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POLLUTION PREVENTION FOR PULP AND PAPER INDUSTRIES

Training Manual

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CHAPTER 1
INTRODUCTION

1 1 Purpose of Manual

This manual provides an introduction to the application of pollution prevention techniques in the pulp and paper industry Other helpful information is provided in the appendices

The Environmental Pollution Prevention Project (EP3) has developed a series of industry-specific training manuals on the topic of pollution prevention The manuals that are available through EP3 include

- Introduction to Pollution Prevention *(TR 95-061)*,
- Pollution Prevention in the Canning Industries *(TR 96-107)*,
- Pollution Prevention for Chemical and Petroleum Processing Industries *(TR 96-106)*
- Pollution Prevention for Dairy Industries *(TR 96-094)*,
- Pollution Prevention for the Fish and Shellfish Processing Industries *(TR 96-097)*,
- Pollution Prevention for Metal Finishing *(TR 95-062)*, and
- Pollution Prevention in the Textile Industry *(TR-064)*

Each of these manuals is intended to provide the reader with basic information relating to the pollution prevention options and benefits for specific industries In addition to the industry sectors listed above, EP3 plans to prepare pollution prevention manuals for the tanning, mining, and printing industries Copies of these manuals may be obtained through the EP3 Information Center Fax your requests to EP3 Information Center, 703/351-6166

The user of this pulp and paper manual should view it as a first source in pursuing process and equipment changes in the industry The manual provides general background information on the manufacturing processes common to the pulp and paper industry and identifies pollution prevention opportunities that exist within the industry Specifically, the manual is intended to assist professionals in determining 1) where there might be potential for improving process efficiency and profitability in pulp and paper facilities, and 2) which alternatives are worthy of consideration for implementation Users of this manual should not rely on its contents alone to carry out specific measures, but rather seek assistance from experienced professionals in the field However, as a general rule of thumb, those process improvement measures which can be implemented at no cost or low cost, or with minimal effort should be considered first, while the

more capital and labor intensive options will require more extensive review

1 2 Background

The pulp and paper industry produces a wide variety of commonly used products such as tissue paper, writing paper, cardboard, and shipping materials In general, pulp and paper mills tend to be located where pulp trees are harvested Paper and paper board mills are typically distributed in the proximity of pulping operations and near markets Repulping mills are often located near recovered paper sources in urban areas

A variety of treatment processes are used to produce the desired product Chemicals are an integral component of the treatment process The pulp and paper-making process is also water-intensive, it is the largest industrial process water user in the United States In 1988, a typical pulp and paper mill used approximately 60,500 to 64,000 liters of water per metric ton of pulp produced This roughly translates into an industry total discharge amount of 16 million m^3/day of water

The implementation of pollution prevention measures can generate revenue and profits by reducing product loss In the pulp and paper plant, a majority of the contaminants in the wastewater is lost product (e g biological raw material, processing chemicals) Many countries require that before plant wastewater can be discharged, these contaminants be removed, a condition that can lead to increased treatment costs By making process changes that prevent these materials from getting into the wastewater product losses can be reduced substantially further increasing profitability Raw materials that previously were lost to the environment can be saved and sold for additional revenue or recycled back into the manufacturing process

In 1993, the pulp and paper industry generated about two trillion pounds of production-related waste in the U S alone The amount of production-related waste generated in the U S however, has been declining in recent years Industry experts attribute this decline to the industry's efforts at pollution prevention The pollution prevention activities cited most often by the pulp and paper industry as highly effective are good operating practices process modifications, and raw material modifications

1 3 Waste Characteristics

Air emissions are a familiar sight at pulp and paper-making facilities and can be traced to a variety of sources Depending on the type of mill toxic air emissions can consist of methanol, chlorinated compounds, sulfuric acid and the chelator methyl ethyl ketone

Pulp and paper mills require large quantities of water for wood handling, pulping, washing, bleaching, and papermaking operations In the U S , great strides have been made at initiating water reuse programs to "close up the process water flow The pulp and paper industry generates a large volume of wastewater containing dissolved lignin, suspended solids, adsorbable

organic halides (AOX, which encompasses many chlorinated organic compounds including chloroform), and other organic contaminants The biological raw material (e g , wood chips sawdust) leads to increased levels of biochemical oxygen demand (BOD) and total suspended solids (TSS)

CHAPTER 2
PULP AND PAPER PROCESSING [1]

2 1 Introduction

This section focuses primarily on the greatest areas of environmental concerns within the pulp and paper industry those from pulp-making processes Due to this focus some components of the pulp and papermaking industry are not addressed in this discussion

Pulp is a watery fibrous substrate that undergoes various processes (described later in this chapter) to become a paper product One important characteristic of the pulp and paper industry is the relationship between pulp mill operations and the downstream processing of pulp into paper, paperboard and building paper Another important characteristic of the pulp and paper industry is the varied processes, chemical inputs, and outputs that are used in pulp manufacture Chemical recovery systems reuse many process chemicals for some of these pulp-making systems On the whole, however, pulp mill processes are chemical intensive

2 2 Product Characterization

The pulp and paper industry produces commodity grades of wood pulp, primary paper products, and paper board products such as printing and writing papers sanitary tissue, industrial-type papers, container board, and boxboard Pulp facilities are comprised of mills that only produce pulp The pulp is sold on the open market or is shipped via pipe, conveyor truck, train, or ship to another facility where it is utilized for the production of a final product Integrated pulp and paper facilities are comprised of mills that produce both pulp and primary paper products Converting facilities are those that "convert" primary paper and paperboard products to finished paper products such as packaging, envelopes, and shipping containers In the following analysis of the pulp and paper industry converting facilities are treated separately from pulp and paper mills due to major differences in industrial processes

Generally speaking, the pulp and paper industry divides itself along pulping process lines

- Chemical pulping (e g kraft chemical pulping),
- Semi-chemical pulping and

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[1] The information in this chapter is derived from the U S Environmental Protection Agency's Office of Compliance Sector Notebook Project, *Profile of the Pulp and Paper Industry*, September 1995 (document # EPA/310-R-95-015) Readers should refer to that document for a comprehensive set of references and sources Contact your local EP3 Information Center for a copy of the EPA document or for information on how to access it electronically via the Internet

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- Mechanical pulping

The products of the pulp and paper industry can also be categorized by the pulping process used in paper and paperboard production The pulping process affects the strength, appearance and intended use characteristics of the resultant paper product Pulping processes are the major source of environmental impacts in the pulp and paper industry each pulping process has its own set of process inputs, outputs, and resultant environmental concerns Exhibit 2-1 describes several of the most common pulp-making techniques and their resulting products

Exhibit 2-1 Description of Pulping Processes

Pulp Process	Description/Principal Products
Dissolving Kraft	Highly bleached and purified kraft process wood pulp suitable for conversion into products such as rayon viscose acetate and cellophane
Bleached Papergrade Kraft and Soda	Bleached or unbleached kraft process wood pulp usually converted into paperboard coarse papers tissue papers and fine papers such as business writing and printing
Unbleached Kraft	
Dissolving Sulfite	Highly bleached and purified sulfite process wood pulp suitable for conversion into products such as rayon viscose acetate and cellophane
Papergrade Sulfite	Sulfite process wood pulp with or without bleaching used for products such as tissue papers fine papers and newsprint
Semi-chemical	Pulp is produced by chemical pressure and mechanical (sometimes) forces with or without bleaching used for corrugating medium (for cardboard) paper and paperboard
Mechanical Pulp	Pulp manufacture by stone groundwood mechanical refiner thermo mechanical chemi-mechanical or chemi-thermo mechanical means for newsprint coarse papers tissue molded fiber products and fine papers
Non wood Chemical Pulp	Production of pulp from textiles (e g rags) cotton linters flax hemp tobacco and abaca to make cigarette wrap papers and other specialty paper products
Secondary Fiber De ink	Pulps from wastepapers or paperboard using a chemical or solvent process to remove contaminants such as inks coatings and pigments used to produce fine tissue and newsprint papers
Secondary Fiber Non-de-ink	Pulp production from wastepapers or paperboard without de inking processes to produce tissue paperboard molded products and construction papers
Fine and Lightweight Papers from Purchased Pulp	Paper production from purchased market pulp or secondary fibers to make clay coated printing un coated free sheet cotton fiber writing and lightweight electrical papers
Tissue Filter Non-Woven and Paperboard from Purchased Pulp	Paper production from purchased market pulp to make paperboard tissue papers filter papers non woven items and any products other than fine and lightweight papers

2 3 Industrial Process Description

This section describes the major industrial processes within the pulp and paper industry, including the materials and equipment used, and the processes employed This discussion also provides a concise description of where wastes may be produced in the process and describes the potential fate (via air, water, and soil pathways) of these waste products

2 3 1 Industrial Processes in the Pulp and Paper Industry

Simply put, paper is manufactured by applying a watery suspension of cellulose fibers to a screen which allows the water to drain and leaves the fibrous particles behind in a sheet Most modern paper products contain non-fibrous additives, but otherwise fall within this general definition Only a few paper products for specialized uses are created without the use of water, via dry forming techniques

Processes in the manufacture of paper and paperboard can, in general terms, be split into three steps pulp making, pulp processing, and paper/paperboard production Paperboard sheets are thicker than paper sheets, paperboard is thicker than 0 3 millimeters (mm) Generally speaking, however, paper and paperboard production processes are identical First, a stock pulp mixture is produced by digesting a material into its fibrous constituents via chemical mechanical, or a combination of chemical and mechanical means In the case of wood, the most common pulping material in the U S , chemical pulping actions release cellulose fibers by selectively destroying the chemical bonds in the glue-like substance (lignin) that binds the fibers together After the fibers are separated and impurities have been removed, the pulp may be bleached to improve brightness and processed to a form suitable for paper-making equipment At the paper-making stage, the pulp can be combined with dyes, strength building resins, or texture adding filler materials, depending on the intended end product Afterwards the mixture is de-watered, leaving the fibrous constituents and pulp additives on a wire or wire-mesh conveyor Additional additives may be applied after the sheet-making step The fibers bond together as they are carried through a series of presses and heated rollers The final paper product is usually spooled on large rolls for storage

2 3 1 1 Pulp Manufacture At the pulping stage, the proceed blend of fibrous materials used to make pulp, or furnish, is digested into its fibrous constituents The choice of pulping technique is dependent on the type of furnish and the desired qualities of the finished product, but chemical pulping is the most prevalent Exhibit 2-2 presents an overview of the wood pulping types by the method of fiber separation and resultant fiber quality Many mills perform multiple pulping processes at the same site most frequently non-de-ink secondary fiber pulping and paper grade kraft pulping The three basic types of wood pulping processes chemical pulping, semi-chemical pulping, and mechanical pulping are detailed below in Exhibit 2-2, followed by a discussion of secondary fiber pulping techniques

Exhibit 2-2 General Classification of Wood Pulping Processes

Process Category	Fiber Separation Method	Fiber Quality	Examples
Mechanical	Mechanical energy	Short weak unstable impure fibers	Stone-ground wood refiner mechanical pulp
Semi-chemical	Combination of chemical and mechanical treatments	Intermediate pulp properties (some unique properties)	High yield kraft high-yield sulfite
Chemical	Chemicals and heat	Long strong stable fibers	Kraft sulfite soda

A variety of technologies and chemicals are used to manufacture pulp, but most pulp manufacturing systems follow the process sequence outlined in Exhibit 2-3

Exhibit 2-3 Pulp Manufacturing Process Sequence

Process Sequence	Description
Fiber Furnish Preparation and Handling	Debarking slashing chipping of wood logs and then screening of wood chips/secondary fibers (some pulp mills purchase chips and skip this step)
Pulping	Chemical semi-chemical or mechanical breakdown of pulping material into fibers
Pulp Processing	Removal of pulp impurities cleaning and thickening of pulp fiber mixture
Bleaching	Addition of chemicals in a staged process of reaction and washing to increase whiteness and brightness of pulp if necessary
Stock Preparation	Mixing refining and adding wet additives to add strength gloss texture to paper product if necessary

2 3 1 2 Furnish Composition Furnish is the blend of fibrous materials used to make pulp The most commonly used furnish material is wood Wood logs are converted into chips and sawdust prior to being used to make pulp Due to different physical and chemical properties, however, certain pulping processes are most efficient on specific wood types The type of wood used can also make a difference in the final characteristics of the pulp In general, softwood fibers are longer than those from hardwood and have thinner cell walls The longer fibers of softwood promote inter-fiber bonding and produce papers of greater strength

Secondary fibers comprise the next most common furnish constituent Secondary fibers consist of pre-consumer fibers (e g mill waste fibers) and post-consumer fiber Post-consumer fiber sources are diverse, but the most common are newsprint and corrugated boxes Although secondary fibers are not used in as great a proportion as wood furnish, approximately 70 percent of pulp and paper manufacturers in the U S use some secondary fibers in their pulp production and approximately 40 percent rely exclusively on secondary fibers for their pulp furnish Secondary fibers must be processed to remove contaminants such as glues or bindings, but, depending on the end product may or may not be processed to remove ink contaminants or brighten the pulp

Secondary fiber use is increasing in the pulp and paper industry due to consumer demand for products made from recycled paper and a lack of adequate virgin fiber In a resource-deficient country such as Japan, the secondary fiber utilization rate is at about 50 percent, whereas the average utilization rate in Europe is approximately 40 percent Due to losses of fiber substance and strength during the recycling process, a 50 percent utilization rate is considered the present maximum overall utilization rate for fiber recycling

Secondary fiber sources are seldom used as feedstocks for high quality or grade paper products Contaminants (e g , inks, paper colors) are often present, so production of low-purity products is often a cost-effective use of secondary fibers, although decontamination technologies are available Approximately 75 percent of all secondary fiber in North America is presently used for multi-ply paperboard or the corrugating paper used to manufacture corrugated cardboard

Other types of furnish include cotton rags and linters, flax, hemp, bagasse (the dry pulp remaining from sugar cane after extraction of the juice), tobacco, and synthetic fibers such as polypropylene These substances are typically for low volume specialty grades of paper, and are therefore not widely used

The types of furnish used by a pulp and paper mill depend on the type of product produced and what is readily available Urban mills use a larger proportion of secondary fibers due to the post-consumer feedstock close at hand More rurally located mills are usually close to timber sources and thus may use virgin fibers in greater proportion

2 3 1 2 1 Furnish Preparation Furnish is prepared for pulp production by a process designed to supply a homogenous pulping feedstock In the case of roundwood furnish (logs), the logs are cut to a manageable size and then de-barked At pulp mills integrated with lumbering facilities, acceptable lumber wood is removed at this stage At these facilities, any residual or waste wood from lumber processing is returned to the chipping process, in-house lumbering rejects can be a significant source of wood furnish at a facility The bark of those logs not fit for lumber is usually either stripped mechanically or hydraulically with high powered water jets in order to prevent contamination of pulping operations Depending on the moisture content of the bark it may then be burned for energy production Hydraulic de-barking methods may require a drying step before burning Usually hydraulically removed bark is collected in a water flume, de-watered, and pressed before burning Treatment of wastewater from this process is difficult and costly, however, whereas dry de-barking methods can channel the removed bark directly into a furnace If not burned for energy production, bark can be used for mulch, ground cover, or as an ingredient in charcoal

De-barked logs are cut into chips of equal size by chipping machines Chippers usually produce uniform wood pieces 20 mm long in the grain direction and four mm thick The chips are then put on a set of vibrating screens to remove those that are too large or small Large chips stay on the top screens and are sent to be re-cut, while the smaller chips are usually burned with bark Certain mechanical pulping processes, such as stone-ground wood pulping, use roundwood,

however, the majority of pulping operations require wood chips Non-wood fibers are handled in ways specific to their composition Steps are always taken to maintain fiber composition and thus pulp yield

2 3 1 2 2 Chemical Pulping Chemical pulps are typically manufactured into products that have high-quality standards or require special properties Chemical pulping degrades wood by dissolving the lignin bonds holding the cellulose fibers together Generally this process involves the cooking/digesting of wood chips in aqueous chemical solutions at elevated temperatures and pressures There are two major types of chemical pulping currently used in the U S kraft/soda pulping, and sulfite pulping These processes differ primarily in the chemicals used for digesting The specialty paper products rayon, viscose, acetate and cellophane are made from dissolving pulp, a variant of standard kraft or sulfite chemical pulping processes

Kraft Pulping

Kraft pulping (or sulfate) processes are extremely effective and popular The success of the process and its widespread adoption are due to several factors First, because the kraft cooking chemicals are selective in their attack on wood constituents, the pulps produced are notably stronger than those from other processes (i e , kraft is German for "strength") The kraft process is also flexible, in so far as it is amenable to many different types of raw materials (i e , hard or soft woods) and can tolerate contaminants frequently found in wood (e g , resins) Lignin removal is high in the kraft process, up to 90 percent -- allowing high levels of bleaching without pulp degradation due to de-lignification Finally, the chemicals used in kraft pulping are readily recovered within the process, making it very economical and reducing potential environmental releases

The kraft process uses a sodium-based alkaline pulping solution (liquor) consisting of sodium sulfide (Na_2S) and sodium hydroxide (NaOH) in 10 percent solution This liquor (white liquor) is mixed with the wood chips in a reaction vessel (digester) The output products are separated wood fibers (pulp) and a liquid that contains the dissolved lignin solids in a solution of reacted and un-reacted pulping chemicals (black liquor) Overall, the kraft process converts approximately 50 percent of input furnish into pulp

The kraft process evolved from the soda process The soda process uses an alkaline liquor of only sodium hydroxide (NaOH) The kraft process has virtually replaced the soda process due to the economic benefits of chemical recovery and improved reaction rates (the soda process has a lower yield of pulp per pound of wood furnish than the kraft process)

Sulfite Pulping

Sulfite pulping processes primarily use softwood furnish However, only non-resinous species are generally pulped The sulfite pulping process relies on acid solutions of sulfurous acid (H_2SO_3) and bisulfite ion (HSO_3) to degrade the lignin bonds between wood fibers

Sulfite pulps have less color than kraft pulps and can be bleached more easily, but are not as strong The efficiency and effectiveness of the sulfite process is also dependent on the type of wood furnish and the absence of bark For these reasons, the use of sulfite pulping has declined in comparison to kraft pulping over time

2 3 1 2 3 Semi-chemical Pulping Semi-chemical pulp is often very stiff making this process common in corrugated container manufacture This process primarily uses hardwood as furnish

The semi-chemical process involves partial digestion of furnish in a weak chemical solution followed by mechanical refining for fiber separation At most the digestion step in the semi-chemical pulping process consists of heating pulp in sodium sulfite (Na_2SO_3) and sodium carbonate (Na_2CO_3) Other semi-chemical processes include the Permachem process and the two-stage vapor process The yield of semi-chemical pulping ranges from 55 to 90 percent, depending on the process used but pulp residual lignin content is also high so bleaching is more difficult

2 3 1 2 4 Mechanical Pulping Mechanically produced pulp is of low strength and quality Such pulps are used principally for newsprint and other non-permanent paper goods Mechanical pulping uses physical pressure instead of chemicals to separate furnish fibers Mechanical processes include stone-ground wood, refiner mechanical, thermo-mechanical, chemi-mechanical, and chemi-thermo-mechanical Pulp yields are high, up to 95 percent when compared to chemical pulping yields of 45-50 percent, but energy usage is also high To offset its weakness, mechanical pulp is often blended with chemical pulp

Secondary Fiber Pulping

Secondary fibers are usually pre-sorted before they are sold to a pulp and paper mill If not, secondary fibers are processed to remove contaminants before pulping occurs Common contaminants consist of adhesives, coatings, polystyrene foam dense plastic chips, polyethylene films, wet strength resins, and synthetic fibers In some cases contaminants of greater density than the desired secondary fiber are removed by centrifugal force while light contaminants are removed by flotation systems Centricleaners are also used to remove material less dense than fibers (wax and plastic particles)

Inks, another contaminant of secondary fibers, may be removed by heating a mixture of secondary fibers with surfactants The removed inks are then dispersed in an aqueous media to prevent re-deposition on the fibers Continuous solvent extraction has also been used to recover fibers from paper and board coated with plastics and/or waxes

Secondary fiber pulping is a relatively simple process The most common pulper design consists of a large container filled with water, which is sometimes heated, and the recycled pulp Pulping chemicals (e g , sodium hydroxide, NaOH) are often added to promote dissolution of the paper or board matrix The source fiber (corrugated containers, mill waste, etc) is dropped into the pulper

and mixed by a rotor Debris and impurities are removed by two mechanisms a ragger and a junker The ragger withdraws strings, wires, and rags from the stock secondary fiber mixture A typical ragger consists of a few "primer wires" that are rotated in the secondary fiber slurry Debris accumulates on the primer wires, eventually forming a "debris rope" which is then removed Heavier debris are separated from the mixture by centrifugal force and fall into a pocket on the side of the pulper The junker consists of a grappling hook or elevator bucket Heat, dissolution of chemical bonds, shear forces created by stirring and mixing, and grinding by mechanical equipment may serve to dissociate fibers and produce a pulp of desired consistency in various pulping machinery

Contaminant removal processes depend on the type and source of secondary fiber to be pulped Mill paper waste can be easily re-pulped with minimal contaminant removal Recycled post-consumer newspaper, on the other hand, may require extensive contaminant removal, including de-inking, prior to reuse Overall, the quality of secondary fiber strongly affects the quality of the paper products

2 3 1 3 Pulp Processing After pulp production, pulp processing removes impurities, such as uncooked chips, and recycles any residual cooking liquor via the washing process Pulps are processed in a wide variety of ways, depending on the method that generated them (e g , chemical, semi-chemical) Some pulp processing steps that remove pulp impurities include screening, de-fibering, and de-knotting Pulp may also be thickened by removing a portion of the water At additional cost, pulp may be blended to insure product uniformity If pulp is to be stored for long periods of time, drying steps are necessary to prevent fungal or bacterial growth

Residual spent cooking liquor from chemical pulping is washed from the pulp using brown stock washers Efficient washing is critical to maximize return of cooking liquor to chemical recovery and to minimize carryover of cooking liquor (known as brown stock washing loss) into the bleach plant, because excess cooking liquor increases consumption of bleaching chemicals Specifically, the dissolved organic compounds (lignins and hemicelluloses) contained in the liquor will bind to bleaching chemicals and thus increase bleach chemical consumption In addition, these organic compounds function as precursors to chlorinated organic compounds (e g , dioxins, furans), increasing the probability of their formation The most common washing technology is rotary vacuum washing, carried out sequentially in two or four washing units Other washing technologies include diffusion washers, rotary pressure washers, horizontal belt filters, wash presses, and dilution/extraction washers

Pulp screening removes remaining oversized particles such as bark fragments, oversized chips, and uncooked chips In *open loop* screen rooms, wastewater from the screening process goes to wastewater treatment prior to discharge In *closed loop* screen rooms, wastewater from the process is reused in other pulping operations and ultimately enters the mill's chemical recovery system Centrifugal cleaning (also known as liquid cyclone, hydrocyclone or centricleaning) is used after screening to remove relatively dense contaminants such as sand and dirt Rejects from the screening process are either re-pulped or disposed of as solid waste

2 3 1 3 1 Chemical Recovery Systems The chemical recovery system is a complex part of a chemical pulp and paper mill Chemical recovery is a crucial component of the chemical pulping process it recovers process chemicals from the spent cooking liquor for reuse The chemical recovery process has important financial and environmental benefits for pulp and paper mills Economic benefits include savings on chemical purchase costs due to regeneration rates of process chemicals approaching 98 percent, and energy generation from pulp residue burned in a recovery furnace Environmental benefits include the recycling of process chemicals and lack of resultant discharges to the environment

Both kraft and sulfite chemical pulping processes use chemical recovery systems, although the actual chemical processes at work differ markedly Due to its widespread usage, only the kraft chemical recovery system will be covered in depth in this document Sulfite chemical recovery systems are discussed briefly at the end of this section

2 3 1 3 2 Kraft Chemical Recovery Systems The kraft chemical recovery process has not been fundamentally changed since its patent issue in 1884, but has been refined into a stepwise progression of chemical reactions The kraft chemical recovery process consists of the following general steps

Black Liquor Concentration

Residual weak black liquor from the pulping process is concentrated by evaporation to form "strong black liquor " After brown stock washing in the pulping process the concentration of solids in the weak black liquor is approximately 15 percent, after the evaporation process, solids concentration can range from 60 - 80 percent In some older facilities, the liquor then undergoes oxidation for odor reduction The oxidation step is necessary to reduce odor created when hydrogen sulfide is stripped from the liquor during the subsequent recovery boiler burning process Common modern evaporator types include multiple effect evaporators as well as a variety of supplemental evaporators

Recovery Boiler

The strong black liquor from the evaporators is burned in a recovery boiler In this crucial step of the overall kraft chemical recovery process, organic solids are burned for energy and the process chemicals are removed from the mixture in molten form Molten inorganic process chemicals (smelt) flow through the perforated floor of the boiler to water-cooled spouts and dissolving tanks for recovery in the re-causticizing step

Energy generation from the recovery boiler is often insufficient for total plant needs, however, so facilities augment recovery boilers with fossil-fuel-fired and wood-waste-fired boilers (hogged fuel) to generate steam and often electricity

Re-causticizing

Smelt is re-causticized to remove impurities left over from the furnace and to convert sodium carbonate (Na_2CO_3) into active sodium hydroxide (NaOH) and sodium sulfide (Na_2S) The re-causticization procedure begins with the mixing of smelt with "weak" liquor to form green liquor, named for its characteristic color Contaminant solids called dregs are removed from the green liquor, which is mixed with lime (CaO) After the lime mixing step the mixture, now called white liquor due to its new coloring, is processed to remove a layer of lime mud ($CaCO_3$) that has precipitated The primary chemicals recovered are caustic (NaOH) and sodium sulfide (Na_2S) The remaining white liquor is then used in the pulp cooking process The lime mud is treated to regenerate lime in the calcining process

Calcining

In the calcining process, the lime mud removed from the white liquor is burned to regenerate lime for use in the lime mixing step The vast majority of mills use lime kilns for this process, although a few mills now use newer fluidized bed systems

2 3 1 3 3 Sulfite Chemical Recovery Systems There are a variety of sulfite chemical pulping recovery systems in use today Heat and sulfur can be recovered from all liquors generated, however the base chemical can only be recovered from magnesium and sodium base processes

2 3 1 4 Bleaching Bleaching is defined as any process that chemically alters pulp to increase its brightness Bleached pulps create papers that are whiter, brighter, softer, and more absorbent than unbleached pulps Bleached pulps are used for products where high purity is required and yellowing (or color reversion) is not desired (e g printing and wrapping papers, food contact papers) Unbleached pulp is typically used to produce boxboard, linerboard and grocery bags

Any type of pulp may be bleached, but the type(s) of fiber furnish and pulping processes used, as well as the desired qualities and end use of the final product, greatly affect the type and degree of pulp bleaching possible The lignin content of a pulp is the major determinant of its bleaching potential Pulps with high lignin content (e g , mechanical or semi-chemical) are difficult to bleach fully and require heavy chemical inputs Excessive bleaching of mechanical and semi-chemical pulps results in loss of pulp yield due to fiber destruction Chemical pulps can be bleached to a greater extent due to their low (10 percent) lignin content Typical bleaching processes for each pulp type are detailed below

2 3 1 4 1 Chemical Pulps Chemical pulps are bleached in traditional bleach plants where the pulp is processed through three to five stages of chemical bleaching and water washing The number of cycles is dependent on the whiteness desired, the brightness of the initial stock pulp, and plant design

Bleaching stages generally alternate between acid and alkaline conditions Chemical reactions

with lignin during the acid stage of the bleaching process increase the whiteness of the pulp The alkaline extraction stages dissolve the lignin/acid reaction products At the washing stage, both solutions and reaction products are removed Chemicals used to perform the bleaching process must have high lignin reactivity and selectivity to be efficient Typically 4-8 percent of pulp is lost due to bleaching agent reactions with the wood constituents cellulose and hemicellulose but, these losses can be as high as 18 percent

The most common chemicals used in the bleaching process are sodium hydroxide, elemental chlorine, and chlorine dioxide The use of chlorine dioxide in the bleach process has steadily increased relative to molecular chlorine usage due to its reduction in the formation of chlorinated organics in bleach plant effluent and lower bleach plant chemical consumption Common bleaching chemicals are presented in Exhibit 2-4 along with their chemical formulae and bleach chemical code letter

Exhibit 2-4 Common Chemicals Used in the Bleaching Process

Bleaching Chemical	Chemical Formula	Code Letter
Sodium Hydroxide	$NaOH$	E
Elemental Chlorine	Cl_2	C
Chlorine Dioxide	ClO_2	D
Hypochlorite	$HClO$ $NaOCl$ $Ca(OCl)_2$	H
Oxygen	O_2	O
Hydrogen Peroxide	H_2O_2	P
Sulfur Dioxide	SO_2	S
Sulfuric Acid	H_2SO_4	A

Bleaching process descriptions commonly refer to chemical reaction stages by their chemical code letter Exhibit 2-5 represents the most common bleaching sequences used in the U S and Canada

Exhibit 2-5 Bleaching Sequences

Sequence	Percent of Mills
C-E D E D	38%
C-E H E D	19%
C E H D-E D	13%
C E-H, C-E-H P	8%
Other (e g , chlorine dioxide first stage)	22%

The production of chlorinated pollutants such as dioxin as well as production of chloroform results from the bleaching of pulps with chlorine and chlorine derivatives A variety of bleaching processes have been developed which may be chlorine free, where bleaching chemicals such as ozone (Z), oxygen (O), and peroxide (P), replace chlorine and chlorine derivatives Overall, there has been a recent major trend in the industry toward reductions in both the types and amount of chlorine and chlorine-containing chemicals used for pulp bleaching Some changes include reduced use of hypochlorite in response to concerns about chloroform emissions, modifications to the injection process, and improved de-lignification processes to minimize dioxin formation while reducing bleach chemical usage Some of these de-lignification technologies include extended de-lignification during kraft pulping, solvent pulping, and pulping in the presence of the catalyst anthraquinone

Oxygen de-lignification is also used as a post-pulping method of increasing de-lignification These processes can be more costly, lead to reduced pulp yield and strength, and be potential sources of other pollutants Some positive aspects of these processes may include lower bleach chemical costs, lower energy consumption, reduced toxicity, reduced color and reduced BOD Totally chlorine-free (TCF) bleaching of selected market grades of sulfite and kraft pulps has been demonstrated in Europe

2 3 1 4 1 Semi-chemical Pulps Semi-chemical pulps are typically bleached with hydrogen peroxide (H_2O_2) in a bleach tower

2 3 1 4 2 Mechanical Pulps Mechanical pulps are bleached with hydrogen peroxide (H_2O_2) and/or sodium hydrosulfite (Na_2SO_3) Bleaching chemicals are either applied without separate equipment during the pulp processing stage (i e in-line bleaching), or in bleaching towers Full bleaching of mechanical pulps is generally not practical due to bleaching chemical cost and the negative impact on pulp yield

2 3 1 4 3 De-inked Secondary Fibers De-inked secondary fibers are usually bleached in a bleach tower, but may be bleached during the re-pulping process Bleach chemicals may be added directly into the pulper The following are examples of chemicals used to bleach de-inked secondary fibers hypochlorite (HClO, NaOCl, $Ca(OCl)_2$), hydrogen peroxide (H_2O_2), and

hydrosulphite ($Na_2S_2O_4$)

2 3 1 5 Stock Preparation At this final stage, the pulp is processed into the stock used for paper manufacture Market pulp, which is to be shipped off-site to paper or paperboard mills is processed little, if at all, at this stage Processing includes pulp blending specific to the paper product desired, dispersion in water, beating and refining to add density and strength, and addition of any necessary wet additives Wet additives are used to create paper products with special properties or to facilitate the papermaking process Wet additives include resins and waxes for water repellency, fillers such as clays, silicas, talc, inorganic/organic dyes for coloring, and certain inorganic chemicals (calcium sulfate, zinc sulfide, and titanium dioxide) for improved texture, print quality, opacity, and brightness

2 3 1 6 Processes in Paper Manufacture The paper and paperboard making process consists of the following general steps wet end operations (formation of paper sheet from wet pulp) and dry end operations (drying of paper product, application of surface treatments, spooling for storage)

