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18959

POLLUTION PREVENTION
THE PAINT MANUFACTURING INDUSTRY
A CASE STUDY

Primary Reference:

Guides to Pollution Prevention, The Paint Manufacturing Industry, EPA/625/7-90/005

Case Study supplemented by a phone conversation with Hubert Kim, Process Engineering Manager, Standard Brands Paint Company, 16 October 1990.

The ERM Group

3C Mr. R Luken

PROCESS AND FACILITY DATA

Facility Description

Plant A produces a wide variety of architectural coatings: 76 lines of paint products and eight lines of aerosol spray paints for distribution through retail outlets, and 55 lines of aerosol and specialty paints for sale through distributors. Some of the paints produced at this facility are water-based and the remainder are solvent-based. The water-based coatings are latexes and the solvent-based coatings are mostly alkyd resins dissolved in solvents. Most of the paints produced are for use by the general public. During the past year the plant manufactured 8.5 million gallons of paint.

Raw Materials Management

The raw materials used in Plant A include resin solutions, emulsions, solvents, pigments, bactericides, fungicides, and extenders. Some defoamers and surfactants are also added to the water-based batches.

The solvents used at the facility include aliphatics, aromatics, ketones, alcohols, and glycol ethers. The solvents are either delivered and stored in drums or delivered in bulk and held in above ground storage tanks. The pigments are delivered in bags and are used in powder form.

Process Description

Pigments in dry form are added to other raw materials in portable tanks. Tank contents are dispersed in a sand mill, ball mill, or high-speed mill and either collected in another portable tank or directly added to the let down tank. The portable tanks are used for different products as are the dispersion mills. A mill is not cleaned if used for the same product more than once. When changing products, the mills are purged with solvent, an alkaline solution, or water at the end of the dispersion process.

In the letdown step, the dispersed pigments from the milling operation are mixed in portable or stationary tanks with additional diluents, resins, and additives. The tanks have capacity varying from 50 to 10,000 gallons. The additives constitute bactericides, fungicides, surfactants, defoamers, or extenders. The bactericides and fungicides used for water-based batches are mercury-based whereas non-mercurials are used for solvent-based batches. Solvents such as diethylene glycol or propylene glycol are added to water-based paints to extend the drying time and act as an anti-freeze in cold climates.

Waste Description and Generation Rates

Solid Waste

Solvent waste sludge constitutes the principle solid waste stream generated by Plant A. Currently, the 223.5 tons of solvent wastes generated annually are dumped at a local facility. Since shipments to this nearby dump are dependent upon local trucking availability and sufficient quarterly profit (pollution control funding is last on the distribution list) drums of solvent wastes are often stockpiled behind the main factory building. Several groups of old drums are rusted and leaking.

Air Emissions

The principle air emission source generated by Plant A is dust from dry pigments. This dry raw material may become entrained in the air when being introduced to mixing vats. Losses of this powdered material are estimated at approximately one percent of the total amount used. Particulate matter from this source is evident in indoor plant air (many workers wear respirators but take much more frequent breaks complaining from exhaustion) and to a lesser extent, in the air directly outside the facility. Residences of plant workers immediately surrounding the property are often covered with the fine dust resulting from windblown pigments. This problem is often so severe that residents cannot hang out their laundry without having tiedyed sheets.

