



Welcome to the CLU-IN Internet Seminar

OSC Readiness Presents...Electro-Plating Process, Cleanup, and Case Study

Sponsored by: EPA Office of Superfund Remediation and Technology
Innovation

Delivered: August 2, 2012, 1:00 PM - 3:00 PM, EDT (17:00-19:00 GMT)

Instructor:

James Mullins, Tetra Tech EM Inc. (James.mullins52@gmail.com)

Moderator:

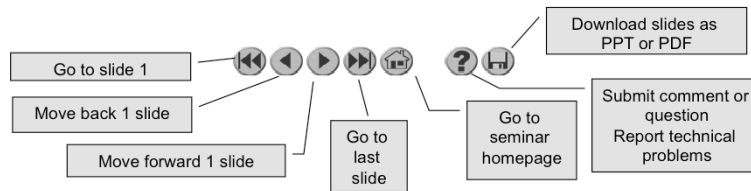
Jean Balent, U.S. EPA, Technology Innovation and Field Services Division (balent.jean@epa.gov)

Visit the Clean Up Information Network online at www.cluin.org

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Housekeeping

- Please mute your phone lines, Do NOT put this call on hold
- Q&A
- Turn off any pop-up blockers
- Move through slides using # links on left or buttons



- This event is being recorded
- Archives accessed for free <http://clu.in.org/live/archive/>

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Although I'm sure that some of you have these rules memorized from previous CLU-IN events, let's run through them quickly for our new participants.

Please mute your phone lines during the seminar to minimize disruption and background noise. If you do not have a mute button, press *6 to mute #6 to unmute your lines at anytime. Also, please do NOT put this call on hold as this may bring delightful, but unwanted background music over the lines and interrupt the seminar.

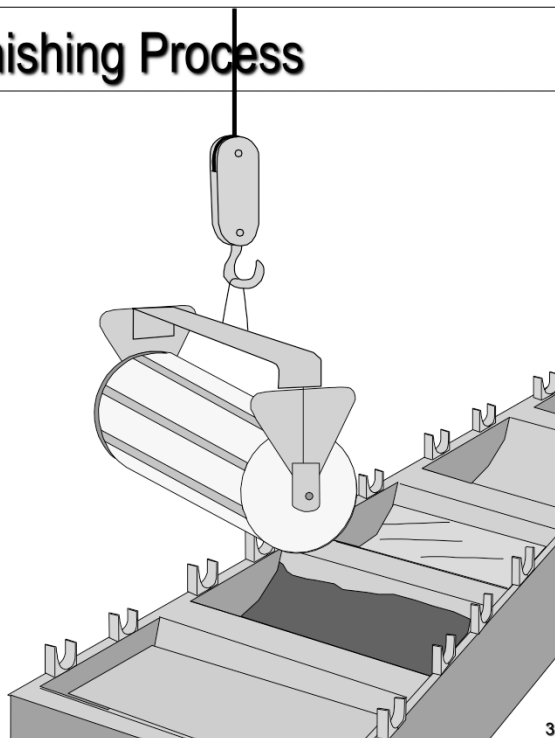
You should note that throughout the seminar, we will ask for your feedback. You do not need to wait for Q&A breaks to ask questions or provide comments. To submit comments/questions and report technical problems, please use the ? Icon at the top of your screen. You can move forward/backward in the slides by using the single arrow buttons (left moves back 1 slide, right moves advances 1 slide). The double arrowed buttons will take you to 1st and last slides respectively. You may also advance to any slide using the numbered links that appear on the left side of your screen. The button with a house icon will take you back to main seminar page which displays our agenda, speaker information, links to the slides and additional resources. Lastly, the button with a computer disc can be used to download and save today's presentation materials.

With that, please move to slide 3.

Metal Finishing Process



Barrel method electroplating



Metal Finishing Objectives

- **List key chemicals associated with metal finishing**
- **Describe basic metal finishing processes**
- **Describe electroplating process details**
- **List major modes of release to the environment**
- **Identify analytical methods useful for detecting metal finishing contaminants in the environment**

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Process Overview

- Billion of dollars per year
- Tens of thousands of businesses
- Both large and small businesses, from steel rolling mills and automotive manufacturing to "mom and pop" job shops



Zinc-plated screws
"galvanized"



Gold-plated jewelry clasps

Process Overview

- Metal surface preparation
- Surface protection and / or decoration
- Focus on electroplating
(Barrel method)



