diagrams for both the general process and individual processes can be developed. These diagrams, along with the material balances, help provide an understanding of the process and the waste generated. A typical process has raw material inputs, product outputs and waste generation. It can be represented by a general process flow diagram. A process flow diagram shows the movement of raw material through the process as well as the generation of final product and waste.

Most production operations can be subdivided into a series of unit processes. Each unit process has its own inputs and outputs; the product from one step becomes the input material for the following step. It is critical to determine the types/composition/quantities of raw materials consumed, product yield and wastes generated as accurately as possible for each unit process. All wastes released to the environment (gas, liquid and solid) should be characterized.

- **Perform material balance**

A material balance accounts for all inputs and outputs into a process. In other words, what goes in must come out. Such a balance is an organized system of accounting for the flow, generation, consumption and accumulation of mass in a process. In its simplest form, a material balance is drawn up according to the mass conservation principle:

$$\text{Mass in} = \text{Mass out} - \text{Generation} + \text{Consumption} + \text{Accumulation}$$

If no chemical reaction occurs and the process progresses in a steady state, the material balance for any specific compound or constituent is as follows:

$$\text{Mass out} = \text{Mass in}$$

Material balances are essential to organize data, identify gaps and permit estimation of missing information. They can help calculate concentrations of waste constituents where quantitative composition data are limited. They are particularly useful if there are points in the production process where it is difficult or uneconomical to collect or analyze samples.

- **Identify and address potential obstacles**

As the pollution prevention planning team begins to develop and implement a waste minimization program, a number of factors may be encountered that will complicate the process. These need to be recognized, and the means for overcoming them need to be defined. They fall into four broad categories: economic, technical, regulatory and institutional.

- **Economic obstacles**

  Potential economic obstacles include relatively complex cost analysis requirements and the need for capital improvements funding. Many proposed waste minimization options will have start-up costs. Limited financial resources for capital improvements may also be a problem, even for options that will ultimately be profitable. The team should investigate the availability of and conditions for funding assistance or low-interest loans from government agencies.

- **Technical obstacles**

  Information will be needed on alternative procedures that should be considered, how to integrate them in the production process and what side effects are possible.

  Information resources could be a problem. As a small or medium-sized business, access to a central source of information on waste minimization techniques may not be readily available. There are several ways to deal with this problem. Contact appropriate agencies for assistance. Encourage employees to watch for information in the technical journals and newsletters they read and pass it on to the task force. If the scope of the technical problem and resources permits, it may be appropriate to retain a consultant.

  Limited flexibility in the manufacturing process may pose another technical barrier. A proposed pollution prevention option may involve modifying the workflow or the product or installing new equipment; implementation could require a production shutdown, with loss of production time. It might be a concern that the new operation will not work as expected or might create a bottleneck that slows production. In addition, the production facility might not have space for pollution prevention equipment. These technical barriers can be overcome by having design and production personnel take part in the planning process and by using tested technology or setting up pilot operations
  Product quality or customer acceptance concerns might cause resistance to change. A plan should be implemented to avoid potential product quality degradation by verifying customer needs, testing the new process or product and increasing quality control during manufacture.

- **Regulatory obstacles**

  Regulations maybe a barrier to some waste minimization options. Working with the appropriate environmental and health regulatory agencies early in the planning process will help overcome this barrier. Industry task forces and consultants might also be contacted.

- **Institutional obstacles**

As with any new other new program, general resistance to change and friction among elements within the organization may arise. These can result from organizational barriers, such as lack of awareness of corporate goals and objectives, individual or organizational resistance to change, lack of commitment, poor internal communication, requirements of existing labor contracts or an inflexible organizational structure. Management is concerned with production costs, efficiency, productivity, return on investment and present and future liability. Workers are concerned about job security, pay and workplace health and safety. The extent to which these issues are addressed in the waste minimization program will affect the success of the program.

An often -encountered barrier is the fear that the waste minimization option will diminish product quality. This is particularly common in situations where unused feed materials are recycled back to the process.

Institutional barriers in general can be overcome with education and outreach programs. It is vital to gain the support of staff at all levels very early in the waste minimization effort.