2 3 1 6 1 Wet End Operations The processed pulp is converted into a paper product via a paper production machine, the most common of which is the Fourdrinier paper machine In the Fourdrinier system, the pulp slurry is deposited on a moving wire belt that carries it through the first stages of the process Water is removed by gravity, vacuum chambers and vacuum rolls This waste water is recycled to the slurry deposition step of the process due to its high fiber content The continuous sheet is then pressed between a series of rollers to remove more water and compress the fibers

2 3 1 6 2 Dry End Operations After pressing, the sheet enters a drying section, where the paper fibers begin to bond together as steam heated rollers compress the sheets In the calender process the sheet is pressed between heavy rolls to reduce paper thickness and produce a smooth surface Coatings can be applied to the paper at this point to improve gloss color, printing detail, and brilliance Lighter coatings are applied on-machine while heavy coatings are performed off-machine The paper product is then spooled for storage

2 3 1 7 Energy Generation Pulp and paper mill energy generation is provided in small part from the burning of liquor waste solids in the recovery boiler, but other energy sources are needed to make up the remainder of mill energy needs Over the last decade the pulp and paper industry in the U S has changed its energy generation methods from fossil fuels to a greater utilization of processes or process wastes These wastes include a combination increase in use of woodroom wastes, spent liquor solids, and other self-generation methods

Power boilers at pulp and paper mills are sources of particulate emissions, SO_2, and NO_x Pollutants emitted from chemical recovery boilers include SO_2 and total reduced sulfur compounds (TRS)

2 3 2 Raw Material Inputs and Pollution Outputs in the Production Line

Pulp and paper mills use and generate materials that may be harmful to the air, water, and land pulp and paper processes generate large volumes of wastewaters which have the potential to adversely affect freshwater or marine ecosystems, residual wastes from wastewater treatment processes often contribute to existing local and regional disposal problems and air emissions from pulping processes and power generation facilities frequently release odors, particulates or other pollutants Major sources of pollutant releases in pulp and paper manufacture occur at the pulping and bleaching stages respectively As such, non-integrated mills (i e , those mills without pulping facilities on-site) are not significant environmental concerns when compared to integrated mills or pulp mills

2 3 2 1 Water General water pollution concerns for pulp and paper mills are effluent solids BOD, toxicity, and color Toxicity concerns arise from the presence of chlorinated organic compounds such as dioxins furans, and others (collectively referred to as adsorbable organic halides, or AOX) in wastewaters after the chlorination/extraction sequence

Due to the large volumes of water used in pulp and paper processes, virtually all mills in the U S have primary and secondary wastewater treatment systems installed to remove particulate and BOD produced in the manufacturing processes These systems also provide significant removals (e g , 30-70 percent) of other important parameters such as AOX and chemical oxygen demand (COD)

The major sources of effluent pollution in a pulp and paper mill are presented in Exhibit 2-6

Exhibit 2-6 Common Water Pollutants from Pulp and Paper Processes

Source	Effluent Characteristics
Water used in wood handling/de barking and chip washing	Solids BOD color
Chip digester and liquor evaporator condensate	Concentrated BOD can contain reduced sulfur
"White waters" from pulp screening thickening and cleaning	Large volume of water with suspended solids can have significant BOD
Bleach plant washer filtrates	BOD color chlorinated organic compounds
Paper machine water flows	Solids often precipitated for reuse
Fiber and liquor spills	Solids BOD color

Screening and cleaning operations during the pulp processing stage are usually sources of large volumes of wastewaters This effluent stream, called "white water" due to its characteristic color, can contain significant BOD if washing efficiency is low and is always a source of suspended solids from wood particles Similar white water wastes are also produced during the papermaking process White waters can be reused to dilute furnish mixtures or the solids can be

collected for reuse Fiber and liquor spills can also be a source of mill effluent Typically spills are captured and pumped to holding areas to reduce chemical usage through spill reuse and to avoid loadings on facility wastewater treatment systems Separate pump systems recycle recoverable materials into the process cycle The condensates from chip digesters and chemical recovery evaporators are a low-volume, but high BOD effluent source Some of these condensates contain reduced sulfur compounds

Wastewater treatment systems can be a significant source of cross-media pollutant transfer For example, waterborne particulate and some chlorinated compounds settle or absorb onto treatment sludge and other compounds may volatilize during the wastewater treatment process

2 3 2 2 Air Exhibit 2-7 presents an overview of the major types and sources of air pollutant releases from various pulp and paper processes

Exhibit 2-7 Common Air Pollutants from Pulp and Processes

Source	Type
Kraft recovery furnace	Fine particulates
Fly ash from hog fuel and coal-fired burners	Course particulates
Sulfite mill operations	Sulfur oxides
Kraft pulping and recovery processes	Reduced sulfur gasses
Chip digesters and liquor evaporation	Volatile organic compounds
All combustion processes	Nitrogen oxides

Water vapors are the most visible air emission from a pulp and paper mill

Pulp and paper mill power boilers and chip digesters are generic pulp and paper mill sources of air pollutants such as particulates and nitrogen oxides Chip digesters and chemical recovery evaporators are the most concentrated sources of volatile organic compounds The chemical recovery furnace is a source of fine particulate emissions and sulfur oxides In the kraft process, sulfur oxides are a minor issue in comparison to the odor problems created by four reduced sulfur gasses (which comprise TRS) hydrogen sulfide methyl mercaptan, dimethyl sulfide, and dimethyl disulfide The TRS emissions are primarily released from wood chip digestion, black liquor evaporation, and chemical recovery boiler processes TRS compounds create odor nuisance problems at lower concentrations than sulfur oxides Humans can detect some TRS compounds in the air as a "rotten egg" odor at as little as one part per billion (ppb)

Chemical recovery and recycling systems in the chemical pulping process significantly reduce pollutant outputs while providing substantial economic return due to recovery of process chemicals Chemical recovery is necessary for the basic economic viability of the kraft process All kraft pulp mills worldwide have chemical recovery systems in place Some sulfite mills,

however, still do not have recovery systems in place Scrubber system particulate "baghouses" or electrostatic precipitators (ESPs) are often mill air pollution control components

2 3 2 3 Residual Wastes The significant residual waste streams from pulp and paper mills include bark, wastewater treatment sludges lime mud, lime slaker grits, green liquor dregs boiler and furnace ash, scrubber sludges, and wood processing residuals Because of the tendency for chlorinated organic compounds (including dioxins) to partition from effluent to solids, wastewater treatment sludge has generated the most significant environmental concerns for the pulp and paper industry To a lesser extent, concern has also been raised over whether chlorinated organics are partitioned into pulp products, a large portion of which become a post-consumer residual waste

With the exception of bark, wastewater treatment sludge is the largest volume residual waste stream generated by the pulp and paper industry Sludge generation rates vary widely among mills Pulp-making operations are responsible for the bulk of sludge wastes, although treatment of paper-making effluents also generates significant sludge volumes Potential environmental hazards from wastewater sludges are associated with trace constituents (e g , chlorinated organic compounds) that partition from the effluent into the sludge

2 3 2 4 Process Inputs and Pollutant Outputs Kraft chemical pulping and traditional chlorine-based bleaching are both commonly used and may generate significant pollutant outputs While the use of traditional chlorine bleaching is in decline, a significant proportion of kraft mills currently use the process

Pollutant outputs from mechanical semi-chemical, and secondary fiber pulping are small when compared to kraft chemical pulping In the pulp and paper industry the kraft pulping process is the most significant source of air pollutants Pollutant outputs from chlorine bleaching, the chlorinated by-products chloroform and dioxin, are particular problems due to their persistence, non-biodegradability, and toxicity Exhibit 2-8 illustrates the process inputs and pollutant outputs for a pulp and paper mill using kraft chemical pulping and traditional chlorine-based bleaching Currently, extensive chlorine dioxide substitution is practiced in many bleaching processes in place of traditional chlorine bleaching The process outlined below produces a large portion of pulp in the United States

Exhibit 2-8 Kraft Chemical Pulped-Chlorine Bleached Paper Production

Process Step	Material Inputs	Process Outputs	Major Pollutant Outputs*	Pollutant Media
Fiber Furnish Preparation	Wood logs chips sawdust	Furnish chips	Dirt grit fiber bark	Solid
			BOD TSS	Water
Chemical Pulping Kraft Process	Furnish chips	Black liquor (to chemical recovery system) pulp (to bleaching/processing)	Resins fatty acids	Solid
			Color BOD COD AOX VOCs (terpenes alcohols phenols methanol acetone chloroform methyl ethyl ketone (MEK))	Water
			VOCs (terpenes alcohols phenols methanol acetone chloroform MEK)	Air
	Cooking chemicals sodium sulfide (Na_2S) NaOH white liquor (from chemical recovery)		Reduced sulfur compounds (TRS) organo chlorine compounds (e g 3 4 5-trichloroguaiacol)	
Bleaching	Chemical pulp	Bleached pulp	Dissolved lignin and carbohydrates color COD AOX inorganic chlorine compounds (e g chlorate (ClO_3))[1]	Water
	Elemental chlorine (Cl_2) chlorine containing compounds		Organo-chlorine compounds (e g dioxins furans chlorophenols)	
	Hypochlorite (HClO NaOCl $Ca(OCl)_2$) chlorine dioxide (ClO_2)		VOCs (acetone methylene chloride chloroform MEK carbon disulfide chloromethane trichloroethane)	Air / Water
Papermaking	Additives bleached/ unbleached pulp	Paper/paperboard product	Particulate wastes organic compounds inorganic dyes COD acetone	Water
Wastewater Treatment Facilities	Process wastewaters	Treated effluent	Sludge	Solid
			VOCs (terpenes alcohols phenols methanol acetone chloroform MEK)	Air
			BOD TSS COD color chlorophenolics carbon disulfide VOCs (terpenes alcohols phenols methanol acetone chloroform MEK)	Water
Power Boiler	Coal wood unused furnish	Energy	Bottom ash (incombustible fibers)	Solid
			SO_2 NO_x fly ash, coarse particulates	Air

Process Step	Material Inputs	Process Outputs	Major Pollutant Outputs*	Pollutant Media
Chemical Recovery System				
Evaporators	Black liquor	Strong black liquor	Evaporator non condensibles (TRS volatile organic compounds alcohols terpenes phenols)	Air
			Evaporator condensates (BOD suspended solids)	Water
Recovery Furnace	Strong black liquor	Smelt, energy	Fine particulates TRS sulfur dioxide	Air
Re-causticizing	Smelt	Regenerated white liquor	Dregs	Solid
		Lime mud	Waste mud solids	Water
Calcining (lime kiln)	Lime mud	Lime	Fine and coarse particulates	Air

* Pollutant outputs may differ significantly based on mill processes and material inputs (e g wood chip resin content)
[1] Chlorate only significantly produced in mills with high rates of chlorine dioxide substitution to reduce dioxin and furan production

2 4 Summary of Health and Toxicity Effects of Selected Pulp and Paper Processing Chemicals

Additional information on the following listed chemicals can be found in *Health and Environmental Impacts of Selected Chemicals*, available from the EP3 Information Center

2 4 1 Methanol

Toxicity Methanol is readily absorbed from the gastrointestinal tract and the respiratory tract, and is toxic to humans in moderate to high doses In the body methanol is converted into formaldehyde and formic acid Methanol is excreted as formic acid Observed toxic effects at high dose levels generally include central nervous system damage and blindness Long-term exposure to high levels of methanol via inhalation cause liver and blood damage in animals

Ecologically, methanol is expected to have low toxicity to aquatic organisms Concentrations lethal to half the organisms of a test population are expected to exceed one mg of methanol per liter of water Methanol is not likely to persist in water or to bioaccumulate in aquatic organisms

Carcinogenicity There is currently no evidence to suggest that this chemical is carcinogenic

Environmental Fate Liquid methanol is likely to evaporate when left exposed Methanol reacts in air to produce formaldehyde which contributes to the formation of air pollutants In the atmosphere it can react with other atmospheric chemicals or be washed out by rain Methanol is readily degraded by microorganisms in soils and surface waters

Physical Properties Methanol is highly flammable

2 4 2 Hydrochloric Acid

Toxicity Hydrochloric acid is primarily a concern in its aerosol form Acid aerosols have been implicated in causing and exacerbating a variety of respiratory ailments Dermal exposure and ingestion of highly concentrated hydrochloric acid can result in corrosivity

Ecologically, accidental releases of solution forms of hydrochloric acid may adversely affect aquatic life by including a transient lowering of the pH (i e , increasing the acidity) of surface waters

Carcinogenicity There is currently no evidence to suggest that this chemical is carcinogenic

Environmental Fate Releases of hydrochloric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems The extent of these reactions will depend on the characteristics of the specific environment

Physical Properties Concentrated hydrochloric acid is highly corrosive

2 4 3 Sulfuric Acid

Toxicity Concentrated sulfuric acid is corrosive In its aerosol form, sulfuric acid has been implicated in causing and exacerbating a variety of respiratory ailments

Ecologically, accidental releases of solution forms of sulfuric acid may adversely affect aquatic life by inducing a transient lowering of the pH (i e , increasing the acidity) of surface waters In addition, sulfuric acid in its aerosol form is a component of acid rain Acid rain can cause serious damage to crops and forests

Carcinogenicity There is currently no evidence to suggest that this chemical is carcinogenic

Environmental Fate Releases of sulfuric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems The extent of these reactions will depend on the characteristics of the specific environment

In the atmosphere, aerosol forms of sulfuric acid contribute to acid rain These aerosol forms can travel large distances from the point of release before the acid is deposited on land and surface waters in the form of rain

2 4 4 Chloroform

Toxicity Target organs of chloroform toxicity include the liver kidneys, heart, eyes and skin Short-term exposure to high concentrations of chloroform leads to inebriation and excitation followed by central nervous system depression, including fainting, dizziness and anesthesia gastrointestinal upsets, including nausea, vomiting, and salivation kidney damage and liver damage Exposure to very high concentrations of chloroform may lead to respiratory depression loss of motor functions, coma, and death due to heart, liver or kidney failure Long-term exposure to chloroform is associated with liver and kidney damage, and mood changes Contact with the eyes and skin causes reversible damage

Populations at special risk from exposure to chloroform include individuals with liver, kidney or central nervous system damage, and chronic alcoholics

Carcinogenicity Chloroform is a probable human carcinogen based on evidence in animals due to both oral and inhalation exposure

Environmental Fate The majority of chloroform releases to the environment are to the atmosphere, releases to water and land will be primarily lost by evaporation and will also end up in the atmosphere Atmospheric releases may be transported long distances and will photodegrade with a half-life of a few months Releases onto the land that do not evaporate will also leach through the soil and persist in the groundwater for a long time Little chloroform is adsorbed to soil particles Biodegradation is generally slow

Chloroform is not expected to bioconcentrate in the food chain, though contamination of food is likely due to its use as an extractant and its presence in drinking water

2 4 5 Ammonia

Toxicity Anhydrous ammonia is irritating to the skin, eyes, nose, throat, and upper respiratory system

Ecologically, ammonia is a source of nitrogen (an essential element for aquatic plant growth) and may therefore contribute to eutrophication of standing or slow-moving surface water, particularly in nitrogen-limited waters In addition aqueous ammonia is moderately toxic to aquatic organisms

Carcinogenicity There is currently no evidence to suggest that this chemical is carcinogenic

Environmental Fate Ammonia combines with sulfate ions in the atmosphere and is washed out by rainfall, resulting in rapid return of ammonia to the soil and surface waters

Ammonia is a central compound in the environmental cycling of nitrogen Ammonia in lakes,

rivers, and streams is converted to nitrate

Physical Properties Ammonia is a corrosive and severely irritating gas with a pungent odor

CHAPTER 3
POLLUTION PREVENTION OPPORTUNITIES

3 1 Introduction

The best way to reduce pollution is to prevent it in the first place Industries have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, and employing substitution of toxic chemicals

In order to encourage these approaches, this section provides both general and company-specific descriptions of some pollution prevention advances that have been implemented within the pulp and paper industry While the list is not exhaustive, it does provide basic information that can be used as the starting point for facilities interested in beginning their own pollution prevention projects When possible, this section provides information from real activities that can, or are being implemented by this sector -- including a discussion of associated costs, time frames, and expected rates of return When possible, information is provided that gives the context in which the technique can be effectively used

Please note that the activities described in this section do not necessarily apply to all facilities that fall within this sector Facility-specific conditions must be carefully considered when pollution prevention options are evaluated, and the full impacts of the change must examine how each option affects air, land and water pollutant releases

3 2 Pollution Prevention Opportunities for the Pulp and Paper Industry

Many recent pollution prevention efforts in the pulp and paper industry have focused on reducing the releases of toxics, in particular, chlorinated compounds Pollution prevention techniques have proven to be more effective in controlling these pollutants than conventional control and treatment technologies Most conventional, end-of-pipe treatment technologies are not effective in destroying many chlorinated compounds and often merely transfer the pollutants to another environmental medium Efforts to prevent chlorinated releases have, therefore, focused on source reduction and material substitution techniques such as de-foamers, bleaching chemical or wood chip substitution to reduce the industry's use and releases of chlorinated compounds Such source reduction efforts and material substitutions usually require substantial changes in the production process

The chemical recovery systems used in chemical pulping processes are an example of pollution prevention technologies that have evolved alongside process technologies An efficient chemical recovery system is a crucial component of chemical pulping mill operation the chemical recovery process regenerates process chemicals reducing natural resource usage and associated

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costs, as well as discharges to the environment and producing energy

In addition to the major process changes aimed at reducing toxic releases the industry is implementing a number of pollution prevention techniques to reduce water use and pollutant releases (BOD, COD, and TSS) such as dry de-barking, recycling of log flume water, improved spill control, bleach filtrate recycle, closed screen rooms, and improved storm water management

The pulp and paper industry has also worked to increase the amount of secondary and recycled fibers used for the pulping process According to industry sources, the pulp and paper industry in the U S set and met a 1995 goal of 40 percent recycling and reuse of all paper consumed nationwide Currently, the industry has set a new goal of recovering 50 percent of all paper consumed for recycle and reuse by the year 2000 These figures should be compared with the utilization rate of secondary fibers (secondary fibers as a percentage of the total fibers used to make pulp) which is at approximately 30 percent and is climbing slowly Current secondary fiber utilization rates in resource deficient countries such as Japan are close to 50 percent

Because the pulp and paper industry is highly capital intensive and uses long-established technologies with long equipment lifetimes, major process-changing pollution prevention opportunities are expensive and require long periods of time to implement The trend towards materials substitutions is reflected in an increasing demand for alternative pulping and bleaching chemicals

Brief descriptions of some pollution prevention techniques that have been found to be effective at pulp and paper facilities are provided below It should be noted that although many of the pollution prevention opportunities listed below are primarily aimed at reducing toxics releases, the process changes can often lead to reductions in the conventional pollutants such as BOD and TSS as well as COD and AOX These changes can also contribute to reduced water use, decreased volumes of sludge, and lowered air emissions

3 2 1 Wood Yard Operations

3 2 1 1 Chip Quality Controls and Chip Thickness Screens Chip quality can have a significant impact on wood waste generation and digestion efficiency Chippers should be maintained and operated to produce chips of uniform dimensions, emphasizing control of chip thickness Chip thickness screens can be used to ensure that thick chips are not introduced into the digesters This promotes uniform kraft liquor penetration, higher pulping yield, and reduced rejects content Uniformly sized chips will be more evenly digested, resulting in lower bleach consumption and subsequent reduction in formation of chlorinated compounds that enter the air and wastewater

Chip screening for size and thickness can enhance the pulping process by providing more uniform chips that will be completely digested Chip size screens alone will not do as thorough a

job as size screens and thickness screens

Sawdust and fine rejects generated from screening operations can be used in a hogged-fuel boiler for power generation Oversize material can be reshipped, screened, and pulped, or also used in the hogged-fuel boiler

3 2 1 2 Dry De-barking Dry de-barking methods are preferred over wet methods because wet de-barking consumes approximately 7,500 to 11,000 liters of water per metric ton of wood barked, which requires treatment before discharge Bark from dry de-barking operations does not have to be de-watered before use as hogged fuel Dry de-barking can be used at kraft and sulfite mills where roundwood comprises the fiber source

3 2 1 3 Log Flume Recycling The water used to convey logs from log piles to de-barkers and chippers can be recycled with minimal blowdown to wastewater treatment facilities Collected bark and fiber can be burned in hogged-fuel boilers for energy recovery Treated wastewater may be used as makeup water for the log flumes This alternative is applicable to any mill that uses log flumes

The benefits of this practice are reduction in water consumption and reduced wastewater discharge loadings of BOD and TSS

3 2 1 4 Storm water Control Curbing and diking around chip piles and chip-PROCESSING areas and collection of wastewater can prevent chips and dust from entering runoff Collected Storm water can then be processed in a wastewater treatment system

The benefits of Storm water control include the avoidance of contaminated surface water

3 2 2 Pulping and Chemical Recovery

Many waste minimization options are available for improved performance in the pulping and chemical recovery processes

3 2 2 1 Extended De-lignification The purpose of this pulping process is to produce brownstock by cooking the fiber in modified time-temperature-alkaline cycles, typically with the same total alkali charge Continuous digesters can be modified to allow for the addition of cooking liquor at several points, a process called modified continuous cooking (MCC) or extended modified continuous cooking (EMCC) In batch digesters, extended de-lignification can be conducted by completing several liquor exchanges during the pulping cycle This process is called rapid-displacement heating (RDH)

The benefits of extended de-lignification are reduced bleach plant chemical consumption, reduction in chlorinated compounds in effluent, improved energy efficiency through enhanced recovery of liquor solids, reduction of rejects, and increased pulp yield

3 2 2 2 Closed Screen Room New pulp-screening and de-knotting systems can be installed to increase the capture and recycling of black liquor into the recovery system Closed screening systems improve the efficiency of the recovery process and reduce the demand for makeup chemicals in white liquor Elimination of spills and overflows reduces the BOD loading and concentration of other organic contaminants in raw wastewater Closed screening systems can be used in sulfite as well as kraft mills

3 2 2 3 Black Liquor Spill Prevention and Control The mixture of dissolved lignin and cooking liquor effluent from the pulping reactor and washed pulp is known as black liquor Raw black liquor contains high levels of BOD, COD, and organic compounds

Spills of black liquor can result from overflows, leaks from process equipment, or from deliberate dumping by operators to avoid a more serious accident Spills of black liquor can have impacts on receiving waters, are a source of air emissions, and can shock the microbial action of wastewater treatment systems Black liquor losses also result in the loss of the chemical and heat value of the material Systems needed to control black liquor spills are a combination of good design, engineering, and, most importantly, operator training A few elements of an effective spill control system include physical isolation of pieces of equipment, floor drainage systems that allow spills to be collected, backup black liquor storage capacity, sensors that provide immediate warning of potential or actual spills, and enclosed washing and screening equipment

The benefits of a comprehensive liquor spill prevention and control program accrue from improved efficiency of the chemical recovery process due to increased capture of liquor solids This reduces the demand for makeup chemicals and decreases the contaminant loading in wastewater Fugitive emissions containing odorous reduced sulfur compounds and VOCs will also be minimized

3 2 2 4 Improved Brown Stock and Bleaching Stage Washing Liquor solids remaining in the brown stock pulp are carried over to the bleach plant and then compete with the remaining lignin in the pulp for reaction with the bleaching chemicals Improved washing, therefore, can reduce the required amount of bleaching chemicals and the subsequent reductions in chlorinated compounds as well as conventional pollutants Modern washing systems with improved solids removal and energy efficiency are beginning to replace the conventional rotary vacuum washers State-of-the-art washing systems include atmospheric or pressure diffusion washers, belt washers, and pulp presses

Opportunities for reduced effluent flows and water use are also present in the bleaching plant Acid filtrates from the hypochlorite or chlorine dioxide stages can be used as dilution and wash water for the first bleaching stage Similarly, second extraction stage filtrates can be used as dilution and wash water in the first extraction stage Most new mills are designed with these counter-current washing systems and some mills are retrofitting their existing wash systems

3 2 2 5 Enzyme Treatment of Pulp Biotechnology research has resulted in the identification

of a number of microorganisms that produce enzymes capable of breaking down lignin in pulp Although the technology is new, it is believed that a number of mills are currently conducting enzyme treatment trials The microorganisms capable of producing the necessary enzymes are called xylanases Xylanases for pulp bleaching trials are available from several biotechnology and chemical companies Since enzymes are used as a substitute for chemicals in bleaching pulp their use will result in a decrease in chlorinated compounds released somewhat proportional to the reduction in bleaching chemicals used Enzymes are also being used to assist in the de-inking of secondary fiber Use of enzymes may also reduce the energy costs and chemical use in retrieving ink sludge from de-inking effluent

3 2 2 6 Use of De-foamers and Pitch Dispersants De-foamers and pitch dispersants that do not contribute to the formation of dioxins and furans during the bleaching process can be substituted for agents that contain dioxin and furan precursors (i e , chlorine compounds) These substitutes can be water-based or oil-based additives

The advantages of this material substitution are reduced formation of chlorinated compounds in the bleaching process, or reduced toxic contaminant loading in the wastewater sludges and effluent in unbleached kraft mills

3 2 2 7 Steam Stripping of Foul Condensates Digester, evaporator, and turpentine condensates can be steam-stripped to remove reduced sulfur compounds (TRS) and BOD (methanol and acetone) A 15 to 20 percent proportion of steam to feed is necessary to achieve efficient BOD removal Stripper overheads can be burned for energy recovery in the power boilers, and stripper bottoms can be reused for brownstock washing

Steam stripping can significantly reduce emissions of VOCs to the air, and can also reduce TRS emissions to a lesser extent In bleached-kraft mills, steam stripping may reduce raw wastewater BOD loadings by up to one-third, and more in unbleached-kraft mills This method also reduces raw water consumption The formation of chlorinated compounds contributing to wastewater contamination is also decreased

3 2 2 8 TRS Controls for High-Volume-Low-Concentration and Low-Volume-Low-Concentration Vents Ten to twenty percent of total mill TRS emissions are contributed by vent streams from brownstock washers foam tanks, black-liquor filters, oxidation tanks and storage tanks that are not typically collected in the non-condensible gas (NCG) system The emissions from these sources can be collected and combusted for energy recovery, reducing the atmospheric emissions of TRS and VOCs

3 2 2 9 Conversion of Recovery Boilers to Low-Odor Design Old-design recovery boilers may contribute 60 to 80 percent of total mill TRS emissions These boilers can be converted to low-odor design by elimination of the direct contact evaporator, modification of secondary- and tertiary-combustion air systems and installation of a new economizer section Moderate expansion of boiler capacity can be accomplished at the same time

Although expensive, this alternative has significant benefits improved boiler efficiency and reduction of recovery boiler emissions by more than 90 percent

3 2 2 10 Recovery Boiler Operations for Low-Odor Emissions Reduced TRS emissions can be achieved through the operation of recovery boilers within specific parameters These include operating within critical loading levels for liquor solids, maintaining secondary- and tertiary-combustion air at greater than 35 percent of total air supply, maintaining excess oxygen levels between 2 0 and 2 5 percent, maintaining liquor sulfidity as low as possible while maintaining pulp quality, maximizing liquor solids within the capability of the evaporator system, minimizing inert contents of the liquor, and maximizing dispersion of the liquor spray by using and maintaining appropriate liquor spray nozzles

Little or no capital investment may be required to implement these practices, which will improve boiler efficiency and reduce atmospheric emissions

3 2 2 11 Use of Weak Wash for Scrubbing Fluid in Air Pollution Control Systems Weak washwater from the causticizing system can be used as scrubber solution for smelt-dissolving-tank emissions, bleach plant and chlorine dioxide plant vents, lime slakers and lime kilns The scrubber water is then returned to the causticizing circuit

This operation will reduce fresh water consumption decrease air emissions and wastewater discharge, and improve chemical recovery efficiency

3 2 2 12 Lime Mud Diversion Basin Lime mud that is usually discharged to the wastewater treatment system from process upsets and lime mud clarifier maintenance activities can be captured in a diversion basin

A relatively inexpensive option, installation of a lime mud diversion basin would improve resource recovery, reduce wastewater loading and treatment costs, and reduce sludge accumulation

3 2 2 13 Oxygen De-lignification Oxygen de-lignification is a process in which the pulp is treated with oxygen in an alkaline environment prior to bleaching and after a conventional or extended pulping process In medium-consistency systems (10 to 20 percent), an additional 40 to 45 percent de-lignification is achievable De-lignification up to 50 percent is attainable in high-consistency operations (25 to 28 percent) This procedure requires a moderate amount of available recovery boiler capacity If ozone bleaching is used, oxygen de-lignification is a prerequisite

The advantages of oxygen de-lignification are primarily in bleach plant chemical savings and reduced wastewater contamination Significant reductions in effluent contaminant loadings are achievable, including BOD, chlorinated compounds, AOX, and color Chlorine consumption may be reduced by 50 percent

3 2 2 14 Use of Anthraquinone in Digesters Anthraquinone can be injected into the digesters to accelerate the pulping process and increase pulp yield This practice can be used selectively to offset increased recovery boiler loading caused by oxygen de-lignification This technique is particularly applicable in bleached-kraft mills where increased pulp yield is desired but which are limited by recovery boiler capacity

Though operating costs are significant with anthraquinone use the advantages of this practice include improved yield, slight reduction in bleach plant chemical consumption and associated formation of chlorination contaminants, and reduction in effluent color and BOD

3 3 1 Bleaching

The bleaching process has been the focus of much research in recent years to develop methods to reduce the production of dioxins, furans, and other chlorinated compounds that are environmentally undesirable

3 3 1 1 Chemical Controls Special instrumentation can be used to monitor and control the addition of chlorine and/or chlorine dioxide in the first bleaching stage in order to maintain the chlorine multiple or kappa factor within specific ranges This type of control can minimize the formation of dioxins, furans and other chlorinated compounds thereby reducing air and wastewater contaminants

3 3 1 2 Chemical Mixing High-shear mixing equipment can be installed in the bleach plant to ensure efficient and even chemical application Such mixers minimize the tendency for localized over chlorination, which leads to the formation of undesirable chlorinated compounds This option is relatively inexpensive and can assist in maximizing bleaching efficiency and minimizing the generation of chlorine compounds that may be released to the atmosphere and wastewater

3 3 1 3 Split Addition of Chlorine/Improved pH Control Reducing the chlorine concentration during the bleaching process by adding elemental chlorine in incremental charges has been shown to reduce the formation of unwanted chlorinated organic compounds A high pH in the chlorination stage is also known to reduce the formation of chlorinated organic compounds, but normally this also results in a decreased pulp yield A high pH, in combination with split chlorine addition, however, has been observed to reduce the formation of chlorinated compounds without a loss of yield It was reported that by using split chlorine addition, the generation of certain dioxin and furan molecules were reduced by up to 70 percent With the addition of pH control these discharges reportedly fell by 90 percent However, consistency in reduction of chlorinated organic pollutants has been problematic

3 3 1 4 Chlorine Dioxide Substitution The substitution of chlorine dioxide for elemental chlorine as a bleaching agent is gaining widespread use due to its beneficial impacts on pulp and effluent quality The use of chlorine dioxide in place of chlorine increases the proportion of

oxidative reactions thereby reducing the formation of residual chlorinated organic pollutants Chlorine dioxide bleaching produces about 20 percent of the chlorinated compounds produced using elemental chlorine A substitution of 50 to 70 percent in the first bleaching stage has become relatively common in recent years Chlorine dioxide substitutions approaching 100 percent have been shown to increase pulp yields and quality

Despite its benefits, the use of chlorine dioxide is two to four times more expensive than the equivalent oxidizing power using elemental chlorine Because chlorine dioxide is unstable and cannot be stored, it must be continually generated at the mill The processes used to manufacture chlorine dioxide generate a number of byproducts (e g , spent acids, chlorine gas, salt cakes and acid cakes) that may have environmental impacts A number of alternative chlorine dioxide generation processes are being developed to reduce or eliminate the formation of such byproducts

3 3 1 5 Enhanced Extraction Oxygen alone or in combination with hydrogen peroxide or hypochlorite in bleach plant caustic extraction stages is used in many bleached-kraft mills to improve extraction efficiency and de-lignification As the pulp enters the extraction stage, a small amount of molecular oxygen is mixed with it Residual lignin in the pulp reacts with the oxygen, subsequently reducing the demand for chlorine dioxide in the following bleaching stage Small amounts of hydrogen peroxide or hypochlorite can be added with the oxygen, producing better de-lignification with finer control of the process