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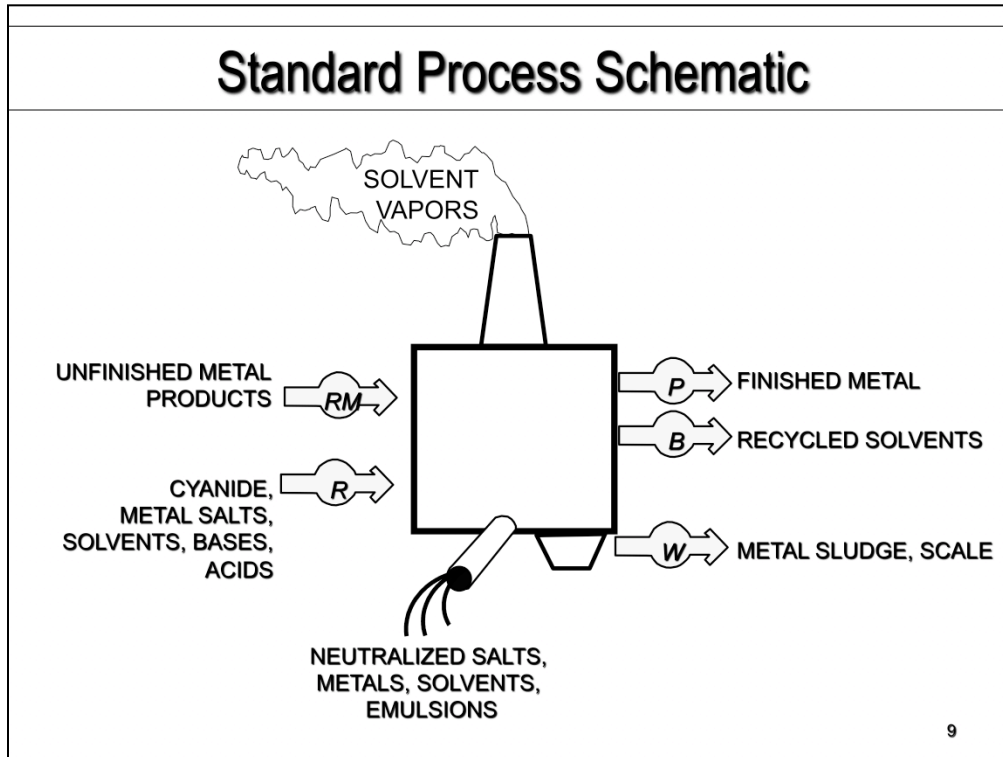
Key Chemicals	
<u>Solvents</u>	
Benzene	
TCE	
etc.	
<u>Coatings</u>	
Cadmium	
Chromium	
Cyanide	
etc.	
<u>Acids and Bases</u>	
HCL	
Caustic	

Specialty Electronic Parts - Rack Method



Cu, In, Ga, Se sequentially electroplated onto solar panels

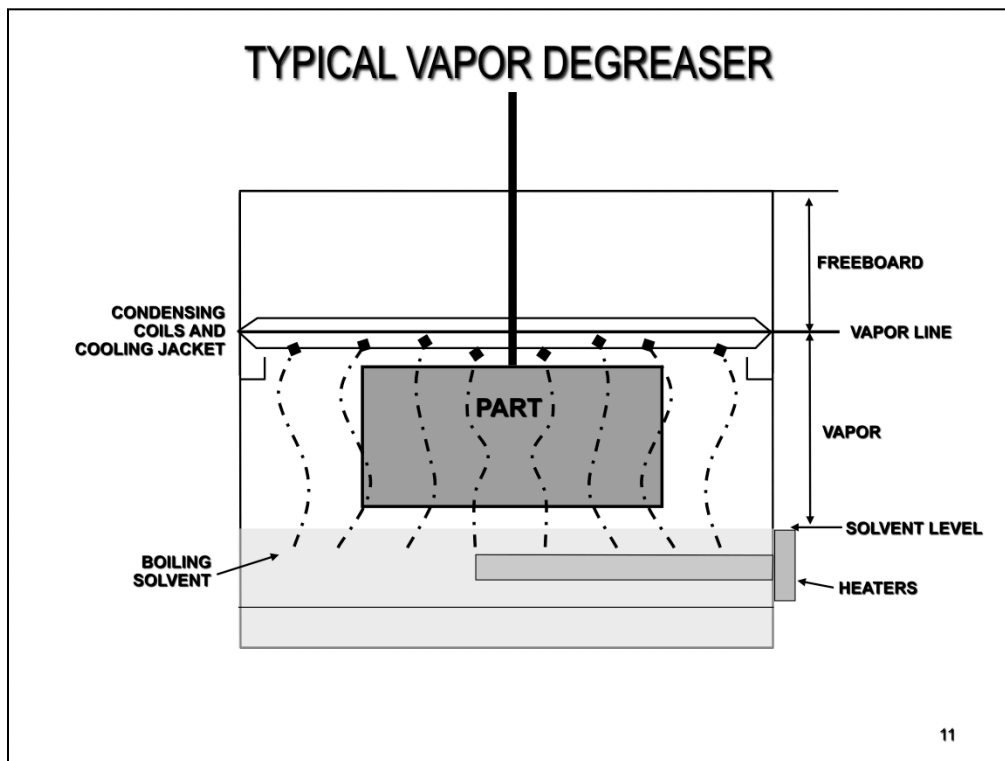
8



Process Details - Metal Surface Preparation

- **Physical modification**
 - De-scale, cut, shape, smooth
- **Surface oil removal**
 - Wipe, dip, vapor degrease
- **Final cleaning**
 - Detergent, acid, base, anodic, cathodic, ultrasonic