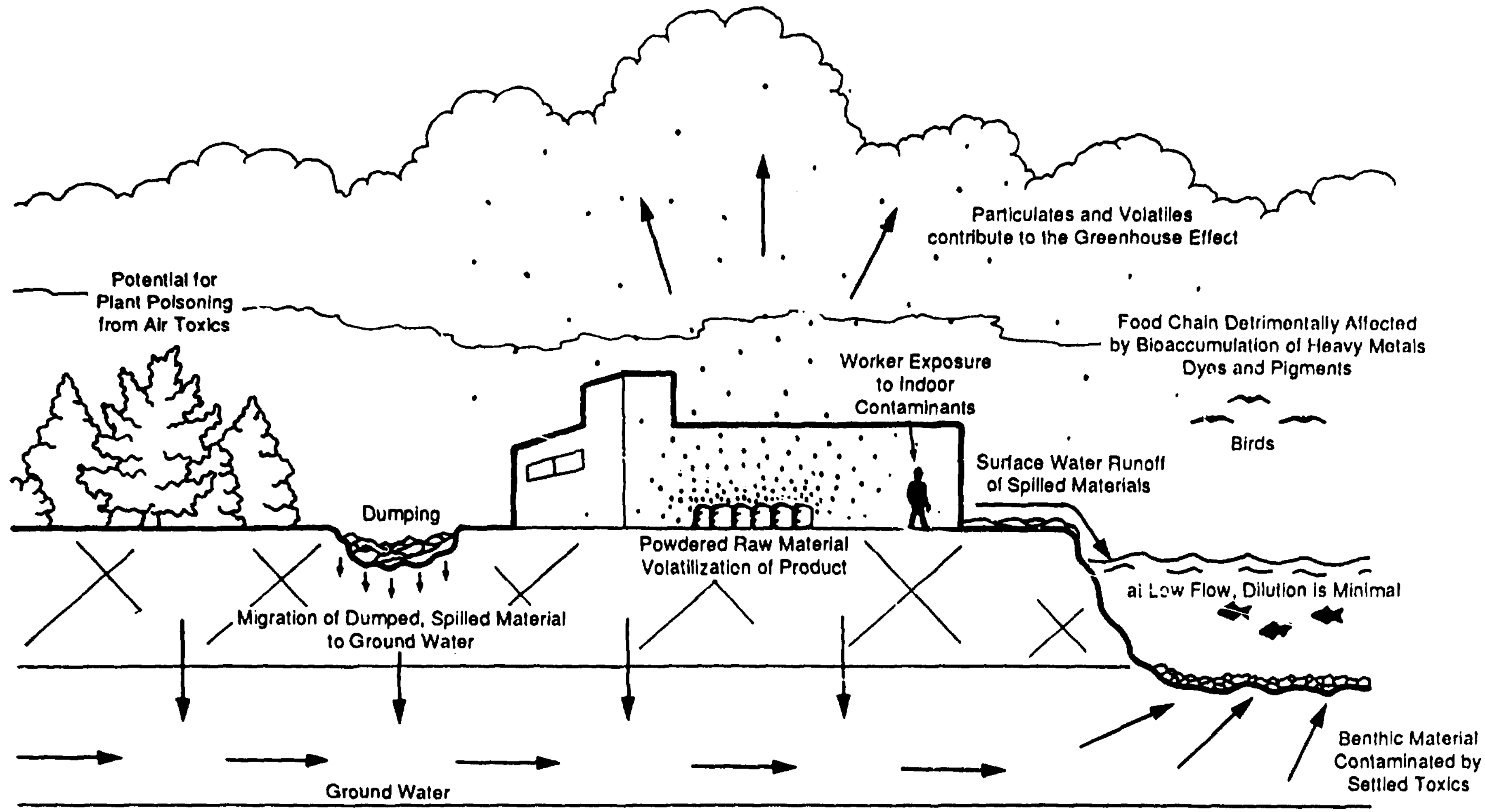
Wastewater

The principle wastewater streams generated by Plant A include tank rinse, dispersion mill rinse, and equipment cleaning wastes. Each of these streams contain water or solvents. This rinse and wash wastewater is discharged to either the sewer system or the local waterway, depending upon which way the y-valve is thrown, which in turn depends upon whether the wastewater treatment plant is in repair (it usually isn't). Approximately 350 tons of wastewater sludge leaves the plant annually. Some ends up in the local waterway and some is trucked to the local dump, if the wastewater treatment plant is in repair and if trucking funds are allocated for the quarter (some of these occurances are dependent on the schedule of the local government inspector).

Current Environmental Impacts

Refer to the attached illustration for a qualitative assessment of the environmental impacts resulting from current practices at Plant A.

Environmental Impacts
Qualitive Assessment



WO# B20-01-00-01	Drawn by / Date: D. Grabowski 10/25/90	Checked by / Date: K. Klaber 10/25/90	Notes:	The ERM Group
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PROCESS ALTERNATIVES

Several options are available to Plant A to avoid pollution fines. For each media into which waste is discharged, namely, land, air, and water, three options shall be investigated. For all three waste streams, the alternative of no action in the form of a legal delay will be considered. Two other remedies shall be compared to this option for each of the waste streams.

Solid Waste Disposal Alternatives

In addition to the legal delay to avert punishment for polluting practices, at least two alternatives exist for managing the solvent solid waste at Plant A. Solvent waste may be recycled off-site or recovered on-site.

Off-site Recycling

By sending solid solvent wastes off-site for recycling, Plant A may boast of an environmentally sound practice. However, the cost of this alternative totals $160/ton.

Assume the total waste sent to the off-site recycler is 223.5 tons per year, which amounts to 44,700 gallons per year (assuming a density of 10 pounds per gallon).

On-site Recovery

Although on-site recovery of solvent solid waste requires capital investment, costs of off-site disposal are avoided. On-site reclamation has the following benefits:

- The transportation of the wastes and the associated risks are minimized because less waste leaves the facility;
- The plant has more control over the purity of the reclaimed solvent;
- Distillation residues can be reused;
- Disposal costs will be less affected by increases in charges by off-site recyclers because the waste volume is considerably reduced; and
- It is cheaper to recover on-site.

The disadvantages of on-site reclamation are:

- Capital investment needed for the still

- Additional operating costs
- Possible need for operator training

Air Emissions Alternatives

Several changes may be made to decrease air pollution from dry pigments at Plant A. Steps may be taken to replace powdered raw material with a slurry product, thereby eliminating the possibility of entrainment of pigment dust. Alternatively, a baghouse may be installed in order to collect dust at the dispersing vats where dry raw material is introduced. This unit would consist of a series of fabric bags through which polluted air is passed. Particulate matter is captured in the bags and then reused as a raw material.

Baghouse installation

By installing a baghouse raw materials are both cleaned from the air and recovered for reworking into the production process. However, the annualized cost of owning and operating a fabric filter baghouse can be very high. The (annualized) capital cost due to depreciation and lost interest is about 35% of the annual operating cost; fan power costs are about 15%, replacement bag purchases are about 15%, and operating and maintenance labor are about 35% of the annual operating cost. For a plant such as Plant B, a 6 unit baghouse with a total of 200 individual bags is sufficient.

