Pinellas County
Pollution Prevention Program

Aerospace Information Packet

Department of Environmental Management
Pollution Prevention and Resource Recovery Section

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Clearwater, FL 33756

PINELLAS COUNTY POLLUTION PREVENTION PROGRAM
AEROSPACE INFORMATION PACKET

PURPOSE

This packet was designed to assist businesses in the aerospace industry with waste minimization. You can use the enclosed information to conduct a self-audit and identify opportunities to reduce unnecessary wastes and pollution costs.

What is Pollution Prevention?

Pollution Prevention is any activity that results in the reduction or elimination of waste at its source. **Reducing wastes and pollution can reduce operating costs and increase your profits.** Pollution prevention activities can include changes in production technology, materials, processes, operations or procedures, or the use of in-process, in-line, or closed-loop recycling. Actual disposal is only considered as a last resort. Pollution prevention is not de-watering, dilution, evaporation, waste burning or shifting, off-site recycling or other method of end-of-pipe management of waste.

Instructions:

1. Read the information packet
2. Identify your business' wastestreams
3. Identify potential pollution prevention measures provided in this packet that may work for your business
4. Evaluate any P2 measures before you put them in place. Consider economic feasibility, productivity effects, and long-term usefulness.
5. For assistance, contact the Pollution Prevention and Resource Recovery Section at 464-4761.

This packet contains:

1. POLLUTION PREVENTION PROGRAM BROCHURE

The brochure is an introduction to the program and provides a summary of the benefits of pollution prevention (P2).

2. POTENTIAL AEROSPACE WASTESTREAMS AND ASSOCIATED POLLUTION MEDIA

Over 300 wastestreams have been associated with the aerospace industry. Operations can include stripping, painting, halogenated solvent cleaning, fiberglass fabrication, chrome plating, and pc board fabrication. What are the wastestreams that these operations may create and what media are affected? Identifying where the wastes may end up will provide you a measuring point to help you monitor your waste reduction and calculate savings.

3. AEROSPACE OPERATIONS AND ASSOCIATED WASTESTREAMS

What processes or chemicals create wastestreams? What wastestreams are associated with each process? The first step toward waste minimization is to identify the source that created the waste. The table identifies common waste-generating processes and associated wastestreams. Use the information to help you identify your processes. Once you identify your processes, ask yourself the following questions:

- What chemicals and wastes are associated with this process?

- What properties help me meet my operational requirements (ie. cleans quickly, little residue, water soluble, compatible with my product material, low "costs", etc.)
- Is there a safer chemical or material that will do the same job at the same or lower cost/unit basis and reduce wastes?

4. POTENTIAL POLLUTION PREVENTION MEASURES FOR THE AEROSPACE INDUSTRY

This is the first step to finding a safer material or process technology. The measures identify potential best management practices (BMPs), changes to production processes or equipment, and potential chemical substitutes. Consider potential measures that may work for your business. Ask questions such as "Is the measure economically feasible and does it apply to my particular operation?" The measures are only recommendations. You must consider your operational requirements before implementing a change.

5. POLLUTION PREVENTION CASE STUDY COMPENDIUM

What are businesses with similar operations to yours doing to reduce their wastes and operational costs? Pollution Prevention is the key! The compendium includes the following case studies:

Solvent Use Reduction at Kilmartin Tool Company

Kilmartin reduced chlorofluorocarbon (CFC) usage by more than 80%, saving $5,000 in CFC purchase costs. The reduction resulted from a simple housekeeping change.

Replacing Methylene Chloride Degreasing: A Case Study

Parker Hannifin Corporation eliminated the use of methylene chloride through the purchase of an aqueous parts washer. A $106,395 savings in material, labor, and maintenance costs resulted.

TVA 12: Vehicle Seating

A seat manufacturer substituted a water wash system for a trichloroethylene degreaser, water-based paint for lacquer to eliminate the need for toluene paint thinner, and improved overall solid waste reduction and recycling. The need for trichloroethylene and toluene was eliminated, hazardous waste was reduced by 147,000 lbs/yr ($50,000/yr savings), solid waste disposal costs were reduced by 75% ($45,000/yr savings), and raw material costs were reduced 10% annually.