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Process Details – Cleaning / Degreasing

Solvents that are most used:

- Trichloroethylene**
- 1,1,1-Trichloroethane**
- Methylene chloride**
- Tetrachloroethylene (Perchloroethylene)**

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Process Details - Surface Protection / Decoration

Organic coatings

- Solvent based
- Water based
- 100% solids

Inorganic / metal coatings

- Physical deposition
- Chemical deposition
- Electrochemical methods

Process Details – Chemical Conversion Coating

- Conditions surface for painting or coating
- Uses chromates, phosphates, phosphoric acid, and hexavalent chromium

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Process Details - Anodizing

- **Electrochemical process**
- **Converts surface metal to insoluble oxide**
- **Uses chromic, sulfuric, or boric acids**



Chromic Acid Anodizing vat



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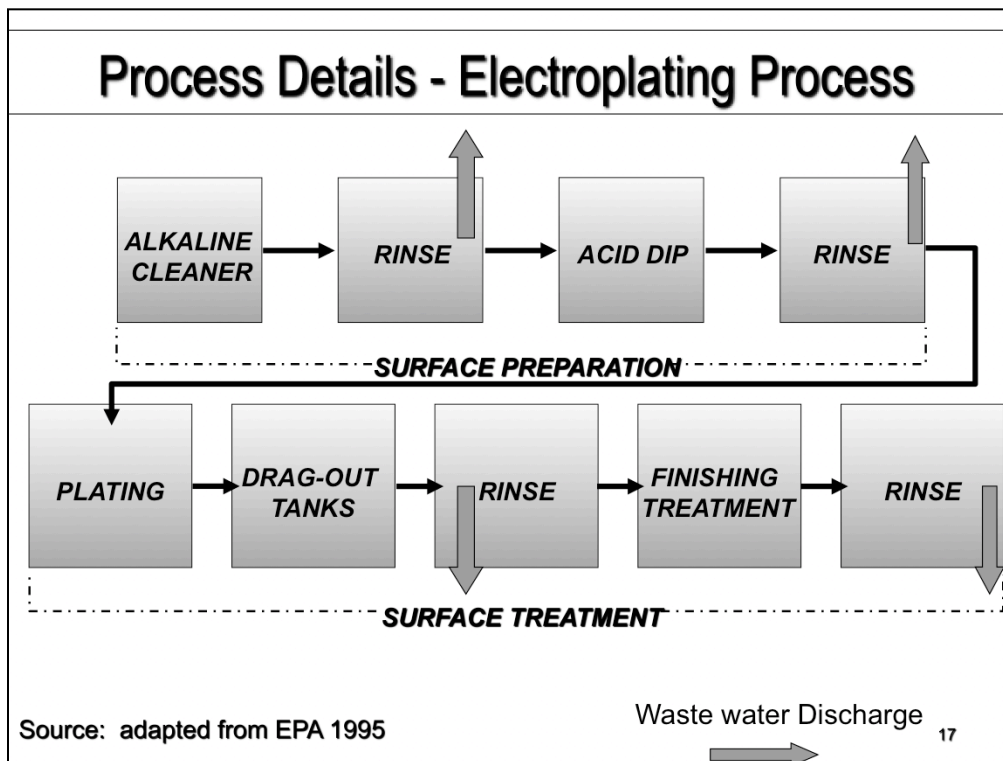
Process Details - Electroplating Process

- Electrochemical process
- Acid, alkaline, or neutral pH
- Uses metal salts, cyanides, brighteners, solid metal anodes
 - Cyanides keep metal ions in solution
 - Brighteners make surface more reflective