Total one-time capital costs for baghouse installation are $50,000 .

Operating costs and revenues resulting from baghouse installation are as follows:

- $ 7,048 / year increase in utilities cost;
- $ 300 / year increase in O & M labor cost;
- $ 2,608 / year increase in O & M supplies cost (filter bag replacement); and,
- $ 10,912 / year revenues from marketable by-products.

Net operating savings are $ 956 / year.

Raw materials substitution / Slurry usage

By replacing powered raw material with slurried raw material, several economic benefits will result. Processing losses will be reduced as slurried material will not escape to the air. The production step of mixing dry material with a wetting agent will be avoided thereby saving labor and cleaning costs. Costs avoided by using slurried rather that powdered material include:

Surfactant for wetting	$0.20/gal
Energy for mixing	$0.05/gal to $0.10/gal
Labor	$0.20/gal
Overhead	$0.30/gal to $0.40/gal

Overall operating costs and revenues resulting from slurry usage are as follows:

- $ 100,000 / year increase in raw material costs;
- $ 4,000 / year decrease in utilities cost;
- $ 17,000 / year decrease in calalysts and chemicals;
- $ 17,000 / year decrease in O & M labor costs; and,
- $ 15,000 / year decrease in other operating costs.

Net operating costs are $ 47,000 / year.

Wastewater Discharge Alternatives

As with the two other waste streams, punishment for pollution from the plant wastewater may be averted through political avenues. However, investigation of process changes may result in alternatives more economically advantageous. Implementation of an improved wastewater treatment system is environmentally sound. Sludge produced by treatment may either be disposed of off-site or recycled into a usable product.

A wastewater treatment program may proceed as follows. Ferric chloride is introduced to the washwater to promote floc formation and settling of the paint solids. Neutralization and polyelectrolyte addition follows, yielding a clear supernatant.

Wastewater Treatment with Off-Site Sludge Disposal

Total one-time capital costs for improvements to the wastewater treatment plant are $ 269,000 .

Operating costs and revenues resulting from wastewater treatment with off-site sludge disposal are as follows:

- $ 22,500 / year increase in sludge disposal costs;
- $ 3,100 / year increase in utilities costs;
- $ 23,600 / year increase in catalysts and chemicals; and,
- $ 30,000 / year increase in O & M labor cost;

Net operating costs are $ 79,200 / year.

Wastewater Treatment with Sludge Recycled to a Product

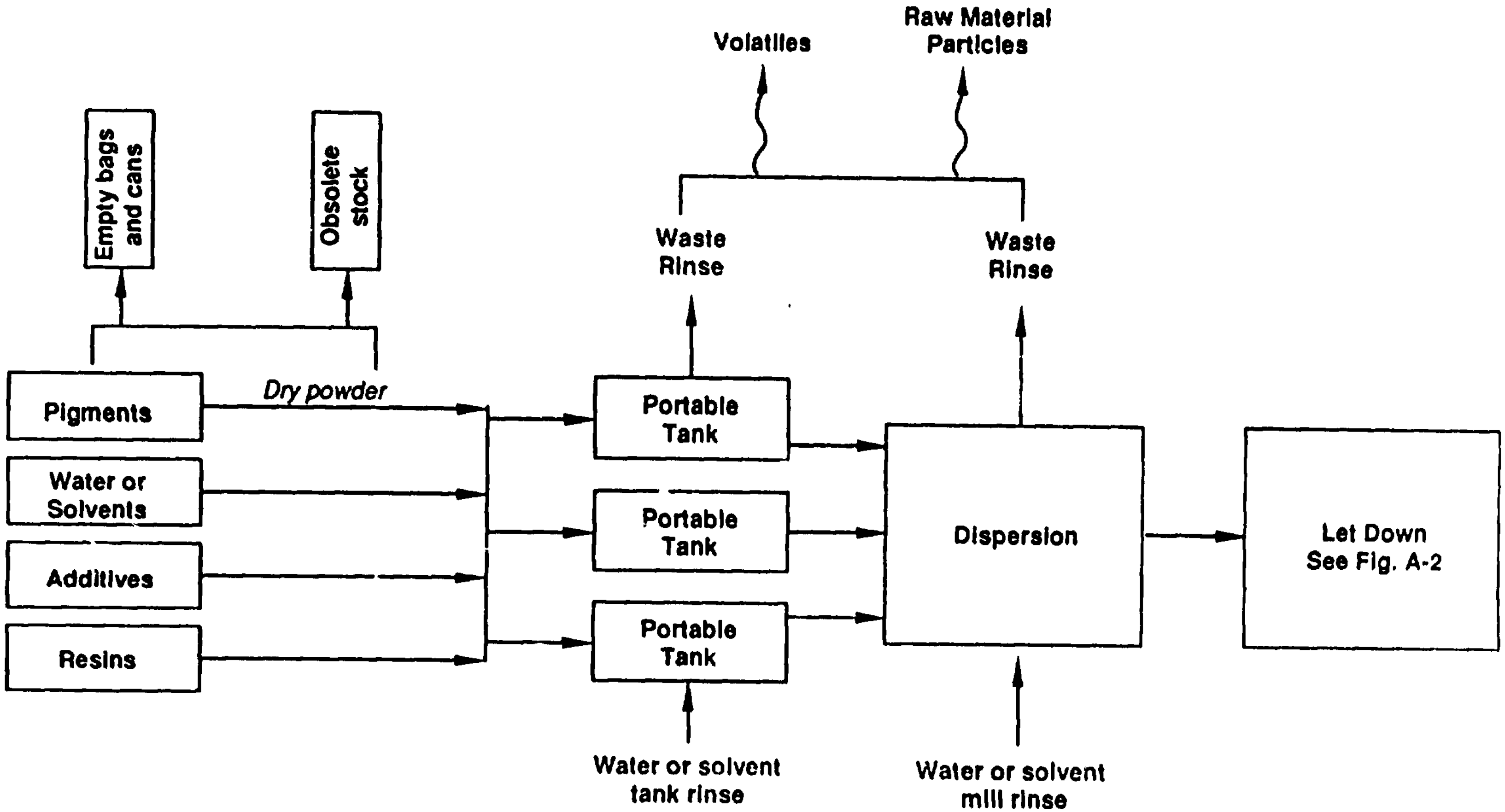
Total one-time capital costs for improvements to the wastewater treatment plant are $ 331,000. (Note that these improvements are similar to those in the off-site sludge disposal alternative however including extra process equipment necessary to thicken recycled sludge to the consistency needed to be used in a recycled paint product.)

