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DART/NIOSH
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NIOSH Perchloroethylene (PCE) Vapor Degreaser Study

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PCE Vapor Degreaser Study

OSHA asked NIOSH to study PCE vapor degreasing to determine:

- Vapor degreasing technology available.
- Associated engineering controls.
- Exposure levels associated with the different types of vapor degreasers.



Preliminary Study

- Literature search
- Halogenated Solvents Industry Alliance (HSIA)
- Institute for Research and Technical Assistance (IRTA)
- Degreaser manufacturers
- PCE Distributors



PCE USAGE

- 1991 – EPA estimated 2070 PCE vapor degreasers in use in the United States.
- 1998 – HSIA estimates 34 million pounds of PCE used for vapor degreasing.



Study Design Factors

- Industrial sectors
- Geographic Areas
- Degreaser equipment manufacturers
- Types of PCE vapor degreasers
- Size of units
- Vapor degreaser options



What Industries Use Vapor Degreasers?

Vapor degreasing is a small, essential part of many manufacturing and maintenance processes.

- Aircraft manufacturing
- Aircraft maintenance
- Medical devices
- Electronic circuitry
- Screws, nuts, bolts



Why use Vapor Degreasing?

- Parts cleaning
- Remove oils, dirt, polishing compounds or other surface contaminants prior to painting, welding or other manufacturing processes.
- Often solvents are used in place of water to prevent rusting or to clean difficult to reach areas, such as, interior surfaces.



Solvent Vapor Degreasing Process

- Solvent heated in a tank to near boiling point to generate vapor.
- Parts are placed in the vapor zone within the degreaser tank.
- Warm solvent vapor condenses on the cold part.
- Liquid condensate flushes contaminants from the part surface.
- Clean part is removed from the degreaser unit.



Types of Vapor Degreasing

Three types of vapor degreasers

- In-line degreasers (continuous)
- Open-top (batch)
- Airless vacuum (batch)



Study Included

- Open-top vapor degreasers (OTVD)
- Vacuum or airless/airtight vapor degreasers
- Continuous degreasers not included
 - Unable to identify a plant where this equipment was being used.



Open Top Vapor Degreasers Components

- **Solvent tank** - solvent heated to a boil.
- **Vapor zone** – area immediately above solvent tank where vaporized solvent is present.
- **Condensation coils** – located above vapor zone. Forms a sharply defined interface between the solvent and air above the coils.
- **Freeboard** - area between the condensation coils and the top of the degreaser. Provides additional control.

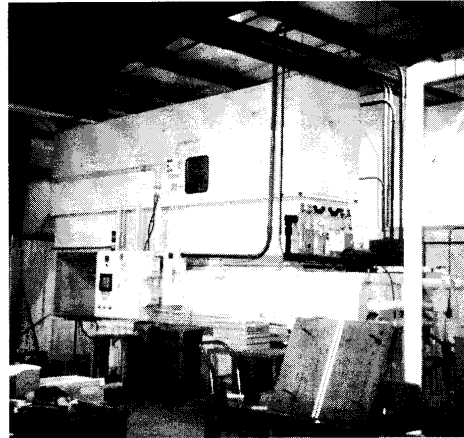
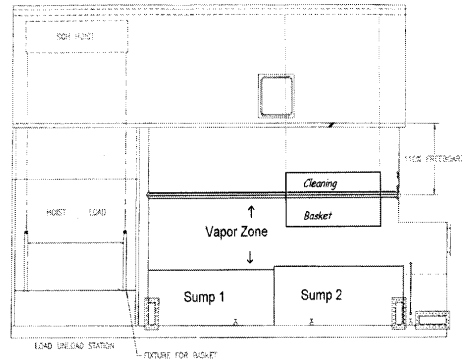


