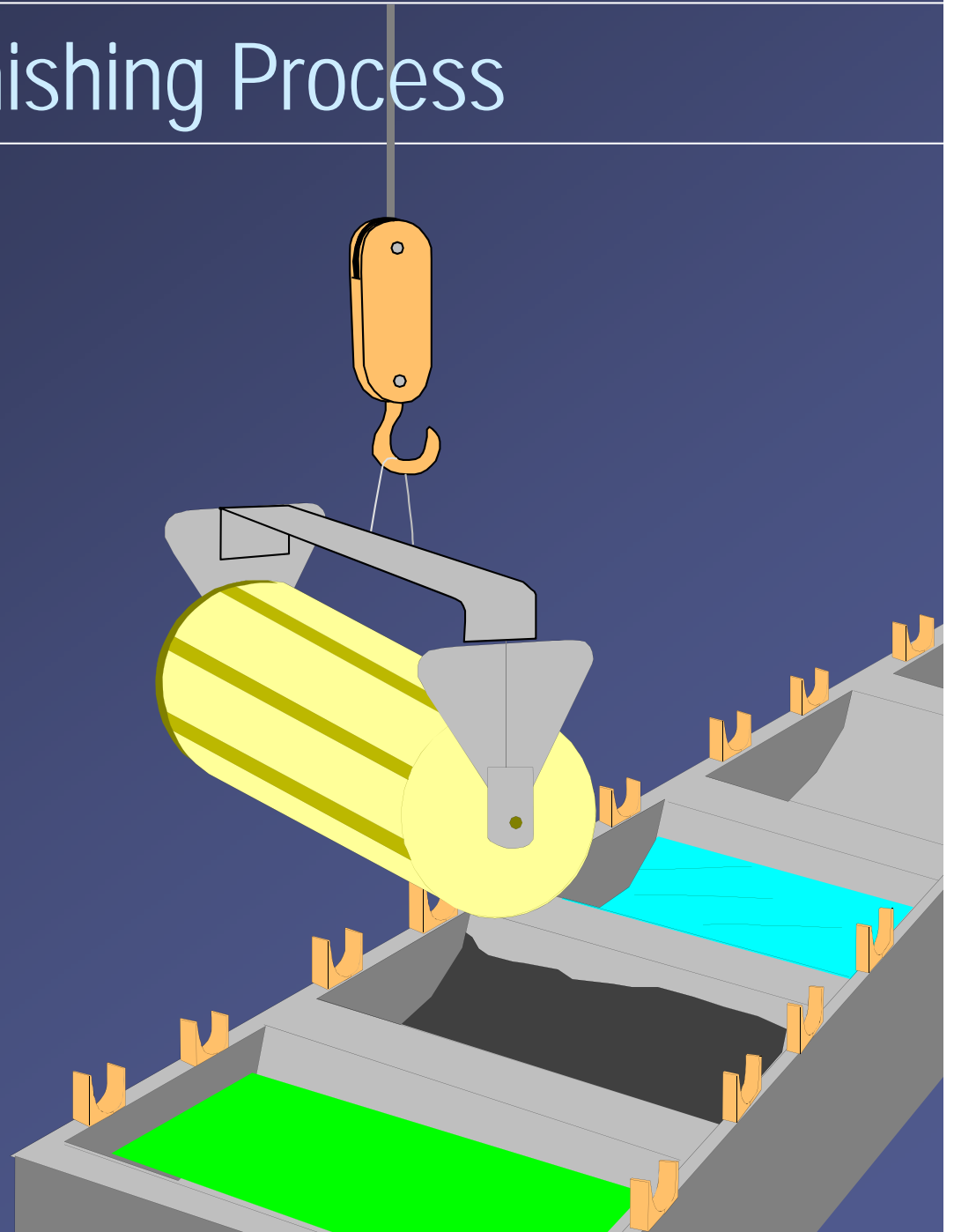


# Metal Finishing Process



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

# 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 )



# Metal Finishing Process Video



# Metal Finishing Process Video



# Key Chemicals

## Solvents

Benzene

TCE

etc.

## Coatings

Cadmium

Chromium

Cyanide

etc.