Fiber drums of ZnCN concentrate in abandoned plating shop

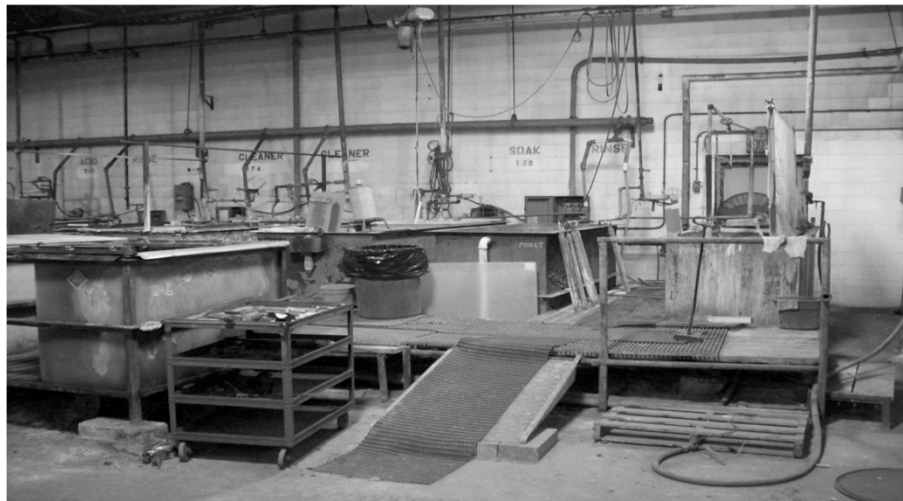
16



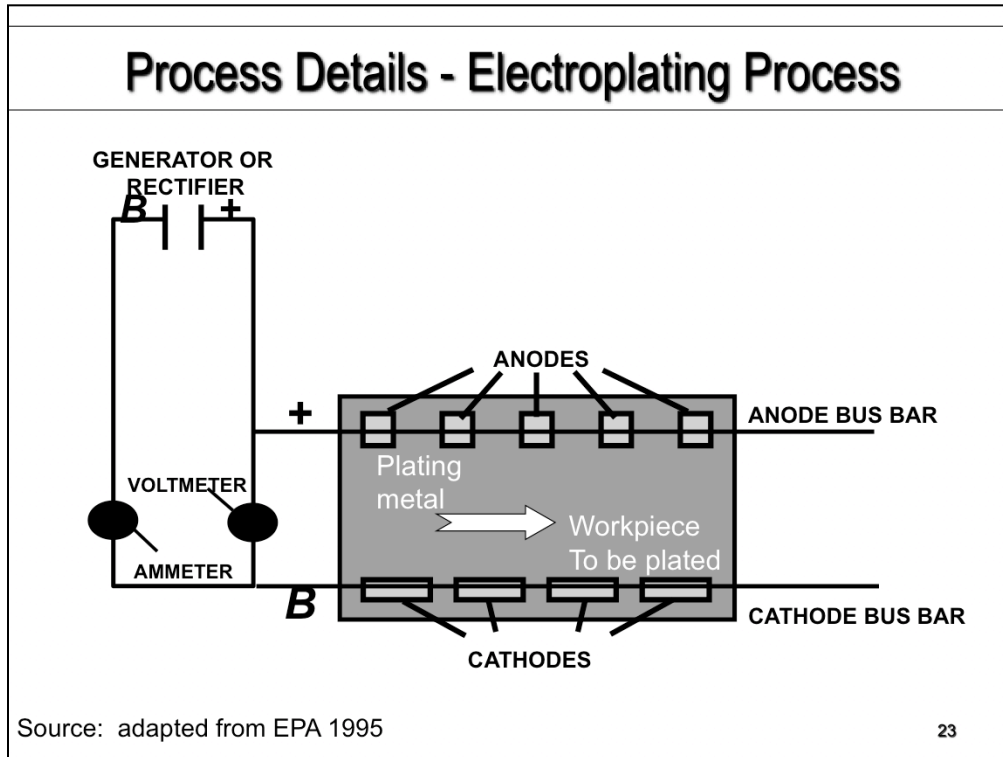












Plating vat for Chrome Plating



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Process Details - Common Electroplating Bath Compositions

<u>Bath Name</u>	<u>Composition</u>
Brass and bronze	Copper cyanide, zinc cyanide, sodium cyanide, sodium carbonate, ammonia, Rochelle salt
Chromium	Chromic acid, sulfuric acid
Cadmium cyanide	Cadmium cyanide, cadmium oxide, sodium cyanide, sodium hydroxide
Cadmium fluoroborate	Cadmium fluoroborate, fluoroboric acid, boric acid, ammonium fluoroborate, licorice
Zinc	Zn metal, sodium hydroxide, sodium cyanide (some non-CN baths too)

Source: EPA 1990 25

Modes of Release

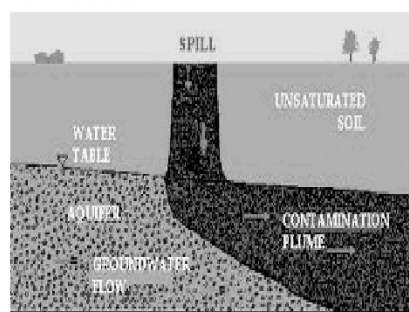
- **Air emissions**
 - Solvent vapors
 - Acid mists

- **Water releases**
 - Rinse water
 - Spent plating bath treatment
 - Washdown liquids