Operating costs and revenues resulting from wastewater treatment with sludge recycled to a product are as follows:

- $ 3,800 / year increase in utilities cost;
- $ 23,600 / year increase in catalyst and chemicals;
- $ 30,000 / year increase in O & M labor cost; and,
- $ 160,000 / year revenues from marketable by-products.

Net operating savings are $ 102,600 / year.

Figure A-1
Dispersion and Let-Down Steps - Prevalent Route



WO#	Drawn By / Date: A. Della Camera 10.25.90	Checked By / Date: K. Klaber 10.25.90	Notes:
B2001.00.01	Revised By / Date: P. MacAllen 10.26.90	Checked By / Date: K. Klaber 10.26.90	

Figure A-2
Let Down Operation

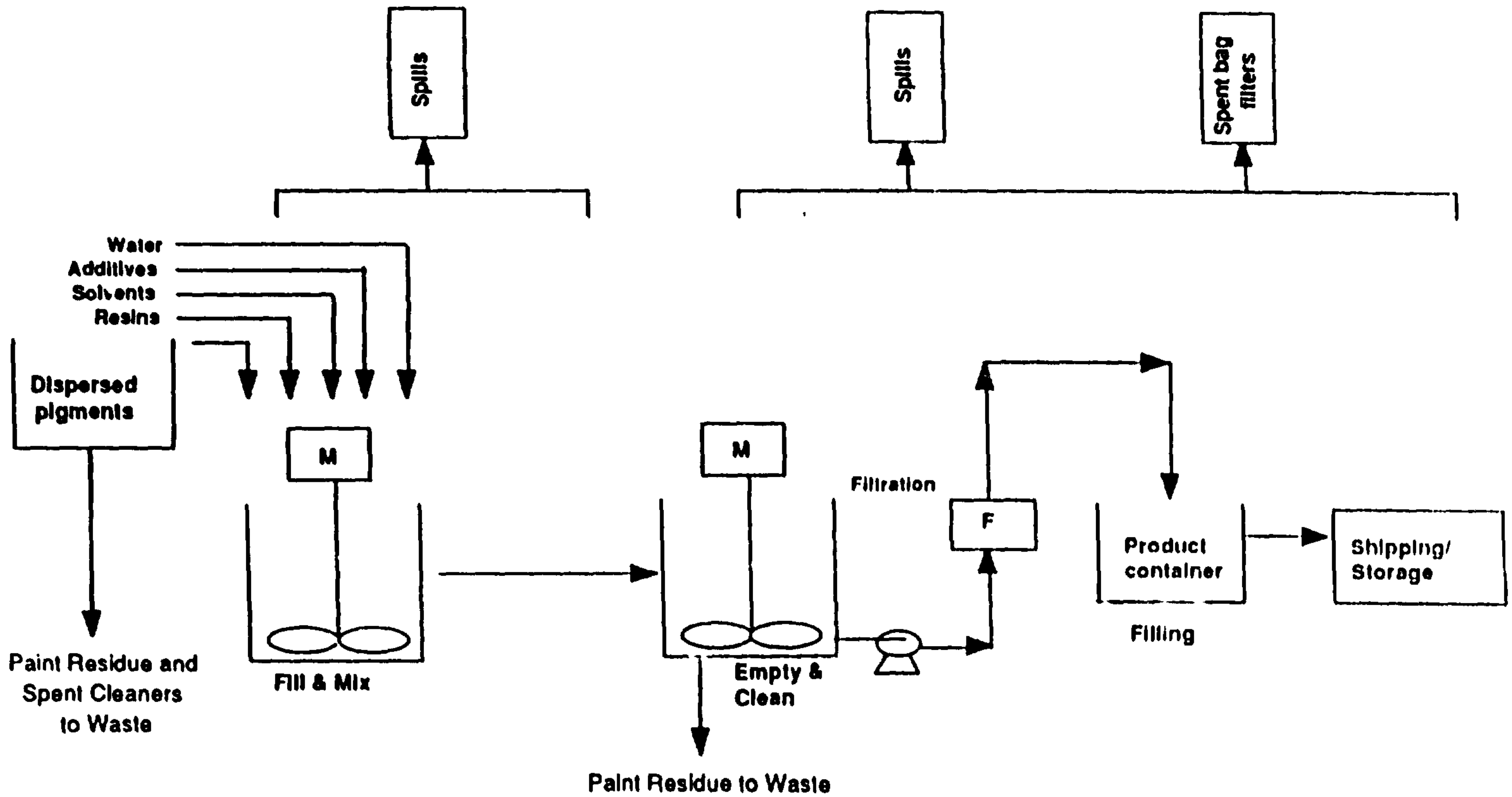


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Figure A-3
Dispersion and Let-Down Steps - Prevalent Route

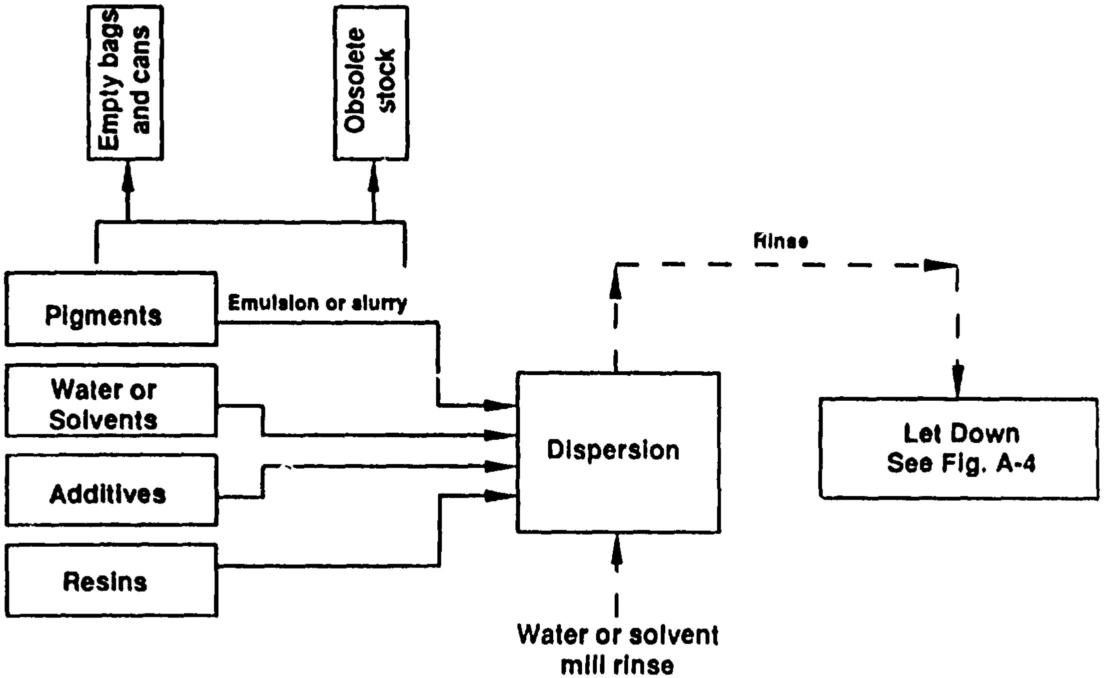

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Figure A-4
Let Down Operation