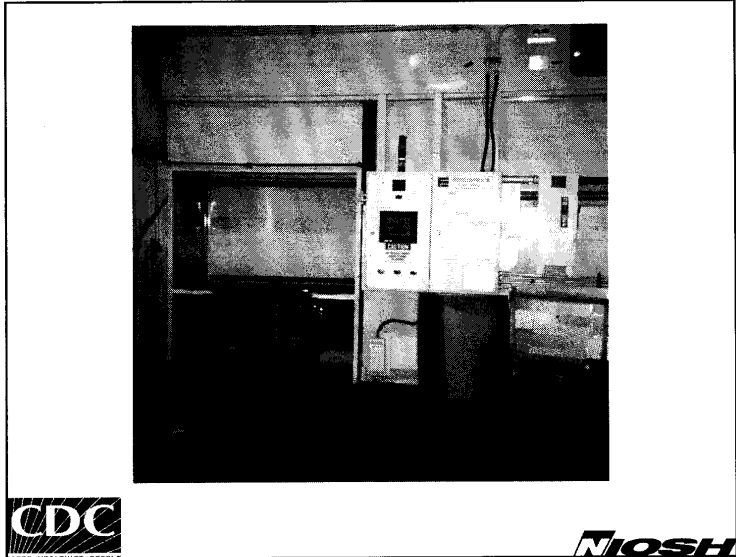
Auxiliary Equipment

- Water separators
- Solvent recovery stills
- Refrigerated freeboards
- Super heat coils
- Carbon absorption filters
- Handheld spray lances

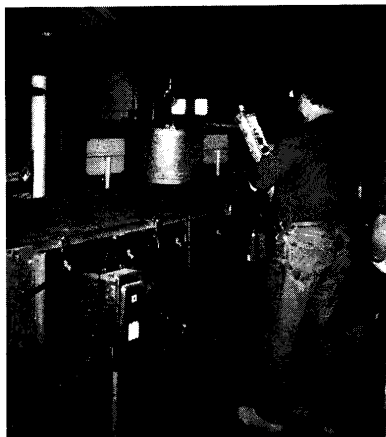
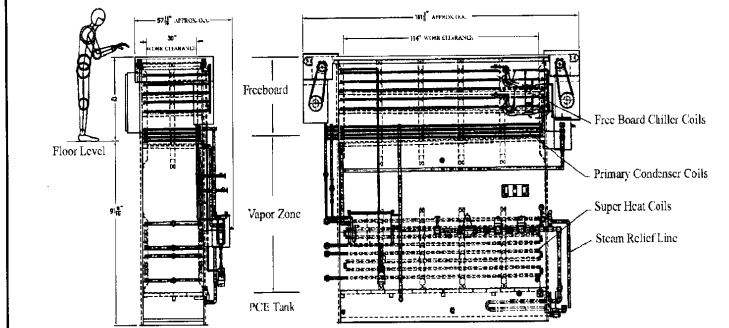