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Modes of Release

- **Soil**
 - Washdown liquids
 - Solvent spills
- **Groundwater**
 - Hexavalent chromium
(more mobile)
 - Chlorinated solvents
(DNAPL)



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Modes of Release

- Solid and hazardous wastes
 - TCLP metals (D006, D007, etc.)
 - Wastewater (F006)
 - Spent plating baths (F007, F008, F009)
 - Quenching baths, etc. (F010, F012, F019)



Nickel Plating Bath

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Analytical Considerations

- **Laboratory methods**
 - Metals: AA, ICP
 - Solvents: GC/MS



- **Field analytical methods**
 - Hazard Categorization
 - Metals: XRF
 - Solvents: Portable GC, Portable GC/MS
 - CN gas: Real time instruments, Draeger



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Summary

- **Mostly small businesses with limited environmental control programs**
- **Use a wide variety of chemicals:**
 - Organic solvents
 - Metals, metal salts, and cyanide
 - Corrosives
- **Metal finishing wastes can affect all four media: soil, surface water and sediment, air, and groundwater**

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Industrial Process “Composite” Electroplating Case Study

Real EPA cleanups from www.epaosc.org

Traditional Case Study
Learn by ONE example

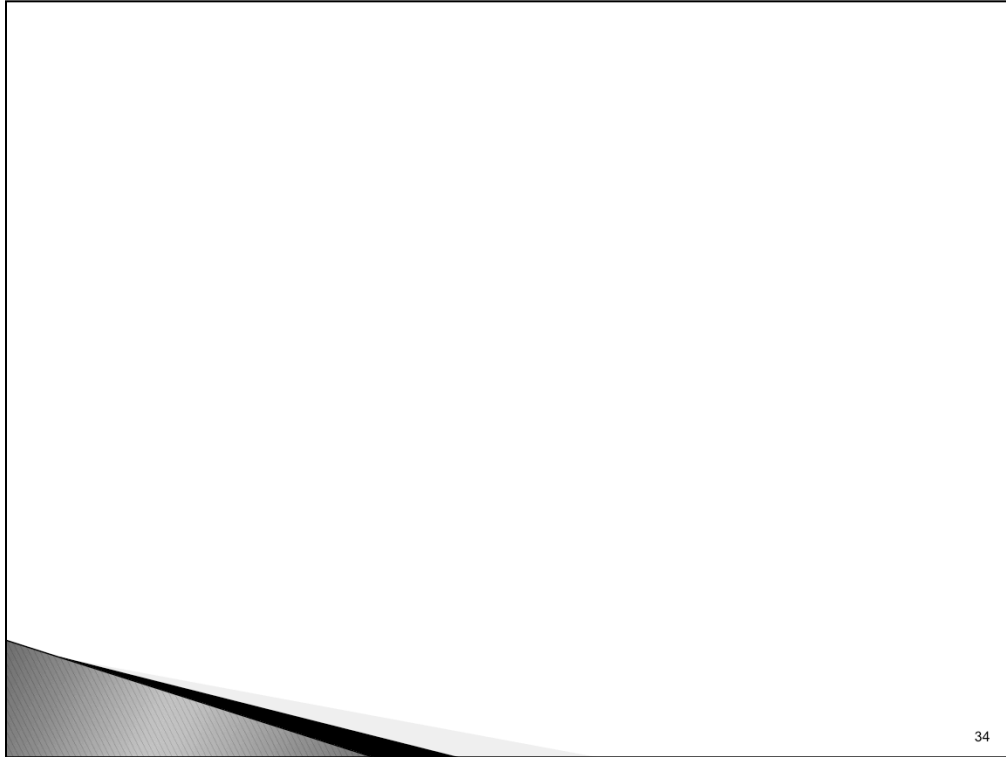
Composite Case Study approach
Learn by MANY examples

- ▶ OSC.org & OSC interviews
 - Lessons Learned
 - Advice from an OSC
 - Tricks of the Trade
 - Cautions



Industrial Process – “Composite” Electroplating –Case Study

- ▶ Key to 13 EPAOSC.org site id
 - http://www.epaosc.org/site/site_profile.aspx?site_id=xxxx
- ▶ Replace xxxx with 2 to 4 digit alpha-numeric
- ▶ Examples
 - 4771, UG,1981, etc.
 - http://www.epaosc.org/site/site_profile.aspx?site_id=1981



Clicking or entering the "...id=1981", URL on the previous slide will bring up a particular website on epaosc.org, which happens to be the R.N. Hitchcock Electroplating Facility in Port Byron, NY (Region 2). Tell students that additional details may be obtained by following the URL links (and if that is not enough, feel free to contact the OSC(s) of record directly).