The advantages of this method are its relatively low cost, minimization of chlorinated compounds, and reduced BOD COD, and color in the effluent

3 3 1 6 Replacement of Hypochlorites Chlorine dioxide can be used in place of sodium or calcium hypochlorites in the bleaching process This method is most effective when high-rate chlorine dioxide substitution is used in the first bleaching stage and when hypochlorite is replaced with high-purity chlorine dioxide (i e , less than 0 2 percent chlorine)

The benefits include a significant reduction in the formation of chloroform

3 3 1 7 Ozone Bleaching Research into methods for elimination or reduction of chlorine-bearing chemicals for bleaching has resulted in the development of several alternatives One technique recently applied (1992) at commercial scale is ozone bleaching In this process ozone is used as the primary bleaching agent instead of chlorine, following oxygen de-lignification

In addition to eliminating the formation of undesirable chlorinated compounds, ozone bleaching also facilitates the recovery of ozone and extraction stage filtrates in the chemical recovery system This method significantly reduces wastewater discharge loadings of AOX, BOD, and color from the bleach plant

3 3 1 8 Bleach Plant Washing Countercurrent jump-stage washing entails the reuse of acid-stage filtrates (from hypochlorite or chlorine dioxide stages) as dilution and washwater on the first bleaching stage (using chlorine, chlorine/chlorine dioxide, or chlorine dioxide/chlorine) Filtrate from the second extraction stage can be used in the first extraction stage on log sequence bleach lines

The advantages of this method include (1) reduction in bleach plant wastewater flow by approximately 7,500 to 22,710 liters per metric ton of product in conventional bleach plants (2) steam and energy savings, (3) reduced water consumption, and (4) slight reduction in BOD5 loadings from the bleach plant

3 3 1 9 Oxygen-Reinforced/Peroxide Extraction Oxygen-reinforced extraction (or oxidative extraction) and peroxide-reinforced extraction processes used separately or together have been shown to reduce the amount of elemental chlorine and chlorine dioxide needed in the bleaching process while increasing the pulp brightness Gaseous elemental oxygen (in the case of oxygen-reinforced extraction) and aqueous hydrogen peroxide (in the case of peroxide extraction) are used as a part of the first alkaline extraction stage to facilitate the solubilization and removal of chlorinated and oxidized lignin molecules Oxygen-reinforced extraction has seen widespread adoption by the industry in recent years The use of peroxide extraction is also increasing

3 4 1 Pulp Drying and Paper Making

3 4 1 1 Fiber and White Water Recovery with Savealls Fiber can be recovered from white water or brown water from pulp dryers and paper machines using settling-tank, drum, flotation or polydisc savealls Fiber from the savealls is returned to the stock system and subsequently reused Depending upon the solids loading of the cleaned white water or brown water, it can be reused for stock dilution, wire, headbox, grooved-roll, trim knockdown, wire knockoff, and breast roll showers, consistency regulation, and beaters The primary benefit of using savealls is an increase in yield

Fiber recovery may exceed 90 percent, depending on the type of paper and type of saveall In addition, savealls reduce water and energy consumption, wastewater effluent loadings, wastewater treatment costs, and sludge disposal costs Fresh water reductions from approximately 750 to 37,800 liters per metric ton of product have been reported, depending on the type of paper machine and the level of white water reuse

3 4 1 2 Reuse of Vacuum Pump Seal Water Another method that reduces water and energy demand is the use of cascade systems or recirculating water systems for the operation of water ring vacuum pumps New installations include this feature, and retrofits can also be accomplished

Resulting water savings are estimated at 7,500 liters per metric ton of product There is also a reduction in wastewater flow and therefore in treatment costs

3 4 1 3 Recovery of Steam Condensates The steam condensates from pulp dryers and paper machines can be collected and recovered

This method reduces boiler feedwater treatment costs and improves energy and water conservation

3 4 1 4 Chemical Substitutions A number of non-fiber additives may be utilized in paper making, including sizing agents, resins, fillers, dyes or pigments, flocculants, brighteners, and other chemicals for specific paper characteristics

Some additives have been found to produce undesirable or toxic emissions for example, formaldehyde from urea formaldehyde resins Adequate substitutes for toxic additives can be used The benefits are reduced worker exposure to toxic substances, potential product quality improvements, reduced hazardous waste disposal, and reduced levels of toxics in emissions and effluent

APPENDIX 1

PULP AND PAPER CASE STUDIES

HBI-95-072-04 Pub 11/30/95

EPP Environmental Pollution Prevention Project

CASE STUDY

Pollution Prevention Assessment for a Recycled Paper Mill

Executive Summary

A pollution prevention diagnostic assessment was conducted at a recycled paper mill which produces paper, paper board, and egg cartons The objectives of this assessment were to 1) 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, 2) demonstrate the environmental and economic value of a comprehensive pollution prevention assessment, and 3) improve manufacturing competitiveness and product quality for this facility

The assessment identified six waste minimization and pollution prevention opportunities that together can save around US$741,500 per year for a one time investment of $586 000 The investment figure does not include plant modifications necessary to install the new projects or any duties or taxes, but does include the estimated cost of import duty from new electric motors ($27,500)

Five of the pollution prevention opportunities identified in the assessment are short-term savings options with payback periods of 9 months or less the sixth is an intermediate-term project with a 21-month payback period The short-term projects entail the following reduction in steam losses, recovery of fibers lost in wastewater discharge, recovery of fibers lost due to poor housekeeping practices, and more efficient electrical motors for production Lines 1 and 2 The intermediate-term project involves the replacement of two boilers with one new larger boiler

Facility Background

This facility manufactures a number of paper products from recycled materials The plant employs 160 production workers and 40 administrative staff, and operates on a 24-hour day, 290-days per year basis Steam is generated by on-site oil-fired boilers to meet the plant's thermal energy requirements, while electric power is supplied by the local utility grid

Manufacturing Process

Production occurs on three manufacturing lines, known as Line 1 Line 2, and Line 3 (refer to Figure 1), each of which produces paper products from recycled materials

Line 1 has five production steps First, recycled paper products (newspaper, egg cartons, office paper, etc) are fed into three pulpers, each of which handles different types of paper products Water is added and the mixture is slurried together to form a pulp which is used as feedstock for the making of new paper products The feedstock from each pulper is then fed separately into the paper machine, which rolls the feedstock flat and stacks the material from each pulper thus producing a three-layered paper (the machine has five rolls and is capable of making a five-layered paper) The newly formed paper is fed into squeeze rolls and partially dewatered The paper is then fully dried in steam-heated drying rolls Finally, the paper is trimmed to the proper width and either wound onto a roll or cut into sheets

Line 2 has four production steps There is a large single pulper, which combines recycled materials with

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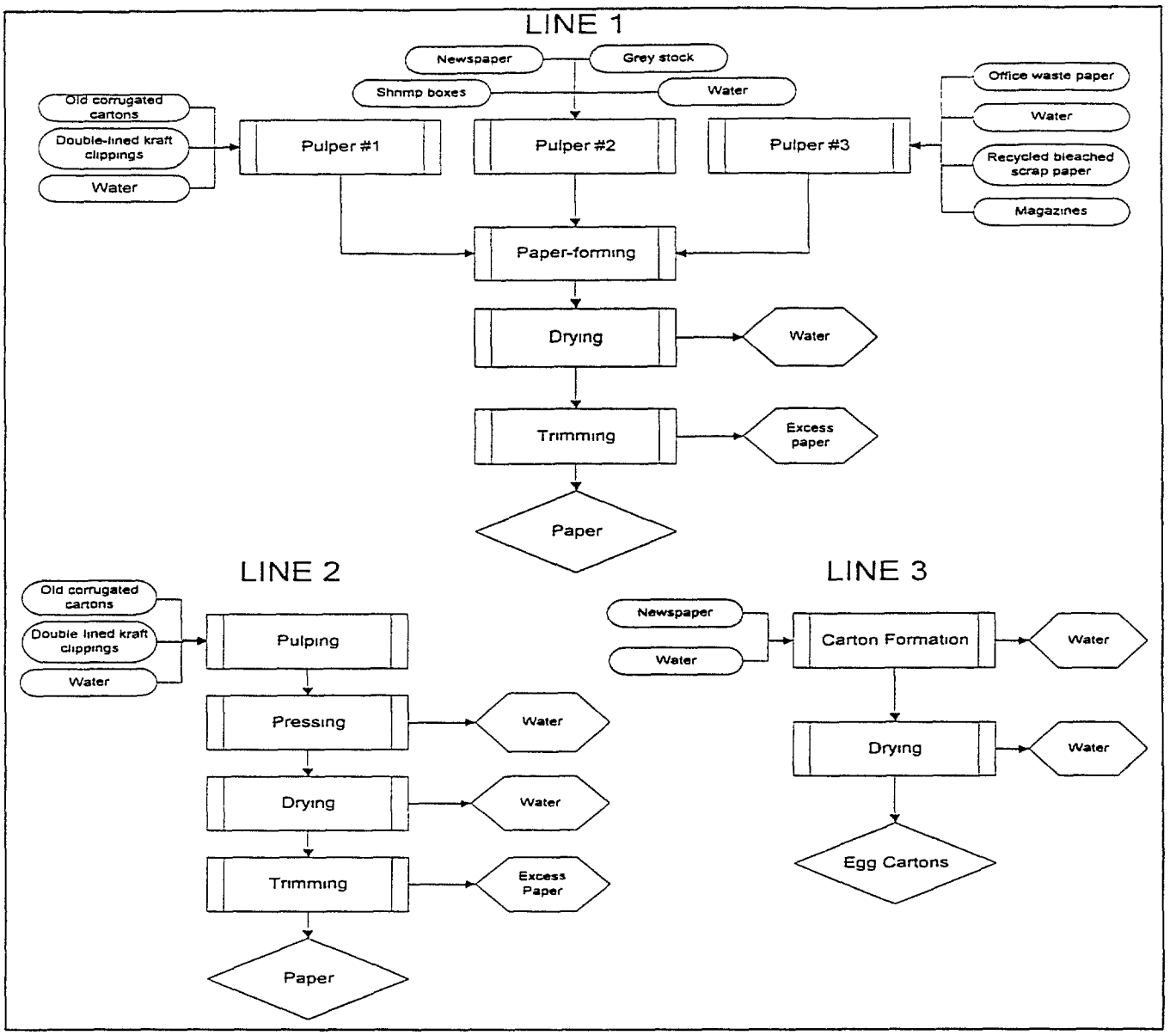
Figure 1 Overview of Facility's Paper Milling Process



water to form a feedstock This feedstock is pumped into a Fourdrinier machine, where it is deposited onto a moving, wire screen Here, most of the water is drained and the screen vibrates to order the fibers in a particular direction The material is then transferred from the wire screen to a felt blanket, which carries it through a series of press rolls where more water is removed The continuous pressed sheet of newly formed paper is processed through a set of steam-heated rolls to complete the drying process The paper is then either rolled or cut into specified sizes of sheet paper

Line 3 has three production steps In the pulper newspaper is continually pulped and fed into the forming section, where the pulp is picked up by the lower forming die vacuums, and then mechanically pressed in to the upper die to force out as much water as possible The wet pressed egg cartons are placed on the screen trays in the dryer trucks to drain water Virtually all of the remaining moisture is removed in the batch dryer

Environmental Problems

There are water, air, and solid waste problems and inefficient energy use at this facility Uncontaminated water is wasted during the pulping process on Line 2, because there is no automatic shut-off valve Wastewater is contaminated with fibers, and is discharged into a nearby creek Air pollution (including carbon dioxide, sulphur dioxide, nitrous oxides, and particulates) is emitted from the power generating plant Solid waste is found in the form of excess and unused papers Raw materials, especially fibers, are lost due to poor housekeeping Energy is lost through steam escaping and inefficient motors

Table 1 Summary of Recommended Pollution Prevention Opportunities

Operation	Pollution Prevention Option	Environmental and Health Benefits	One-Time Implementation Cost (US$)	Financial Benefits (US$)	Payback Period (Months)
Lines 1 and 2 Paper machines	Improved housekeeping practices	Reduced fiber losses thus conserving raw materials and input and reducing the amount of fiber carried in effluent wastewater stream	$50 000	$138 000	4 1/3
Lines 1 and 2 Paper machines	Screen fibers from the water effluent going into the creek	Reduced fiber losses thus conserving raw materials and input and reducing the amount of fiber carried in effluent wastewater stream	$250 000	$324 000	9 1/3
Utilities Steam	Repair steam piping leaks repair or replace steam traps and insulation on steam lines insulate steam lines	Reduced or eliminated steam leaks to save water reduced energy/fuel requirements thus reducing emissions from boiler/s	$40 000	$55 600	8 1/2
Utilities Steam	Replace two old boilers with one large new boiler	Increased boiler operating efficiency enables fuel savings and reduces emissions from boiler/s	$150 000	$87 000	21
Line 1 5-roll paper machine	Replace electrical motors with premium efficiency motors	Reduced electrical energy usage reducing emissions from power generating plant	$55 600	$79 600	8 1/2
Line 2 Fourdrinier machine	Replace electrical motors with premium efficiency motors	Reduced electrical energy usage reducing emissions from power generating plant	$40 200	$56 500	8 1/2
Total	--	--	$586 000	$741,500	--

Pollution Prevention Opportunities

Table 1 lists the pollution prevention opportunities identified by this assessment, the environmental benefits associated with these opportunities, and projected implementation costs and savings

Housekeeping Practices Currently the plant loses a large quantity of fiber in the pulping area and around the paper-forming machines due to poor housekeeping practices By improving these practices at a one-time cost of $50,000, it is estimated that $138,000 per year can be saved

Fiber Screening It is estimated that 70% of the lost paper fibers exit into the wastewater discharge system Most of these fiber losses can be recovered by installing a filtering system in the wastewater system before discharging the water into the creek An amount of fiber worth approximately $324,000 per year can be recovered with a filtering system The one-time cost of the filtering system is estimated at $250,000, which would provide a payback period of 9 3 months

Steam Losses Major leaks are found throughout the plant in broken steam traps and rotary mechanical joints In addition, large and small lines in the dryer drainage system are not insulated It is estimated that the loss of steam and heat due to non-insulated pipes is costing the plant $55 600 per year The estimated one-time cost to repair these items is $40,000

Boiler System There is a loss of heat transfer within the boiler due to fouling of the inside of the tubes, which is caused by poor control of the burner flame and a lack of boiler feed water which could be used to coat the outside of the tubes This inefficient heat transfer results in a loss of $100,000 annually The plant plans to replace the two older boilers with one new boiler The new boiler should include an automatic blowdown and treatment system for the boiler feed water It is estimated that the new boiler system,

at a one-time cost of $150,000, will allow the plant to recover $87,000 of the estimated losses Although the pay back time is 21 months, the plant will have a greatly improved and more reliable steam supply system

Electrical Motors All of the electrical motors in the plant appear to be at least 15 to 20 years old The motors in the plant are estimated to have an efficiency of 85-87% Replacing these motors with new premium efficiency motors could save the plant about 1 65 million kWh/year in power consumption It is recommended that a motor replacement program be initiated to replace all motors of 25 horsepower or more Along Line 1, in the 5-roll paper machine, this replacement would cost $55,600, and create an annual savings of $79,600 Along Line 2, in the Fourdrinier machine, this replacement would cost $40,200 and annually save the firm $56,500

Other Recommendations

Continuous Pulping The pulpers in Lines 1 and 2 should be run on a continuous batch basis, as they were in the past It was reported that the mill is limited in the grades of paper it can produce by the availability of the pulper The pulper is currently operating in a batch mode, but additional capacity can be achieved by changing to continuous operation

Pulper Redesign Pulpers are no longer designed with round tubs as seen at this facility on Lines 1 and 2 because it was discovered that an irregular flow in the pulper produces better pulping than the continuous whirl produced in a round tub To improve this process, the firm should install one of the systems available on the market that modify and improve the process by reconfiguring the round tubs

Bailing Modifications Tying the bails of compacted cardboard and scrap paper from the processes on Line 1 with fiber rather than wire will reduce the bailing cost Eliminating the use of wires for bailing purposes will also prolong pulper rotor life

Water Savings Approximately 20 gallons of water per minute can be saved by installing an automatic cut-off valve in the water flushing line This line should be installed on the vibrating screen reject discharge drum in the pulping process of Line 2

Fiber Treatment In Line 1, two of the refiners are operating in parallel Adding a flow measurement device to each refiner will ensure that the flows are equal

Cylinder Vat Temperature Better paper formation and pressing will be achieved in the cylinder vats on Lines 1 and 2 if the temperature is raised from the ambient air temperature to between approximately 51°C and 54°C

Steam Supply Each dryer section of the drying machines on Lines 1 and 2 is supplied with fresh steam A cascade or thermo-compressor system will make better use of the energy remaining in the used steam and would result in steam savings The steam used is generated at a higher pressure than that used in production The pressure is reduced with a pressure-reducing valve, but the temperature of the reduced pressure steam is not reduced, so the steam is superheated The maximum energy available from the steam occurs when the steam is driven through the critical point and condensed to water If excess superheat is in the steam, the condensing point is not reached and the steam consumption is greater than necessary A de-superheater should be installed along Lines 1 and 2, at a cost of $7,500 each

Vacuum Boxes The felt cleaning vacuum boxes on the presses are connected with a common pipeline to one undivided vacuum pump This is a poor arrangement since the clean felt gets more vacuuming than the dirty felt A divided vacuum pump of similar size could be switched to felt-cleaning service, with a half-pump put on each box

Conclusion

The recommended pollution prevention options are known to result in a product quality that is superior to the previous quality standard Through reduced fiber losses, electrical consumption, steam losses, and improved boiler efficiency, paper manufacturers can become more competitive

For Further Information

For further information on this assessment or other activities sponsored by EP3, call the EP3 Clearinghouse at (703) 351-4004, send a fax to (703) 351-6166, or on Internet ep3clear@habaco com

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ENVIRONMENTAL RESEARCH BRIEF

Waste Reduction Activities and Options for a Laminator of Paper and Cardboard Packages

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Abstract

The U S Environmental Protection Agency (EPA) funded a project with the New Jersey Department of Environmental Protection and Energy (NJDEPE) to assist in conducting waste minimization assessments at 30 small- to medium sized businesses in the state of New Jersey One of the sites selected was a facility that laminates paper and cardboard substrates which are used for packaging purposes The lamination is accomplished by application of a liquid laminate to the surface of the substrate followed by curing The facility also applies metallic coatings to similar substrates by transfer from mylar films A site visit was made in 1990 during which several opportunities for waste minimization were identified Options identified included changing to UV curing for laminates and onsite distillation and reuse of solvents Implementation of the identified waste minimization opportunities was not part of the program Percent waste reduction net annual savings implementation costs and payback periods were estimated

This Research Brief was developed by the Principal Investigators and EPA s Risk Reduction Engineering Laboratory in Cincinnati OH to announce key findings of this completed assessment

Introduction

The environmental issues facing industry today have expanded considerably beyond traditional concerns Wastewater air emissions potential soil and groundwater contamination solid waste disposal and employee health and safety have become increasingly important concerns The management and disposal of hazardous substances including both process related wastes and residues from waste treatment receive significant attention because of regulation and economics

As environmental issues have become more complex the strategies for waste management and control have become more systematic and integrated The positive role of waste minimization and pollution prevention within industrial operations at each stage of product life is recognized throughout the world An ideal goal is to manufacture products while generating the least amount of waste possible

The Hazardous Waste Advisement Program (HWAP) of the Division of Hazardous Waste Management NJDEPE is pursuing the goals of waste minimization awareness and program implementation in the state HWAP, with the help of an EPA grant from the Risk Reduction Engineering Laboratory conducted an Assessment of Reduction and Recycling Opportunities for Hazardous Waste (ARROW) project ARROW was designed to assess waste minimization potential across a broad range of New Jersey industries The project targeted 30 sites to perform waste minimization assessments following the approach outlined in EPA s *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003) Under contract to NJDEPE the Hazardous Substance Management Research Center at the New Jersey Institute of Technology (NJIT) assisted in conducting the assessments This research brief presents an assessment of the lamination of paper and cardboard substrates which are used to make packaging (1 of the 30 assessments performed) and provides recommendations for waste minimization options resulting from the assessment

Methodology of Assessments

The assessment process was coordinated by a team of technical staff from NJIT with experience in process operations basic chemistry and environmental concerns and needs Be

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cause the EPA waste minimization manual is designed to be primarily applied by the in house staff of the facility the degree of involvement of the NJIT team varied according to the ease with which the facility staff could apply the manual In some cases NJIT's role was to provide advice In others NJIT conducted essentially the entire evaluation

The goal of the project was to encourage participation in the assessment process by management and staff at the facility To do this the participants were encouraged to proceed through the organizational steps outlined in the manual These steps can be summarized as follows

- Obtaining corporate commitment to a waste minimization initiative
- Organizing a task force or similar group to carry out the assessment
- Developing a policy statement regarding waste minimization for issuance by corporate management
- Establishing tentative waste reduction goals to be achieved by the program
- Identifying waste generating sites and processes
- Conducting a detailed site inspection
- Developing a list of options which may lead to the waste reduction goal
- Formally analyzing the feasibility of the various options
- Measuring the effectiveness of the options and continuing the assessment

Not every facility was able to follow these steps as presented In each case however the identification of waste generating sites and processes detailed site inspections and development of options was carried out Frequently it was necessary for a high degree of involvement by NJIT to accomplish these steps Two common reasons for needing outside participation were a shortage of technical staff within the company and a need to develop an agenda for technical action before corporate commitment and policy statements could be obtained

It was not a goal of the ARROW project to participate in the feasibility analysis or implementation steps However NJIT offered to provide advice for feasibility analysis if requested

In each case the NJIT team made several site visits to the facility Initially visits were made to explain the EPA manual and to encourage the facility through the organizational stages If delays and complications developed the team offered assistance in the technical review inspections and option development

No sampling or laboratory analysis was undertaken as part of these assessments

Facility Background

The facility provides additional protection or aesthetic value to paper or cardboard stock which is used for packaging purposes Two major activities include application of a plastic laminate to the packaging substrate by application of a liquid laminating material and then curing the layer either thermally when solvent is used or by initiation of polymerization by exposure to ultraviolet radiation The other major activity at the facility consists of applying metallic highlights to the packaging material The highlights are applied by the transfer of a decorative aluminum layer from a mylar backing to the packaging substrate

About 100 people are employed at the suburban location of the facility which has been in operation about 30 years

Manufacturing Processes

The process of coating printed stock with a solvent based glossy coating is known as liquid lamination " In the past almost all such coatings were applied using solvent based formulations Now only about a third of the laminations are accomplished using the solvent based materials The newer technology uses a liquid multi-functional acrylate which is polymerized after exposure to ultraviolet (UV) radiation

Liquid laminates are applied to the sheet fed or web fed stock using offset machinery The coated stock then proceeds through a thermal curing system that volatilizes the solvent The solvent vapors are largely destroyed by thermal oxidation and emitted into the atmosphere

For the UV coatings the coated stock is exposed to high intensity UV radiation which initiates the polymerization and solidification of the coating There are no solvent emissions because the coating formulations contain no solvents

The application of the metallic highlights or decorative features to the stock is accomplished by a stamping operation using metallized mylar film According to the design or pattern on the stamping die the aluminum coating is transferred from the mylar film on which it is supplied to the facility to the stock substrate This is essentially a mechanical operation and the waste which results is the used mylar material which still contains aminotransferase aluminum It is not uncommon for five times as much aluminum to remain on the mylar backing as is transferred to the product

Existing Waste Management Activities

The company has already taken important steps leading to pollution prevention The movement to UV coatings and the resulting reduction in solvent usage and emissions is an important accomplishment

The laminating process generates about 40 drums of solvent annually from cleaning of the presses used to apply the coatings to the substrate The cleaning is necessary for both the solvent based and UV coating formulations Presently the drummed waste is disposed of offsite A variety of solvents may be used including methyl ethyl ketone and xylol Some of the solvent washings waste is used to thin later batches of laminates but the volume is too great to allow it all to be used for this purpose

Common solvents used in the formulation of the solvent based coatings include xylene isopropanol and n butanol Other ingredients may include formaldehyde naphtha aliphatic hydrocarbons ethyl acetate toluene and carbon tetrachloride These materials are passed through the thermal oxidation system and then emitted to the atmosphere

The stamping process produces aluminized mylar film waste This material is landfilled as non hazardous waste At this time there is no known commercial reuse market for this material While the quantity of this waste is a function of the rate of production of the stamping operation no information could be provided by the company about the quantity of this material produced annually

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Waste Minimization Opportunities

The type of waste currently generated by the facility the source of the waste the quantity of the waste and the annual treatment and disposal costs are given in Table 1

Table 2 shows the opportunities for waste minimization recommended for the facility The type of waste the minimization opportunity the possible waste reduction and associated savings and the implementation cost along with the payback time are given in the table The quantities of waste currently generated at the facility and possible waste reduction depend on the level of activity of the facility

It should be noted that the economic savings of the minimization opportunity in most cases results from the need for less raw material and from reduced present and future costs associated with waste treatment and disposal It should also be noted that the savings given for each opportunity reflect the savings achievable when implementing each waste minimization opportunity independently and do not reflect duplication of savings that would result when the opportunities are implemented in a package Also no equipment depreciation is factored into the calculations

The two major options for pollution prevention at this facility consist of completion of the move toward UV coatings and away from solvent based coatings This effort is complicated by customer demands and specifications which require the continued use of solvent based laminates Continued educational efforts and perhaps improved performance of the UV coatings may be required to change this situation

Because cleaning of the equipment will still be required after changing to UV coating laminates it is recommended that a single solvent ideally one with relatively low toxicity be selected for this purpose That solvent should be segregated and a distillation capability obtained for the facility to allow recycling and reuse This will create another waste stream the still bottoms but the volume of that stream will be substantially less than the total volume of the washings

The practice of using washing solution as makeup or thinner solvent for application of new batches should be continued and expanded where possible Additionally care should be taken to keep containers of volatile solvents covered when not in use This will reduce the amount which evaporates into the atmosphere

Regulatory Implications

There are no significant regulatory issues which would impede the implementation of additional pollution prevention initiatives at this facility Increased regulatory attention to air quality may spur the development of additional types of UV coatings for lamination purposes addressing some of the performance and appearance concerns of clients who insist upon solvent-based lamination A need remains for an outlet for the residual mylar film This may not be a regulatory issue but increased attention to solid waste disposal may develop new options for material of this type

This Research Brief summarizes a part of the work done under cooperative Agreement No CR-815165 by the New Jersey Institute of Technology under the sponsorship of the New Jersey Department of Environmental Protection and Energy and the U S Environmental Protection Agency The EPA Project Officer was Mary Ann Curran She can be reached at

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Mention of trade names or commercial products does not constitute endorsement or recommendation for use

Table 1 Summary of Current Waste Generation

Waste Generated	*Source of Waste*	*Annual Quantity Generated*	*Annual Waste Management Costs*
Mixed Organic Solvents	*Washing of equipment used to apply coating to stock*	*40 drums*	*$4 000*
Volatile Solvents	*Solvents driven off from solvent based coatings*	*>1000 gal*	*(Cost of operating thermal oxidation system)*
Metallized Mylar Film	*Excess from stamping operation*	*Variable (Estimated 2000 lb)*	*65/ton*

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Table 2 *Summary of Recommended Waste Minimization Opportunities*

Waste Generated	Minimization Opportunity	Annual Waste Reduction Quantity	Annual Waste Reduction Percent	Net Annual Savings	Implementation Cost	Payback Years
Volatile Solvents	Complete changeover to UV laminates	> 1000 gal	100	Cost of operation of thermal oxidizer	$ 0	immed
Washing Solvents	Acquire distillation capability to allow recycle and reuse of solvent	40 drums	100	$4000 (However a still bottoms waste stream will be created)	5000	1 2

Savings result from reduced raw material and treatment and disposal costs when implementing each minimization opportunity independently

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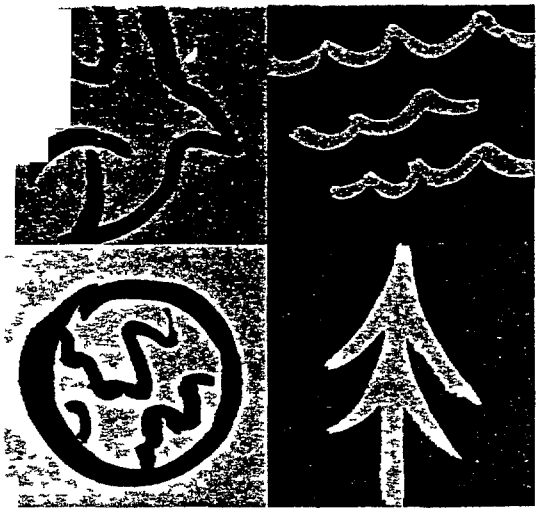


Where We Stand

Pollution Prevention

Environmental Stewardship In Action

The Federal Pollution Prevention Act of 1990 (PPA) defines a pollution prevention hierarchy in which source reduction is the preferred option, followed by recycling, treatment and disposal According to the PPA

Pollution should be prevented or reduced at the source whenever feasible pollution that cannot be prevented should be recycled in an environmentally safe manner whenever feasible pollution that cannot be prevented or recycled should be treated in an environmentally safe manner whenever feasible and disposal or other release(s) into the environment should be employed only as a last resort

How Does It Work At G-P?

Historically Georgia-Pacific has practiced pollution prevention at individual facilities and through voluntary state and federal programs As part of its vision to promote environmental stewardship Georgia-Pacific is implementing a company-wide program to develop and support pollution prevention initiatives

At Georgia-Pacific pollution prevention is a broad-based program that encourages proactive approaches to address a variety of environmental challenges The company s efforts in this area focus on reducing environmental impacts through source reduction improvements in processes and products and increased reuse recovery and recycling Pollution prevention is being incorporated as a routine practice to identify environmentally sound projects and activities that are technically workable and add value to the company

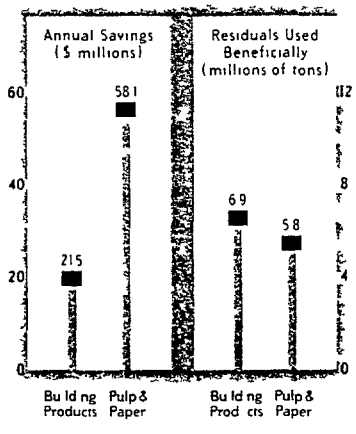
Where Are The Efforts Focused?