Alternatives for Cold Cleaning and Wipe Solvent Operations

Smith & Wesson replaced TCA cold immersion degreasing with an aqueous drum top washer and agitated parts washer. TCA emissions were virtually eliminated. $6,900 is being saved annually as a result of the change.

The case studies are intended to help you find a starting point for waste reduction. Additional studies are available from the Pollution Prevention Program.

6. DESIGN FOR THE ENVIRONMENT (DFE)

Additional help is available for the aerospace industry. Design for the Environment (DfE) works with both large and small businesses on a voluntary basis to assist in waste reduction. DfE is assisting the aerospace industry in searching for solvent and chemical substitutes. The packet article on DfE summarizes what the program can do for your business.

7. ADDITIONAL RESOURCES

Now that you have made a commitment to waste reduction, what resources are available to help you find cost-effective alternatives and answers to your questions? There are several resources available to your business to assist you in pollution prevention. In addition, our pollution prevention program can assist you at no charge and participation is voluntary.

REMEMBER..

Effective pollution prevention (P2) measures can reduce your operational costs, hazardous waste-related liability, worker exposure to hazardours chemicals, and improve your bottom line. Pre-testing P2 ideas can eliminate unnecessary loss of capital expenditures on an idea that may not prove viable for your particular needs. Ask yourself the following questions before implementing a new prevention measure:

- What new wastestreams will be created and how will they be handled?
- Are there any health or safety risks associated with the new materials?
- What is the effect on product quality and production?
- What experiences have other members of my industry had with this alternative?

The same prevention idea that worked for one business may not necessarily work for yours. **Trouble-shoot all prevention ideas first before you put them in place!**

Always consider your facility's specific needs and requirements before using any of the suggestions offered in this packet.

POTENTIAL AEROSPACE WASTESTREAMS AND ASSOCIATED POLLUTION MEDIA

INDUSTRY-RELATED PROCESS	WASTESTREAMS	SOLID WASTE	GROUND-WATER	WASTE-WATER	AIR
Stripping Operations	Solvent-laden Rags	X			X
	Vapor Emissions				X

	Spills	X	X	X	X
	Spray Guns			X	X
	Coating Lines			X	X
	Hazardous Wastewater			X	
	Metal Particulates				X
	Incinerator Emissions				X
	Leaks		X	X	X
Halogen Solvent Cleaning	Waste Solvent Evaporation				X
	Solvent Carryout				X
	Solvent Bath Evaporation				X
	Spills	X	X	X	X
	Spray Evaporation				X
	Exhaust Streams				X
	Leaks		X	X	X
Fiberglass Fabrication Operations	Emissions of VOCs				X
	Solvent Cleaning of Tools		X	X	X
	Spent Emulsifier	X	X	X	
	Uncatalyzed Resin	X		X	
	VOCs from Resin Surface				X
	Curing Resin Evaporation				X
	Particulate Matter				X
INDUSTRY-RELATED PROCESS	WASTESTREAMS	SOLID WASTE	GROUND-WATER	WASTE-WATER	AIR

Chrome Plating	Cyanide Wastewaters			X	
	Acid Mist Emissions				X
	Alkaline/Acid Solutions			X	
	Spent Solvents	X		X	X
	Spent Process Baths			X	X
	Process Rinsewaters			X	
	Process Sludges	X			
	Wastewater Sludges	X			
	Spent Metal Working Fluids	X		X	
	Lubricating/Cutting Oils	X		X	
PC Board Fabrication	Waste Treatment Sludges	X			
	Metals (Cu,Cr,Pb,etc.)	X		X	X
	Alkaline/Acid Cleaning			X	X
	Spent Process Baths			X	X
	Copper Sulfate Crystals	X			
	Halogenated Solvents	X		X	X