Interviews & Photos

TRICKS OF THE TRADE TOPICS

- ▣ ▶ Safety-objectives
 - CN ,Air monitoring
 - Thermal Stresses
- ▣ ▶ Basics
- ▣ ▶ Neighborhood issues
- ▣ ▶ Management Tool
- ▣ ▶ Fires/contingency plan
- ▣ ▶ No Utilities-light, elec, waste streams
- ▣ ▶ Soil- Cleanup, Sampling
- ▣ ▶ T& D -promptness, staging,
- ▣ ▶ Tote safety
- ▣ ▶ Recycling, Scrap & Trash
 - Congestion
 - Hot work

“Best Advice” for A Good Beginning

- ▶ Safety in every topic
- ▶ Seek an experienced OSC’s advice
- ▶ Legally sufficient access
- ▶ Good site sketch
- ▶ Engage State/locals early
 - Operational history
 - Contingency plan for site
 - Public land use
- ▶ Quality of support staff
 - ERRS & START w/ Plate Shop experience
 - Onsite chemist- “Hazcat”, bulking, incompatibles

State that several of the pieces of OSC advice can be consolidated under the category of “Best Advice for Solid Beginning”.

Tell students that, Since we have just begun to think about these kinds of sites, it might be best to summarize this advice now (at the beginning).

Note to instructor: Do not read every bullet, but pick a few to highlight while the students are (hopefully) reading the entire list.

For example:

These advice are summarized on this slide. They include a reminder to include safety in every consideration and to seek the advice of an experienced OSC before and after you begin work..... Several OSC’s commented that the quality of contractor support staff was a critical consideration.

Optional: Some issues were elevated in status by failure to do it right the first time....legally sufficient access.

#1 Protect Public Health and Ensure Workforce Safety

- ▶ Pervasive & Controlling
 - 12/12 OSC interviews
- ▶ Cyanide –#1 H&S issue
 - High disaster potential
 - LD₅₀ very low ~6mg/kg
 - Oral, dermal, inhalation hazards
 - H&S every activity
 - Attention to detail/protocol
- ▶ Air monitoring
- ▶ Plating solutions–high pH
- ▶ Concentrates

Concentrated Cyanide

H/S Issue

1981



- ▶ CN Salts
 - AgCN, CuCN, NaCN, KCN conc. solids
- ▶ CN Solutions—High pH

Incompatible w/ Acids

- HCN gas evolves



Pumping CN Solution Residential Setting

ID 4689

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Air Monitoring Inside & Outside



Thermal Stress #2 H&S Issue

- ▶ “115°F– our biggest problem”
- ▶ “4am–11am shift”
- ▶ “Tried nights–NG”
 - Trackhoe @ 1:30am
 - Some day work always
- ▶ Work/Rest time_ = 1 / 1
- ▶ Vital signs & weight & close observation
- ▶ Rehydration– constant struggle

Phoenix AZ

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Thermal Stress

#2 H&S Issue

- ▶ “-20° F was huge problem. Some days we went home”
- ▶ Short Work period, then Warm & Rest
 - Wind chill
- ▶ Careful monitoring/observation of workers
- ▶ Coffee dehydrates
 - Caffeine jitters
 - Diuretic -inefficiency
- ▶ Heavy clothing/gloves
 - Hard to move
 - Low dexterity
- ▶ Building Corrosion
 - leaks rain + snow
 - Freezes at night
 - Black ice on slab



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Neighborhood Settings



Light Industrial-commercial



- ▶ Variable
- ▶ Other real hazards
 - Traffic
 - Local Crime Rate
 - “Shooting Gallery”
- ▶ Limited OSC Training
 - Experience
 - Advice



Plating Shop Cleanup Efficiency “Art of Waste Stream Management”

- Plating Shop spread sheet developed
- Standardized format
- Tool to manage ERRS & START
 - Display “critical path” & next steps
 - Framework for Daily Work Order Meeting
 - All waste streams in parallel processing
 - Schedule evaluation
- OSC Steve Renninger