- **Develop schedule**

One important aspect of planning corporate waste minimization program is to list the milestones within each of the steps from assessing waste through implementation of waste minimization options and assign realistic target dates. Adherence to the schedule will help control the start-up or implementation costs of the program.

4. Identify Waste Minimization Options

In a two-step procedure, the team will propose and then screen waste minimization options. The objective of the exercise is to generate a comprehensive set of options, ranked as to priority, that merit detailed feasibility assessment.

- **Propose options**

As with other planning efforts, each assessment team member will achieve the best results in an environment that encourages creativity and independent thinking. Brainstorming sessions are useful for encouraging creative thought because they provide a non-judgmental, synergistic atmosphere in which ideas can be shared.

Another approach to identifying waste minimization options is by contacting other facilities, vendors, trade associations, government-run technical assistance programs, and publications for ideas. These groups maybe aware of waste minimization technologies that have been successfully implemented. Further waste minimization opportunities maybe identified through “upstream” suppliers and “downstream” consumers. These individuals should be allowed to provide inputs into the company’s program.

Still another way to identify pollution prevention options is through benchmarking. In the benchmarking process, a company selects an area for improvement and identifies other companies who have similar practices that they consider to be “best in class”. They then compare their own practices to those companies’ processes to determine where differences exist.

Structuring option definition sessions will encourage the team to look first at true source reduction options, such as improved operating procedures and changes in technology, materials and products. Then options that involve re-use or closed –loop recycling, would be examined. Finally the team would consider off-line and off-site recycling and alternative treatment and disposal methods.

- **Screen options**

Since detailed technical, economic and environmental feasibility analysis can be costly, the assessment team should screen the proposed options. Some options will be found to have no cost or risk attached; these can be implemented immediately. Others will be found to have marginal value or to be impractical; these will be dropped from further consideration. The remaining options will generally be found to require feasibility assessment. Screening procedures can range from an informal review with a decision made by either the program manager or a vote of the team members, to the use of quantitative decision-making tools. The informal review is a procedure by which the assessment team selects the options that appear best after discussing and examining each option. As in the case when the team is proposing options, their approach to screening should employ group decision-making techniques whenever possible.

During screening and selection of options, the hierarchy of environmental management options should be followed: source reduction, recycling, treatment and disposal. As the pollution prevention portion of the hierarchy is applied, more waste is prevented, recycled, reclaimed, or treated, reducing the amount left to be managed in a secure disposal facility or emitted or released to the environment.

Another consideration is the degree of sophistication in implementing the options. In general, there are three generations of waste minimization techniques:

- First – housekeeping (e.g. good operating practices and material tracking);
- Second – in-house process recycling, substituting inputs, modifying processes;
- Third – modifying processes, changing end-products, optimizing process design.

The more sophisticated the technique becomes, the longer it takes to develop and costs more capital to implement. Quick and cheap solutions should be implemented as soon as possible.

5. Evaluation of Technical and Economic Feasibility and Environmental Impacts

a. Evaluate technical feasibility

The assessment team will perform an evaluation to determine whether a proposed waste minimization option is technically feasible. Technical evaluation for a given option may be relatively quick or it may require extensive investigation. Typical technical evaluation criteria that could be used in a technical evaluation that could be used in a technical evaluation are given below:

- Will it reduce waste?

- Is the system safe for workers?
- Will product quality be improved or maintained?
- Is space available in the facility?
- Are the new equipment, materials or procedures compatible with the production operating procedure, work flow and production rates?
- Is hiring of additional labor needed to implement the option?
- Should personnel with special expertise be trained or hired to operate or maintain the new system?
- Are the utilities needed to run the equipment available? O, must they be installed at increased capital cost?
- How long will production be stopped during system installation?
- Will the vendor provide acceptable service?
- Will the system create other environmental problems?

All groups in the facility that will be affected directly if the option is adopted should contribute to the technical evaluation. In some cases, customers may need to be consulted and their requirements verified. Prior consultation and review with these groups will ensure the viability and acceptance of an option. If the option calls for a change in production methods or input materials, its likely effects on the quality of the final product should be carefully assessed. If after the technical evaluation the option appears impractical or can be expected to lower product quality, it should be dropped.