AEROSPACE OPERATIONS
AND
ASSOCIATED WASTESTREAMS

OPERATION	WASTE-GENERATING PROCESS	WASTESTREAMS*
Stripping	Cleaning (solvents such as TCA, TCE, methylene chloride, MEK)	Line cleaning solutions Solvent-laden Rags Transfer Spills Vapor Emissions
	Primer (surface coatings to protect parts)	Vapor Emissions Incinerator Emissions Metal Particulates (Cd, Cr) Coating Lines Hazardous Wastewater
	Topcoat (coatings for decorative purposes)	Vapor Emissions Incinerator Emissions Metal Particulates (Cd, Cr,Se) Coating Lines Hazardous Wastewater
	Depainting (methylene chloride)	Paint chip particulates Spent Chemical Strippers Solvent Emissions
	Chemical Milling Maskant	Incinerator Emissions Coating Dip Tanks Spray Equipment Maskant
	Handling & Storage of Wastes (spent MEK, acetone, solvents; sludges, waste paints)	Spills Leaks Open Container Emissions Heavy Metal Sludge
Halogenated and Non-halogenated Solvent Cleaning	Degreasing (commonly use methylene chloride, MEK)	Waste Solvent Evaporation Solvent Carryout Solvent Bath Evaporation Spray Evaporation Exhaust Streams Leaks
	Raw Material Transfer (cleaning chemicals, oils, solvents)	Solvent Emissions Spills
OPERATION	WASTE-GENERATING PROCESS	WASTESTREAMS*

Chrome Plating	Surface Preparation/ Cleaning/Degreasing (strippers, halogenated solvents)	Acid/Alkaline Solutions Spent Metal Working fluids Spent Solvents
	Electroplating/Electroless Plating (involves use of nickel & other heavy metals, cyanide)	Cyanide Wastewaters Process Rinsewaters Process Sludges Wastewater Sludges
	Anodizing (strong acids)	Process Rinsewaters Acid Gas Emissions
	Coating (chromium is commonly used in the coating process)	Process Rinsewaters Process Sludges Chromium Wastewaters Chromium Particulates Wastewater Sludges
	Paint Stripping (thinners, chemical strippers)	Paint Residues Sludges Emissions of VOCs
	Pickling (chromic acid)	Spent Process Baths Spent Chromic Acid
PC Board Fabrication	Activation	Solvent Emissions
	Plating	Metals (Cu,Cr,Pb,etc.)
	Imaging	Alkaline/Acid Cleaning
	Resist	Spent Process Baths
	Etching (ferric chloride, acids)	Copper Sulfate Crystals Waste Treatment Sludges Metals (Cu,Cr,Pb,etc.)
	Stripping (acids)	Spent Process Baths
	Soldering	Lead wastes
	Cleaning (halogenated solvents for cleaning & drying boards)	Alkaline/Acid Cleaning Halogenated Solvents For Cleaning & Drying Boards

OPERATION	WASTE-GENERATING PROCESS	WASTESTREAMS*
Fiberglass Fabrication	Mold Cleaning (typically uses MEK, acetone)	Emissions of VOCs Spent Solvent Solvent Cleaning of Tools
	Fiber Chopping (glass fibers)	Particulate Matter

	Raw Material Transfer (chemicals, resins, solvents)	Spills Emissions of VOCs
	Resin Application (involves catalysts, resins, styrene)	Spent Emulsifier Uncatalyzed Resin Resin Evaporization
	Curing (resins, catalyst)	VOCs From Resin Surface Curing Resin Evaporation
	Hand Rolling (woven fiberglass sheets)	Hazardous Solid Waste

POTENTIAL POLLUTION PREVENTION MEASURES FOR THE AEROSPACE INDUSTRY

Facility Modifications

- Improve material tracking & inventory practices
- Improve material usage, handling, & storage
- Improve scheduling batch production to reduce tank cleaning frequencies
- Recover copper sulfate from etching & stripping processes by cooling & crystallization
- Substitute drip pans for rinse tanks in circuit board facility
- Utilize ion exchange metal recovery to reduce sludge production

Electronic/Final Assembly

- In-line solvent recovery on vapor degreasing
- Extend solvent life by avoiding unnecessary solvent additions
- Recycle glycol coolant & hydraulic oil
- Use low VOC coating operations
- Install halogenated solvent recovery system
- Frequently inventory & reduce use of shelf-life sensitive material to save material, money, & costs of disposal for outdated hazardous materials