## Acids and Bases

HCL

Caustic

# Key Chemicals

<u>Solvents</u>	<u>2005 ATSDR Rank</u>
Benzene	6
TCE	16
etc.	
<u>Coatings</u>	<u>2005 ATSDR Rank</u>
Cadmium	8
Chromium	18, 77
Cyanide	28
etc.	
<u>Acids and Bases</u>	<u>2005 ATSDR Rank</u>
HCL	>100
Caustic	>100

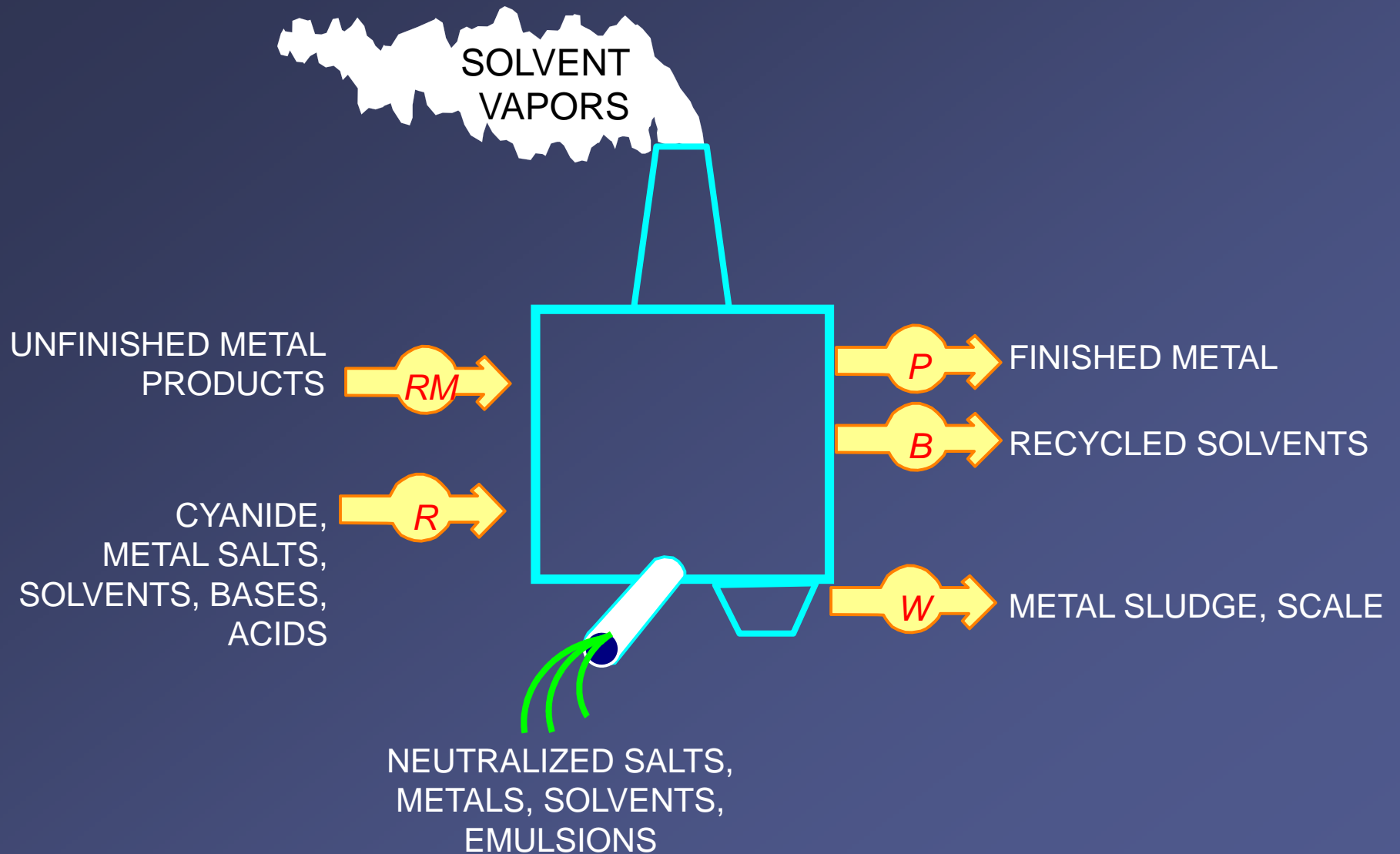


