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- Frequently inventory & reduce use of shelf-life sensitive material to save material, money, & costs of disposal for outdated hazardous materials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 ≥ 0.75)
C Install freeboard chillers on tanks

1. Equipment Modifications Continued

C Slow speeds of parts removed from vapor zone (< 11Fpm for automated parts handling)
C Rotate parts to allow condensed solvent to be removed
C Use cleaning devices rather than chemicals to clean transfer lines
C Use super-heated vapor degreasers to facilitate drying and minimize solvent drag-out

2. Chemical Changes

C Use dry & non-solvent cleaning procedures when feasible
C 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

C Use electrodialysis to regenerate chromic acid etchant and drag-out recovery of rinsewaters (use with a still rinse tank)

C Use ultrafiltration as a wastewater treatment process for reduction of spent coolants, cleaners, & rinsewaters; to regenerate alkaline cleaners, coolants, or process baths

C Use electrolytic metal recovery

C De-water sludge by use of mechanical device (ie. centrifuges, filter presses, vacuum filters, sludge dryers)

2. Chemical Changes

C 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 bath

Substitution 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