Georgia-Pacific is demonstrating environmental leadership by putting pollution prevention into practice The following examples are only a sampling of the company s pollution prevention projects and activities

♦ Promote source reduction

Over the years Georgia-Pacific has worked hard to get the most from every tree that comes into its plants and mills Today technological innovations have significantly improved utilization levels and Georgia-Pacific continues to look for ways to reduce waste and stretch its renewable wood resources

G P Pollution Prevention Projects



Georgia Pacific s Pulp and Paper and Building Products divisions have reported over 200 pollution prevention projects that are achieving operational savings and environmental benefits Additional projects currently are being identified

As a source reduction leader Georgia-Pacific searches for new and innovative ways to effectively minimize waste at the source A good example is the company s efforts to create a compressed napkin for quick-service restaurants that achieves substantial reduction in packaging and saves transportation costs This approach reflects our commitment to the environment while at the same time responsibly using our natural resources to make quality products that meet customer expectations

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Pollution Prevention

♦ Reduce waste to landfills

The nation s solid waste problem continues but G P and its employees are committed to be part of the solution Currently three facilities burn old rubber tires diverted from landfills in their fuel boilers Each year our tire-derived fuel program burns more than 8 million tires and generates $2 7 million in fuel landfill and transportation savings Additional fuel sources include pelletized paper, bark and other wood residuals

At Monticello, Ga , the Zeno grinder offered an alternative solution to landfilling the plant's wood waste Today the Zeno grinder annually reduces 500 tons of wood scrap into fiber that is used to produce panelboard, making Monticello a zero wood-waste operation

Employees at the Sheboygan Wis packaging plant formed a team to look at the facility s trash output and find reduction opportunities As a result, the plant greatly reduced the solid waste going to landfills and saved more than 50 percent in hauling costs

> Georgia-Pacific is well on the way to achieving its 1995 goal of saving 1 percent of operating costs – about $100 million – and reducing waste in many areas

♦ Increase recycling

Georgia-Pacific is among the nation s top paper recyclers, reprocessing over a million tons of recovered paper and old corrugated materials each year The company expects to double its annual usage of recovered paper by 1997 One way the company will meet its recovered paper needs is by establishing recycling programs at more G-P locations Also Georgia-Pacific helps its customers recover and recycle through its Coming Full Circle with Georgia-Pacific program

♦ Reduce air/water pollution

Georgia-Pacific manages its forests and operates its plants and mills in a manner that reflects its commitment to protect air and water quality For instance its participation in the US EPAs 33/50 voluntary pollution prevention program demonstrates how the agency and industry are working together to achieve environmental benefits The company is on target to accomplish its goal to reduce emissions of 17 substances by 50 percent by the end of 1995 and has established an additional voluntary goal for further reductions by 2000

Currently 13 of 18 Georgia Pacific chemical manufacturing facilities are closed loop reducing and or reusing all water that comes into contact with raw materials or finished products The company has committed to beneficially reuse process wastewater or become closed loop at all chemical plants by 1998 and all packaging plants by 2000

G-P uses Best Management Practices on its 6 million acres of timberlands to protect soil and water quality conserve wildlife habitats, and minimize non-point source pollution In addition the company has embarked on a long term environmental strategy for forestry operations designed to meet timber production needs while practicing environmental stewardship

♦ Develop new products/uses

Georgia-Pacific is focusing on ways to produce more fiber-efficient building products Engineered wood products such as particleboard and oriented strand board, use smaller fast growing trees or wood by-products as raw materials, which conserves resources and reduces landfilling Georgia-Pacific continues to research and advance environmentally sound solutions to supply new products and technologies

In addition, the company has formed a mill residuals team to encourage beneficial reuse of residuals from the manufacturing process For example, sawdust, chips and shavings from one process can become raw materials for other products Also residuals with nutrient value can be used on company forestlands or neighboring farmlands Residual sources include pulp mill sludge, gypsum and lime materials, boiler ash and other wood by-products

What Are The Results?

Pollution prevention makes good sense for Georgia-Pacific and for the environment Currently, more than 200 projects resulting in $80 million in annualized savings have been identified With these projects, the company is well on the way to achieving its 1995 goal of saving 1 percent of operating costs – about $100 million – and reducing waste in many areas

For more information about Georgia-Pacific s environmental programs please write Environmental Information Corporate Communications Dept Georgia Pacific Corporation 133 Peachtree Street N E Atlanta Georgia 30303

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Paper Georgia Pacific s Hopper® Valorem® Vellum White 65 lb Cover

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APPENDIX 2

MISCELLANEOUS INFORMATION

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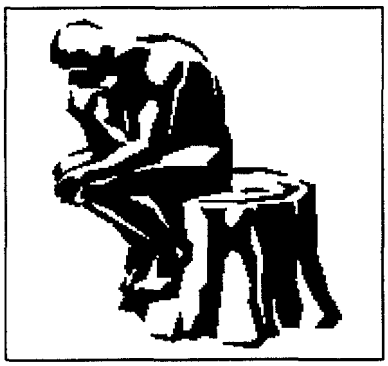
RETHINK PAPER



An Ecological Vision for Paper

With precious forest wildlands disappearing on an ever expanding scale, Earth Island Institute has put into motion ReThink Paper (RTP) ReThink Paper is a network of environmental activists, scientists and paper-industry experts working to achieve ecological sustainability in the U S pulp and paper market Our mission is to convince the consumer, paper-industry, and government sectors of society to *rethink* -- and then *replace* -- current paper-consumption and production practices

One of the most critical environmental issues today is the decimation of North American forests to meet the demand for wood products With half of the forests that once covered the planet now gone, the US now consumes an estimated 3 4 billion cubic meters of wood (1991) more than double the consumption of wood in 1950 Thirty percent of these trees are used to manufacture paper products The destruction of forest ecosystems by the modern timber industry has caused severe loss of wildlife and habitat, degradation of riparian systems, local and possibly global climate changes, and the disruption of local communities and economies over time While there are signs of hope in the form of labor-intensive and community-based sustainable forestry plans and practices, these efforts are still in their infancy Meanwhile, worldwide paper consumption is projected to expand 46% by the year 2040

Reducing paper consumption levels through reduction, reuse, and recycling strategies is crucial to preserving our forests However, these approaches alone have yet to succeed in adequately protecting domestic forests Virgin fibers remain an essential component in paper making Every time a fiber is broken down (pulped / recycled), it becomes weaker, making an addition of strong virgin fibers a neccessity Until virgin wood pulp is replaced as the primary fiber 'strengthener' in paper manufacturing, the industry will continue to destroy forest ecosystems One of the most promising solutions to this situation is the replacement of virgin wood fibers with more environmentally benign 'tree-free' agricultural fibers A largescale substitution of this kind would make a substantial contribution to the protection of forests and other natural systems adversly impacted by the virgin wood pulp and paper industry Ecological Alternatives

The term "tree-free paper" refers to paper made entirely from fibers that do not come from trees RTP's work focuses on paper products made from recycled wood fibers and tree-free fibers including kenaf, hemp, and agricultural residues (eg wheat and rice straws) cotton linters, and reclaimed fabric

These 'earth friendly' paper alternatives offer viable, job-creating solutions to environmental problems directly caused by timber harvesting and virgin wood pulp and paper manufacturing processes However, nonwood paper is currently more expensive than virgin-wood paper due to significant industry start-up costs, smaller economies of scale, and heavy government subsidization of the pulp, paper and timber industries Government regulatory and procurement policies and subsidy programs have encouraged growth of the timber, pulp and paper industries based on the destruction of forest ecosystems and wildlife habitat, the pollution of air and watersystems, and the creation of some of the most deadly known chemical toxins, by making this the most inexpensive way to operate This situation has instituted an uneven competitive climate, skewed towards virgin wood-based paper production If subsidies were eliminated and policies designed to encourage the development of a sustainable paper industry, ecological paper alternatives would make great progress

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RETHINK PAPER

Tree-Free Fibers

The US Department of Agriculture has spent 40 years investigating more than 500 plants to find the best fiber for pulping paper While hemp has historically been the most recognized plant for tree-free paper, the USDA has identified another plant, kenaf, as the most viable fiber to produce tree-free paper

There are numerous agrifibers ideally suited for paper production, including kenaf, hemp, agricultural residues (cereal straws, cotton linters, etc), and reclaimed fabric Most of these agrifibers yield more pulp-per-acre than forests or tree-farms, and require fewer pesticides and herbicides In addition, fewer chemicals and less time and energy are needed to pulp and bleach agricultural fibers In fact, agrifibers can be effectively brightened using totally-chlorine-free (TCF) bleaching processes, thus eliminating the production of highly toxic chlorine byproducts such as dioxin commonly associated with paper production Crops such as hemp and kenaf also provide a means of adding strength to recycled fibers without using wood

The Inside Scoop

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RETHINK PAPER
The Network for Ecological Paper Alternatives

Kenaf...

ReThirk Factsheet #2

An Ecological Alternative to Virgin Wood-Based Paper

The kenaf plant (Hibiscus cannabinus) is considered one of the most promising alternatives to virgin soft- and hardwoods for paper production An herbaceous annual related to cotton and okra, kenaf is a member of the mallow family indigenous to West Africa The US Department of Agriculture (USDA) began researching kenaf in the 1940s, when World War II put a stop to jute imports from Asia In 1960, the US Department of Agriculture (USDA) chose kenaf from among 500 candidates as the most promising non-wood fiber for pulp and paper production After much research and numerous trials runs, kenaf paper is now available from several commercial retailers and is being used by major corporations, printing and graphics firms and publishers

- Companies like Apple, Sony, Warner Bros , REI, J C Penny, The Nature Co , The Gap, Esprit International and Birkenstock have begun to use kenaf paper for catalogues and other purposes
- Major Printing and Graphics firms such as Kinkos, Anderson Lithographics, George Rice and Sons, Ventura Printing and Lithographix now provide printing services on kenaf paper
- Earth Island Institute's Earth Island Journal was the first magazine to be printed entirely on 100% 'tree-free' kenaf paper Two and a half years later, the journal continues to be printed on kenaf On Earth Day, 1995, conservationist David Brower's latest book, *Let the Mountains Talk, Let the Rivers Run* (HarperCollins) became the first hardcover book to be published on 100% kenaf paper Several other books have been published on kenaf, including **Proceedings from the First Biomass Conference of the America's Energy, Environment, Agriculture and Industry**, and Peter Kreitler's **The Earth's Killer C's**

The USDA identified kenaf as the best non-wood paper alternative for several reasons

1 **Rapid growth** Kenaf reaches 12-18 feet in 150 days, while southern pine (the largest paper pulp crop in the US) must grow 14-17 years before it can be harvested

2 **High yield** Kenaf also yields more fiber per acre than southern pine, producing 5-10 tons of dry fiber per acre annually, or roughly 3-5 times as much as southern pine

3 **Exceptional papermaking characteristics** Kenaf fibers can be pulped with existing virgin-wood technology and require fewer chemicals, and less heat and time, because they are not as tough as wood fibers and contain less lignin (an average kenaf plant contains only 9% lignin, while southern pine contains 29% lignin) Lignin binds together plant cellulose fibers and must be broken down and removed before fibers can be made into paper Toxic chemicals, especially chlorine, are predominantly used to de-lignify and bleach wood pulp However, mounting evidence suggests serious ecological and human health risks associated with chlorine pulp bleaching The kenaf paper currently produced in the US is bleached with more benign chemicals, like hydrogen peroxide

Despite its commercial and environmental advantages, the kenaf paper industry is just beginning to develop As of 1995, New Mexico's KP Products was the only company commercially producing kenaf

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paper in the US The company manufactured 2200 tons of kenaf paper in 1995, approximately ten times its 1994 production level Because of significant industry start-up costs, smaller economies of scale and government subsidies to pulp, paper and timber industries, kenaf paper is more expensive than virgin wood-based papers

These virgin, wood-based papers may be cheap, but their prices do not reflect environmental costs that have been externalized by the pulp and paper and timber industries The destruction of ancient forest ecosystems, fragmentation of wildlife habitat, and the pollution of air and water systems are the most obvious If the enormous costs of environmental restoration are also taken into account, the development of the kenaf paper industry, which would leave forests intact while reducing industrial pollution and energy consumption, begins to make both economic and ecological "cents/sense "

However, depending on how the kenaf industry develops several environmental problems could arise

- Large-scale monoculture farming is often chemically intensive Although only one pesticide and two herbicides can be currently used on kenaf, there is concern that chemical use could increase as the industry expands However, many kenaf pests can be successfully eliminated with organic-farming methods, pest-tolerant kenaf varieties, and rotation with other pest-resistant crops (e g corn) RTP is currently investigating other non-polluting solutions to kenaf pest and disease problems

- Kenaf, like many virgin wood fibers, is presently pulped by the kraft process Pulping is a polluting process However, kenaf pulping requires less chemical inputs and consumes less energy than most virgin wood pulping processes and is thus less polluting

- In the U S , kenaf is bleached with hydrogen peroxide which breaks down into water and oxygen during the bleaching process However, there is the possibility that a growing kenaf industry, striving to compete with wood-based paper prices, may begin to use chlorine, which is substantially less expensive than hydrogen peroxide

Despite these concerns, kenaf-paper production saves critical forest habitat and can be considerably less polluting and environmentally destructive than virgin wood-based paper production RTP's goal is to ensure that as the kenaf industry develops environmental concerns remain a priority

KENAF RESOURCES

- ReThink Paper (415) 788-3666 (N CA)
- KP Products Only domestic kenaf paper manufacturer Sells paper by the case (10 reams) and web roll (505) 294-0293 (NM)
- TREECO Sells kenaf and other non-wood and recycled office supplies (310) 399-TREE (S CA)
- Earth Care Products Sells kenaf supplies for home and office (800) 347-0070 (N CA)
- International Kenaf Association Kenaf industry association (903) 367-7216 (TX)

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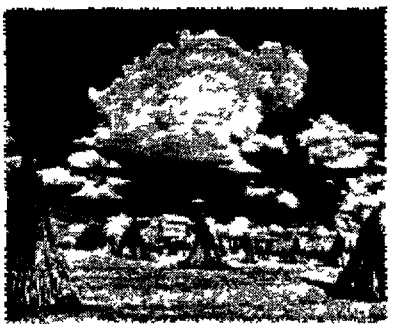
The Network for Ecological Paper Alternatives

Hemp. . .

ReThink Factsheet #1



Hemp: A paper fiber for the ecological era

Hemp is intertwined with American history We grew it to rig the great New England sailing ships, traveled west in Conestoga wagons covered in hemp, dressed in homespun hemp cloth when we got there and wound up wearing hemp jeans We tied our cargo with hemp rope and fed the poultry with hemp seed We used hemp to help develop this country " -

Willie Nelson

Hemp is an herbaceous annual plant native to Asia that grows well in many temperate climates It typically reaches 6-12 feet in its four-month growth period, producing approximately 3-6 tons of dry fiber per acre annually - nearly twice as much as southern pine Hemp also competes well with weeds and is resistant to most pests As a result, few pesticides and herbicides are required for cultivation Hemp's rapid growth rate, high fiber yield, and its many applications make it an attractive industrial crop for manufacturing a variety of products

Hemp has been cultivated worldwide for 6-10,000 years Cultivation spread from Central Asia to China in 4500 BC, where hemp fiber was used to make rope By 400 BC, Hemp was being cultivated in Europe and has since been grown in almost all temperate-zone countries Hemp can be used to make everything from cloth, rope, birdseed, paint, varnish, soap, and oil, to paper

The use of hemp fibers for paper production dates back almost 1900 years to China, where paper was first manufactured In fact, the oldest-known piece of paper (circa 140-87 BC) contains hemp fibers Until the 19th century, paper was manufactured from cloth rags in Europe and the Americas Because most cloth was made from hemp and flax, they became the primary paper feedstocks The Gutenberg Bible (15th Century), the King James Bible (17th Century), the first and second drafts of the Declaration of Independence, and the original works of Mark Twain, Victor Hugo, Alexander Dumas, Lewis Carroll, and Thomas Paine were all printed on paper made of hemp fibers

Technological advances in the late 19th century made it cheaper to use wood instead of rags for pulp and paper production Despite renewed interest in hemp during WW I, cultivation was banned in 1937 because of hemp's association with marijuana Ironically, however, industrial hemp is a different plant variety and makes a poor recreational drug because of its low tetrahydrocannabinol (THC) content During WW II, restrictions on hemp production were temporarily lifted because jute, which was used to make rope, could no longer be imported from Asia In 1940, world hemp production peaked at approximately 832,000 tons per year However, after WW II, the restrictions were reinstated and global hemp production declined significantly Approximately 124,000 tons of hemp are currently harvested annually worldwide The majority is now produced in China and Eastern Europe

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In the 1980s, interest in hemp as a viable and sustainable fiber crop began to develop in Western Europe and North America in association with growing concern about the impacts of deforestation and air and water pollution caused by the pulp and paper industry Hemp has developed a reputation as an ecologically sound, non-wood alternative to wood for paper production As a result, the market for hemp paper has begun to grow steadily In 1994, the US imported approximately 2,000 tons of hemp paper

It is difficult to analyze the economic costs and environmental impacts of hemp paper production because the fiber is frequently processed with antiquated technology Outdated mill technology can only convert 50 percent of the stalk into pulp and the scale of production is small (an average of 5,000 tons/year compared with modern wood pulp mills' 250,000 tons/year) As a result of these economies of scale, hemp pulp and paper is expensive These antiquated mills tend not to have chemical recovery systems, releasing effluents directly into local environments

However, recent laboratory research and new pulping processes (now at the demonstration level) have shown that hemp can be pulped more productively, cheaply, and with fewer negative environmental impacts than trees When modern pulping processes and mill technologies are used, fewer chemicals and less energy are required to pulp hemp fibers In addition, up to 80 percent of unprocessed hemp can be converted to pulp (compared with an average of 43 percent of wood fibers), and mill effluent is significantly cleaner Furthermore, toxic chlorine bleaching processes can be replaced with environmentally benign processes that use oxygen, hydrogen peroxide, or ozone

The greatest barrier to hemp paper production in the US today is the ban on legal cultivation However, the relaxation of farming restrictions in both Canada and Europe, and new varieties of industrial hemp that have extremely low levels of psychoactive components (0 1-1% THC, as opposed to 3-15% in marijuana), could positively influence the future of industrial hemp cultivation in the US As new advances in farming, processing, and pulping move from experimental to commercial applications, hemp's potential to become a major pulp feedstock for paper production may finally be realized

HEMP RESOURCES

- TREECO Sells hemp paper and office supplies (310) 399-TREE (N CA)
- Tree Free Eco-Paper Sells hemp and agri-residue paper (800) 775-0225 (OR)
- Ohio Hempery Offers hemp papers and products (800) BUY-HEMP (OH)
- Ecolusion Sells hemp paper and products (703) 207-9001 (VA)
- Arbour Sells a selection of hemp paper (613) 567-3168 (Ontario, Canada)

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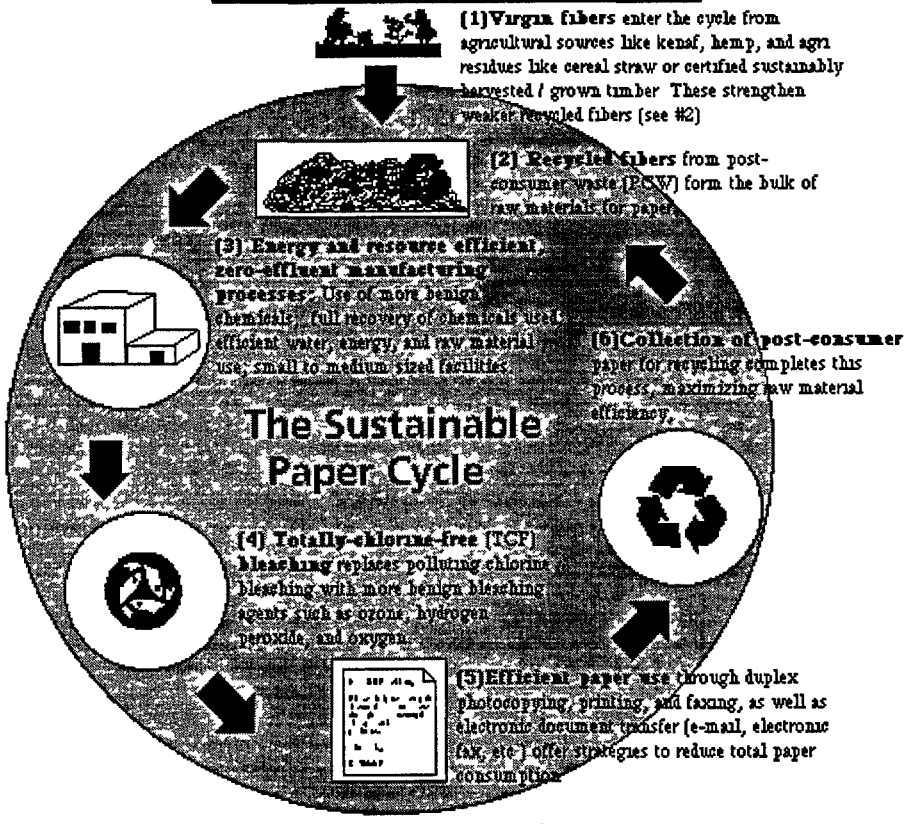
ReThink Paper



The Sustainable Paper Cycle

ReThink Paper supports a conversion by paper producers and consumers toward the sustainable paper cycle model described above This model represents a feasible vision of sustainable paper production and consumption cycles The technologies and knowledge needed to implement this model exist today However, developing the infrastructure and policies needed to achieve these changes will be a costly and long-term process

Paper consumers can make a difference!

Purchase non wood and post-consumer recycled paper products, bleached without chlorine (specify these products with your paper suppliers)

Reduce paper consumed by reusing paper that s only been used on one side, two-sided printing and photocopying, and electronic document transfer

Implement recycling collection in places of work and community

Contact ReThink Paper to learn more (415) 788-3666

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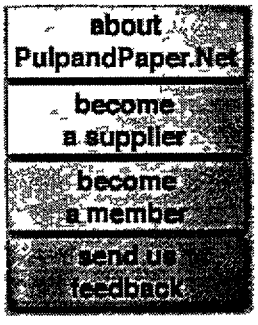
Welcome to Pulp and Paper Net

An Easier Way to Get More Information in Less Time



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Pulp and paper industry tradeshows are another valuable resource for industry information Pulp and Paper Net wants to keep you informed about tradeshows and seminars that may be of interest to you This section offers you information on upcoming tradeshows and seminars and includes images from past tradeshows we have attended

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New Business News

In the information age, staying up to date on industry information is not an easy task This section provides

New Classified Ads

Whether you are in the market for a new job or just curious about available openings, this section of Pulp and Paper Net allows you to search the Job Opportunities database If you locate a posting that interests you, Pulp and Paper Net will provide the information you need to confidentially contact the company posting the job opportunity

Job Opportunities
Coming soon - Used Equipment

New From The 'NET

The Internet is a valuable resource for information, but finding that information is not always easy Pulp and Paper Net's goal is to make pulp and paper producers' jobs easier by putting them closer to the information they need This section of Pulp and Paper Net provides information and links to other sites on the Internet containing industry information Make a bookmark for Pulp and Paper Net and begin your search for pulp and paper industry information with us

"The Pulp and Paper Jumplist"
Newsgroup Topics

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pulp and paper industry information Whether it is unique information we bring to you or other pulp and paper on-line resources, we want to help you find the information quicker and easier

Newsgroup Topics

Walden Paper Report
Walden Fiber and Board Report

The New PulpandPaper Net home page has been accessed 6182 times since May 6, 1996

GOING GREEN
IT'S A HABIT
NOT A HOBBY

WISCONSIN TISSUE

POLLUTION PREVENTION (P2) INITIATIVE

AT

WISCONSIN TISSUE

ANNUAL REPORT 1995

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NOTE *TO MAKE THE 1995 REPORT COMPLETE AND STAND ON ITS OWN, SECTIONS I-III OF THE 1994 REPORT ARE DUPLICATED HERE*

I COMPANY.

Wisconsin Tissue (WT) is a recycling tissue mill which operates on the Lower Fox River in Menasha, Wisconsin, and currently recycles approximately 300,000 Tons Per Year (TPY) of wastepaper to produce 200,000 TPY of tissue and napkin products to serve commercial and industrial markets We are also a leading manufacturer of quality placemats, table covers, and tray covers

The jumbo rolls of finished paper are sent to our converting operations across Little Lake Butte des Morts, where they are made into one of more than 1,800 products Our converting operations has more than 100 converting machines, which print, emboss, cut, fold, wind, wrap, and package millions of pieces every hour

Connected to our Converting Plant is our computerized automatic storage and retrieval distribution center which handles approximately 110,000 cases of product per day

Our products are sold to a North American distributor network Our products are distributed to restaurants airlines, fast food chains, lodging chains, cash-and-carry operations industrial complexes, office buildings, nursing homes, and hospitals, to name a few We are one of the largest manufacturers of disposable products in the industry today

WT has increased its production capacity by over 400% in the last 12 years with capital expenditures of over $250 million and employs over 1,450 people, making it one of the largest employers in the Fox River Valley These expansions have brought growth and vitality to local communities creating a dependable tax base to build schools and roads and public works of every description

Wisconsin Tissue became part of the Chesapeake Corporation (NYSE-CSK) in 1985 Chesapeake Corporation is a Richmond, Virginia, based paper and packaging company with annual sales of $898 million Its primary businesses are tissue and Kraft paper products and packaging Other businesses include consumer tissue products, land development and building products

II COMMITMENT TO THE ENVIRONMENT

Wisconsin Tissue is well recognized and takes pride in the fact that it is one of the foremost environmental leaders in the industry as someone who goes beyond the letter of regulations and toward the spirit of doing things earlier better, and voluntarily Our historical accomplishments listed in the next Section (III) of this report are significant and attest to, or speak clearly, to our claim to be an environmentally responsible corporate citizen in our community

We have committed time, energy, and capital resources which enable us to minimize the environmental impact of our mill operations and maximize its compatibility with the surrounding community

Since 1980, we have committed in excess of $50 million in capital expenditure for environmental projects In addition, we have spent millions of dollars in recycling technology which allows the recycling of post-consumer graded wastepaper, which would have otherwise gone to the landfills

We are committed to doing our part by continuously improving our environmental performance, by making major investments in new technology and better science and by working in partnership with our customers, community, supplier's companies to reduce, recover, and recycle This commitment is embodied in the (10) principles which were adopted by Wisconsin Tissue's management a few years ago (please see Exhibit A) and in the brochure titled "It's Everyone's Earth Wisconsin Tissue Treats It That Way" (This was an exhibit {Exhibit B} in the 1994 Annual Report) If you would like to check out a copy, please call 414-725-7030, Ext 2315, and a copy will be sent to you to view for a couple of weeks

But we can do more We can do it better, and we will We will continue looking for opportunities to eliminate or reduce the environmental impact of our mill which are technologically and economically feasible

III HISTORICAL POLLUTION PREVENTION ACCOMPLISHMENTS (UNTIL AUG 1994)

We have a good story to tell and we are very proud of our historical accomplishments, which are a testament to our commitment to the environment This section of the Report illustrates our progress over the decades Everything we manufacture at our paper mill is made from 100% recycled fiber It has been our way of doing business since 1927, long before recycling was in vogue or fashionable

We have millions of capital dollars invested in modern recycling technology to allow us to recycle post-consumer graded wastepaper, which otherwise would have gone to the landfills We have increased our post-consumer grade wastepaper recycling to approximately 30% of our wastepaper mix in the past five years

By using 100% recycled paper in our manufacturing process, we save more than 5 million trees, 2 billion gallons of water, and 892,500 cubic yards of landfill space each year

1 The attached two Graphs (please see Exhibit B) illustrate reductions in emissions to air, water, solid waste, or use of chemicals in the manufacturing processes per output ton in the last 5 years and since our 1994 P2 Report

Table of Graphs

EMISSION OR CHEMICAL USE 1990-1995	% REDUCTION
NH_3-N Discharges to Water	97
BOD_5 Discharge to Water	61
Solvent Emissions Per Output Ton	62
VOC	68
Phosphorous Discharges to Water	63
TSS Discharge to Water	77
Chlorine Use	32
Chloroform Emissions Per Output Ton	32
Effluent	17
Nitrogen Discharges to Water	29

2 No detection of dioxin at 10 parts per quadrillion (ppq) detection limit in all tests to date

3 No detection of PCBs at 0 2 parts per billion (ppb) detection limit since 1986

4 Our recent innovative product line is ***Second Nature Plus®***, which is manufactured from 100% recycled paper, 100% bleach-free process, and 100% post-consumer grade material ***Second Nature Plus®*** was recently awarded the Wisconsin Governor's New Product Award for its engineering and environmental innovation This product line shows our continuous commitment to developing new and unique environmental products

5 Wisconsin Tissue encourages environmental involvement as charter members of both the Buy Recycled Business Alliance and the EPA WasteWI$E Program These involvement's offer an opportunity to share our recycling expertise with others and further our point—**RECYCLING AND THE ENVIRONMENT ARE IMPORTANT**

6 We have formed an internal Buy Recycled Task Force to explore additional items we could purchase with recycled content These efforts have been extremely successful as we will purchase more than $40 million worth of recycled content raw materials and supplies in 1994 Most of our packaging materials are already 100% recycled, and our efforts are continuing to maximize the recycled content in virtually everything we buy We would encourage any of our business contacts to join the Buy Recycled Business Alliance

7 Wisconsin Tissue s source reduction constantly searches for ways to reduce weight and volume of packaging materials on the products we buy or sell The attached Exhibit C shows our product line, which provides source reduction opportunities for our customers

8 Meet Irth™ (please see Exhibit D) Irth™ is Wisconsin Tissue's Close-the-Loop mascot Irth's goal is to assist our customers in establishing an in-house recycling program

9 In the Fox River Valley, we work with local municipalities to recycle phone books, newspapers, and other residential materials that would end up in landfills Our involvement with our community has earned us the National Recycling Coalition Award and the 'Golden Earth" Award for our recycling efforts in Winnebago county

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10 We have an in-house office wastepaper recycling program, which allows the office wastepaper to be recycled in our processes to make napkin and tissue products

11 We recycle poly, cases, waste ink, light bulbs, wooden skids, and other materials

12 We eliminated the use of Perchloroethylene in our plate making operations in our printing department

13 In addition to the above awards, we were the first recipient of the Izaak Walton League Clean Water Award for our effluent treatment plant We also won the prestigious Environmental and Energy Achievement Award of the American Paper Institute and National Forest Product Association for Air Pollution to reduce chloroform emissions by 65% in our new recycling line

14 We shut down the operation of the chiller, which used ozone depleting HCFC

15 We receive all our shipments of chemicals either in bulk tanks or recyclable containers

16 We burn clean natural gas in our processes, except for gas curtailments by the gas company

17 We eliminated the use of Kraft liner for tissue jumbo rolls and use thinner poly with higher tension

IV AN AGENDA FOR ACTION (SEPT 1994 - SEPT 1995)

This section of the Report is in two parts **Part A** describes the process or procedures initiated by Wisconsin Tissue to implement its "Going Green - It's A Habit, Not A Hobby" Pollution Prevention Initiative throughout our organization **Part B** describes specific success stories or actions taken by Wisconsin Tissue in 1995, primarily as a result of the Going Green P2 Initiative

The Wisconsin Paper Council (WPC) has recognized and chosen Wisconsin Tissue's Going Green P2 Initiative by profiling it as the WPC's first Company Profile for their Pollution Prevention Partnership (P3) promotion (please see Exhibit E)

Part A

1 Going Green P2 Initiative was first introduced with some humor (please see Exhibit F)

- Where are we going? (pages 26-28)

2 At the disclosure of the final logo a coffee mug and Question and Answer Sheet (please see Exhibit G) were sent to each employee's home

3 A 10 minute video was prepared by in-house crews, featuring employees and highlighting historical successes and a call for action If you would like to borrow a copy of the video, please call 414-725-7030, Ext 2315 (Please see Exhibit H)

4 Presentations, which reinforced the message in the video (please see Exhibit I), were made to the crews

5 A cross functional steering committee was formed, consisting of volunteers from the following various departments at Wisconsin Tissue

- Technical
- Deink
- Maintenance
- Safety
- Converting
- Paper Machine
- Customer Service
- Engineering
- AS/RS
- Hourly

The mission of the steering committee is to *Be Missionaries of the Message*, Be Catalysts for Action, A Source of Information, Be Cheerleaders and to Be Leaders in Individual Areas for Identifying Opportunities The Steering Committee meets quarterly to discuss progress and opportunities for improvement in areas of education, training, awareness, and new projects and reports to the Top Management

6 The Going Green P2 Initiative is kept alive and reinforced by highlighting recent P2 successes, by giving helpful hints for pollution prevention, even for at-home activities (please see pages 41, 45 46, 47, 48, 49, and 50 of Exhibit J) in daily newsletter articles These articles related to environmental issues seem to increase environmental awareness and encourage employees to be environmentally conscientious in all their activities at work as well as at home

7 We ask and encourage our employees for ideas they may have for pollution prevention and we follow-up in a timely fashion with resolutions of their ideas

Part B

The following are some of the successes at WT in 1994 - 1995

1 WT has been looking for an alternative to putting sludge into the landfill After several years, WT has been successful and has joined forces with Minergy, a subsidiary of Wisconsin Energy to process sludge to make glass lightweight aggregate (see Exhibit K)

2 Plant 2 has reduced the waste hauled to the landfill by 58% or by 700,000 lbs

3 Eighty percent (80%) reduction in the use of solvent (VOC) in the deinking operation

4 Elimination of napthalene based solvent in the deinking operation

5 WT has increased purchases of recycled content supplies of raw materials by 25% to $54 5 million in 1994-1995 WT s goal for 1995 is $60 million