# Specialty Electronic Parts - Rack Method



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

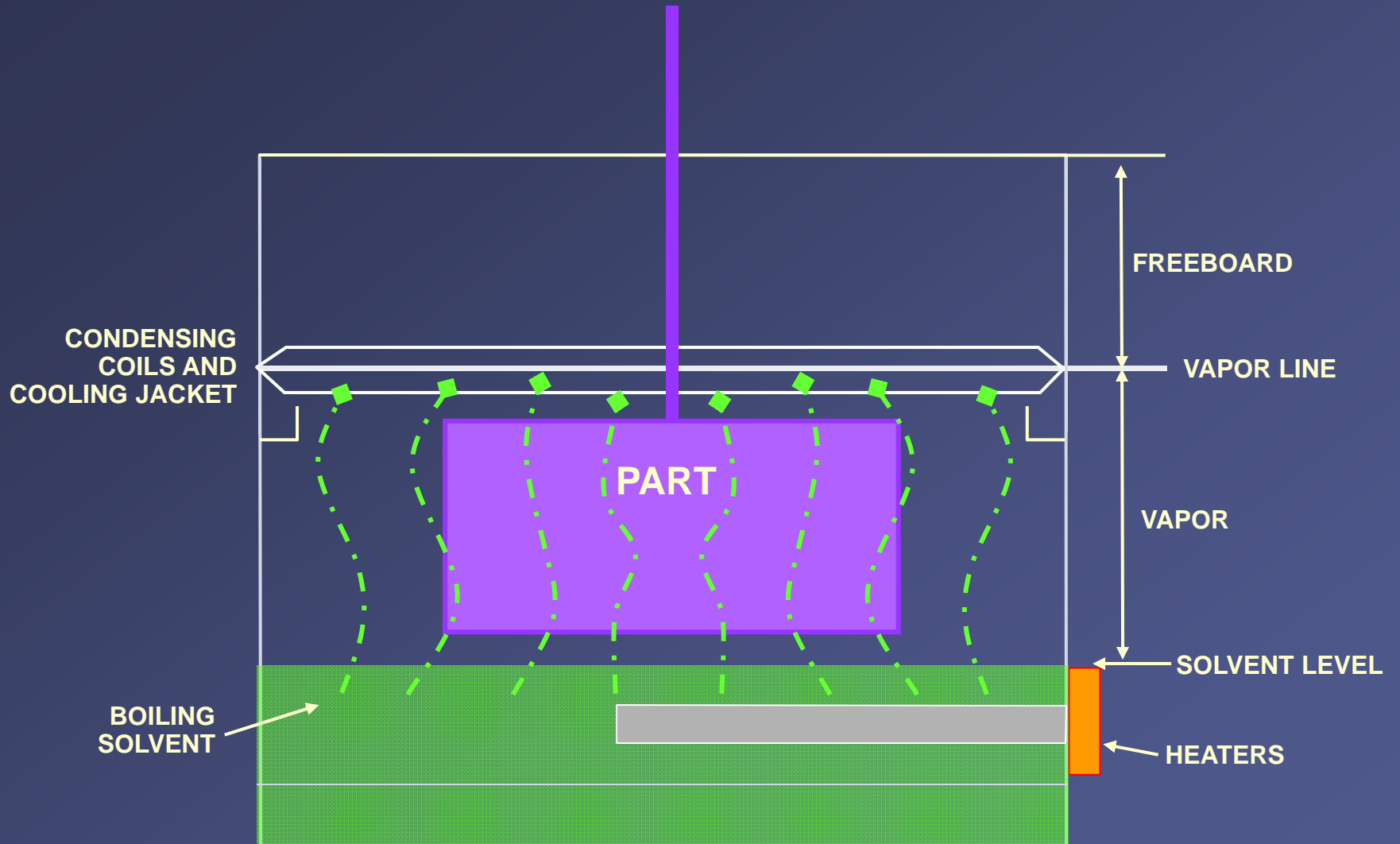
# Standard Process Schematic



# 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

# TYPICAL VAPOR DEGREASER



# Process Details – Cleaning / Degreasing

Solvents that are most used:

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

# 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

# Process Details - Anodizing

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



Chromic Acid Anodizing vat





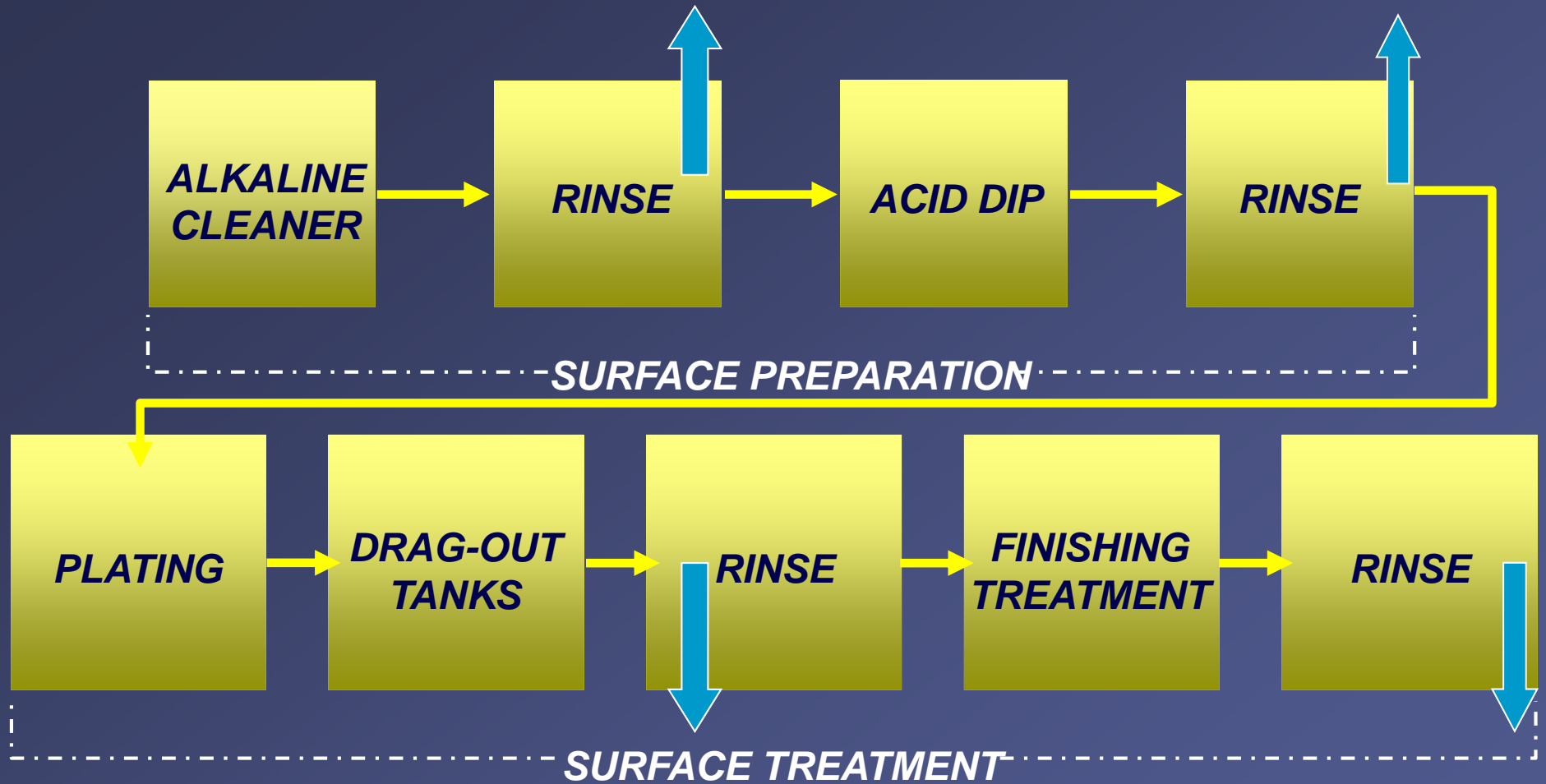
# Process Details - Electroplating Process