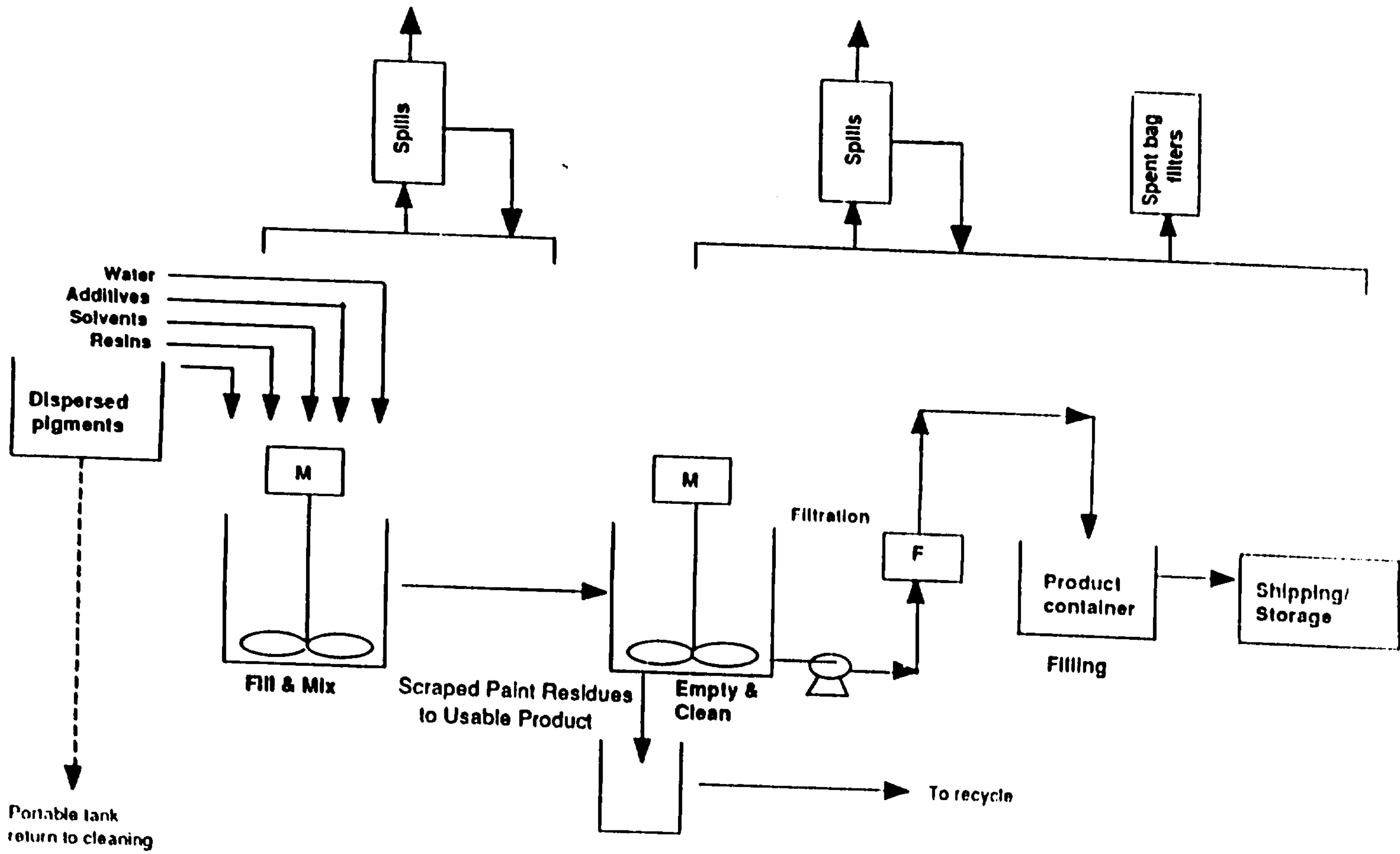

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