6 Graph 2 of Exhibit B and the following table show reductions in targeted pollutants since the 1994 P2 Report

EMISSION OR CHEMICAL USE 1993-September 1995	% REDUCTION
NH_3-N Discharges to Water	67
BOD_5 Discharge to Water	50
Solvent Emissions Per Output Ton	36
VOC	32
Phosphorous Discharges to Water	25
TSS Discharge to Water	22
Chlorine Use	11
Chloroform Emissions Per Output Ton	9
Effluent	8
Nitrogen Discharges to Water	4

7 WT targeted chemicals for reduction and set up projects to reduce them See the table in Exhibit L, which highlights some of the successes

8 Modified the hypo tank to get better efficiency - Should reduce Cl_2 use in deinking lines

9 Vending machines were converted to accept a reusable mug

10 WT has converted the following items to 100% recycled cases cores, kraft overwrap and tissue wrappers even recycled laser toner cartridges WT is also doing an excellent job of increasing the recycled content in items like business forms, computer paper, and other office supplies (please see Page 60 of Exhibit M)

11 Replace oak wood scuff plates (as they need to be replaced) in trailers with 100% recycled milk bottle plastic

12 Implemented a program for recycling ink buckets Buckets will be crushed then shredded for recycling

13 Send core knife blades to Napuk for recycling with other scrap metal

14 Send stub tape rolls, which used to be landfilled, back for use in hand tapers

15 Discontinued buying styrofoam cups

16 Implemented a program for employees to bring in wastepaper recyclables from home Bins have been set outside the plant to make it more convenient for employees to drop off the wastepaper from their cars

17 Any employee (especially those who sign requisitions or purchase orders) are encouraged to consult the Recycled Product Guides

18 Encourage employees to use recycled copy paper instead of virgin

19 Encourage all employees to reduce waste by cutting less paper off parent rolls, making two-sided copies, using E-Mail, getting off unwanted mailing lists, and posting notices instead of making multiple copies

Some of these successes are listed on the "Going Green Successes" sheet (please see Exhibit M)

We will continue to identify additional projects as we move forward into the 2nd year with our P2 initiative and will report it the next year

EXHIBIT A

WISCONSIN TISSUE

♦ Committed to Our Environment ♦

1 We will utilize 100% recycled fiber in our manufacturing process

2 We will use the highest concentration of post-consumer waste practical in our product offering

3 We will buy recycled raw materials and supplies whenever possible

4 We will take an active role in setting national policies on recycling and environmental issues

5 We will work with government leaders to ensure passage of workable regulations

6 We will emphasize environmental awareness in our relations with employees and business associates

7 We will conduct monthly environmental audits to ensure compliance with all regulations established for our products and processes

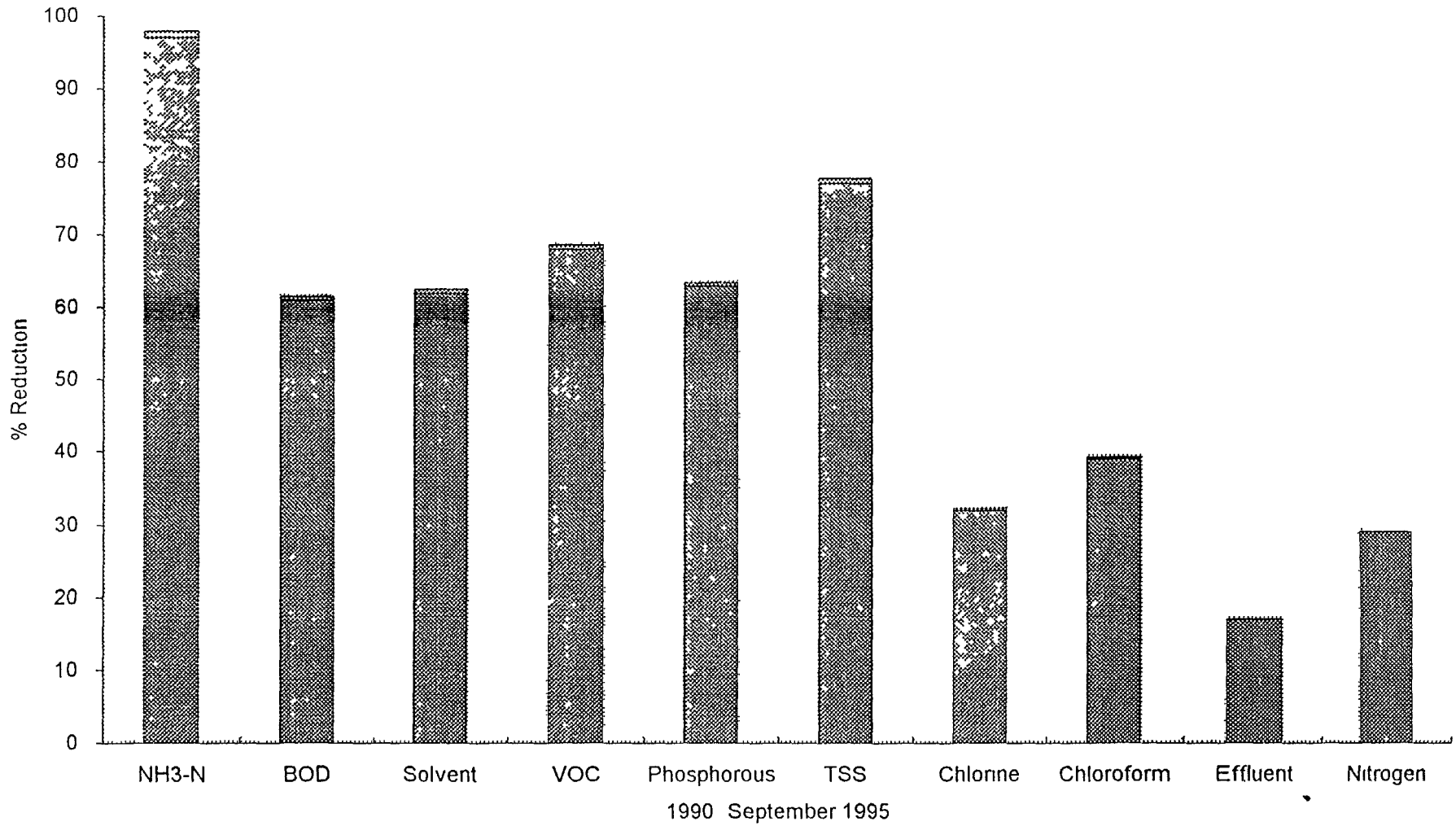
8 We will work to reduce the weight and volume of packaging materials in the products we buy and those we sell

9 We will reduce chemical usage

10 We will coordinate our recycling efforts with the local community to help our neighbors gain a better life

EXHIBIT B

Wisconsin Tissue



Wisconsin Tissue

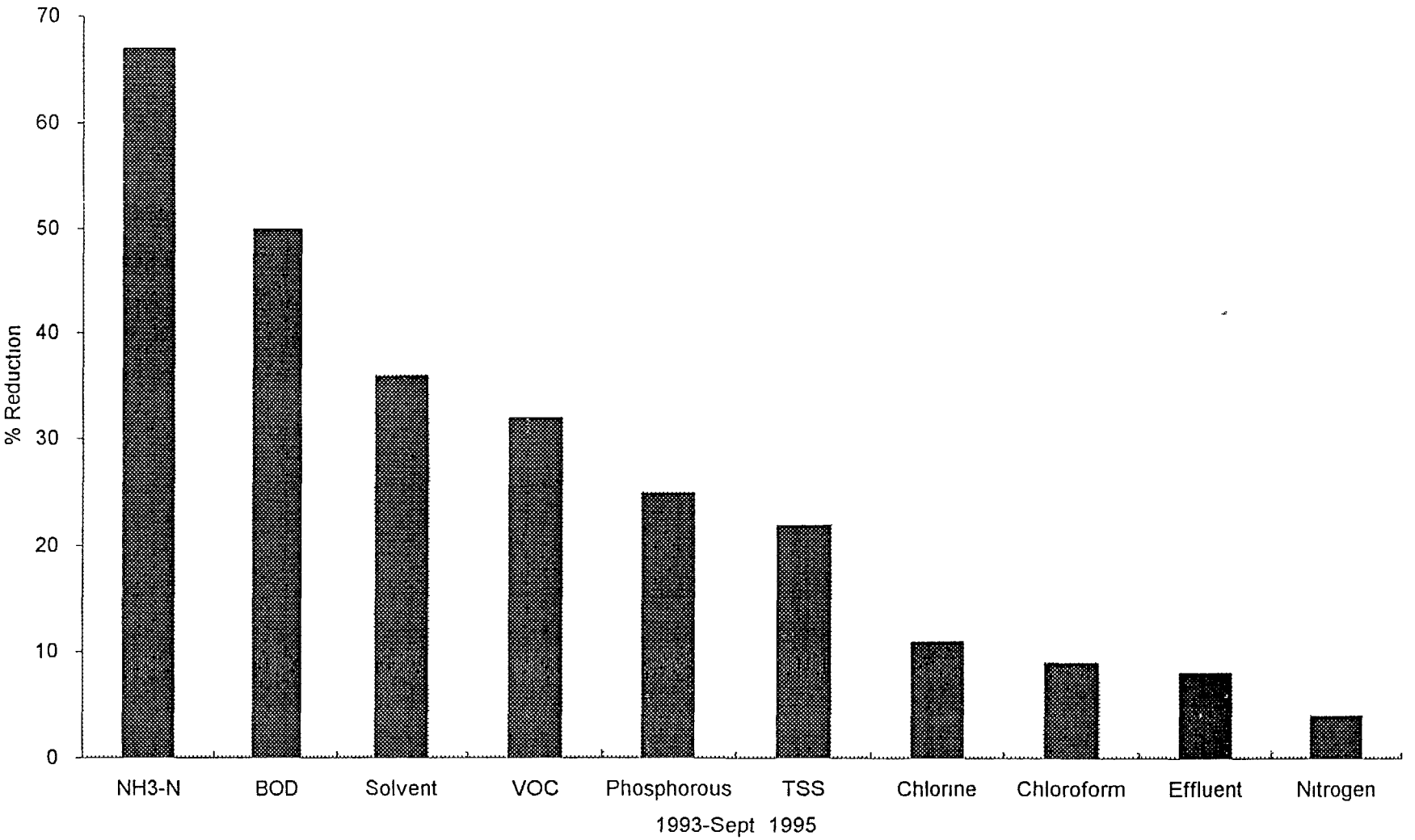


EXHIBIT C

Source Reduction

The key to handling the solid waste crisis

The Environmental Protection Agency's frontline solution to handling the solid waste crisis is **source reduction.** Wisconsin Tissue is in agreement with the EPA and we've taken steps to control our waste stream By conserving our raw materials through effective product design, packaging and manufacturing practices we are eliminating waste from the stream

Source reduction is simple - we work to eliminate the amount of material that enters landfills

What Source Reduction Can Do

➡ Cut solid waste by minimizing volume and/or weight of products

➡ Lower product shipping costs and waste entering the stream by reducing weight of product packaging

➡ Saving raw materials through efficient design, manufacturing and production

What You Can Do

➡ Talk with your customers about working toward source reduction and improving their efficiency

➡ Use the most appropriate disposable paper product that will yield the best results with the least amount of paper

➡ Help prolong the life of a landfill by keeping as much waste out of the waste stream as possible

Opportunities abound at Wisconsin Tissue

Amid growing concern for our environment and especially the landfill crisis, people in all walks of life are becoming more involved than ever before

As we begin to tackle these problems, Wisconsin Tissue realizes that using recycled fibers is admirable, but we know there are other opportunities We've grown up in the "throwaway" society where most things have been designed for convenience With landfills overflowing

Wisconsin Tissue has become much more proactive in helping solve our solid waste problem

At Wisconsin Tissue we have countless opportunities within our product line to help with source reduction In most of our product line, less paper is being used so there is also a cost reduction to customers -- so by being energetic about environ mental care the distributor and end-user are also saving money

HOW CAN YOU ACHIEVE SOURCE REDUCTION?

Below is a chart that will demonstrate what products are more efficient at keeping waste out of the stream The environmentally friendly products are highlighted

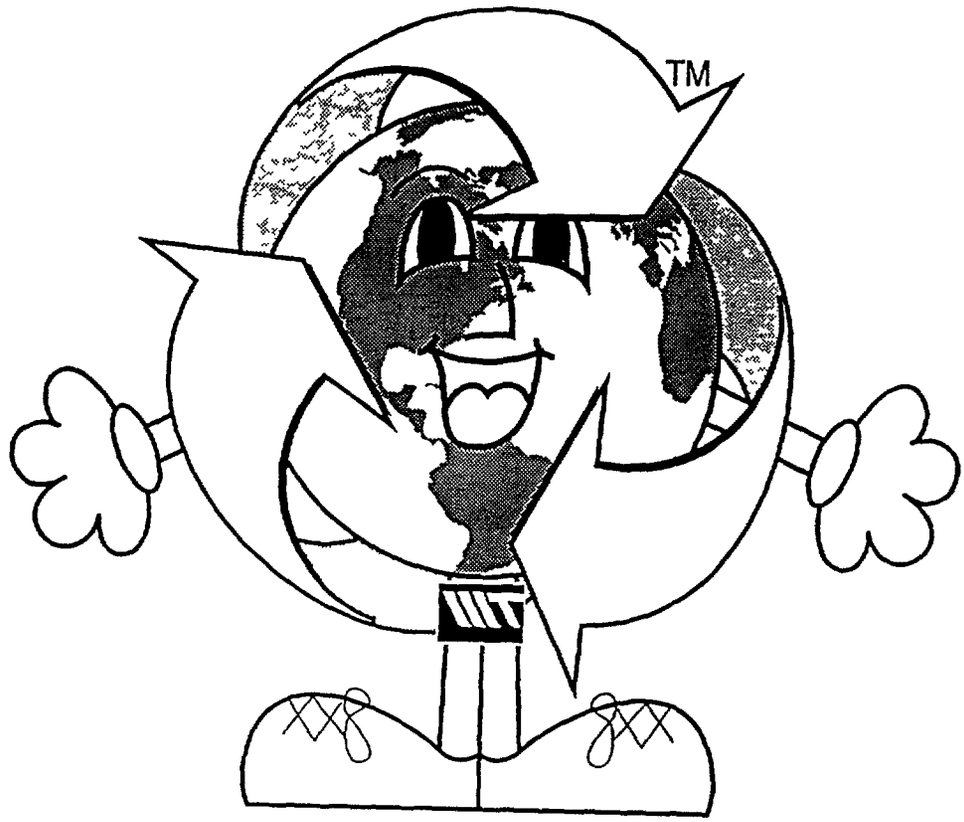
Non perforated roll towels vs Folded towels	◆ Less towel being used ◆ 20-50% less paper hitting waste stream ◆ No cores, no wrappers, less carton to discard in landfills
Multifold or ExCeed C-Fold vs Standard C-Fold (If two towels are used per hand dry)	◆ Square inches of two multifolds is 175 ◆ Square inches of two ExCeed C-Folds is 130 ◆ Square inches of two C-folds is 270 ◆ Savings in wrappers and cartons
Jumbo roll tissue vs Conventional tissue	◆ Rolls are wound tighter and on a equated basis less shipping carton is used ◆ One core replaces eight or nine conventional style core ◆ No wrappers to worry about
Bigger is better Example **13" x 17" lap size napkin** vs Small tall fold napkin	◆ Reduce overall consumption - 11/3 napkins will be used per serving ◆ Small tallfold napkins four or five napkins used ◆ Square inch basis savings can be 10% to 25% ◆ Less cartons and wrappers
Luxri facial grade dispenser napkins vs Semi-crepe overall embossed	◆ Cubic displacement is 10% less ◆ Cartons and paper sleeves or bags are reduced
Lighter towel/napkin vs Heavier towel/napkin (If two towels/napkins are used)	◆ Less total paper is used creating less waste - competitive 28 lb white towel vs 1830E SecondNature 1830E represents 10% source reduction improvement
Crank dispenser cabinet vs Center cabinet	◆ User has to work to get at paper ◆ Can t pull paper out in bunches ◆ Saves on paper waste
Adjustable lever - 85 & 85TU	◆ Because of unique control setting at optional 2 1/4" it discourages people from taking large amounts of paper
Controlled faced dispenser vs Open faced	◆ Smaller opening which tends to deter user from dispensing many napkins

Napkin potential unlimited

In use 17 x 17, 3-ply Substitute 17 x 17, 2-ply, 15 x 17, 2-ply, 17 x 17, 1-ply
In use 17 x 17, 2 ply Substitute 15 x 17, 2-ply, 17 x 17, 1-ply

The 1-ply Luxri, in particular, is a highlight to consider in source reduction The opportunities are extensive when you think in terms of 15 x 15 and 13 x 17 sizes All contribute to source reduction

EXHIBIT D



"Irth" TM

EXHIBIT E

POLLUTION PREVENTION PARTNERSHIP

Profile

One of a series of profiles highlighting pollution prevention achievements by Wisconsin pulp and paper companies

WISCONSIN TISSUE MILLS

"GOING GREEN...IT'S A HABIT AND NOT A HOBBY"

Impressive achievements in pollution prevention and an innovative communications program that encourages employee involvement highlights Wisconsin Tissue Mills' outstanding pollution prevention program

The Menasha-based firm's program is titled "GOING GREEN IT'S A HABIT AND NOT A HOBBY " The program assures that Wisconsin Tissue Mills' employees understand and actively support the company's commitment to environmental protection and pollution prevention

The paper manufacturer, a 100 percent recycled fiber operation since 1927, has an impressive record of environmental protection and pollution prevention achievements For example, more than $50 million has been invested in environmental projects at Wisconsin Tissue Mills since 1980

During the past five years alone, the company reduced its solvent emissions 89 percent, TSS or total suspended solids, 70 percent, phosphorus, 60 percent, nitrogen, 37 percent, chloroform, 33 percent, chlorine, 30 percent, and BOD or biochemical oxygen demand, 29 percent

Wisconsin Tissue Mills' aggressive pollution prevention goals include reducing its landfill disposal needs, finding alternative methods of papermill sludge disposal by converting it into marketable products such as lightweight aggregate, asphalt or binders, and continuous, further reductions in its VOC emissions

The "GOING GREEN " initiative is complemented by a communications component It's an effective tool that does more than assure employee support and participation -- it also broadens awareness of the benefits of pollution prevention across a wider audience of suppliers, customers and neighbors Here is a profile of this firm's successful "Going Green " program

Keeping the Environment in Mind Daily

"GOING GREEN " was launched in mid-1994 when Bharat Shah, manager, technical services, briefed senior managers on the concept that pollution prevention could be a new, or different "paradigm "

Wisconsin Tissue Mills' goal is to "increase employee's environmental awareness in their daily lives equal to that of safety," Shah said Key elements of the initiative include

- Support by senior management
- Voluntary participation by all employees
- Opportunity for each department to establish its own pollution prevention goals
- Development of cross-functional teams (multi-disciplinary, including hourly and salaried personnel)
- Integration of pollution prevention into corporate business planning
- Regular measurement of progress communicated to all employees
- Cost effectiveness, but with vision to look beyond the bottomline
- Flexibility

Grass Roots, Volunteer Guidance

Following endorsement of the program by senior management, a pollution prevention steering committee was created in the third quarter of 1994 to provide program guidance It comprises volunteers from throughout the company's facilities and meets quarterly to review and assess program progress

Shah characterizes the steering committee as "disciples" or "missionaries" dedicated to effectively communicating Wisconsin Tissue Mills' pollution prevention message to every workplace and station

Program Identity and Support

The foundation for the company's achievements in marketing the program began with creation of the slogan "GOING GREEN IT'S A HABIT AND NOT A HOBBY" and combining it with an eye-catching logo depicting Wisconsin Tissue Mills' employees joining in to help "shoulder" responsibility for the planet

The slogan reinforces the company's vision that "GOING GREEN " is not a short-lived campaign, but a long-term commitment

GOING GREEN
IT'S A HABIT
NOT A HOBBY
WISCONSIN TISSUE

Heightened interest in the program was created prior to its in-plant announcement by revealing the logo to employees incrementally over a three-week period Billboards and posters throughout the company displayed portions of the logo and asked, "What's coming?" Each week additional portions of the logo were revealed

Accompanying final unveiling of the logo were colorful logo coffee mugs They served as a practical, hands-on introduction to the program, and now serve as a daily reminder

The mugs also demonstrate pollution prevention in action at Wisconsin Tissue Mills as "throw away" styrofoam coffee cups disappeared and vending machines were reconfigured to handle the mugs

Employees were also sent a personal letter of commitment and support for the pollution prevention program, signed by senior management

Related materials designed to increase awareness and generate support include

- Full color posters designed to fit on trash containers throughout the company's facilities

- Lists of pollution prevention goals and activities organized by categories -- drink operations, wastewater treatment, maintenance, papermill and corporate offices -- as program bench-marks and "thought starters "

- Stickers imprinted with the pollution prevention logo that can be attached to personal letters, internal memorandum and sales department correspondence The stickers are popular with employee's children

"GOING GREEN " Coming to a VCR Near You Soon

A 10-minute videotape, developed in-house by the company's Training Department, made its debut earlier this year It explains Wisconsin Tissue Mills' commitment to pollution prevention

The company's history as a recycling facility, current achievements in environmental protection and pollution prevention are documented in the tape The key message, however, is to encourage employees to actively seek out ways to improve the environment at work and at home

In the workplace, for example, the video encourages employees to self-evaluate their jobs, because Wisconsin Tissue Mills believes "nobody knows a better way to accomplish something than the person doing it "	The video is shown to employees throughout the company's facilities at regular group meetings and other opportunities	**A Commitment In Writing** Wisconsin Tissue Mills clearly articulates its pollution prevention principles to employees, neighbors, suppliers and customers The principles are presented as a clear statement of the company's commitment to pollution prevention

WISCONSIN TISSUE MILLS

Commitment to Our Environment

1. We will utilize 100% recycled fiber in our manufacturing process.
2. We will use the highest concentration of post-consumer waste practical in our product offing.
3. We will buy recycled raw materials and supplies whenever possible.
4. We will take an active role in setting national policies on recycling and environmental issues
5. We will work with government leaders to ensure passage of workable regulations.
6. We will emphasize environmental awareness in our relations with employees and business associates.
7. We will conduct monthly environmental audits to ensure compliance with all regulations established for our products and processes.
8. We will work to reduce the weight and volume of packaging materials in the products we buy and those we sell.
9. We will reduce chemical usage
10. We will coordinate our recycling efforts with the local community to help our neighbors gain a better life

Questions?

For more information on "GOING GREEN ," contact Mr Bharat Shah, Manager, Technical Services, Wisconsin Tissue Mills, Inc , P O Box 489, Menasha, WI 54952 (414/727-2946)

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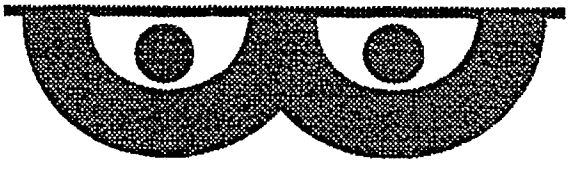
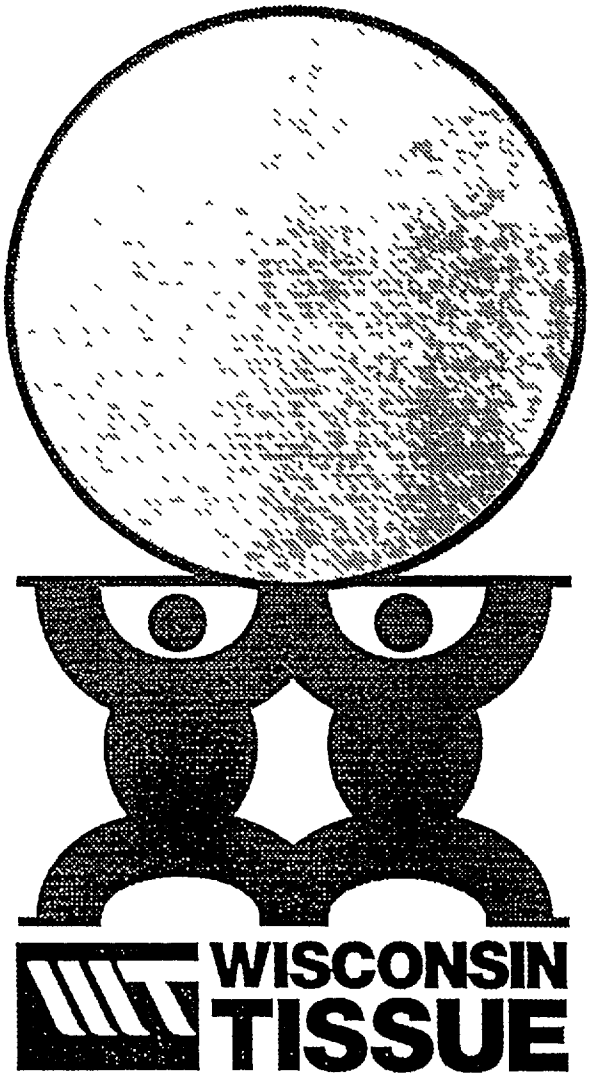
EXHIBIT F



Where are we going?

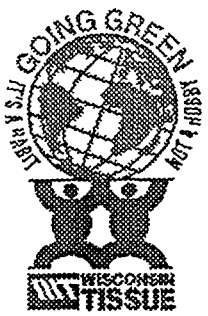
WISCONSIN TISSUE

Where are we going?



Where are we going?

EXHIBIT G



GOING GREEN - IT'S A HABIT AND NOT A HOBBY
Questions and Answers

Q – WHAT IS *GOING GREEN - IT'S A HABIT AND NOT A HOBBY*?

Going Green - It's A Habit And Not A Hobby is the Pollution Prevention Initiative (P2) voluntarily taken on by Wisconsin Tissue The P2 Initiative challenges our employees to identify opportunities, in their job duties and surroundings, to minimize or eliminate environmental impacts, small or large, which are technologically and economically feasible

Q – WHAT IS DIFFERENT ABOUT THE *GOING GREEN* P2 INITIATIVE?

It is not a temporary program but an evolving process or a new way of looking at our job duties with environment in mind every day This message is depicted in the logo, i e WT employees shouldering their responsibilities to the earth, and with the byline "*It's a Habit and Not A Hobby*" Wisconsin Tissue believes that our employees are concerned about the environment and that they are in the best position to do something about it because they know more about their jobs than anyone else

Q – WHAT IS THE GOAL OF THE *GOING GREEN* P2 INITIATIVE?

The goal of the P2 is to increase environmental awareness of our employees in their daily lives to that of safety It is believed that this increase in awareness among our employees will result in tangible reductions in small steps, some may not even get measured but eventually they will add up to be significant

Q – WHAT HAS WISCONSIN TISSUE DONE FOR THE ENVIRONMENT IN THE PAST YEARS?

We have a good story to tell and we are very proud of our historical accomplishments We have committed in excess of $50 million in capital expenditure for environmental projects since 1980 and currently spend in excess of $8 million every year for environmental protection The Section III of the P2 Annual Report (1994) presented to the Wisconsin Department of National Resources (WDNR) last year lists some eighteen (18) specific items of our success You will also get an opportunity to see highlights of our achievements in the *Going Green* P2 video to be released in the near future Please call Bharat Shah (Ext 2946) if would like to review or want a copy of the report

Q – HOW CAN I PARTICIPATE IN THIS EXCITING AND WORTHY INITIATIVE?

You can volunteer now and take on the challenge of identifying opportunities to minimize the impact of your job on the environment and communicate any ideas or concerns to your supervisor He/she will help you to evaluate your idea(s) and implement them, where feasible, and also address any concerns

To get you started, we have enclosed a coffee mug, which we would like you to use at work when getting coffee or soda from vending machines or anywhere else Your use of the mug can be one visible demonstration of your participation and communicate that message to others (Vending machines are now fitted, or will be in the near future, to use these mugs) Look for details on bulletin boards and in Daily Newsletters for Plants 1 and 2

Q – HOW WILL I KNOW HOW WE ARE DOING?

The Steering Committee, assembled to coordinate and support this initiative, will put in progress reports discussing new ideas, successes, and other information regularly either in newsletters (i e Plant 2 Daily Newsletter and the Company Newsletter), postings on bulletin boards, or through reports from your supervisor, etc

Q – WHERE CAN I GET MORE INFORMATION?

Your participation and involvement is critical to the success of this initiative For more information, ideas, or comments, please contact your supervisor or any of the following people

Plant 1	Plant 2
Bharat Shah (Extension 2946)	Dick Stauss (Extension 3765)
Paul Johnson (Extension 2348)	Deb Gorman (Extension 3766)

Harbour Place

Jeff Johnson (Extension 8814)

EXHIBIT H

If you would like to borrow a copy of WT's video,
please call 414-725-7030, Ext 2315

EXHIBIT I

WISCONSIN TISSUE'S UNOFFICIAL TOP TEN LIST OF POLLUTION PREVENTION ACCOMPLISHMENTS

1 No detection of dioxin at 10 parts per quadrillion (ppq) detection limit in all tests One part per Quadrillion is the equivalent of one second in 32 million years

2 No detection of PCB's at 0 2 parts per billion (ppb) detection limit

3 Reduced chlorine consumption by 35% in the last six years

4 In 1994, we discharged an average of 25 ppm of T S S , which was approximately 5 5% of our WPDES permit daily allotment

5 In 1994, we discharged an average of 19 ppm of BOD, which was approximately 11 7% of our WPDES permit daily allotment

6 We used only 9,983 gallons of water per ton of paper in 1994 vs the national paper industry average of 17,000 gal/Output ton of Paper

7 Solvent emissions per output ton have been reduced by 92% since 1987

8 Since 1980, we have committed in excess of $68 million in capital expenditures for environmental projects

9 Won the prestigious Environmental and Energy Achievement Award of the American Paper Institute and National Forest Product Association for Air Pollution to reduce chloroform emissions by 65% in new recycling line

10 We shut down the operation of the carbon adsorption system water chiller, which used ozone depleting HCFC

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WHAT CAN I DO?

Papermill

Mineral Spirits	• Reduction of 92% over last 7 years • Excess use can spur odor complaints • No 2 paper machine highest solvent user • Modified equipment in J1 & J2 to reduce solvent used on No 1 PM and No 2 PM • Used 375,317# in 1995 + 3 7#/Output Ton of Paper
PerforMax 401	• Close loop cooling tower control on No 3 PM, No 4 PM, and Carbon Absorption Unit Towers • Conductivity monitors to control blowdowns • Usage dropped significantly since 1991 • Used 811# in 1995 + 0 008#/Output Ton of Paper
Amoco White Oil	• Slitter Oil for No 2 PM rewinder • Use @ 6 5 barrels/month in 1995 • Waiting on installation of a controlled automatic spray system to replace manual oil can • Estimate a 2/3 usage reduction after installation

**These figures are for the first half of 1995 (6 months)*

WHAT CAN I DO?

Deink

Sulfur Dioxide	• pH probes calibrated and maintained • Control peroxide and hypo residuals • Monitor/control bleach stage pH prior to SO_2 addition • Possible chemical change to carbon dioxide pending • Used 628,909# in 1995 + 6 2#/Output Ton of Paper
Muriatic Acid	• Better scale control with scale inhibitors • Substitute sulfamic acid whenever possible • Used 46,661# in 1995 + 0 46#/0utput Ton of Paper
Busan 30WB	• Possible chemical change pending • Used 9,129# in 1995 + 0 09#/0utput Ton of Paper
Quaker 2332	• Use detergent first before solvent • Identify/Reject badwastepaper • Possible chemical change pending • Used 12,172# in 1995 + 0 12#/Output Ton of Paper
Chlorine **Chloroform**	• Monitor/Control chlorine residuals • Monitor/Control bleach stage pH • Monitor/Control bleach stage temperature • Monitor/Control groundwood content • Used 4,564,665# of chlorine in 1995 + 45#/Output Ton of Paper

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WHAT CAN I DO?