- 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

# Process Details - Electroplating Process



Source: adapted from EPA 1995

Waste water Discharge





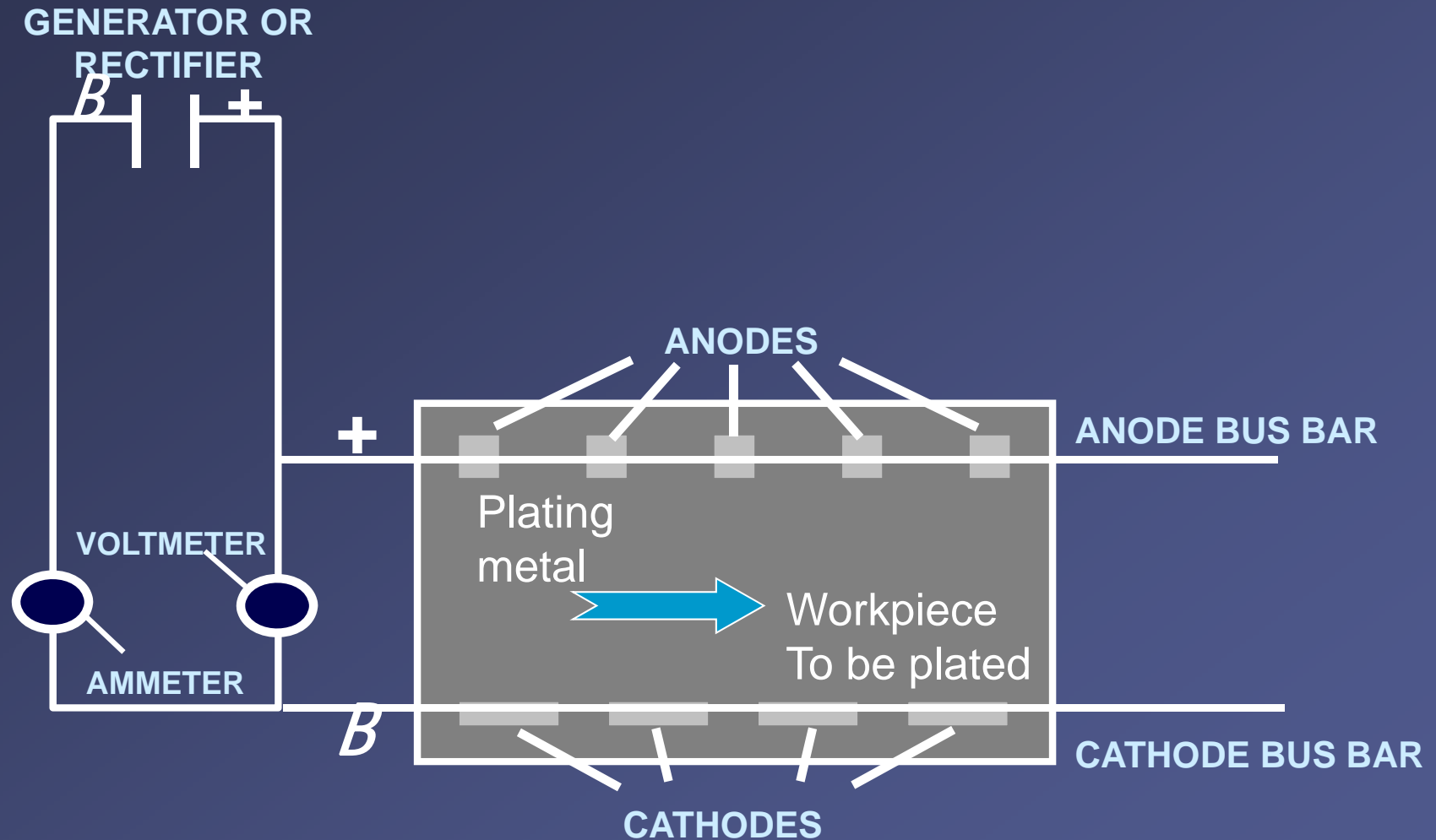








# Process Details - Electroplating Process



Source: adapted from EPA 1995



# Plating vat for Chrome Plating



# 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

# Modes of Release

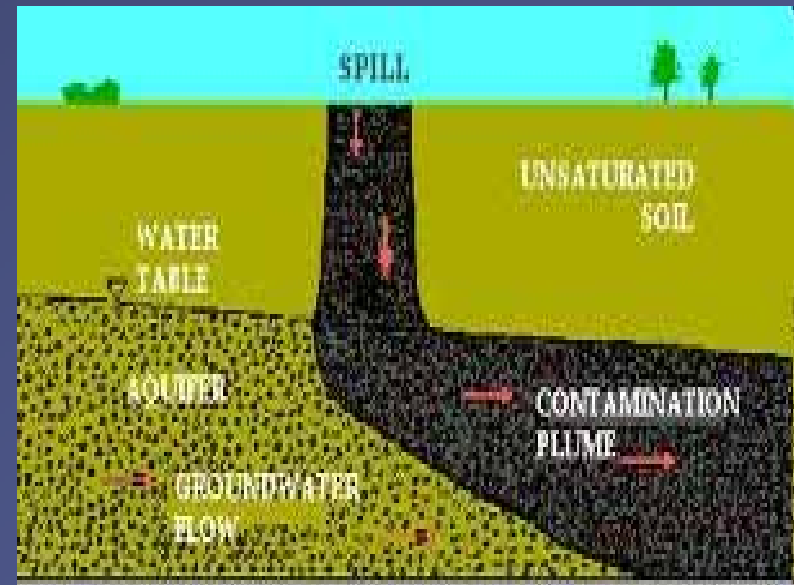
- Air emissions
  - Solvent vapors
  - Acid mists
- Water releases
  - Rinse water
  - Spent plating bath treatment
  - Washdown liquids

# Metal Finishing Process Video



# Modes of Release

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



# 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

# 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



# 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