Parts Painting

- Use water-based primers
- Use low VOC paints (or powder coatings) & solvents
- Use proportional mixers for multi-component paints
- Use fiber or deep bed air filters to replace water wall spray booths
- Use plastics beads or other mechanical method for paint stripping
- Use electrostatic paint application methods
- Use low-solvent topcoat paints
- Install solvent recovery system for waste paints & sludges
- Install oxidative destruction system for VOC emissions
- Use high volume, low pressure application technology

Solvent Cleaning

1. Equipment Modifications

- Install cleaning tank covers with an impervious material to prevent vapor loss
- Install a vapor level control device for sump shut-off if vapor level rises above chiller
- Increase freeboard space on tanks (freeboard ratio $\geq$ 0.75)
- Install freeboard chillers on tanks
- Slow speeds of parts removed from vapor zone (< 11Fpm for automated parts handling)
- Rotate parts to allow condensed solvent to be removed
- Use cleaning devices rather than chemicals to clean transfer lines
- Use super-heated vapor degreasers to facilitate drying and minimize solvent drag-out

2. Chemical Changes

- Use dry & non-solvent cleaning procedures when feasible
- Substitute less hazardous solvents (ie. petroleum solvents instead of chlorinated solvents) or alkali washes

C Use coolants that have a long life

3. Process Changes

C Use counter-current cleaning methods where possible
C Recover spent solvent on- or off-site
C Preclean parts by wiping, air blowers, or pre-dipping in cold mineral spirits
C Centralize and consolidate cold cleaning operations to minimize vapor losses
C Extend life of cleaners through filtration and replenishment
C Increase drain times for parts before & after washing to reduce dragout
C Remove sludge from cleaning tanks on a regular basis

Machine Shop

C Use water soluble coolants
C Use water-based cutting fluids
C Separate dye penetrants from water
C Consider ultrafiltration for water/organic mixtures
C Phase out flammable solvents & use water-based cleaners

Additionally, the Aerospace Industry may have metal finishing, plating, printed circuit board fabrication processes, and fiberglass fabrication.

Metal Finishing, Plating, & Printed Circuit Board Fabrication

1. Process Changes:

C Reduce dragout

- Decrease bath viscosity and/or decrease bath surface tension
- Lower the withdrawal rate of parts from a bath
- Increase the drain time over the plating tank
- Install drain boards, drip bars, & drip tanks
- Carefully rack & remove parts to minimize entrapment of bath materials
- Design parts to promote drainage (ie.- no cups or shelves)
- Design plating racks with a minimum surface area to promote drainage
- Use oil-free compressed air knives to free parts of plating films
- Use fog & spray rinses of deionized water to reduce wastestream contaminants

C Modify rinsewater

- Still rinse or drag-out tank
- Rinse tank mixing
- Install water supply control valves to regulate water feed rates
- Spray rinse to use impact & diffusion to wash parts & reduce water usage
- Fog rinse to reduce water usage by using air pressure to rinse
- Cascade rinsewater recycling
- Countercurrent rinse with multiple tanks to reduce rinse flows

C Maintain plating baths by removing impurities using filtering, activated carbon adsorption, chemical precipitation, and using deionized water for makeup and as rinsewater
C Dragout recovery of rinsewaters through evaporation of hot chromium baths, ambient temperature nickel baths, & metal cyanide baths
C Dragout recovery of rinsewaters through reverse osmosis of the following plating baths: acidic nickel, nickel sulfamate, copper pyrophosphate, Copper sulfate, nickel fluoroborate, zinc chloride, zinc sulfate, & cyanide baths for copper, zinc, & cadmium
C Use ion exchange process for purifying spent process baths, recovery of anodizing baths, &

dragout recovery of acid copper, acid zinc, nickel, tin, cobalt, & chromium baths

- Use electrodialysis to regenerate chromic acid etchant and drag-out recovery of rinsewaters (use with a still rinse tank)
- Use ultrafiltration as a wastewater treatment process for reduction of spent coolants, cleaners, & rinsewaters; to regenerate alkaline cleaners, coolants, or process baths
- Use electrolytic metal recovery
- De-water sludge by use of mechanical device (ie. centrifuges, filter presses, vacuum filters, sludge dryers)