Wastewater

Aqua Ammonia	• Ammonia Nitrogen is monitoring parameter in permit • Excess discharge blamed for algae blooms in receiving waters • Monitor residuals daily • Used 659,341# in 1995 + 6 5#/Output Ton of Paper
Phosphoric Acid	• Phosphorus has rolling 1 yr max limit of 1 ppm • Excess discharge blamed for algae blooms in receiving streams • Monitor residuals daily • A limit of 1 ppm daily max , starting in 1996 • Used 101,437# in 1995 + 1 0#/Output Ton of Paper

**These figures are for the first half of 1995 (6 months)*

WHAT CAN I DO?

Maintenance

Perclene D	• Monitor levels in transformers • Reportable spill is 1# • Store 80,000# on-site
Safety Clean	• Conserve amount used • Used 4,057# in 1995 + 0 04#/Output Ton of Paper
Natural Gas	• Efficiency checks on boilers • Efficiency checks on air cap burners • Conserving steam • Conserving building heat • Used 16,500,000 Therms in 1995

Mill-Wide

Trash	• Recycle Co-Mingled materials • Recycle all paper fiber material • Recycle copper, brass, light bulbs (fluorescent), scrap metal • Dispose of all bale wire in proper compactor • Dispose of all loose paper in proper compactor • Keep scavenger plates unplugged • Disposed of 2,124 tons in 1995

**These figures are for the first half of 1995 (6 months)*

EXHIBIT J

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx **Date, 1995**

Recycling News Issue 10, 2-21-95

REDUCE WASTE

You heard previously that we are charter members of the Environmental Protection Agency's WasteWI$E Program One of our waste prevention goals in connection with this program is to reduce our use of office papers The following are some activities all of us can practice in order to use less paper

- Make Two-Sided Copies
- Post Notices
- Route Correspondence
- Use back of memos, etc for notes/scratch pads incoming faxes
- Keep documents small by using smaller type face smaller margins, or single spacing
- Use voice mail rather than hard copy when practical
- Remove your name from routing lists for internal reports and correspondence which you no longer need to receive

If you are not already doing so please get in the habit of practicing as many of these ideas as you can If you have other ideas for reducing paper usage, please notify your supervisor or a member of the Buy Recycled Task Force We'll put together a complete listing and share the ideas with everyone

Prepared By Jeff Johnson

Issue 6&4, 6-20-95

Going Green Mugs

Tom Toothman

If you would like another Pollution Prevention "P2" mug, please see me I have received another dozen for distribution Remember to keep the recyclables out of the trash!

If you have any questions about the program, see me or one of the other P2 coordinates such as Steve Smith, Gene Koeppel, or Pa. Johnson

Issue 1' 4-3-95

P2 MEETINGS

Pollution Prevention initiative meetings for the *"Going Green - It's A Habit, Not A Hobby"* project are scheduled for this week. Please make pollution prevention a priority this week by attending one of the meetings

PERSONNEL	TIME	DAY
"A" Crew	3 00 P M	Tuesday April 4, 1995
"B" Crew	2 00 P M	Tuesday April 4, 1995
"C' Crew	2 00 P M	Friday April 7, 1995
"D" Crew	7 00 P M	Friday April 7, 1995
Day Shift/Salary	9 15 A M	Tuesday April 4, 1995
Day Shift/Salary	9 15 A M	Thursday April 6, 1995

All meetings will be held in Conference Room A

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx **Date, 1995**

Issue 21
4-10-95

RECYCLING NEWS

Previous articles made reference to our internal Buy Recycled Task Force The committee consists of the following individuals

Steve Wolosek	Gene Simons	Tom Reuss
Mike Belt	Barry Shah	Glenn Wiegand
Jack Steidl	Tim Allen	Mike Graverson
Dick Stauss	Ron Thiry	Bob Penzenstadler
Jeff Johnson		

Although it also gets involved in other issues relating to the environment, the main mission of the task force is *to increase our purchases of recycled content raw materials and supplies* You can help by providing ideas on additional items we might be able to buy with recycled content, new ideas for reducing waste, or thoughts on how we can collect more materials to be recycled

Better yet--join the task force! It meets the third Thursday of each month from 10 00 a m. to 11 00 a m in in the PIC Conference Room To submit ideas or join the committee, contact any of the individuals listed above

Prepared By Jeff Johnson

Issue 23
4-12-95

PLANT 1 TRASH UPDATE

As promised from the P2 Initiative meetings, we will be starting to give you facts and figures pertaining to Pollution Prevention on a regular basis through the Plant 1 newsletter Below are the figures on Plant 1 trash for the 1st Quarter of 1995, compared to the 1st Quarter of 1994

PLANT 1 TRASH
(hauled to Winn. Co landfill)

1995	1,012 1 Tons
1994	914 8 Tons

As you can see, we've generated 10 6% more trash in 1995 vs 1994 Y-T-D Even with the new recycling law (Wisconsin Act 335), which bans recyclables from landfills, i e aluminum cans, paper, glass, etc , we've generated more trash.

On a more positive note, we've decreased our paper mill sludge generation, hauled from wastewater treatment plants by 4.7% Below is the data on paper mill sludge Y-T-D

PLANT 1 SLUDGE
(hauled to Wis Tissue Landfill)

1995	46,710 Wet Tons
1994	49,025 Wet Tons

Listed below are some strategies to help reduce trash

- Be sure all reusable wooden pallets are brought back to Building #55
- Please continue your efforts to keep the recyclables out of the landfill
- Try to make an effort to keep excess water out of trash hoppers, i e scavenger hoppers.
- Continue to use the north compactor in Building #55 for recycling scrap wire and banding

Prepared By Paul Johnson

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx Date, 1995

Issue-56
6-5-95

Recycled Products Guides

Jeff Johnson

In connection with our involvement in various "Buy Recycled" programs, all employees have been encouraged to submit ideas on items we might be able to purchase with recycled content. We can follow-up on those ideas by consulting various source books to see if the item is available with recycled content. One of the best source books we know of is called *The Official Recycled Products Guide* The RPG contains over 4,500 recycled product listings certified by over 600 manufacturers and distributors and over 800 regional merchants Copies of the current RPG have been placed in the Purchasing Offices at both plants and Harbour Place You are encouraged to go through your supervisor or work directly with our Purchasing people to consult the *Recycled Products Guide* to determine if a particular item is available with recycled content, and, if so from whom

All of us have a wonderful opportunity to support our company's efforts to buy recycled Please take advantage of it!

To All Company Employees:

Issue 60
6-9-95

P2 Pollution Prevention

Tom Toothm

We regularly change the clothing on the pap machines A sample of the used clothing is sent back the supplier for analysis The rest is waste and can er up in the landfill

Each paper machine changes some clothin every month. The fabrics are a fine mesh plastic scree We typically have no problem giving these away The make a good landscaping ground cover The felts a thrown out more than we like We usually cut these o in about 6 pieces Typical dimensions are about 30 fe by 19 feet, and smaller The felt is similar to a sti blanket about 1/10 inch thick.

If you would like a piece, please call over to th Paper Mill at Extension 2958 We hand these out on first come, first serve basis They need to dry for couple days to reduce their weight.

If you have a good application for these, pleas let us know We may be able to give away all th clothing and keep it out of the landfill

90

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx Date, 1995

Issue 69
6-23-95

Introduction to the Four Environmental Initiatives

Jeff Johnson

Wisconsin Tissue has launched four separate environmental initiatives which have been lumped under the umbrella phrase *Going Green - It's A Habit, Not A Hobby* To give these programs focus and identity, a logo was developed which symbolizes Wisconsin Tissue employees holding up the earth, and shouldering responsibility for the environment. The logo was included on a reusable coffee mug which was sent to our homes, and all employees are encouraged to reduce waste by using the mugs

The four environmental initiatives are Buy Recycled, WasteWI$E, Compliance with Wisconsin Act 335, and Pollution Prevention (P2) A recap of each initiative will be included in future issues of the newsletter

Plant 1 Issue 96, Monday, August 07, 1995

Recap of the Four Environmental Initiatives

Jeff Johnsor

In recent issues of the newsletter you read about the various environmental initiatives which are taking place here at WT Now you know about our efforts to buy recycled, take part in the WasteWI$E program, comply with Wisconsin Act 335, and bring about Pollution Prevention

Now it's time to "just do it" This is not a spectator sport, and ALL OF US need to take an active roll in protecting and enhancing our environment. This is not a "program of the month", but rather an on-going, long term commitment That's the reason our logo says *Going Green - It's A Habit, Not A Hobby*

Issue
6-29-9

Buy Recycled

Jeff Johnsc

You previously heard about the four environmen initiatives symbolized by the logo and phras *Going Green - It's A Habit, Not A Hobby* Tl first of those initiatives we became involved in is call Buy Recycled. This is an effort to increase the recyc content in our raw materials, packaging, office supplie and other items Wisconsin Tissue has joined otl private companies in the Buy Recycled Busin Alliance There are both State and National chapters the Alliance, and our company is represented on Steering Committees at both levels Our efforts h been successful, as we purchased more than $43 mill worth of recycled content products in 1994

An internal Buy Recycled Task Force has formed to facilitate our company's purchases of recyc products Source books for various recycled items available in our Purchasing Offices Anyone who si a requisition or purchase order is asked to consult th source books to see if the item is available with recyc content prior to placing the actual order All employ are asked to contact their supervisor, our Purcha Dept., or a member of the Buy Recycled Task Force ideas on items to purchase with recycled content.

Did You Know Issue 125 9-18-95

- About 80% of our solid waste is disposed of landfills
- Trash disposal costs us over $15 billion a ye and is expected to cost $100 billion by the ye 2000
- At least 25% of our trash is a valuable resou and can be recycled!

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx Date, 1995

1994 Recycled Purchases

Jeff Johnson

As an active member of the Buy Recycled Business Alliance on both the State and National levels, Wisconsin Tissue has made a commitment to get as much recycled content as possible in our raw materials, packaging materials, office supplies, etc The National Recycling Coalition asks members of the Alliance to submit an annual recap of their recycled content purchases We just submitted our numbers to the NRC, and you might be interested in knowing that we increased our recycled content purchases from $43 6 million in 1993 to $54 5 million in 1994, or in increase of 25% Many of you played a roll in achieving this impressive increase by suggesting items we could buy with recycled content Please keep those suggestions coming!

Issue 116 9-5-95

Recycling in the Office

Issue 132 9-28-95

Taken from the 1994 Bryant Metals Calender

The average office generates about 130 pounds of high grade waste paper per year per person. That means it takes only about 15 people in that office to generate a ton of waste paper very year If the paper is recycled, it can save 17 trees, 96 gallons of water, and the energy equivalent of 2 5 barrels of oil Now multiply that by millions of offices throughout our country, and imagine the savings!

There are many materials used in office that can be recycled, but by far, paper is the most abundant The EPA estimates that 90% of the material an office throws away is paper, so it makes good sense for businesses to implement an office paper recycling program It's not hard to do, and the benefits are well worth the effort

Note Wisconsin Tissue has recognized this and is a leader in the recycling effort! Keep up the good work!!

Plant 1 Issue 117, Wednesday, September 06, 1995

Paper Usage

Mary Kunkel

Following is a memo I sent to Jeff Johnson earlier this month I am including it in the newsletter as a recycling initiative **Every little bit helps!**

Jeff,

Just a piece of reference for your use, for the month of August I decided to keep track of the number of copies I made This was done not to take up extra time, but as a source of reference for the P2 Initiative This only includes the number of copies I make on the copy machine, not included is the amount of copies I make on my printer *Please note that this number is approximate but that it is consistent with the amount of copying I do in a normal month*

Back-To-Back Copies		
Standard White Paper	Standard Recycle Paper	Colored Recycled Paper
865	406	517

By making back-to-back copies, I saved a total of 1,788 pieces of paper (this is a little over 3 reams of paper; 1 ream of paper consists of 500 sheets) In one year, this could add up to 36 reams of paper! By using recycled paper, I save 923 sheets of standard paper (about 1 3/4 reams) In one year this could add up to be 21 reams of paper (or 10 500 sheets!)

One-Sided Copies		
Standard White Paper	Standard Recycle Paper	Colored Recycled Paper
1655	650	278

Although not always feasible, if I had used back-to-back copies instead of one-sided, I could have cut down the amount of paper used to 1,290 sheets This is about 2 1/2 reams In one year, this could add up to 30 reams of paper By using recycled paper instead of standard paper I save 928 sheets of standard paper (or about 1 3/4 reams) In one year this could add up to 21

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx Date, 1995

Plant 1 Issue 122, Wednesday, September 13, 1995

DID YOU KNOW

Every year, we use and throw away more than 25 billion polystyrene foam cups Do your part to reduce waste whenever possible, choose reusable!

Polystyrene Pros & Cons

As I was walking around the Maintenance and Engineering Departments this morning (doing my morning routine), I noticed quite a few styrofoam cups being used by employees This article is dedicated to those people

Best known by the brand name "Styrofoam" polystyrene is an excellent packaging material but in recent years there has been much debate about its effect on the environment Here are just a few of the pros and cons

CON Polystyrene is non-biodegradable, so it never goes away It sits in landfills forever

PRO Polystyrene is 100% recyclable Recycled resins are currently being made into durable products such as insulation board, school supplies and various household products (*Note Wisconsin Tissue has not been able to locate a recycler to-date*)

CON Most polystyrene recycling today is on an industrial level only It's difficult for consumers to find a place to take the material

CON Polystyrene is made from non-renewable resources - petroleum and natural gas - and its production pollutes the air with toxic gases

PRO Only a fraction of 1% of all petroleum and natural gas is used to manufacture polystyrene In additional, it takes 30% less energy to produce polystyrene than alternative materials, and it creates 45% less air pollution and 40% less water pollution

Toward a Better Tomorrow

Issue 125 9-18 95

20 SMALL WAYS TO MAKE A BIG DIFFERENCE

1 Reduce, reuse, recycle
2 Save water and energy
3 Buy recycled and recyclable products
4 Start a compost pile
5 Avoid buying and using toxic substances
6 Plant trees
7 Avoid products with excessive packaging
8 Don't take the car if you could walk or bike
9 Buy high-quality, long-life products instead of disposables
10 Use natural pesticides in your garden, pull weeds instead of using chemical killers
11 Borrow, rent or share tools and equipment
12 Don't litter and if you see someone else's litter, pick it up
13 Buy used and rebuilt goods
14 Re-sell or donate used clothing, toys, books, furniture, etc
15 Dispose of hazardous wastes properly
16 Take a coffee mug to work instead of using disposable cups (P2 mugs work great!!)
17 Don't use electrical appliances for things you could easily do by hand
18 Carpool when possible
19 Keep up-to-date on environmental issues in your community and worldwide
20 Teach children to respect nature and the environment

IT'S NOT HARD TO DO YOUR PART!

PAPER OPERATIONS UPDATE

Plant 1 Issue xxx Date, 1995

Why Recycle?

9-26-95 Issue 130

Taken from the Bryant 1994 Calender

Before we address that question, let's deal with another one that's even more basic *What is recycling?* The EPA defines it as "collecting, reprocessing, marketing, and using materials once considered trash" Stated in most simple terms, it's just reusing something For the consumer, recycling means sorting out and collecting items that can be reused or reclaimed

Why Should We Recycle?

- **Too much garbage** Every person produces about a half a ton of garbage every year, and landfills are starting to fill up and close down Landfills can also be dangerous since toxic leachate can leak into the groundwater
- **It's economical** Communities and consumers save money by recycling When there's less garbage, we pay less to dump it. In some places, you can also make money by bringing materials to recycling centers
- **It can save natural resources** It takes natural resources to make the products we use Many of those resources are not renewable, so we could use them up if we don't recycle
- **It saves energy** When new products are made from recycled materials, less energy is used For example, making a new can from recycled aluminum takes on 1/20th of the energy needed to make one from bauxite
- **"Waste not, want not"** If we conserve and reuse, we will continue to have the things we need and want

RECYCLING MAKES GOOD SENSE!

Recycling Motor Oil

Issue 135 10-4-95

Taken from the Bryant Metals 1994 Calendar

Recycling used oil could reduce national petroleum imports by 25 5 million barrels of oil a year and save 1 3 million barrels of oil every day One gallon of used oil can be re-refined to make 2 5 quarts of new oil, but it takes 42 gallons of crude oil to produce the same amount

What You Should Do

If you get your oil changed at a gas station

Check first to make sure they plan to recycle the used oil If they don't, go somewhere that does

If you do it yourself

Be careful not to spill oil on the ground Put it into a container, like a plastic milk jug, that has a lid and will not leak Then, find a place to take the oil Many gas stations, oil-changing outlets and retailers collect oil for recycling

If recycling is not available in your area

The best you can do is to take the oil to a hazardous waste dump site

What You Shouldn't Do

Never pour used oil on the ground.

It will leak into the groundwater or wash into rivers and streams, polluting the water

Never throw used oil in the trash

Even if it's in an airtight container, it will seep out and leak into groundwater when the container is crushed at the landfill

Never pour oil into sewers

It can cause major water pollution problems Just one quart of motor oil can pollute 250,000 gallons of water

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Date, 1995 Volume xx.xx

Product Supply Newsletter

A daily update of operations news and people in Product Supply and AS/RS of Wisconsin Tissue Mills

VOL 69 04 06

RAG-TIME 4-6-95

In 1988, American exported 135,000 tons of used clothing to Third World countries

No, clothes cannot be recycled the way bottles and cans are recycled You can t melt down an old pair of bellbottoms and come up with new blue jeans

But old clothes can be reused By donating them to nonprofit organizations like Goodwill Industries or the Salvation Army, you provide clothes for disaster victims and the homeless and redistribute them into your community through nonprofit thrift stores

Second-hand clothes are also important to people in Third World countries Americans send millions of tons of old clothing to Africa and Asia every year In 1988, for example 23 million pounds of used textiles went to Pakistan alone In fact, someone there may be wearing your old blouse or sports shirt right now

CASE CLOTHED

- About 835 000 pairs of jeans are produced in the U S every day
- It s hard to reuse most fabrics to make new clothes because they re treated with chemicals, or "finished" to make them smooth, or they've been chemically combined with other fabrics
- However, wool is occasionally recycled that way It has long fibers which can be pulled apart and rewoven And cotton fibers are sometimes recycled into high quality paper

WHY RECYCLE?

- It saves resources About half the clothes Americans wear are made of synthetic fibers produced from oil--a non-renewable resource
- The rest are made of natural fibers like cotton, often produced with pesticides chemical fertilizers, etc Making them has already had an effect on the earth, we owe it to the planet to use them as long as they last
- Reusing clothes can save landfill space too, in Washington D C , for example, 2 million pounds of clothes are kept out of landfills every year by the Salvation Army alone

-- The Recycler s Handbook The EarthWorks Press
(Simples Things You Can Do -- tomorrow)

Preserve Our Planet . 4-13-95
Reduce ... Reuse .. Recycle

Being "waste wise" means making environmentally responsible decisions--really thinking about the products we buy and the way we do things every day It means using critical thinking--the process of evaluating conflicting environmental information and making decisions based on our desire to be good stewards It means doing our part to reduce the amount of waste we produce It means taking time to think before we act And most of all, it means remembering to reduce, reuse and recycle so we can each do our part to help preserve our planet -- and save our precious natural resources

FACT One out of every $14 Americans spend on food goes to packaging

4-4-95

RECYCLE NEWS

Recycling efforts at Plant 2 and AS/RS continue to show improvement in what is put into the compactors In March of 1994, 158,820 lbs was taken to the landfill In March of 1995, 40, 680 was hauled This is a great improvement over the previous two months It is obvious that everyone is making a conscientious effort to recycle instead of filling trash containers After three months in 1995 we have sent 181 220 lbs of trash to the Winnebago County Landfill During the same period in 1994, we sent 458,920 lbs

Good Citizens Recycle

95

Date, 1995 Volume xx.xx

Product Supply Newsletter

A daily update of operations news and people in Product Supply and AS/RS of Wisconsin Tissue Mills

Things You Can Do To REDUCE Solid Waste 4-18-95

One of the best ways to help reduce the amount of garbage entering our solid waste stream is to simply produce less trash to begin with It's what is known as source reduction or prerecycling

Prerecycling involves thinking before we buy--making a conscious decision to support responsible products and packaging--and to reduce the amount of garbage we throw away

Take a minute to think about what s in your trash Milk cartons and plastic bags are both forms of packaging and unless we become more earth-conscious consumers, all will end up in our solid waste stream

Keep these things in mind when you shop

1 Think about whether you really need a product before you buy it
2 Buy products only in the amount you need
3 Look for products with the least packaging
4 Buy items in bulk or buy economy sizes of your most-used products--larger food containers contain less waste than several smaller containers
5 Buy products in reusable containers for which concentrated refills may be purchased
6 Look for products packaged in readily recyclable materials such as cardboard aluminum and glass
7 Ask clerks not to bag small purchases or bring your own bag

The key to being a friend of the planet is to think about every product before you buy--to use critical thinking While it usually makes good sense environmentally to buy large quantities that may not be the case for a one-person household or if you only need a small amount of something

MAKE EVERY DAY EARTH DAY 4-21-95

The 25th Anniversary of Earth Day will be observed by millions of people this Saturday, April 22 The first Earth Day was suggested by Wisconsin Senator Gaylord Nelson His idea was supported in 1970 by 1,000 cities in the U S who celebrated the theme, "Save the Earth "

To help the earth in 1995

- Attend Earth Day events
- Help to improve your local park
- Be a friend to wildlife
- Elect earth-friendly legislators
- Dispose of waste properly
- Keep your car engine tuned up
- Support recycling
- Compost food and yard debris
- Buy recycled products
- Buy used or antique items

WHAT CAN YOU DO TO RECYCLE? 5-3-95

Begin by familiarizing yourself with the recycling program in your community Know what types of products are acceptable - and what types of products to avoid when you shop The next time you shop buy those items which come in containers that are recyclable Many communities accept

- Clear, brown and green glass containers
- Aluminum and tin (steel) cans
- Paper bags and scrap paper
- Cardboard
- Newspapers
- Plastics - #1 & #2 - which are identified with the recycling symbols

More news on reverse ⇒

96

Date, 1995 Volume xx.xx

Product Supply Newsletter

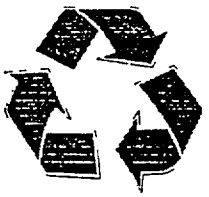
A daily update of operations news and people in Product Supply and AS/RS of Wisconsin Tissue Mills

Glad You Asked ...

5-9-95

"Suggestion I think we should have grope boxes or knockdowns on the first floor of the shipping department When a case gets damaged where it cannot hold the product, the toweling or toilet paper gets thrown away We cannot send it back to repack because there isn't anything to put the product in This could help reduce our waste "

The AS/RS will set up a gaylord in the repack area for these cases so that they can be recycled and not thrown out Please inform your supervisor of the product number and quantity so that these can be written off the inventory Thanks for the suggestion!



Coming Soon ..

WT EMPLOYEE PAPER RECYCLE PROGRAM

In a short time we will have a container located near the South Entrance that employees can put recyclable papers into

More information will be published when the container becomes available

8-28-95

NO-COST ENERGY-SAVERS

5-12-95

Saving energy reduces your monthly gas and electric bills as it helps preserve the natural energy resources used to generate power These no-cost, energy-saving suggestions are courtesy of Con Edison in New York City

ENERGY-SAVERS

- *Dust light bulbs* Grime from kitchen vapors, cigarette smoke and dust can reduce the output of light bulbs
- *Place lamps according to room use* You may not have to light up an entire room if you place a lamp on your desk or by your favorite reading chair
- *Clean refrigerator coils* Dust- and dirt-free coils are more efficient Clean the dirt off the coils at least once a year
- *Move your refrigerator to the right location* A unit uses more electricity if it s adjacent to a stove, in direct sunlight or near a heating vent
- *Run full loads through your dishwasher* Half loads use as much energy and water Use the air-dry instead of the heat-dry option
- *Run full loads through your clothes washer* Wash clothes on the warm-wash cold-rinse cycle

RECYCLE AND BE SAFE

Used core blade containers are now available for your use Containers have been placed at each machine When your container is full please recycle the blades in the Maintenance Shop metal bin A new container may be obtained from the shift trainers

5-23-95

More news on reverse ⇒

9M

Date, 1995 Volume xx.xx

Product Supply Newsletter

A daily update of operations news and people in Product Supply and AS/RS of Wisconsin Tissue Mills

"Going Green" Successes 9-13-95

Jeff Johnson

Listed below is a few of the items Wisconsin tissue has accomplished with the P2 Initiative More successes will appear in future newsletters *Keep up the good work!*

- Reduced trash to landfill Year-to-date through July, we have landfilled 445,420 lbs of trash from Plant 2 compared to 1 051,660 last year That s a difference of 606,240 lbs , or a 57 6% improvement
- Ink pail recycling Arranging to have steel containers crushed and shredded for recyling We ll generate revenue of $55 per ton vs having to pay for them to be landfilled
- Wire coiling and recycling Wires from bales of wastepaper are currently being landfilled Investing in coiling machine to have them recycled
- Retrofitted vending machines All employees were given a reusable plastic mug Vending machines for coffee and soda were changed to accept a reusable cup instead of dispensing a disposable cup
- Use of stub tape rolls Stub rolls from case sealing machines in the converting plant had been landfilled Now they are placed in light blue containers and returned to supply cabinets to be used in hand tapers
- Recycled scuff plates Scuff plates in trailers had been made from oak boards Conducted a successful trial using scuff plates made from recycled plastic milk jugs manufactured by a Wisconsin company Plastic scuff plates are more durable last at least twice as long and cost $500 less per trailer Going to plastic as replacements are needed
- Recycling core knife blades Used steel knife blades had been landfilled Now they are collected with other metals for recycling

RECYCLING UPDATE 8-4-95

The total tonnage from the compactors at the AS/RS and Plant 2 for July was 42,520 lbs compared to 133,740 lbs in July 1994 This is a 68% improvement, and by far the best month we've had in reducing trash

A "*class*" operation has that reputation because the employees make it happen *You make it happen!*

RECYCLE NEWS . 6-30-95

Pre-Consumer vs. Post-Consumer Material

Since the passing of Wisconsin Act 335 recycling law last January, we are hearing the terms "pre-consumer" and "post-consumer" about recycled materials If you aren't familiar with the distinction, post-consumer material is generally defined as items which have completed their end use as a consumer item For example newspapers or magazines which have been read and discarded are post-consumer items Likewise, office paper and used corrugated cases are considered post-consumer material

Pre-consumer items are those which have not reached the end user For example trimmings misprints and overruns from a printer are considered pre-consumer material

Generally speaking post-consumer material is more difficult to recycle because it contains more contamination, including inks from copiers and laser printers which are difficult to remove in a deinking process This is one reason our *Second Nature PLUS®* product line, which is made from 100% post-consumer materials is so good for the environment For all of our product lines in total about 25% of our wastepaper would be considered post-consumer material

More news on reverse ⇒

Date, 1995 Volume xx.xx

Product Supply Newsletter

A daily update of operations news and people in Product Supply and AS/RS of Wisconsin Tissue Mills

RECYCLE NEWS ... 8-1-95

Pollution Prevention (P2)

The Pollution Prevention (P2) initiative at Wisconsin Tissue focuses primarily on reducing chemical usage and pollution in our manufacturing operations However, it also encompasses waste reduction and any other efforts to benefit the environment, and all employees in all departments can play a role in this effort Under the guidance of the department head, all departments are being asked to develop a "Base Case" by determining current chemical usage, emissions, waste, etc Once the base case is established, you can determine goals for reduction and finalize methods and report on your progress toward meeting those goals

Our solvent emissions per output ton have been reduced by 92% since 1987 We have reduced chlorine consumption by 35% In the last six years, we discharged only a fraction of our permit allotment for total suspended solids and biological oxygen demand We have had no detection of Dioxin or PCBs in our effluent We have had many outstanding successes But we can do more! Please get together with your supervisor and co-workers to talk about additional action we can take to "bring us to the next level of environmental stewardship

KEEP THE CYCLE GOING ... RECYCLE! 7-10 95

Recycling is one of the most effective ways to reduce the amount of waste that ends up in our nation's landfills It involves collecting materials such as glass bottles, plastic containers and paper, and using these materials as the raw materials for new products Recycling is important because it helps reduce pollution, saves energy and helps save our precious natural resources and saves valuable landfill space And the best part is, it s easy Here are a few points to ponder

- Using recycled aluminum instead of aluminum ore cuts air pollution by 95%, water pollution by 97% and energy use by 95% on average
- Using recycled materials to make paper reduces air pollution 74%, water pollution 35%, water use 58% and energy use more than 70%

RECYCLING UPDATE 6-8-95

The total tonnage hauled to the Winnebago County Landfill from the compactors at AS/RS and Plant 2 during May was 69,260 pounds In May of 1994, the total was 146,800 pounds

Your efforts to keep things out of the compactors result in making more items availabl for recycling and making the County Landfill last longer

More news on reverse ⇒

Date, 1995 Volume xx.xx

Product Supply Newsletter

A daily update of operations news and people in Product Supply and AS/RS of Wisconsin Tissue Mills

RECYCLE NEWS ...

6-28-95

WasteWI$E

Wisconsin Tissue is a charter member of the Environmental Protection Agency's WasteWI$E program The program is designed to encourage businesses to reduce waste increase collection of recyclable materials, and buy or manufacture products with recycled content We meet the requirements in those latter two areas through our compliance with Wisconsin Act 335 and our involvement in the Buy Recycle Business Alliance Our waste reduction goals have to do with using less office paper generating less broke in the converting plant, and reducing our use of disposable cups

To reach these goals employees in all areas are asked to reduce their use of paper by making two-sided copies, using the back of memos for taking notes, routing correspondence rather than making multiple copies using E-Mail, etc Employees in our manufacturing areas are being asked to redouble their efforts to reduce paper waste whenever possible The objective to reduce our usage of disposable cups can be achieved by using our "*Going Green*" mugs whenever possible

IT'S HERE !! 10-4-95

WT EMPLOYEE PAPER RECYCLE PROGRAM

The container for recycled paper is now located outside near the South entrance A sign will be placed on the fence at the container

Employees are welcome to deposit their recyclable paper at any time (see attached listing of acceptable items)

RECYCLE NEWS ... 6-1-95

As you know, besides selling recycled products, our company is making a concerted effort to buy recycled items We've been very successful at it, having purchased more than $43 million worth of recycled raw materials, packaging materials, office supplies, and other items in 1994

In order to maintain and build on those successes, the following individuals have volunteered to field your questions and coordinate our "Buy Recycled" efforts at out various company locations

LOCATION	COORDINATOR
Harbour Place	Wayne Pirman
Plant 1	Paul Johnson
Plant 2	Dick Stauss
AS/RS	Glenn Wiegand
Marketing Services Center	Gayle Schultz

Please feel free to contact any of the above individuals with your questions or suggestions regarding our Buy Recycled efforts

RECYCLING UPDATE

9-4-95

The total tonnage from the compactors at the AS/RS and Plant 2 for August was 63,200 lbs compared to 154,660 lbs in August '94 This is a 59% improvement for the month

WT employees continue to lead the way in recycling efforts!