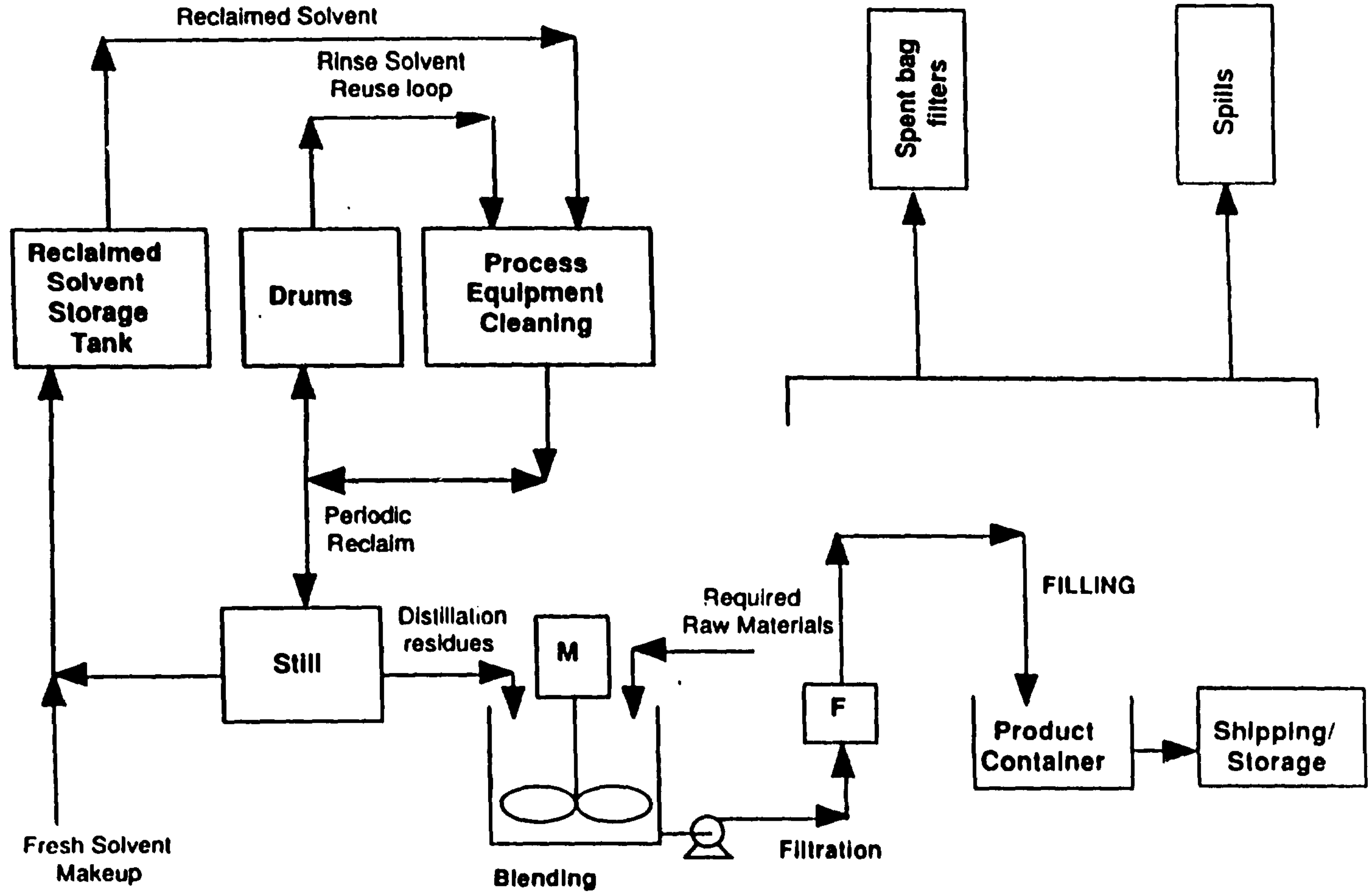
Figure A-5
Management of Solvent Cleaning Waste