2. Chemical Changes

- Chemical substitutes for Alkaline Cyanide Plating Baths include:

  - Zinc plating substitutes: ammonium or potassium chloride, acid sulfate, chloride, & fluoroborate baths
  - Cadmium plating substitutes: cadmium chloride & acid baths of cadmium oxide, sulfuric acid, distilled water & anionic compounds
  - Copper plating substitute: copper sulfate
  - Tin plating substitute: acid tin chloride

- Chromium plating bathsubstitution of hexavalent chromium solutions with trivalent chromium solutions reduce hexavalent chromium dragout concentrations
- Use sulfuric acid or hydrogen peroxide to substitute chromic acid in pickling solutions & bright dip
- Substitute cyanide cleaners with trisodium phosphate or ammonia
- Substitute sulfuric peroxide for persulfate in copper etchants
- Use treatment chemicals that produce less sludge (ie. caustic soda instead of lime)
- Use solvent alternatives (ie. alkaline cleaners, high pressure hot water washings, steam cleaning, mechanical blasting to replace chemical strippers)
- Recover & reuse spent solvents

The key to pollution prevention in PCB manufacturing is to minimize chemical dragout; minimize the amount of water used for rinsing; & the recovery, reuse, & recycle of copper.

Fiberglass Fabrication

1. Best Management Practices

- Control materials inventory to more efficiently utilize raw materials (ie. limit the amount of clean-up solvent issued to lamination employees per day)
- Localize & isolate high emission & hazardous waste-generating operations
- Confine gel coat applications
- Filter contaminated air by dry or wet filtration
- Incinerate or filter styrene emissions that cannot be prevented
- Control air flow & exhaust
- Use gloves to reduce the number of times employees must clean their hands
- Use containers with self-closing lids for work station clean-up solvents

2. Use of Chemicals

- Substitute acetone with solvents that dissolve resin, but do not evaporate as readily (ie. dibasic esters and Ship Shape)

- Use aqueous emulsifiers to separate resin. Aqueous emulsifiers do not evaporate & eliminate emissions

- Use additives for suppressing the release of styrene (Resin suppliers can provide information on various suppressors). ie. Catalysts such as benzoyl peroxide or using UV curing resins, low styrene resins
- Choose resins that reduce both the styrene and total monomer content to effectively reduce voc emissions
- Recover and recycle spent acetone and other clean-up solvents

3. Changes to Production Processes or Equipment

- Use air assisted airless spray guns or high volume low pressure spray guns for resin applications that require spray lay-up to reduce material losses due to excessive fogging, overspray, turbulence, and bounce-back
- Utilize fiber reinforcements that are presaturated with resins (prepregs) to practically eliminate the atomization of pollutants
- In-house resin impregnation would minimize external emissions and can be setup to feed saturated reinforcing materials directly to the molding operation
- Roller dispensing of resin reduces styrene emissions without requiring modifications in molds & materials. Catalyzed resins can be transferred to the molding surface to eliminate material losses from spray vaporization, fogging, overspray, turbulence, & bounce-back
- Utilizing a closed molding system such as vacuum bag molding or infusion reduces waste & emissions of styrene. Resins are confined until curing is complete

The above ideas are only suggestions for waste minimization. As with any new process or change, a facility needs to consider the following before implementing a change in chemicals or procedures:

- Technical feasibility & product quality
- Worker safety & retraining
- Waste handling & environmental impact

ADDITIONAL RESOURCES

Additional information on waste reduction is available through the following agencies:

Pinellas County Solid Waste	727-464-7500
Pinellas County Dept. of Environmental Management Pollution Prevention and Resource Recovery Section	727-464-4761
Florida Department of Environmental Protection	
Southwest Region Office	813-744-6100 ext. 389
Tallahassee Office	904-488-0300
Florida Small Business Assistance Program	800-722-7457
Waste Reduction Resource Center	800-476-8686
Pollution Prevention Information Clearinghouse	202-260-1023

Air Quality's Pollution Prevention Program is non-regulatory and assistance is free. Additional assistance is available by contacting our program at 727-464-4422.