More news on reverse ⇒

100

Oct 4, 1995

WT EMPLOYEE PAPER RECYCLE PROGRAM

YES	NO
DO Place In Paper Recycle Container	**DON"T Place In Paper Recycle Container**
Cardboard	**Bathroom wastepaper** (towels, toilet paper)
Card stock	**Carbon paper, any color**
Corrugated paper	**Cellophane**
Cartons (please empty)	**Cloth**
Envelopes	**Cork**
Window envelopes	**Foil**
Labeled envelopes	**Food, food waste**
Kraft envelopes	**Glass**
Magazines	**Metal** (except small amounts of staples & paper clips on paper)
Newspapers	**Office supplies**
Paper	**Packaged materials** (please unpackage)
White	**Plastic**
Colored	**Polystyrene**
Ledger	**Recording tape**
Shiny/Coated	**Rubber**
Carbonless or NCR	**Styrofoam**
Onionskin	**Waxed anything**

EXAMPLES	*EXAMPLES*	
Brown paper tape	Batteries	Pens
Computer printouts (from any printer)	Bottles	Photographs
File folders, manila	Candy wrappers	Plastic cups
Glued pads, tablets	Cans	Plastic silverware
Keypunch cards	Cigarette butts, ashes	Plastic wrap
Label - OK on envelope or paper	Coffee grounds	Printer ribbons
Paper clip on paper (small amounts)	Cups	Slides
Phone books	Fiberboard	Strapping - metal nylon plastic
Post-It notes	Gum	String
Rubber band on paper (small amounts)	Labels & label backing in sheets	Styrofoam cups
Scotch tape on paper (small amounts)	Light bulbs	Styrofoam packaging
Spiral notebooks with metal	Page protectors if not paper	Tranparencies
Staples on papers		

More news on reverse ⇒

EXHIBIT K

MILWAUKEE JOURNAL SENTINEL TUESDAY AUGUST 29 1995 BUSINESS 3D

$40 million plant to use paper sludge

By Jon Olson
of the Journal Sentinel staff

A subsidiary of Wisconsin Energy Corp plans to build a $40 million plant in Neenah that will recycle paper sludge into steam heat and a glass product that could be used in asphalt sandblasting grit, roofing shingles and landscaping products

Four Winnebago County paper companies have agreed to provide the sludge

Minergy Corp, founded by Wisconsin Energy in 1994 and based in Milwaukee has reached agreements with Kimberly-Clark Corp and P H Glatfelter Co, in Neenah, Wisconsin Tissue Mills in Menasha and Ponderosa Fibres of America, in Oshkosh to supply the new plant with the wood waste material, said Kathy Lange-Novak, a Minergy spokeswoman

Minergy expects its plant to have a capacity of 350 000 tons of sludge a year — virtually 100% of the material produced by the Winnebago County papermakers

Sludge accounts for about two-thirds of the county's total waste stream said Leonard Leverance director of solid waste for the county

"We have been looking for a beneficial use for our sludge for the last 10 or 15 years, said Bharag Shah manager of technical services for Wisconsin Tissue Mills This particular use fits into that very well"

Wisconsin Tissue Mills disposes of 180 000 tons of sludge a year in a landfill that it owns, Shah said

Besides its environmental benefits the new use for the sludge will save the papermakers money said Wendy Strong, director of communications at Kimberly-Clark Corp

Dallas-based Kimberly-Clark pays $28 a ton to dispose of sludge in the county landfill said Leverance — and the company pays for it to be transported It will pay Minergy less Strong said, and Minergy will pick it up

Lange-Novak said the new plant would first dry the sludge which is a mixture of moisture wood and clay Then it will burn the wood, simultaneously consolidating the clay into a glass aggregate After the glass aggregate is cooled, it will be sized according to market demand. The heat will be recovered to heat water

The process requires a state Department of Natural Resources air permit, Lange-Novak said

Minergy is considering a site owned by the City of Neenah near the Glatfelter plant, which may become a customer for the steam, Lange-Novak said

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EXHIBIT L

GOING GREEN
IT'S A HABIT NOT A HOBBY
WISCONSIN TISSUE

P2 CHEMICALS

P2 Initiative

	Area	Lbs./Output Ton of Paper through August (134,904 O.T.)
	Wastewater	
1	Aqua Ammonia	6 5# in 1995 vs 6 7# in 1994
2	Phosphoric Acid	1 1# in 1995 vs 0 8# in 1994
	Deink	
3	Sulfur Dioxide	6 3# in 1995 vs 6 0# in 1994
4	Muriatic Acid	0 51# in 1995 vs 0 3# in 1994
5	Busan 30WB	0 10# in 1995 vs 0 1# in 1994
6	Quaker 2332	0 09# in 1995 vs 0 5# in 1994 ☺ *Operator Education*
7	Chlorine/Chloroform	47# in 1995 vs 50# in 1994 *More brown runs in 1995*
	Mill-Wide	
8	Trash (*through the end of September 1995*)	2934 4 tons in 1995 vs 2737 5 tons in 1994
	Maintenance	
9	Safety Clean	0 04 in 1995 vs 0 06 in 1994
	Paper Mill	
10	Mineral Spirits	3 7# in 1995 vs 3 4# in 1994 *Stickies*
11	PerforMax 401	0 008# in 1995 vs 0 01# in 1994
12	Amoco White Oil	About same usage as 1994

**through the end of August*

C:\WORD\PAUL\P2CHEM.DOC

EXHIBIT M

"GOING GREEN" SUCCESSES

- ✓ **Reduced trash to landfill**--Year-To-Date through July, we have landfilled 445,420 lbs of trash from Plant 2, compared to 1,051,660 last year That's a difference of 606,240 lbs , or a 57 6% improvement

- ✓ **Ink pail recycling**--Arranging to have steel containers crushed and shredded for recycling We'll generate revenue of $55 per ton vs having to pay for them to be landfilled

- ✓ **Wire coiling and recycling**--Wires from bales of wastepaper are currently being landfilled Investing in coiling machine to have them recycled

- ✓ **Retrofitted vending machines**--All employees were given a reusable plastic mug Vending machines for coffee and soda were changed to accept a reusable cup instead of dispensing a disposable cup

- ✓ **Use of stub tape rolls**--Stub rolls from case sealing machines in the converting plant had been landfilled Now they are placed in light blue containers and returned to supply cabinets to be used in hand tapers

- ✓ **Recycled scuff plates**--Scuff plates in trailers had been made from oak boards Conducted a successful trial using scuff plates made from recycled plastic milk jugs manufactured by a Wisconsin company Plastic scuff plates are more durable, last at least twice as long, and cost $500 less per trailer Going to plastic as replacements are needed

- ✓ **Recycling core knife blades**--Used steel knife blades had been landfilled Now they are collected with other metals for recycling

- ✓ **Recycling cores from sleeve stock and purchased paper**--Cardboard cores had been landfilled Now they are chopped and recycled

- ✓ **Recovering oil and rags from oil absorbent materials**--Rags used to soak up oil leaks at converting machines had been landfilled Now the oil is removed in a centrifuge and recovered, and the rags are washed and reused

- ✓ **Recovering/recycling converting waste from new equipment start-ups**--Waste from trials on new converting machines at the equipment manufacturer is now brought back to Wisconsin Tissue for recycling

- ✓ **Recycling scrap metal**--Scrap metal from various fabricating and construction projects is now recovered for recycling

WISCONSIN'S POLLUTION PREVENTION PARTNERSHIP

2ND ANNUAL PROGRESS REPORT: 1994 ACTIVITIES

®

FORT HOWARD CORPORATION

FALL 1995

Wisconsin's Pollution Prevention Partnership
1994 Annual Report
Submitted by
Fort Howard Corporation
Green Bay, Wisconsin

INTRODUCTION

Fort Howard Corporation, founded in 1919 in Green Bay, is a major manufacturer, converter and marketer of sanitary tissue paper products including bath and facial tissue, napkins, towels, and wipers It also manufactures dry form and non-woven paper products The pulp used to manufacture the sanitary tissue products is manufactured on site predominantly from recycled wastepaper Fort Howard presently employs approximately 2900 full-time employees at its Green Bay facility with an annual payroll of about $122 million

Fort Howard's Green Bay mill includes a primarily coal-fired co-generating power plant, a deinking and pulp processing plant, a chemical plant, nine papermaking machines and related drying equipment, one non-woven machine and two dry form machines, and converting equipment for cutting, folding, printing, and packaging tissue paper, non-woven and dry form material into finished products

It is significant to note that Fort Howard was honored as the first recipient of the prestigious U S Environmental Protection Agency's Administrator's Award for its recycling efforts

MANAGEMENT COMMITMENT TO ENVIRONMENTAL STEWARDSHIP

For many years, Fort Howard has recognized that in order to be successful, it must embrace a proactive environmental program The company's management team is dedicated to protecting and enhancing the environment We believe this is an obligation owed to our employees, stockholders, the communities in which we operate, and the general public

Fort Howard has a written Environmental Compliance Policy adopted by the Board of Directors Every full time employee of the company, mill and office, receives annual training with respect to the Compliance Policy which is attached hereto as Appendix 1

There are three keys to effective environmental programs -- (1) Senior Management Commitment, (2) Communication and (3) Capital Resources Senior Management has demonstrated its commitment to sound environmental programs by participation in EPA's 33/50 Program, Wisconsin's Pollution Prevention Partnership and the Fox River Coalition It is the view of Senior Management that mere compliance is simply not good enough, we must, as a corporate citizen, seek out innovative, cooperative and cost effective solutions to very complex environmental issues -- solutions which will generally surpass what is required

Second, given the size and complexity of Fort Howard's Green Bay mill, communication is absolutely essential To facilitate communication on environmental issues, an Environmental Committee, chaired by the Company's Director of Environmental Affairs, meets biweekly to discuss ongoing issues and policy matters The committee is made up of management personnel from Engineering, Operations, R&D, Technical, Governmental Affairs, Legislative Affairs,

Community Affairs and Legal Agendas are prepared and minutes kept Minutes are distributed to committee members and Senior Management Several members of the committee meet quarterly with the Company's Chairman, President and other senior managers for briefings and policy guidance Fort Howard also utilizes the Company newsletter and magazine to keep all employees abreast of environmental policies, procedures and accomplishments Moreover, the "Fort Howard Report", a professionally produced video, is shown on a quarterly basis to all employees and generally includes at least one environmental topic In addition, over the last several years, the Company has increased discussions with both regulators and the environmental community to increase cooperation and understanding

Other checks and balances have been institutionalized to enhance communication in the environmental area The Company follows a strict chemical procurement policy to assure that environmental and occupational health questions are resolved before any new chemical is brought into the facility That policy is attached hereto as Appendix 2 Additionally, every capital expenditure or major expense is reviewed for environmental impacts and to assure that all impacts have been mitigated or minimized as part of the project A copy of the review form is attached as Appendix 3 After the project has been approved but prior to expenditure, the Director of Environmental Affairs reviews the project file and has authority to halt a project or seek modification if necessary

Finally, a good environmental program is not free In addition to rather substantial daily operating costs, capital must be available In 1994, Fort Howard committed approximately $5 5 million to environmental capital expenditures, which is about 29% of the total capital expended at its Green Bay facility Over the past three years, Fort Howard has committed over $18 million to capital environmental expenditures in Green Bay and since 1970, in excess of $110 million has been expended

POLLUTION PREVENTION ACCOMPLISHMENTS

This section presents accomplishments in the areas of recycling and reuse, air emissions, wastewater discharges, solid waste, hazardous waste and a miscellaneous category

Recycling and Reuse

Fort Howard recycles more wastepaper than any other tissue company in the world Currently, on a corporate basis, Fort Howard recycles over 1 3 million tons of wastepaper annually Additionally, Fort Howard uses significant quantities of postconsumer wastepaper Over the last three years, the use of postconsumer wastepaper has averaged over 35% of the total usage at the Green Bay mill Postconsumer wastepaper is supplied as mixed office waste from numerous sources including the State of Wisconsin and curbside and drop-off material collected pursuant to Wisconsin's mandatory recycling law The Company currently accepts curbside and drop-off wastepaper from Brown and Door counties as well as the following municipalities Allouez, Ashwaubenon, Bellevue, Bonduel, Denmark, DePere, Green Bay, Holland, Howard, Humboldt, Lawrence, Ledgeview, Luxemburg, Pittsfield, Pulaski, Rockland, Scott, Suamico, and Wrightstown

Fort Howard also has a policy of purchasing materials with recycled content. Printing and writing paper, cores, shipping cases and paper overwrap for finished products are all purchased with recycled content Poly overwrap for consumer products contains a high percentage of recycled poly

Fort Howard's Green Bay mill collects for recycling all of its office wastepaper, waste poly shrink wrap, ferrous metal, fluorescent light bulbs, tires, wood pallets, metal drums (after thorough cleaning) and has a program to collect aluminum beverage cans throughout the mill Returnable totes or drums are used whenever possible Salaried and hourly employees survey the mill at least annually to find new recycling opportunities or enhance existing programs

Air Emissions

The Company has two major sources of air emissions -- power plant and process The vast majority of air emissions are combustion products associated with the burning of coal and petroleum coke in the Company's power boilers

Since Fort Howard's Green Bay mill has only a limited electrical tie with the local utility and no significant alternate fuel capability for its boilers, coal and petroleum coke will remain the primary fuels Accordingly, it is not anticipated that significant reductions will be made in emissions associated with the power plant Nonetheless, over the last five years Fort Howard has been able to voluntarily reduce SO_2 emissions through a number of mechanisms despite increased production and electrical demand First, the Company installed a fluidized bed boiler specifically designed to minimize SO_2 emissions This boiler operates below a permitted level of 0 70 #/MMBTU sulfur dioxide, which is 84% tighter than Fort Howard's other boilers The permit also states that 90% control of sulfur dioxide is required In 1994, Fort Howard averaged greater than 94% reduction, clearly exceeding this requirement Second, it has sought out reasonably priced lower sulfur coal and finally, it burned over 8000 tons of shredded tires in 1994 (as a participant of DNR's program to clean up waste tire dumps) These tires are low in sulfur content Figure 1 shows the SO_2 emissions over the past five years compared to the allowable emissions over the same period

Fort Howard also began to recover non-recyclable dry form process rejects for fuel use in its existing boilers in 1994 The material is considered off-spec and would have otherwise required some other means of disposal Fort Howard demonstrated that the shredding and pelletizing of this material provides an energy source that on a BTU for BTU basis is better for the environment than the coal it replaces Approval was received from the Wisconsin DNR in March 1994 to burn up to 400 tons of this material per month Although some startup problems were encountered which has resulted in lower tonnages actually formed and burned, subsequent improvements in its operation have resulted in a consistent, usable fuel for Fort Howard's Green Bay power boilers

Reductions in process emissions have been driven by Fort Howard's participation in EPA's 33/50 program The Company committed to achieving an overall 50% corporate reduction of 1,1,1-Trichloroethane, Xylene and Chloroform by December 31, 1995 Figure 2 shows reductions achieved on a corporate basis and by the Green Bay mill The data shows that Fort Howard has significantly surpassed its objectives, achieving an 80% reduction at the Green Bay mill by the end of 1994 These results were achieved by a combination of product substitution and process control For example, primarily due to alternative bleaching strategies installed at great capital expense, 1994 releases of chloroform were reduced 56% from the 33/50 baseline, and 30% from the 1993 total Releases of 1,1,1-Trichloroethane and Xylene were both non-reportable on the SARA Toxic Release Inventory in 1994 due to product substitution In the case of Xylene, which was primarily a component of paper machine cleaning solvent for the wires and felts, an alternative solvent was identified and used Despite this substitution, on a gallon per gallon basis, Fort Howard used 32% less solvent on the paper machines in 1994 than in 1993

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Wastewater Discharges

The Company has concentrated on reducing its discharge of both conventional and toxic pollutants The Company's goal is to maintain its discharge at levels well below allowable permit limits for all pollutants Table 1 shows removal efficiencies for conventional pollutants over the past three years Figure 3 shows the percentage of allowable discharge during non-wasteload allocation periods (November-April) for the last three years As can be seen from the data, Fort Howard's Green Bay mill's average removal efficiency for BOD was 99 2% and 99 6% for TSS over this period Similarly, over the three year period, Fort Howard discharged an average of 8% of the allowable amount of BOD and 15% of the allowable amount of TSS

The Company has expended considerable time and funds to reduce the discharge of PCBs to the Fox River Data from the last several years show that the goal of nondetectable PCB discharge has almost been achieved Table 2 summarizes PCB discharge data over the last three years

The Corporation has continued its efforts to increase the recycling and reuse of wastewater, thereby minimizing the mass discharge to the river and the hydraulic load to the wastewater treatment plant A Water Conservation Committee, chaired by the Director of Environmental Affairs, has the task of achieving aggressive corporate objectives To date the efforts have been very successful As shown on the attached Figure 4, gallons of wastewater discharged to the river per paper machine ton has declined from 17,800 in 1991 to 9823 at the end of August, 1995 - a 45% reduction Total discharges to the Fox River decreased by 17% in 1994 compared to 1993 - a reduction of over 760,000,000 gallons

Fort Howard has also, on its own initiative, taken steps to reduce the potential discharge of nonyl phenols (NP) and nonyl phenol ethoxylates (NPE) These chemical categories have been targeted to be eliminated at the Fort Howard mill To do this, Fort Howard identified any current chemicals used, including basic janitorial supplies, that contained NP or NPE by searching Material Safety Data Sheets Following this, suppliers were notified that their products would no longer be purchased unless reformulated to not contain NP/NPE In the case where a product containing NP/NPE was a primary manufacturing chemical, extensive trials were conducted to find a suitable replacement By the end of 1994, major progress was made in terms of reducing the overall usage of products containing NP/NPE When compared to 1993, the total 1994 reduction was approximately 26% This work continued into 1995

Solid Waste

The Company has three major solid waste streams -- wastewater treatment plant sludge and boiler ash which are disposed of at the Company's licensed landfill and pulper rejects which are disposed of at the Brown County landfill Plans are underway to beneficially reuse a portion of each of these waste streams First, Granulation Technologies presently converts some of Fort Howard's sludge into an inert agrigranular product which is sold as a carrier to the pesticide and fertilizer industries In 1994, 22% of the sludge generated by the Green Bay mill was shipped to Grantech for this purpose Second, Fort Howard has submitted an application for the possible construction and operation of a sludge-fired boiler These two projects together could reduce the volume of sludge going to the Company's landfill significantly However, the ash generated from the sludge boiler, if not marketable, will continue to go to the landfill

Fort Howard presently has in operation a process to pelletize nonrecycleable paper and pulper rejects These pellets are used as an alternate boiler fuel This project has the potential of reducing material hauled from Fort Howard to the Brown County landfill by 5-10%

Additionally, in 1994, Fort Howard explored other alternatives to reduce the volume and tonnage of solid waste sent to the landfill from its recycling processes Specifically, an extruder technology was examined that could potentially reduce tonnage to the landfill by over 300 tons per month by pressing moisture out of rejected materials This work has continued into 1995

Hazardous Waste

Fort Howard has significantly reduced the amount of hazardous waste generated at the facility Figure 5 summarizes the hazardous waste generated over the past five years The increase in 1991 is attributable to a major construction project at the mill which necessitated the relocation of several fuel tanks The tanks had to be thoroughly cleaned and inspected prior to relocation and installation The oil residue in the tank bottoms accounted for the increased hazardous waste The increase in 1994 is due to laboratory "clean sweeps " 34% of the hazardous waste collected in 1994 was reused for energy recovery

Miscellaneous Pollution Prevention Activities

Over the years, the Company has undertaken numerous pollution prevention activities designed to avoid releases of chemicals to the environment These include

- All indoor bulk chemical storage tanks have at least 100% secondary containment or a leak detection system and outdoor tanks have 110% secondary containment

- All process chemical piping has been relocated above ground or in concrete vaults to minimize undetected leaks, spills, etc

- All PCB-filled transformers have secondary containment

- The Company has a program to replace all PCB-filled transformers and capacitors Under this program, all PCB-filled capacitors and over 50 PCB-filled transformers have been removed from service, properly disposed of and replaced The remaining PCB-filled transformers should be phased out by the year 2000

- All underground process chemical tanks were removed and replaced with above ground tanks

- Most asbestos insulation has been removed and replaced

- All defective fluorescent light fixture ballasts are collected, treated as PCB-filled and disposed of accordingly

- A program is in place to collect and properly dispose of mercury, cadmium and lithium batteries

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GOALS AND OBJECTIVES

In Fort Howard's 1993 Annual Progress Report on Pollution Prevention, five environmental goals and objectives were listed for the Corporation Of these five, three of these have been achieved including the two goals with targeted completion dates in 1994 These five goals and their progress reports follow

1 "Reduce chloroform emissions at the Green Bay mill from approximately 180,000 pounds per year to 125,000 pounds per year by April, 1995 "

This goal was accomplished Total releases of chloroform for 1994 were less than 110,000 pounds as reported for the SARA Toxic Release Inventory

2 "Reduce formaldehyde emissions by 15% from 1993 levels by December 31, 1995 "

Fort Howard does not anticipate that this goal will be met Formaldehyde emissions are generated by the use of binders used to make dry form and carded products Although Fort Howard has begun the process of converting to low formaldehyde binders, the amount of time needed for this transition is unpredictable at best This is due to customer/supplier relationships and product requirements Fort Howard works with its suppliers to develop lower formaldehyde binders that will make a final product with similar characteristics Since Fort Howard sells the majority of its dry form and carded material in large roll form to customers who then convert them into a variety of products ranging from wiping cloths to surgical drapes, Fort Howard must also work with these customers to qualify the new material In some cases, a single qualification test can take six months As a result, the complete changeover is not a process that can occur entirely overnight Rather, it is an evolutionary process that Fort Howard continues to aggressively pursue

3 "Complete the sludge-fired boiler permitting "

Fort Howard has submitted all required materials to the Wisconsin Department of Natural Resources for this permit We expect WDNR to issue the permit by the end of October, 1995

4 "Start up the waste pelletization plant and begin burning the fuel by October 30, 1994 "

This goal was accomplished The first fuel pellet was produced and burned in July 1994 This plant has been in operation and pellets burned since that date

5 "Reduce treated wastewater discharged to the Fox River to 9200 gallons per paper machine ton by December 31, 1994 '

This goal was accomplished The value for three out of the twelve months in 1994 was less than 9200 gallons per ton In December 1994, less than 7600 gallons were discharged for every paper machine ton

Fort Howard is committed to continuing its pollution prevention effort and the programs, discussed above, which have been implemented In addition, Fort Howard commits to the following additional goals and objectives

1 Eliminate all PCB-filled transformers by year 2000

2 Operate the extruder technology consistently to reduce the total tonnage of solid waste to the landfill

3 Eliminate at least one currently reported substance from 1994's SARA Toxic Release Inventory submission to non-reportable levels

4 Increase total solid waste recycled by the mill in 1995 when compared to 1994

5 Continue to work on maximizing wastewater reuse

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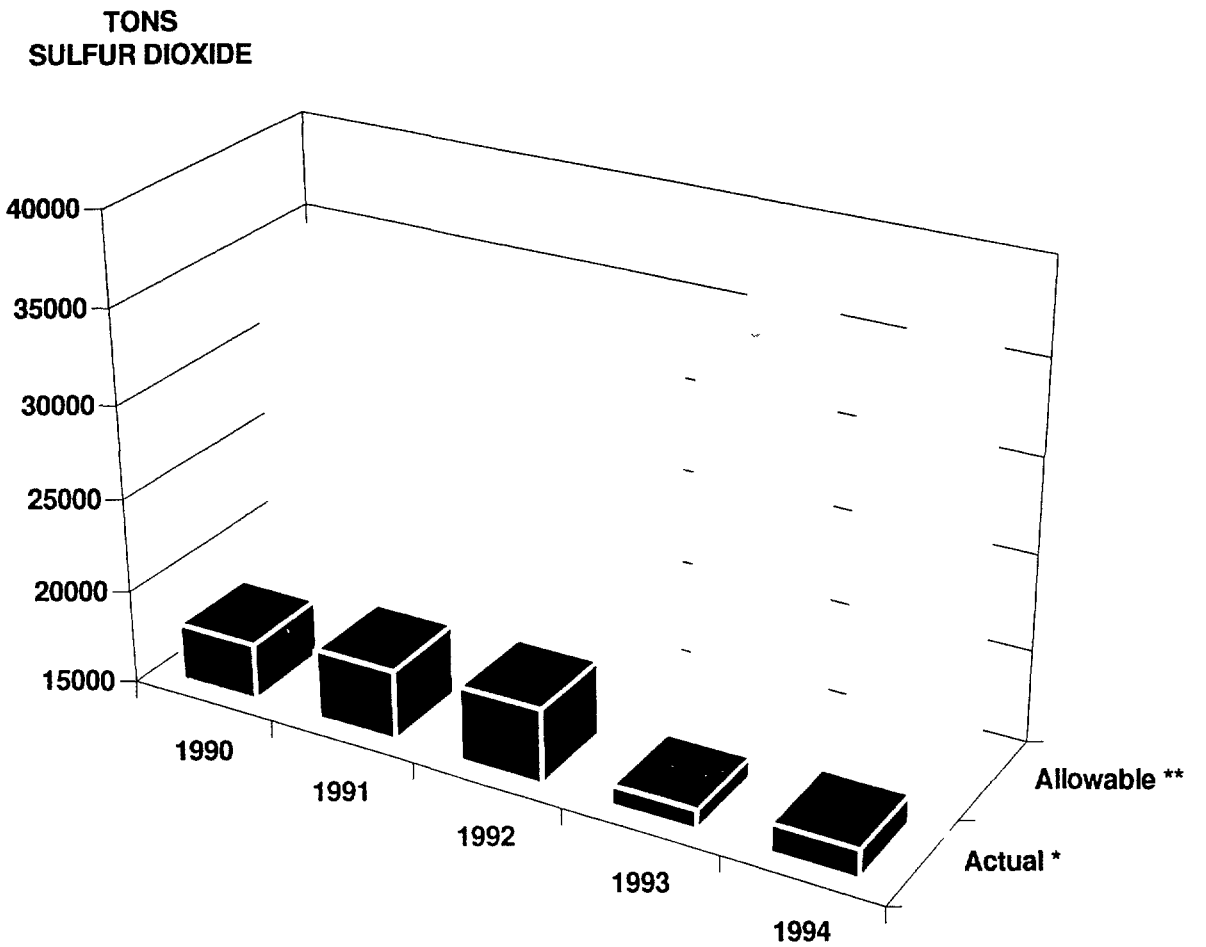
FIGURE 1
FORT HOWARD CORPORATION
GREEN BAY MILL
SULFUR DIOXIDE EMISSIONS



*=BASED ON WDNR EMISSIONS INVENTORY SUMMARIES
**=CALCULATED BY MULTIPLYING MAXIMUM CONTINUOUS RATE OF BOILERS
BY APPLICABLE EMISSIONS LIMITS IN LBS PER MMBTU

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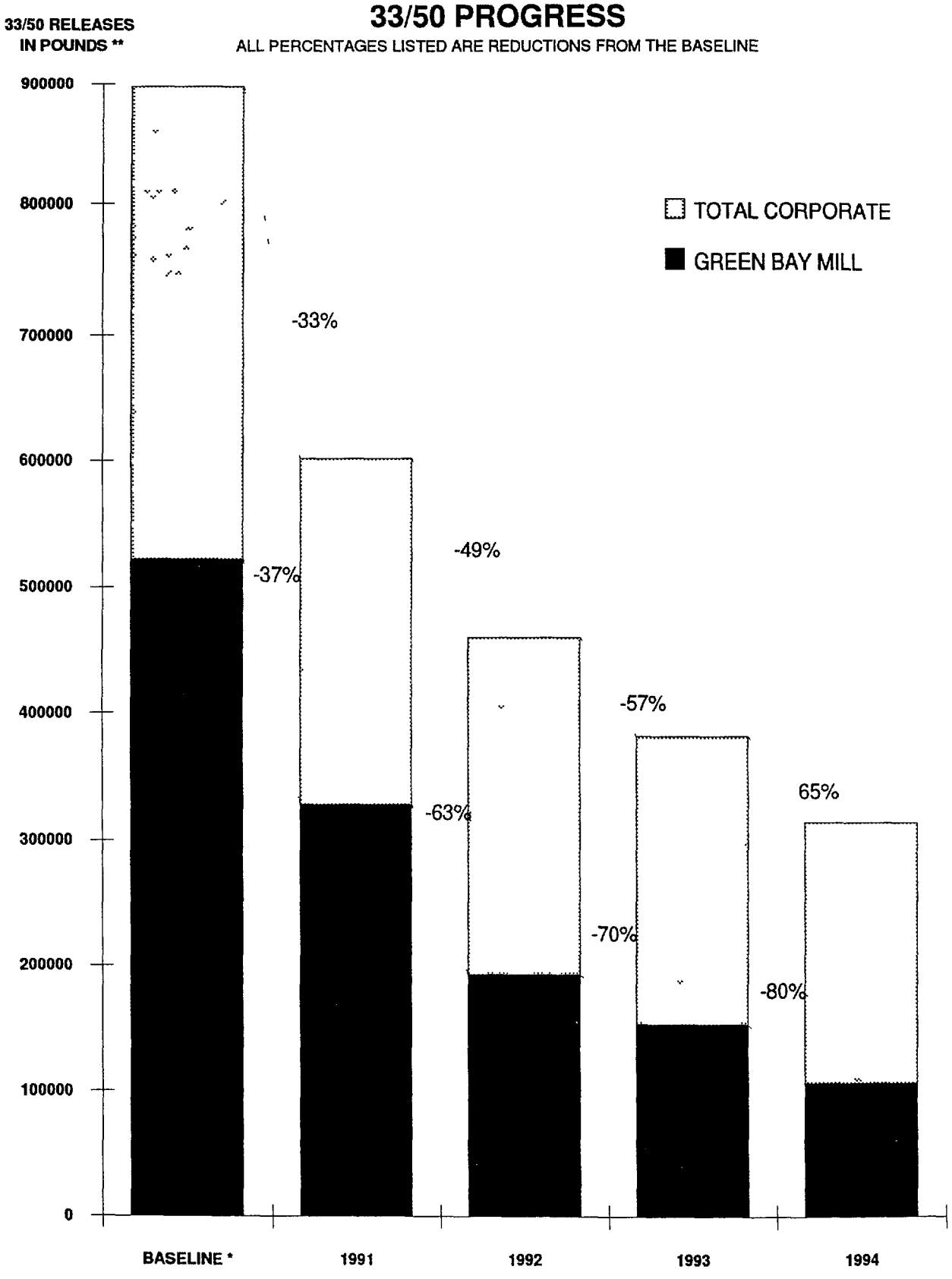
FIGURE 2
FORT HOWARD CORPORATION
33/50 PROGRESS

ALL PERCENTAGES LISTED ARE REDUCTIONS FROM THE BASELINE



* = BASELINE IS 1988 EXCEPT FOR CHLOROFORM (1989)
= CHEMICALS INCLUDED IN REDUCTION PROGRAM ARE CHLOROFORM XYLENE AND 1 1 1 TRICHLOROETHANE

TABLE 1
FORT HOWARD CORPORATION
GREEN BAY MILL
WASTEWATER TREATMENT PLANT REMOVAL EFFICIENCIES

	1992	1993	1994
BOD_5	98 91%	99 37%	99 44%
TSS	99 48%	99 57%	99 61%

FIGURE 3
FORT HOWARD CORPORATION
GREEN BAY MILL
PERCENTAGE OF ALLOWABLE WASTEWATER DISCHARGE
DURING NON-WASTELOAD ALLOCATION PERIODS
1992-1994