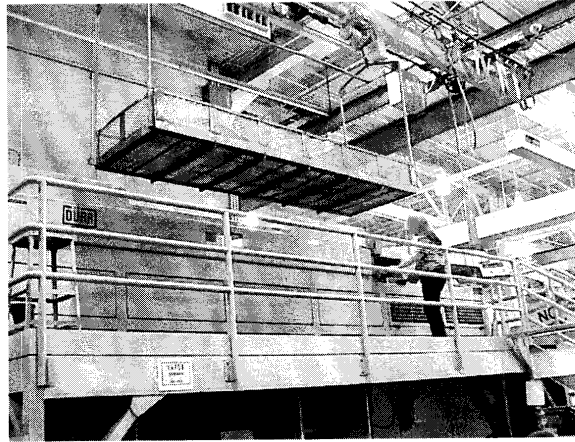
Automated/Enclosed OTVD





OTVD

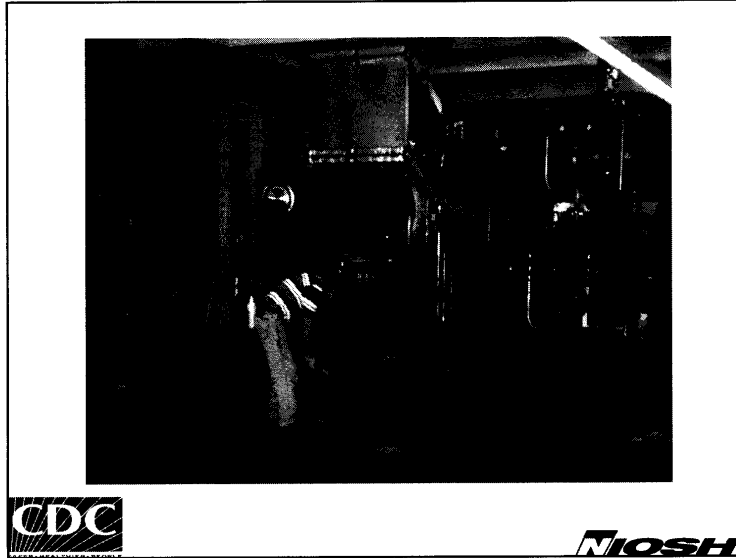
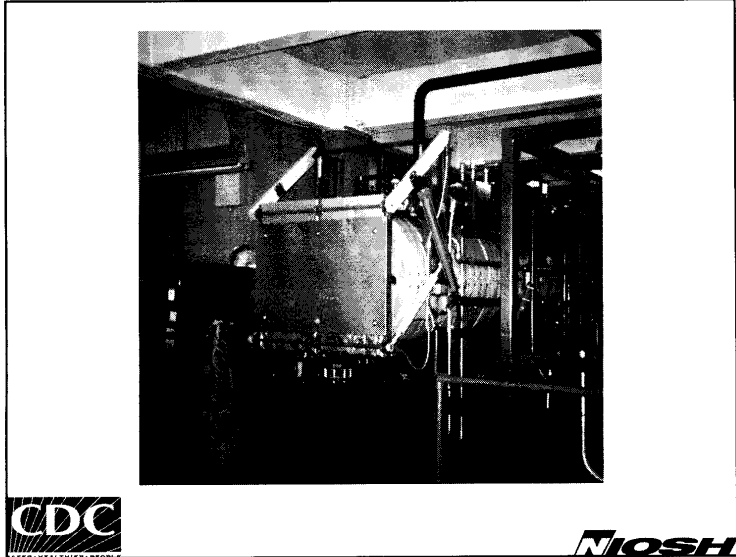




Airless/Airtight Vacuum Vapor Degreaser Components

- **Cleaning chamber** - parts placed here, chamber sealed.
- **Vacuum pumps** - system pressure reduced from 760 torr (atmospheric) to the operating pressure of less than 5 torr.
- **Solvent storage tanks** - kept at ambient temperature.
- **Vapor supply tank** - maintained at operating temperature.
- **Distillation** - jacketed pressure vessel, increases recovery of the cleaning solvent.
- **Condenser** - cools vapor, condensing to the liquid for spraying parts, keeps solvent storage tank at ambient temperature.





Sites Studied

- Site #1 – Aircraft manufacturer
- Site #2 – Heat exchangers and cooling systems
- Site #3 – Aircraft maintenance
- Site #4 – Parts cleaning, job shop



SITE #1 – Vapor Degreasers

Manufacturer	Type	Options
Serec	Vacuum	Solvent Still Carbon filter
Durr	OTVD	Solvent Still
Greco	OTVD	Manual Spray Lance



SITE #2 – #4, Vapor Degreasers

Manufacturer	Type	Options
Site #2 - Finishing Equipment	OTVD	Solvent Still Automated Enclosed
Site #3 – Detrex	OTVD	Solvent Still Spray Lance
Site #4 – Serec	Vacuum	Solvent Still Carbon Filter



Sampling Methods

- Charcoal tubes and passive badge samples.
- Collected in workers breathing zone.
- Area samples collected near degreasers.
- Charcoal tubes were attached via Tygon tubing to battery-operated sampling pumps.
- Charcoal tubes and passive badges were analyzed by NIOSH Method 1003.

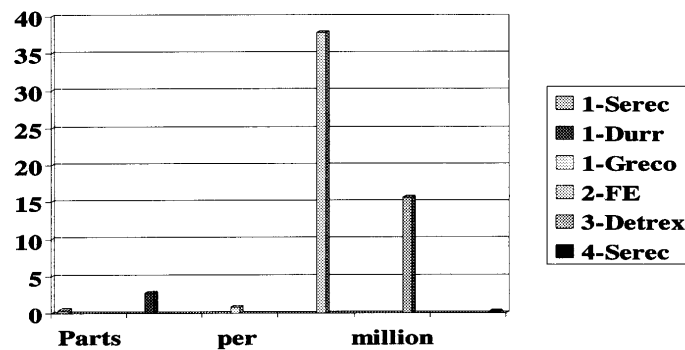


PCE RESULTS

<i>Site/Equipment</i>	<i>Personal BZ (ppm)</i>	<i>General Area (ppm)</i>
1 - Serec	0.08 – 0.4	0.15 – 1.5
Durr	0.55 – 2.8	0.51 – 0.99
Greco	0.09 – 0.76	8, 14
2 - Finish Equip.	23.8 – 37.8	NA
3 - Detrex	0.12 – 15.6	0.3, 1.9
4 - Serec	0.052 – 0.18	NA



PCE RESULTS



What Affected Worker Levels?