For options that do not involve a significant capital expenditure, the team can use a “fast-track” approach. For example, procedural or housekeeping changes can often be implemented quickly, after the appropriate review, approvals and training have been accomplished. Material substitutions, in some cases, also can be accomplished relatively quickly if there are no major production rate, product quality or equipment changes involved.

Equipment-related options or process changes are more expensive and may affect production rate or product quality. Therefore, such options require more study.

- **Evaluate Environmental Impacts**

In this step, the waste minimization assessment team will weigh the advantages and disadvantages of each option with regard to the environmental impact. Often the environmental advantage is obvious – the toxicity of a waste stream will be reduced without generating a new waste stream. Most housekeeping and direct efficiency improvements have this advantage.

Unfortunately, the environmental evaluation is not always so clear-cut. Some options require a thorough environmental evaluation, especially if they involve product or process changes or the substitution of raw materials.

To make a sound evaluation, the team should gather information on the environmental aspects of the relevant product, raw material or constituent part of the process. This information would consider the environmental effects not only of the production phase and product life cycle but also of extracting and transporting the alternative raw materials and of treating any unavoidable waste.

- **Evaluate Economic feasibility**

Once a waste minimization option is found to be technically and environmentally feasible, the economic feasibility of the option should be examined. Before options are evaluated for economic feasibility, the full cost of waste generation must be determined. This full cost is necessary to develop the economics of waste minimization techniques, including the calculation of cost savings and payback periods.

- **Determine full cost of waste**
  The full cost of waste generation includes more than just treatment or disposal costs; it includes all costs incurred by producing and handling waste. All expenditures associated with the waste stream, both direct and indirect, should be identified.

- **Establish cost allocation system**
  A cost allocation system is an important element of a waste minimization program. In this system, each department or process is charged for the total waste management costs for the waste they generate. This cost allocation system will also provide incentives for employees associated with the departments/processes that are charged for the waste handling to reduce their waste generation and subsequently their costs.

6. Selection and Implementation of Waste Minimization Options

- **Selection of options for Implementation**

The decision to select options is generally made by reviewing the technical evaluation, economic evaluation, and benefits to be gained by their implementation. When evaluating technical feasibility of an option, personnel that are directly affected by the implementation of the option should be consulted and included in the decision making. They typically have knowledge of process details that may influence the success of the program. Once the option is found to be technically feasible, the economics of it will be examined. The full cost of waste generation and the cost of savings for implementing the option should be determined.

- **Option's Implementation**

After the waste minimization planning team selects the options to be implemented, management approval must be obtained. The planning team coordinator should present to the management the details of the project along with the budget and project justification. Once the project is approved, the planning team shall secure the funding for the project's expenditures.

7. Evaluate Waste Minimization Program and Projects

As part of waste minimization program, it is important to measure the program progress against the goals. By periodic reviewing the program's successes and failures, managers al all levels can assess the degree to which waste minimization goals at the facility and production unit levels are being met and what the economic results have been. The comparison identifies waste minimization techniques that work well and those that do not.

- **Measure waste reduction**

One way of measuring progress is by looking at actual waste reduction, both in terms of actual change in quantity and change in hazard level.

- **Measure economic results**

Aside from assessing it effectiveness in waste reduction, a project should be evaluated like any other new process or capital investment. The economics of the project can then be evaluated by considering the payback period, net present value, or return of investment.

- **Evaluate program elements**

When evaluating the elements of the program, it is important to identify those strategies and techniques, which have been very successful, marginally successful, or have failed.

8. Maintain Program Momentum

The program must be kept strong and energetic by sustaining the momentum throughout its implementation phase. This involves reaffirming commitment to the program at all levels – including upper management. Employee enthusiasms and interest shall be maintained to ensure continuation of the program through the following: a) rotate assignments of waste minimization team; b) provide refresher training; c) publicize success stories; d) re-establishment of management support; and e) re-evaluation of goals.