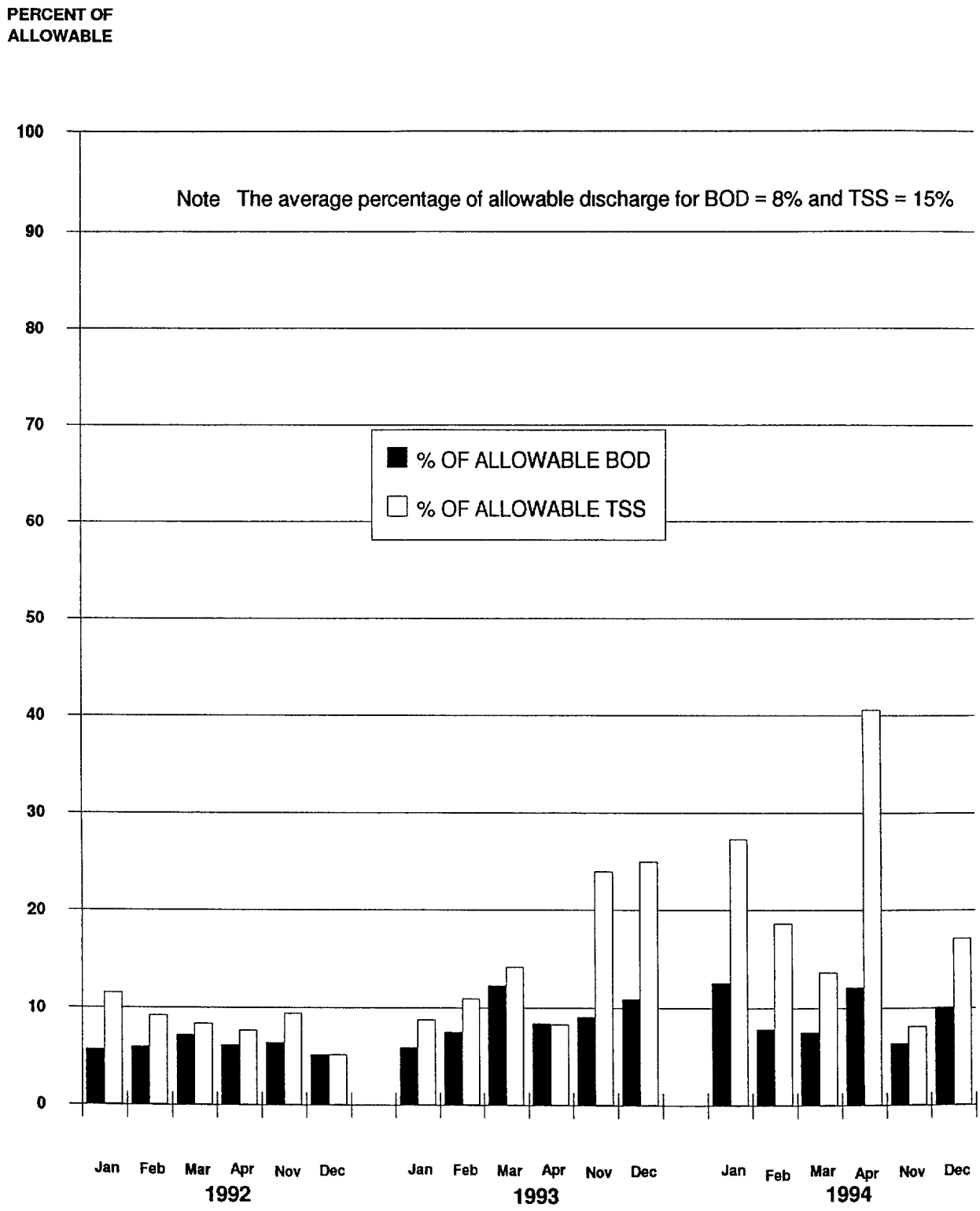


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TABLE 2
FORT HOWARD CORPORATION
GREEN BAY MILL
PCB DISCHARGE DATA

1992	PCB (ug/l)	1993	PCB (ug/l)	1994	PCB (ug/l)
Jan	<0 10	Jan	<0 10	Jan	<0 12
Feb	<0 10	Feb	<0 10	Feb	<0 11
Mar	<0 10	Mar	<0 10	Mar	<0 10
Apr	<0 10	Apr	<0 10	Apr	<0 10
May	<0 10	May	<0 10	May	<0 10
Jun	<0 11	Jun	<0 10	Jun	<0 10
Jul	<0 10	Jul	<0 10	Jul	<0 10
Aug	<0 10	Aug	<0 10	Aug	<0 10
Sep	<0 10	Sep	<0 10	Sep	<0 10
Oct	<0 10	Oct	<0 10	Oct	<0 11
Nov	<0 10	Nov	<0 13	Nov	<0 10
Dec	<0 10	Dec	<0 10	Dec	<0 10

NOTE PCB concentrations which are less than 0 1 ug/l were calculated at a concentration of 0 1 ug/l to obtain the stated values

FIGURE 4
FORT HOWARD CORPORATION
GREEN BAY MILL
WATER USAGE
JULY 1991 - AUGUST 1995

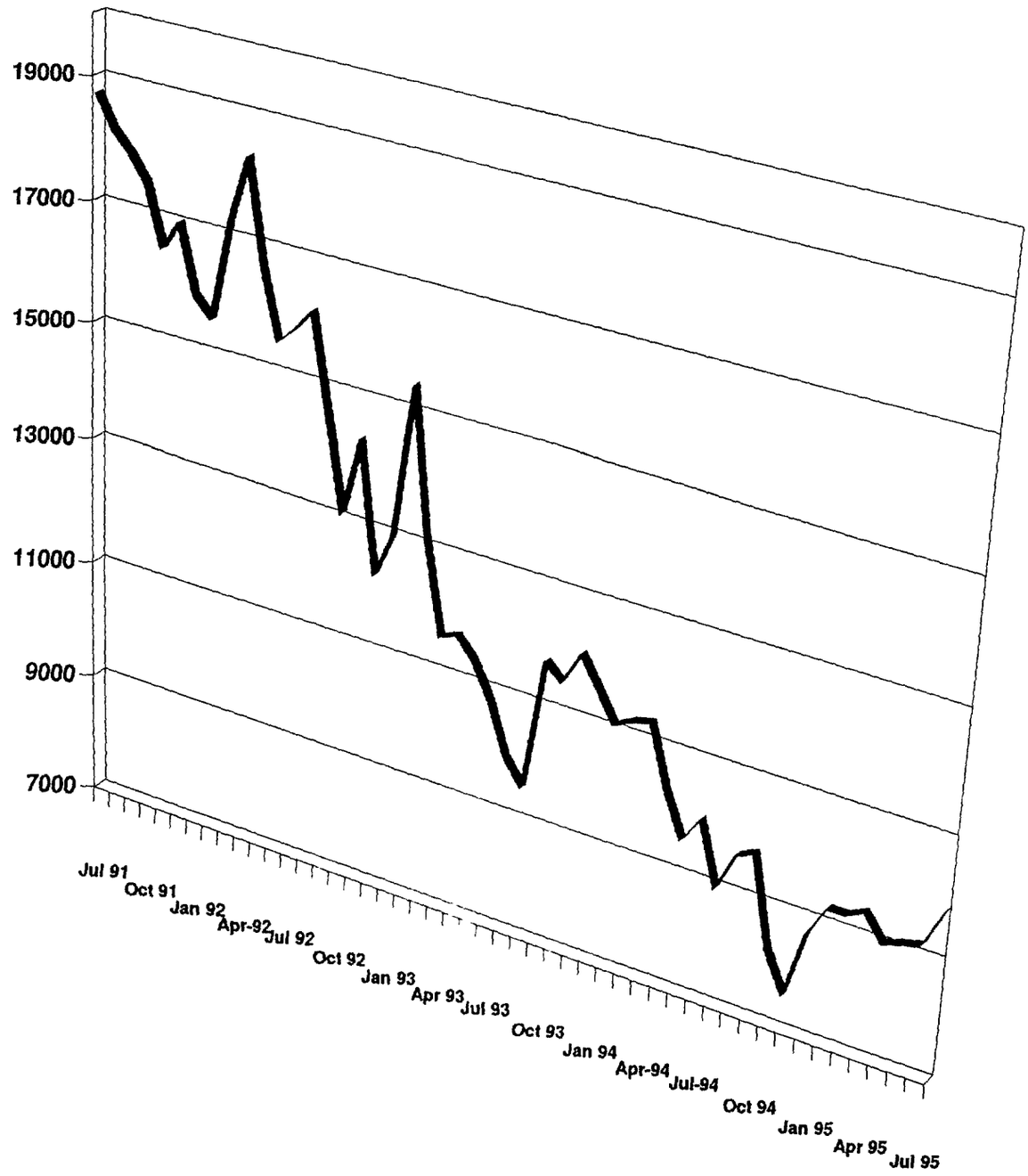
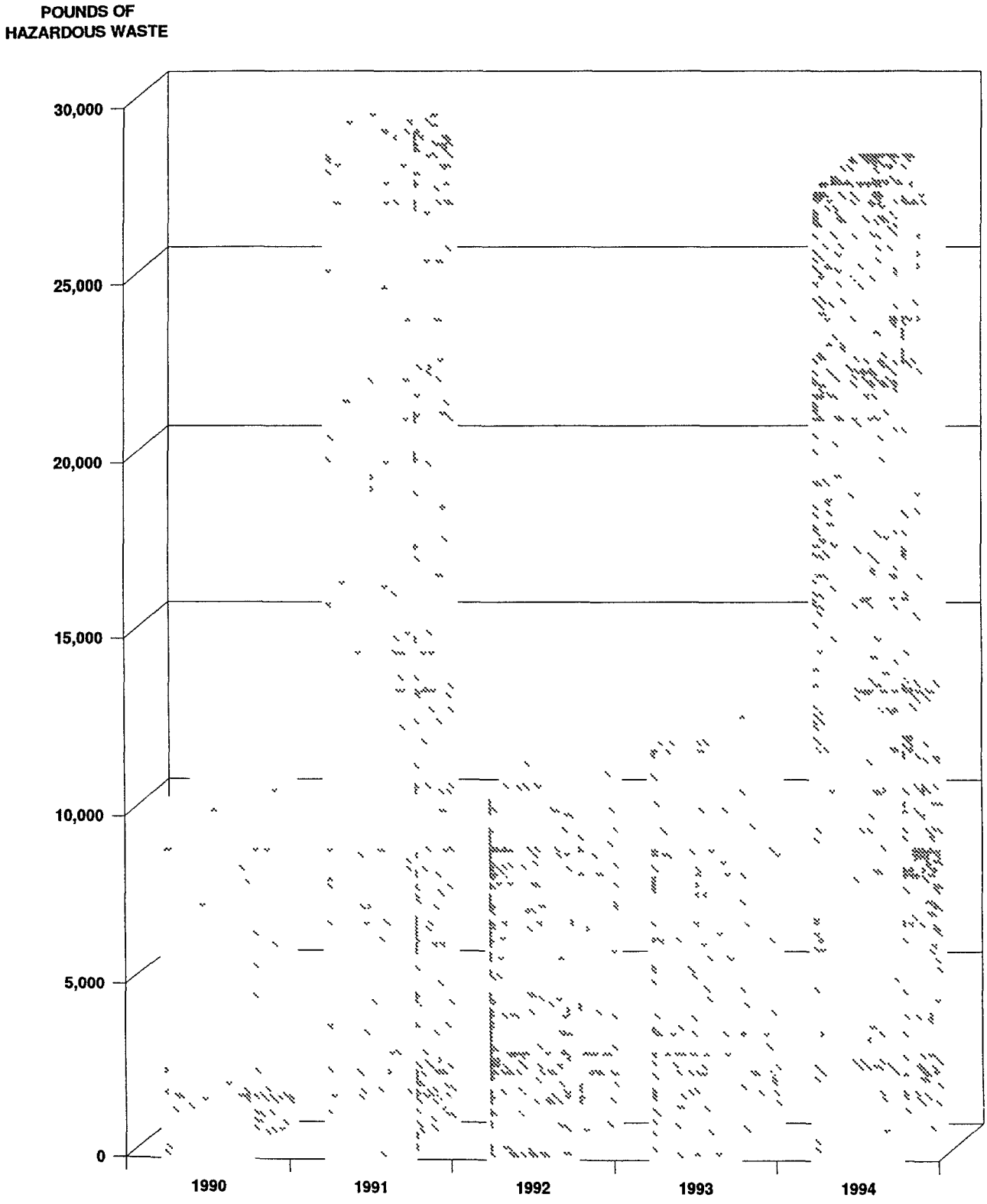


FIGURE 5
FORT HOWARD CORPORATION
GREEN BAY MILL
HAZARDOUS WASTE GENERATED FROM 1990 THRU 1994



APPENDIX 1

FORT HOWARD CORPORATION

ENVIRONMENTAL COMPLIANCE POLICY

1. INTRODUCTION. Fort Howard Corporation recognizes its obligation as a corporate citizen to carry out all of its activities in ways that are consistent with a clean and safe environment. It is the policy of the Company that all of its employees rigorously comply with applicable federal, state and local environmental laws and regulations. No officer, employee or agent of the Company has any authority to engage in conduct that does not comply with this policy or to authorize, direct, approve or condone such conduct by any other person.

The consequences of failure to adhere to the Company's Environmental Policy can be serious for the Company, the individual employees involved, and the communities in which the Company operates. Pollution resulting from manufacturing operations or careless disposal of waste can be offensive and harmful to public health and the environment. It is almost always less costly to prevent pollution than to clean it up.

Violation of pollution control and waste management regulations can subject the Company to civil penalties of $25,000 per day or more. If such violations are "knowing" (and in some cases, if they are merely negligent) very large criminal fines may be imposed on the Company and the individuals involved, and the responsible employees and corporate officers may be imprisoned. Violations of the environmental laws must be taken very seriously and every effort must be made to prevent them from occurring and promptly to correct any that do occur despite our efforts.

Environmental protection and compliance are complex undertakings that require attention at each level of the Company It is not possible to set forth in this Policy all of the specific environmental compliance obligations applicable to the Company because many of these obligations are very detailed and specific to individual plants, process lines or even pieces of equipment, and the requirements for a particular process may vary greatly from state to state. General principles applicable to all operations are stated in this Policy. More specific principles that must be taken into account in structuring and carrying out the Company's environmental compliance program are set forth in the following descriptions of the Statutory Framework and Institutional Responsibilities.

2. THE STATUTORY FRAMEWORK. The activities of the Company are subject to the requirements of a number of federal, state and local environmental laws and regulations. As explained in the section below on Institutional Responsibilities, the corporate Director of Environmental Affairs is responsible for all such requirements and it is the job of each plant, with the assistance

of the Director and his staff to ensure the Company satisfies obligations imposed by applicable environmental laws and regulations. The discussion that follows explains certain basic requirements of major federal environmental laws which generally are applicable to Company facilities.

(a) The Clean Air Act. The Clean Air Act regulates a wide range of activities that may cause air pollutants to become present in the outdoor air. It is the escape of air pollutants from buildings through windows, vents, or otherwise and air emissions from equipment to the outdoor air through stacks and vents that cause pollutants to become airborne that are of concern under the Clean Air Act. Not all such emissions are regulated, but it is the obligation of the Company to ensure that all regulated activities comply with the Act.

For violations of most of its provisions, the federal Act provides for general administrative civil penalties of up to $200,000, unlimited administrative "noncompliance penalties" based on the economic benefit of noncompliance, and administrative field citations assessing penalties of up to $5,000 per day. In addition, EPA may go to court for civil penalties of up to $25,000 per day. Civil liability under the Act is without regard to fault. For "knowing" violations, EPA may seek large criminal fines or imprisonment of responsible employees, including "senior management personnel" and "responsible corporate officers." In some cases, "knowing" means "should have known," and criminal liability can attach to the manager who does not take steps to insure he is getting accurate information from his areas of responsibility. Potential penalties are particularly severe for offenses that endanger human health. In addition to penalties, civil or criminal enforcement actions can result in the violator's debarment from government contracts or subcontracts.

(b) The Clean Water Act. The Federal Water Pollution Control Act (commonly known as the Clean Water Act), regulates direct and indirect discharges of pollutants to most surface waters. "Direct" discharges from point sources of stormwater and process wastewater to lakes, rivers, streams, (or to drainage ditches, storm sewers or other channels that ultimately flow into such bodies of water), are prohibited unless the discharger has a national pollutant discharge elimination system ("NPDES") permit from EPA or a state with an EPA-approved permit program. The prohibition applies alike to industrial process wastewater discharges and many "clean" discharges such as non-contact cooling water.

"Indirect" discharges, such as those to sanitary sewer systems, do not require permits under the federal law, but are regulated under state or local "pretreatment" programs mandated by the federal Act. Stormwater discharges from industrial facilities became widely regulated under rules promulgated by EPA in 1990 In addition, the Act requires a

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company to report to the United States Coast Guard certain spills of oil or hazardous substances that may get into surface waters and to pay for any required government cleanup of such spills Discharges regulated under the Clean Water Act must also comply with various federal, state and local pollution and environmental requirements. Surface water discharges must comply with numerical effluent limitations for individual pollutants found in NPDES permits.

Violations of the Clean Water Act's permitting, effluent limitation, monitoring, reporting and other requirements can result in heavy sanctions. The EPA may levy administrative penalties of up to $125,000 or seek civil penalties of up to $25,000 per day, per violation. If the violation is "knowing," or in some cases merely "negligent," EPA may seek criminal penalties, including large fines and imprisonment of employees, including any "responsible corporate officer." As with the Clean Air Act, heavier penalties are prescribed for offenses that entail endangerment. State agencies authorized to implement the NPDES permit program have comparable enforcement authority.

(c) The Resource Conservation and Recovery Act. The Resource Conservation and Recovery Act of 1976 ("RCRA") requires that "hazardous waste" be treated, stored and disposed of so as to minimize its present and future threat to human health and the environment. Hazardous waste subject to RCRA includes specified wastes listed in the federal (and state) rules, listed commercial chemical products, if they are discarded, and other waste that exhibit one of four hazardous "characteristics" (ignitability, corrosivity, reactivity or toxicity). Under the Act, the Company has the burden of determining whether its wastes are hazardous. RCRA and implementing regulations are designed to control hazardous waste from the point of generation to disposal.

The EPA may seek administrative or judicial civil penalties of up to $25,000 per day and criminal fines or imprisonment for knowing violations and offenses causing endangerment. States with federally-approved RCRA programs have similar enforcement authority and citizens may bring civil enforcement actions under the federal statute.

(d) The Comprehensive Environmental Response, Compensation, and Liability Act. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA" or "Superfund") is unique among the major federal environmental statutes in that its principal purpose is to provide for the clean-up of contamination created in the past rather than to regulate prospectively. CERCLA authorizes EPA to respond to the "release" or threat of release of any "hazardous substance" from any "facility" into the "environment" and generally collect its cost of responding and clean-up from responsible parties.

(e) The Emergency Planning and Community Right-to-Know Act The Emergency Planning and Community Right-to-Know Act of

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1986 ("EPCRA") subjects many companies to requirements for emergency planning, spill notification, and annual reporting of chemical inventories and routine and accidental toxic chemical discharges into the environment. The program is complicated, because EPCRA's various requirements apply to different lists of chemicals: "extremely hazardous substances," "hazardous substances," hazardous chemicals" or "toxic chemicals," and in some instances, only to plants that use more than a specified quantity of one or more of the chemicals on the relevant list. As with other environmental statutes, EPA may seek substantial penalties, including fines or imprisonment for violations of EPCRA.

(f) The Safe Drinking Water Act. The Safe Drinking Water Act ("SDWA") directs EPA to establish and enforce standards for drinking water contaminants. Regulated water systems (which may include industrial facilities that have their own water supply systems serving 25 or more employees) must comply with at least some of these standards.

(g) Other Federal Laws. There are several other federal environmental statutes which may be applicable to Company facilities from time-to-time. The Legal Department should be consulted regarding the applicability of a specific statute.

(h) State and Local Environmental Laws and Regulations. The catalogue of federal environmental law requirements presented above is incomplete in that it only refers to state and local laws that are designed to carry out the mandate of the federal statutes. The state and local regulations adopted under federal programs generally mirror the applicable federal rules or guidelines in most respects, but may include more stringent provisions. In addition, many states and localities have environmental laws with no federal counterpart.

3. INSTITUTIONAL RESPONSIBILITIES. The Company's Director of Environmental Affairs shall be responsible for overseeing the Company's compliance with environmental laws and regulations and with this Environmental Policy. The Director will receive technical support from the corporate Technical, Engineering, and Research and Development Departments, and legal support from the Legal Department. The Director is responsible for developing such environmental compliance initiatives as are determined to be necessary and appropriate to carry out the provisions of this Environmental Policy.

Because of the highly specific nature of most environmental regulation, the Company has vested its plant managers with primary responsibility for day-to-day compliance with this Environmental Policy and for supervising other environmental protection matters. Each mill or other significant Company facility shall have a designated environmental coordinator who must have appropriate technical or regulatory training or experience and who, for each mill or significant

facility, devotes sufficient and appropriate amounts of his or her time to environmental matters. The environmental coordinator at each mill shall report to the supervisor of the Technical Department at that mill or directly to the mill manager. Environmental coordinators for other facilities shall report to the director or manager of that facility. Environmental coordinators shall be responsible for identifying all activities, facilities, sources and conditions present at the mill or facility that are subject to environmental laws or regulations and for developing and implementing programs to ensure that each activity, facility, source or condition attains and maintains compliance with those requirements.

The Director of Environmental Affairs will oversee plant compliance activities through an appropriate combination of direct supervision and checking, regularly scheduled environmental meetings with applicable corporate and plant personnel, and internal environmental audits. At a minimum, this system shall provide for periodic review by the Director of the status of measures planned and taken in response to all applicable environmental laws and regulations and any potential violations. The Director shall also assist in the development of plant-specific environmental initiatives, manuals and training, and shall work with environmental coordinators and committees at the plant level on additional projects (e.g., recycling, energy conservation, waste minimization) undertaken in furtherance of the corporate Environmental Policy. The Director shall further be responsible for providing environmental input into corporate business plans, financial disclosures and other management initiatives and reporting.

The Legal Department (with assistance from the Public Affairs Department) shall be responsible for keeping track of and alerting the Director of Environmental Affairs, plant managers and environmental coordinators to new environmental statutory and regulatory actions that will affect their operations. The Company's Regional Public Affairs representative, with the assistance of the Legal Department, shall monitor relevant state and local statutory and regulatory developments.

4. GENERAL. No employee should ever assume that an activity is unregulated merely because that employee has never been informed that the activity is regulated. No employee should assume that it is acceptable to exceed pollution control standards because such exceedances have not resulted in enforcement actions. As a general matter, neither the silence of regulatory agencies nor informal assurances (e.g., by a field inspector) that a source or activity is not covered by the regulations or that occasional exceedances are expected and acceptable, is a defense to a later enforcement action.

Making a false report to a federal agency (or, in some cases, to a state agency) is a serious crime under the federal

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environmental laws and the federal criminal code. State environmental and criminal laws have similar provisions False reporting is viewed by many prosecutors as a particularly serious offense and is likely to result in prosecution if detected.

APPENDIX B

CHEMICAL PROCUREMENT POLICY

The chemical procurement policy was initially put into effect in 1983 to provide the Safety, Technical and Purchasing Departments better control and handling of all chemicals Recent environmental legislation requires that we more precisely monitor and control handling of all chemicals. We must be able to track chemical usage corporate-wide from purchasing through receipt, storage, waste removal/disposal and/or environmental fate We must also be prepared to deal with all kinds of possible chemical emergencies. The following policy is designed to keep undesirable chemicals out of each facility and provide a mechanism to evaluate the hazards posed by chemicals authorized for specific uses

I **Purchase Requests and Approvals**

A **All chemicals** such as inks, dyes, coatings, solvents, etc , including samples requested for trial, laboratory reagents and chemicals used within the Research and Development and Technical Departments, must be obtained through the Purchasing Department Upon receipt of the requisition for any chemical, the Purchasing Agent will review the requisition and verify that the chemical appears on the list of approved chemicals for the requesting department To appear on the "approved list", a chemical must have previously been approved by the Safety and/or Technical Department and a current MSDS must be on file **If and only if, the chemical has been approved,** will the Purchasing Agent proceed in filling the request

B All purchase orders issued for chemicals must have the following language inserted in the body of the purchase order

"Seller agrees to provide a complete Material Safety Data Sheet in compliance with 29 CFR 1910.1200 (f)" and provide updated MSDS's as they become available

C Emergency approval provisions will only be used in restricted situations tantamount to closing down the mill or curtailing a production or maintenance process In these instances, a faxed MSDS, or a verbal commitment regarding the contents of an MSDS may be obtained by the Safety and/or Technical Department The Safety Department will be advised of those findings and may give verbal authorization to the Purchasing Department prior to receipt of a

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written MSDS. Upon receipt of the written MSDS, it will be reviewed following normal procedures and the right is reserved to curtail use of the chemical immediately if the verbal information conveyed by telephone is inconsistent with the written information supplied.

D. If the chemical has not had prior approval, the Purchasing Agent or the Requester will determine whether chemical approval is desired and initiate the approval process by obtaining an MSDS and attaching it to a completed Form 57522.F1/1 03/21/95 (see attached form)

II **Procedure for Chemical Approval**

A Prior to obtaining **any chemical sample** or **ordering any chemical sample** for an in-plant trial, the Purchasing Agent will obtain a Material Safety Data Sheet (MSDS) from the supplier for the product desired.

B. An MSDS review form 57522.F1/1 03/21/95 must be filled out by the Purchasing Agent or Requisitioner and attached to a legible copy of the MSDS It must then be submitted to the Technical Department for initial approval

C. The Technical Department will review the request and, if necessary, contact the person(s) requesting the product to obtain additional information concerning the chemical's intended use The chemical may be approved for the specific process use, approved with certain restrictions, or prohibited from use

1 **Approved or Approved with Certain Restrictions**

The Technical Department will forward a copy of the completed and signed approval form to the Purchasing and Requesting Department The new chemical will then be added to the Requesting Department's chemical list via Toxic Alert An updated department list and a copy of the MSDS will be forwarded to the Requesting Department each year or upon request.

2. **Chemicals not approved**

If the chemical is not approved, the Safety and/or Technical Department will mark the MSDS Review Sheet "Not Approved" A copy of the MSDS

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Review Form will be forwarded to both the Purchasing and Requesting Departments.

D If upon completion of the MSDS review, further evaluation of the chemical is needed, the Technical, Safety or Requesting Department may request a sample for a "trial" through the Purchasing Department A Purchase Order **must** accompany all trial sample requests. **There will be no exceptions.**

E. Upon trial completion, the final decision as to whether the chemical will be approved for full scale use in the mill must be agreed upon by the Technical, Safety, and Requesting Departments

F Requests for trial chemicals to be used at our Research and Development facilities can be approved by the R & D Director provided that an MSDS is obtained and a Purchase Order accompanies the sample request A copy of the MSDS must be forwarded to the Technical Department

III **Requests for Trial Chemicals**

A Any new and/or trial chemical must be tracked either through the present accounting and inventory system or by the using department Each Department will be responsible for tracking trial chemicals The following information is required for all new or trial chemicals

a Date Chemical Received in Mill
b Quantity Initially Received
c Average Daily Usage based on Month End Inventories
d. Date Chemical is used up
e Proper disposal of unused chemical

B Prior to bringing any new or trial chemical into a department for use, trial specifics must be discussed with the Department Head **and** the Safety Manager. A trial request form (see attached) should be completed to convey chemical handling and spill response information to those individuals in the department that may have to use the chemical, handle spills or repair equipment, etc.

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Table IV-1. ACCOUNT NUMBERS FOR ORDERING CHEMICALS TISSUE ONLY

1325-XXX	CHEMICALS
1325-100	Dry Former Materials
1325-106	Nonwoven Raw Materials
1325-111	Paper Machine Chemicals/Dyes Optical Brighteners
1325-112	PM Chemicals - Solvents
1325-113	PM Chemicals - Release Agents
1325-114	PM Chemicals - Wet Strength
1325-115	PM Chemicals - All Others
1325-116	PM Chemicals - Defoamer
1325-117	PM Chemicals - Krofta Polymer
1325-118	Biocides
1325-126	PP Chemicals - Detergents
1325-127	PP Chemicals - Solvents
1325-128	Water Treatment - Descalers
1325-129	PP Chemicals - Acids
1325-130	PP Chemicals - All Other
1325-131	PP Chemicals - Defoamer
1325-141	Water Treatment - Nutrients
1325-142	Water Treatment - Defoamers
1325-143	Water Treatment - Polymers
1325-144	Sludge Press
1325-145	Water Treatment - Other
1325-156	Lime
1325-157	Purchased Caustic Soda
1325-158	Chlor-Alkali Materials
1325-159	Purchased Bleach Liquor
1325-180	R & D Trial Chemicals

Please contact the accounting department with any questions

HMIS Rating
Health _____
Flammability _____
Reactivity _____
Target Organ _____

MATERIAL SAFETY DATA SHEET REVIEW

CATALOG NUMBER. _____ Date. _____
Purchasing Agent. _____
Requisitioner _____
Chemical Name _____
☐ New ☐ Trial ☐ Substitute ☐ Update
Dates of Trial _____
Vendor (s) _____
_____
Department Supervisor (s) Responsible for Handling _____
Storage Location _____ Storage Type Code. _____
Department Used _____ Chemical's Use. _____
Inventory Information Current Quantity _____ Maximum Quantity _____
Yearly Usage. _____

HCS ☐ Yes ☐ No TSCA ☐ Yes ☐ No RCRA ☐ Yes ☐ No
SARA 313 ☐ Yes ☐ No (M/P/U/E) SARA 311/312 ☐ Yes ☐ No PROP 65 ☐ Yes ☐ No
CERCLA ☐ Yes ☐ No RQ _____ P_____ PSM ☐ Yes ☐ No AIR TOXIC ☐ Yes ☐ No
Chemical Name _____ ☐ Pure ☐ Mixture AIR TOXIC AMOUNT _____
Manufacturer _____ VOC's _____
Vendor _____
Stock Number _____
Physical Characteristics. pH _____ Specific Gravity _____ Flash Pt. _____
Hazard Class ☐ Fire ☐ Sudden Release of Pressure ☐ Reactivity
☐ Immediate (acute) ☐ Delayed (chronic) ☐ FDA Approved
Ventilation Requirements ☐ General Mechanical ☐ Local Exhaust (Hood) ☐ Explosion Proof
Personal Protective Equipment.
**Eyes / Face ☐ Goggles ☐ Face Shield ☐ Safety Glasses w/Side Shields
**Gloves ☐ Nitrile ☐ Neoprene ☐ Rubber ☐ Latex ☐ PVA ☐ Heat Resistant
**Respiratory ☐ SCBA ☐ Comfo II ☐ Dust Mask
**Clothing ☐ Apron ☐ Gauntlets ☐ Rubber Boots ☐ Splash Suit ☐ Hard Hat
**Special _____
Emergency First Aid Eyes/Skin - Flush with water 15 minutes.
Inhalation - Remove to fresh air
Ingestion - DO / DO NOT induce vomiting See Doctor
Waste Generated ☐ Yes ☐ No Quantities Generated _____
Disposal Method ☐ General ☐ Ignitable ☐ Corrosive ☐ Reactive ☐ Listed ☐ EP Toxic
☐ To Be Determined by Technical Department
Spill / Cleanup Dike to contain (Keep out of Sewers)! Remove ignition sources and isolate area. Use appropriate personal protective equipment. Contact Technical Department for proper cleanup and disposal procedures.
_____ ☐ Material Satisfactory _____
_____ ☐ Satisfactory with Restrictions: _____
_____ ☐ Material Unsatisfactory _____

White Copy Technical Dept. Canary Copy Purchasing Agent Pink Copy Department Supervisor

APPENDIX 3

FORT HOWARD CORPORATION
APPROPRIATION ENVIRONMENTAL INFORMATION

PROJECT NAME_____ PROJECT LOCATION_____

Please answer the following questions completely as possible in order that we may evaluate the project s environmental impacts and assess the need for separate environmental permits or approvals

Project Engineer (See Note Below) _____ Telephone No _____

1 Will the project, when completed, involve the generation of any air emissions including any indoor or fugitive emissions? ___ YES ___ NO

If yes, briefly describe _____

2 Will the project, when completed, involve the generation of any waste materials? NOTE Waste materials may be solid or liquid and may be generated by operation of the project or cleanup ___ YES ___ NO

If yes, briefly describe _____

3 Will the project, when completed, result in any effluent treatment discharge either to the pulp processing effluent discharge, or to the mill sewer effluent discharge? ___ YES ___ NO

If yes, briefly describe _____

Expected increase in flow to Mill Sewer G P M _____ (Ave)
G P M _____ (Max)

Pulp Processing Effluent discharge, Expected increase in flow G P M _____ (Ave)
G P.M _____ (Max)

4 Will the project, when completed result in any increased storm water runoff or cooling water discharge? ___ YES ___ NO

If yes, briefly describe _____

Storm water discharge to Mill Sewer, Expected increase in flow G P M _____ (Ave)
G P M _____ (Max)

Storm water discharge to river, Expected increase in flow G P M _____ (Ave)
G P M _____ (Max)

Cooling water discharge to river or sewer system (specify), expected increase in flow
G P.M _____ (Ave) G P M _____ (Max)

5 Will the project, when completed, result in any increased sanitary sewerage ___ YES ___ NO

If yes, briefly describe _____

6 Are there any other known or suspected environmental impacts or occupational exposure concerns associated with the project that you are aware of including, but not limited to the installation and use of a radioactive source? ___ YES ___ NO

If yes, briefly describe _____

7 Will this project result in a new process product or the use of new or increased quantities of chemicals or raw materials? ___ YES ___ NO

If yes, briefly describe _____

NOTE TO PROJECT ENGINEER You are required to provide accurate information in order to determine if environmental permits, licenses or approvals are necessary Increased discharge of wastewater may require review and prior approval by the Water Conservation Committee C.A T If you have answered "Yes" to Item 3, please contact Roger Kaminski, Ext 2198 or Phil Greig, Ext 2230, for further instructions

\SLR\WP\OTHER\RKENVIR