WO# B2001 00 01	Drawn by / Date: E. Knoplle 10/25/90	Checked by / Date: K. Klaber 10/25/90	Notes:	The ERM Group
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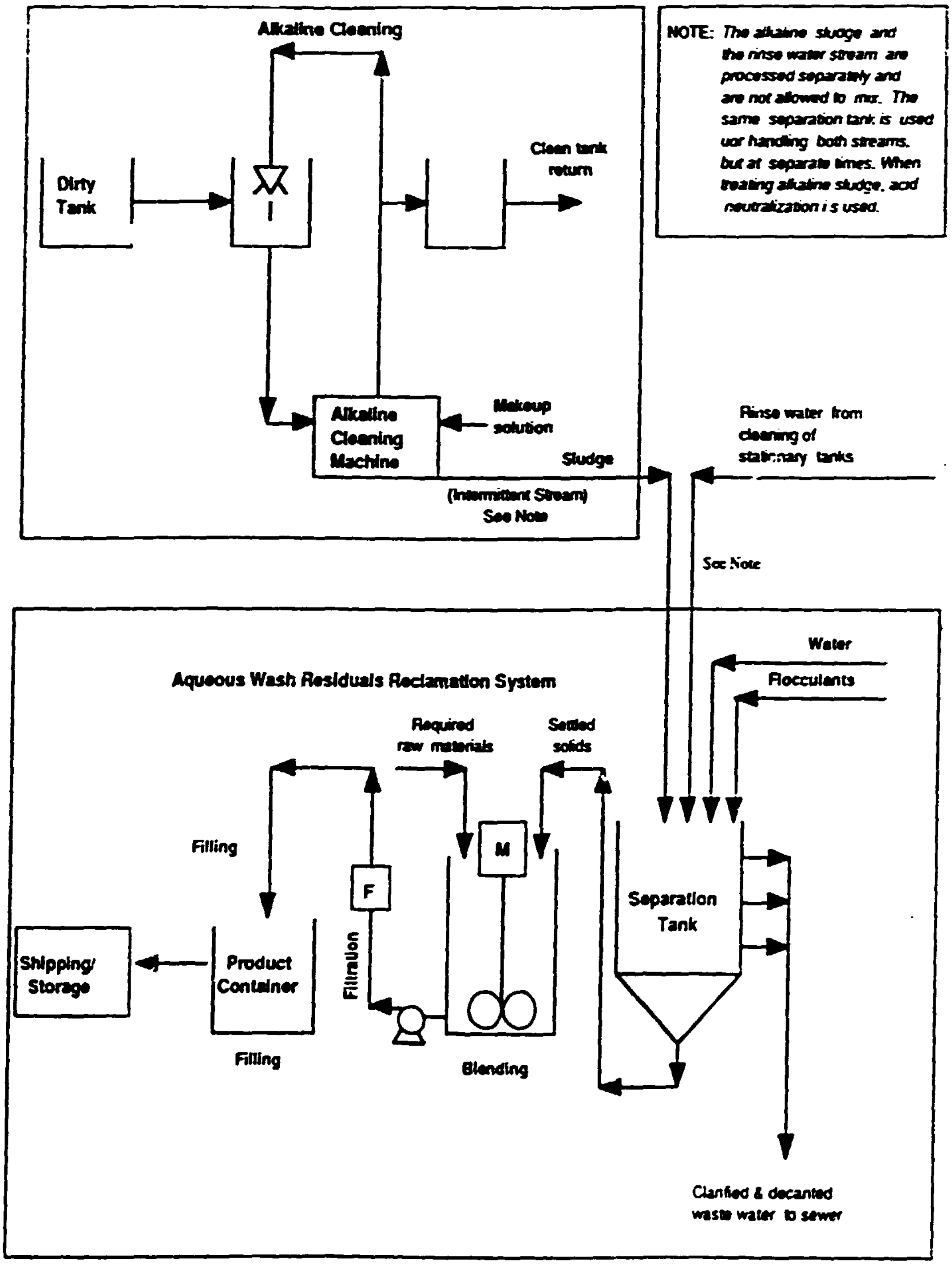
Figure A-6
Alkaline Cleaning of Portable Tanks and Aqueous Wash Residuals Reclamation