- Amount of time working at unit.
- Equipment maintenance.
- Ventilation (natural and general).
- Drafts (air movement) at loading station.
- Drag out – removing parts from degreaser, dragging PCE laden air with them.
- Parts and baskets coming out wet.
- Use of handheld spray lance.

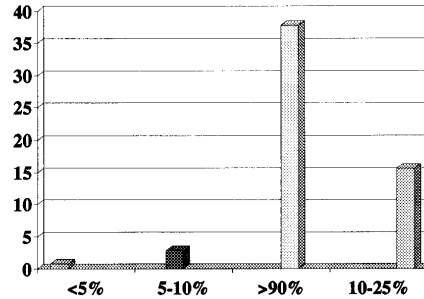


Time Working at Degreaser

Site No./Degreaser Type	Time Spent in Degreaser Area
1 - Vacuum (Large) 2 - Open-top (Large) 4 - Vacuum (Medium)	Entire shift. (~90-100%)
1 - Open-top (Small) 3 - Open-top (Medium)	Only during cleaning cycle. (~10-25%)
1 - Open-top (Large)	Operator Loaded unit and left degreaser area (<5-10%)



OTVD RESULTS vs. TIME (ppm) Site #1, #2, #3

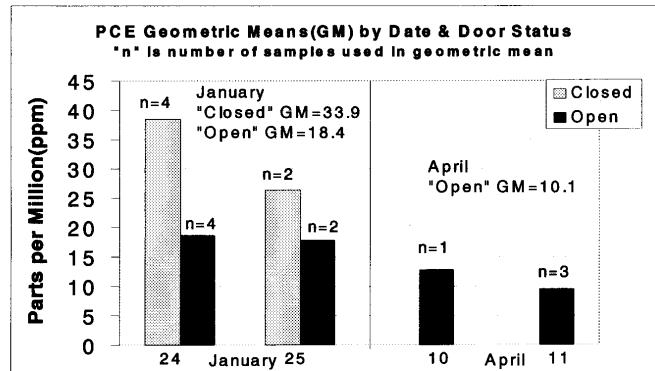


EQUIPMENT MAINTENANCE

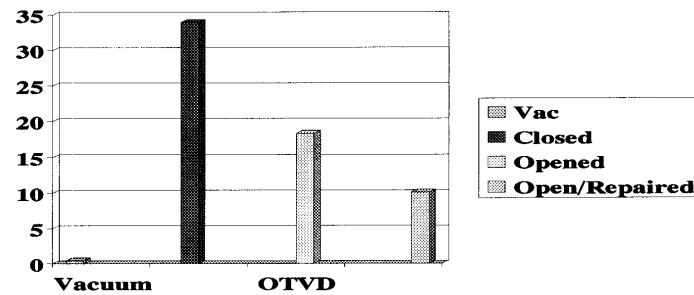
- A problem with both OTVD and Vacuum.
- Equipment often down, not usable due to malfunctioning equipment (e.g., chillers).
- At one site, OTVD unit down 64 days over a one year period and the first day of our visit.
- Vacuum unit down the entire site visit.
- Result in elevated employee exposures and productions delays.



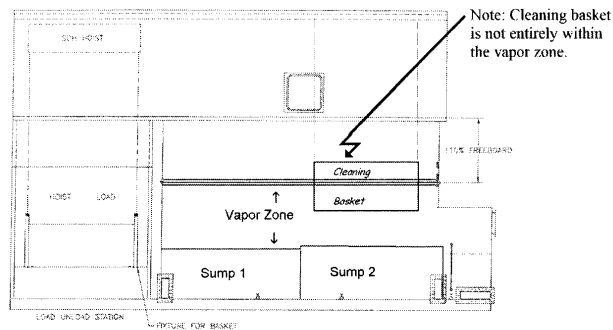
SITE #2 – PCE RESULTS



PCE RESULTS Geometric mean (ppm) Site #2 OTVD vs. Vacuum



Basket Outside Vapor Zone



SUMMARY

- Vacuum degreasers – conc. <1ppm
- OTVD – capable of conc. ~ 10
 - With proper maintenance
 - Good general ventilation
 - Good work practices
- OTVD – conc. > 30 ppm
 - Without proper maintenance
 - Good general ventilation
 - Good work practices.