Waste Disposal Summary Table

1	Waste Stream	Drums, Tanks or Rolloffs	Total Volume	Solid or Liquid	Container Type	I Sample Date	Disposal Sample Results	Color Code	Profile Date Sent	TSD Facility Selected	Approval Date	Trans. Date	Disposal Cost	Trans. Cost
7	Caustic Solids	6 drums	275 gallons	Solid	Transferred into 17H poly drums	7/22/07	TCLP Cr = 36 mg/kg Total CN = 10 mg/kg Hex Cr = 320 mg/kg pH = 12.8 Total Sulfide = ND	Fluor. Pink Pentagon	8/3/07	Environmental Quality Co. Belleville, MI	8/10/07	8/24/07	\$67/drum	
8	Plating Sludge (Pit #s 1, 2, 3 and 4)	Approx. 170 drums		Solid / Sludge	Transfer into 17H poly drums	7/6/07	TCLP Cr = 85 mg/l Hex Cr = 560 mg/kg Total CN = 11K mg/kg pH = 11.8 Failed Paint Filter Amen. CN = 3.1K mg/kg React. CN = 10 mg/kg	N/A	8/3/07	Environmental Quality Co. Belleville, MI (COS, Markham, Ontario, Canada)	8/10/07	8/28/2007 and ??????	\$25/drum	
9	Haz Liquid - Chrome	1 baker tank	4,500 gallons	Liquid	Transferred into Baker Tank	7/22/07	Total Cr = 120 mg/L No SVOCs or VOCs Total CN = 390 mg/L pH = 5.85 Tot. Sulfide = 74 mg/L Amenable CN = ND Hex Cr = ND	Yellow Star	8/20/07	Environmental Quality Co. Belleville, MI	8/22/07		0.45/gallon	\$1,085.75 per tanker
10	Basic Chrome Liquid	1 tanker	4,706 gallons	Liquid	Staged for Tanker Removal	7/22/07	Total Cr = 1,000 mg/L Total CN = 3.5 mg/L pH = 13.2 Total Sulfide = ND Amen. CN = 3.5 mg/L Hex Cr = 550 mg/L	Fluor. Orange Dot	7/25/07	Heritage Environmental Cincinnati, OH	8/9/07	8/20/07	\$0.55/gal	
11	Cyanide Liquid (tanks, drums, trenches, sump by T-45 and decanted Pit #1 water)	2 tankers	4,400 gallons	Liquid	Staged for Tanker Removal	7/22/07	Total Cr = 29 mg/L Total Se = 11 mg/L Total CN = 62K mg/L pH = 12.3 Total Sulfide = 11 mg/L Amen. CN = 62K mg/L Hex Cr = 16 mg/L React. CN = 370 mg/L	Fluor. Green Square	7/25/07	Heritage Environmental Cincinnati, OH	8/9/07	8/22/2007 and 9/5/07	\$2.88/gal	\$598 per tanker, plus 18% fuel surcharge
	Cyanide Solids	20+ drums	1,100 gallons	Solid	Transfer into 17H poly drums	7/22/07	No TCLP Metals No Hex Cr or sulfide Total CN = 55K mg/kg pH = 11 Paint Filter Failed Amen. CN = 55K mg/kg React	Fluor. Pink Dot	7/25/07	Heritage Environmental Cincinnati, OH	8/9/07		\$349.75/drum	\$181/drum + 17.3% fuel surcharge (\$956 max load)

TT Utilities Disconnected
Poor Lighting



Electrical Equipment

**Test
De-Energize
(Electrocution)**

**Copper theft,
Vandalism
PCBs**



Lack of Utilities–Common

- ▶ Utility “disconnect” circumstances
 - Contribute to halt of operation?
- ▶ Frustrates onsite cleanup
 - Reestablish or use generators?
 - Temporary service meters
 - Each has +/-

Liquid Waste Discharge Essential



**City Sewer
Connection
ID 5775**



ID 1369-Series of rinse vats

**Floor Drain
(trough)**

ID 5775

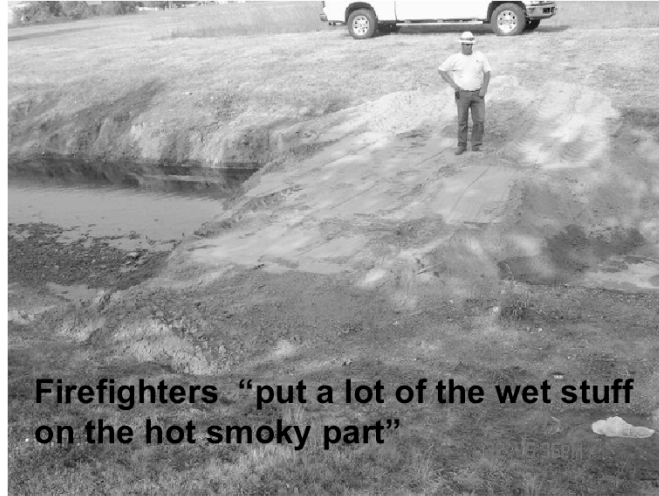


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ID 4106– Cause of Fire? Post Assessment – Pre-Removal



Capturing Firefighting Water



**Firefighters “put a lot of the wet stuff
on the hot smoky part”**

Contingency Plan for Fire Dept.

- ▶ Short Plan – example
 - EPA Contacts
 - Precautions (no water, PPE)
- ▶ Meet Fire Chief Early
 - “Peace time” Meeting & Tour
 - Good will generated
 - Copies–911 Dispatcher, break areas



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Potential Recycling & Trash Issues

- ▶ “Takings”— consult EPA attorney
- ▶ Site Owner wants it...LATER
- ▶ Is it “clean?”--sampling
- ▶ Recycle value of metals
 - High value
 - Steel
 - Funds generated - Credit
- ▶ CERCLA funds and “trash”
 - Manage trash- To allow safe/timely access and removal of hazardous substances

UG-Site Congestion /Non- haz waste stream

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UG-Site Congestion Non-haz waste stream



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-astonishingly bad house keeping... not uncommon at plating shops

-Plating shop sites are often physically congested small spaces, making working conditions very crowded and tight. Presence of non haz trash (in large quantities) is common and complicates space issues. Much of the non-haz waste will have to be moved/disposed of to allow safe and/or timely access and removal of the haz substances.