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Economics of On-Site Distillation

Installation Costs

Capital Cost, still, PRI Model SC-400 with autofill and cycle complete shutoff	$ 32,150
Freight Cost (a)	$ 1,930
Tax (b)	$ 2,090
Installation (labor plus supplies), 50 ft. of 1" pipe for cooling water and two explosion-proof conduits	$ 3,500
Total Installed Cost	**$ 39,670**

Current Annual Disposal Costs

Recycling costs @ $160/ton	$ ______
Total Disposal Costs	**$ ______**

On-Site Distillation
Annual Incremental (Savings)* Cost

Recovered solvent savings (c)	($ ______)
Disposal costs (d)	$ ______
Labor (e)	$ ______
Other (utilities) (f)	$ ______
(Savings) Cost	**$ ______**

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* Parentheses denote savings.

(a) Estimated as 6 % of capital cost.

(b) 6.5 % sales tax.

(c) The solvent is assumed to be MEK at a market cost of $0.30/gal with 90% solvent recovery.

(d) Incineration of distillation residues @ $200/ton assumed, and a 90 % solvent recovery process.(10% solids residue)

(e) Estimated for 40 hr/wk @ $9.00/hr.

(f) Based on a still operating cost of $0.30/gal of recovered solvent.

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ECONOMIC EVALUATION WORKSHEET

	CAPITAL INVESTMENT	CAPITAL AMMORT-IZATION*	ANNUAL O & M	TOTAL ANNUAL COST
I. SOLID WASTE (SOLVENT)				
A. No action (legal delay)	----------------	------------	------------	------------
B. Off-site recycling	----------------	------------	------------	------------
C. On-site recovery	----------------	------------	------------	------------
		NET COST (SAVINGS)		($_____)
II. AIR POLLUTION (PIGMENTS)				
A. No action (legal delay)	----------------	------------	------------	------------
B. Baghouse	----------------	------------	------------	------------
C. Slurry usage	----------------	------------	------------	------------
	NET COST OVER NO ACTION			$ _________
III. WASTEWATER				
A. No action (legal delay)	----------------	------------	------------	------------
B1. Water treatment - Off-site sludge disposal	----------------	------------	------------	------------
B2. Water treatment - Sludge recycle to product	----------------	------------	------------	------------

TOTAL INVESTMENT $________ NET COST (SAVINGS) OVER NO ACTION $_________

ANNUAL COST (SAVINGS) I.?., II.?, III.? $_________

* Use capital recovery factor of 0.15976 (20 years @ 15%)

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ECONOMIC EVALUATION WORKSHEET-ANSWER KEY

	CAPITAL INVESTMENT	CAPITAL AMMORT-IZATION*	ANNUAL O & M	TOTAL ANNUAL COST
I. SOLID WASTE (SOLVENT)				
A. No action (legal delay)	0	0	?	
B. Off-site recycling	0	0	35,760	35,760
C. On-site recovery	39,670	6338	23,190	29,528
			NET SAVINGS	($ -6,232)
II. AIR POLLUTION (PIGMENTS)				
A. No action (legal delay)	0	0	?	
B. Baghouse	50,000	7,988	(- 956)	7,032
C. Slurry usage	0	0	47,000	47,000
		NET COST OVER NO ACTION		$ 7,032
III. WASTEWATER				
A. No action (legal delay)	0	0	?	
B1. Water treatment - Off-site sludge disposal	269,000	42,975	79,200	122,175
B2. Water treatment - Sludge recycle to product	331,000	52,880	(- 102,600)	(- 49,720)
TOTAL INVESTMENT	$ 420,670	NET SAVINGS OVER NO ACTION		(- $48,920)
ANNUAL COST (SAVINGS)		I.C., II.B, III.B2		(- $ 48,920)

* Use capital recovery factor of 0.15976 (20 years @ 15%)

Economics of On-Site Distillation-ANSWER KEY

Installation Costs	
Capital Cost, still, PRI Model SC-400 with autofill and cycle complete shutoff	$ 32,150
Freight Cost (a)	$ 1,930
Tax (b)	$ 2,090
Installation (labor plus supplies), 50 ft. of 1" pipe for cooling water and two explosion-proof conduits	$ 3,500
Total Installed Cost	**$ 39,670**
Current Annual Disposal Costs	
Recycling costs @ $160/ton	$ 35,760
Total Disposal Costs	**$ 35,760**
On-Site Distillation Annual Incremental (Savings)* Cost	
Recovered solvent savings (c)	($ 12,069)
Disposal costs (d)	$ 4,470
Labor (e)	$ 18,720
Other (utilities) (f)	$ 12,069
(Savings) Cost	**$ 23,190**

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* Parentheses denote savings.

(a) Estimated as 6 % of capital cost.

(b) 6.5 % sales tax.

(c) The solvent is assumed to be MEK at a market cost of $0.30/gal with 90% solvent recovery.

(d) Incineration of distillation residues @ $200/ton assumed, and a 90 % solvent recovery process (10% solids residue).

(e) Estimated for 40 hr/wk @ $9.00/hr.

(f) Based on a still operating cost of $0.30/gal of recovered solvent.