Trash must be carefully segregated and sent to a non-haz landfill. The cost of disposal in Subtitle C (haz) and D (non-haz) facilities is dramatically different.

Scrap Recycling



ID 4771-cleaning scrap



ID1981 – Cadmium Anodes



- ▶ 2" diameter Cd balls inside wire anode "springs"
- ▶ High recycle value

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ID 4106- Drums

Staged for Offsite T/D

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Removing Site Wastes Promptly



ID 4771- bulk wastes



ID 4106- loading drums for T&D

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Offsite transportation and disposal (T & D) of plating shop wastes are a frequent issue.

Fast/prompt removal, whether in bulk (left) or in drums (right), is highly recommended.

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Prompt Waste Removal Advantages

- ▶ Rapidly decreases risks at any site.
- ▶ Improves the appearance
- ▶ Uses cleanup budget more evenly
- ▶ Shows progress
- ▶ Reduces congestion—more room to work.
- ▶ Reduces vagrant pilfering & temptation to enter
- ▶ Improves crew morale and instills worker pride.
- ▶ Some OSCs prefer to wait to the end of the clean-up for T & D, I do not think this is wise.

ID 4106- loading drums for T&D

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Leaking Tote



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Tote containers are commonly used in plating shop (and other) cleanups. The Tote is a plastic tank (capacity varies) inside a steel mesh cage for structural strength and protection. The bottom of the Tote is “forklift friendly”

These are usually sized to replace 4-5 drums (55 gal each). The totes are typically very sturdy and safe.

Here is one that is leaking, however.

Tote Container Safety

- ▶ Totes use common at cleanups
- ▶ Max volume rated capacity
 - “Easy” – e.g. 75% full
- ▶ Max weight capacity
 - “Harder”
 - Hi density plating solutions – exceed capacity
 - Catastrophic failure– ugly results
- ▶ “Self-inflicted” emergency response action
 - Could have been avoided



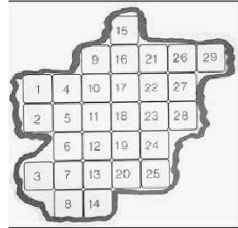
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ID 1981 – Seeps & Concrete Wall Sampling



Approach to Soil Sampling

Understand the Use of Products

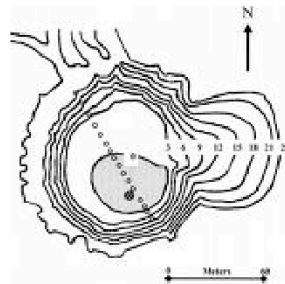


Grid Sampling Approach

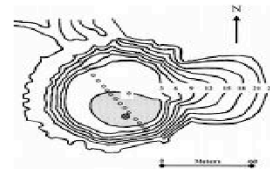
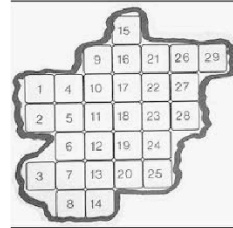


Vsp.pnl.gov

Soil Sampling



ID 4701 – Soil Removal



Thanks to OSC Contributors

- ▶ R1 Mike Barry
- ▶ R2 Cris D'Onofrio
- ▶ R2 Carl Pellegrino
- ▶ R3 Huu Ngo
- ▶ R3 Cindy Santiago
- ▶ R4 Subash Patel
- ▶ R5 Steve Renninger
- ▶ R5 Jim Augustyn
- ▶ R5 Kevin Turner
- ▶ R6 Mike McAteer
- ▶ R7 Katy Miley
- ▶ R9 Marty Powell
- ▶ R9 Chris Reiner

Resources & Feedback

- To view a complete list of resources for this seminar, please visit the **Additional Resources**
- Please complete the **Feedback Form** to help ensure events like this are offered in the future

The screenshot shows a web form titled "U.S. EPA Technical Support Project Engineering Forum Green Remediation: Opening the Door to Field Use Session C (Green Remediation Tools and Examples) Seminar Feedback Form". The form includes a sidebar with navigation links: "Go to Seminar", "Links", "Feedback", "Home", and "CLU-IN Studio". The main content area contains the following text and fields:

U.S. EPA Technical Support Project Engineering Forum
Green Remediation: Opening the Door to Field Use Session C (Green Remediation Tools and Examples)
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Date of Seminar: December 15, 2009

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