**Calculating Costs**

**Guidelines for Calculating Costs for Raw Materials and Waste Disposal from Rejects**
- 0.59 ounce of chromium per square foot of chrome plating per 1,000 square feet of thickness
- Average cost of chromic acid is $0.25 per pound
- 3.5 pounds of sludge generated for each 1 pound of chrome plating stripped
- Cost of sludge disposal is $300 per ton
- Fume-suppressing foam is $50 per gallon

<table>
<thead>
<tr>
<th>Cost Category Due to Rejects</th>
<th>Monthly Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Materials</td>
<td>$5</td>
</tr>
<tr>
<td>Sludge Disposal</td>
<td>$40</td>
</tr>
<tr>
<td>Labor (14 hrs @ $18/hr)</td>
<td>$252</td>
</tr>
<tr>
<td>Total</td>
<td>$297</td>
</tr>
</tbody>
</table>

**Figure 5: Decreased Reject Rates**

**Figure 6: Savings Due to Pollution Prevention**

**Other Applications of the External Cooling System**

The external cooling system is potentially applicable to other electroplating processes, with different heat exchange materials being used:
- Decorative chrome electroplaters could use a heat exchanger made of stainless (columbium).
- Acid copper electroplaters could use a heat exchanger made of titanium or stainless steel.
- Cadmium-copper electroplaters could use a heat exchanger made of steel.

**Additional Sources of Information**

For more information about the Merit Partnership external cooling systems, or chrome emission regulations, you can contact any of the following individuals:
- Laura Bloch (EPA Region 9) (415) 544-2279
- John Stenke (CITC) (310) 264-3097
- Don Cunningham (EPA) (804) 225-3103
- Steve Peterson (Microplate) (310) 745-0577
- Ali Elshamy (Kaiser Aluminum) (909) 393-2451

**Merit Partnership Pollution Prevention Project for Metal Finishers**

**Innovative Cooling Systems for Hard Chrome Electroplating**

**Increased Productivity and Regulatory Compliance**

The Merit Partnership is a joint venture between U.S. Environmental Protection Agency (EPA) Region 9, state and local regulatory agencies, private sector industries, and community representatives. The partnership was created to promote pollution prevention (P2) by identifying P2 technology needs, and accelerate P2 technology transfer within various industries in Southern California. One of these industries is metal finishing, which is represented in the Merit Partnership by the Metal Finishing Association of Southern California (MFASC). Together, MFASC, EPA Region 9, and the California Manufacturing Technology Center (CMT) sponsored the Merit Partnership P2 Project for Metal Finishers. This project involves implementing P2 techniques and technologies at metal finishing facilities in Southern California and documenting results. The project is funded by the Environmental Technology Initiative and EPA Region 9.

This fact sheet provides a summary of emission reduction regulations, information on external cooling systems for hard chrome electroplaters, and the benefits of implementing such systems, including reduced waste, decreased labor and material costs, and increased plating capacity. It also summarizes the results of an external cooling system case study conducted at a hard chrome electroplating facility in southern California.

**Development of Hard Chrome Air Emission Regulations**

Regulation of both temperature and mixing of the plating solution is essential for successful hard chrome electroplating. The hard chrome electroplating process involves long plating times and intense heat generation. Failure to both dissipate the heat and maintain a uniform solution temperature impacts plating quality. In the past, hard chrome electroplaters maintained optimum plating temperature (typically within 1.4°F of the target temperature of 135°F) by directing air bubbles upward through the plating solution. Turbulence created by the bubbles both mixed the plating solution and transferred heat from the solution to the air by evaporative cooling. Air bubbles were an easy and effective means of maximizing production because they addressed the most problematic aspects of hard chrome electroplating: heat dissipation and solution mixing. As the bubbles reached the plating solution's surface and burst, air emissions containing chromium were created.

EPA introduced the National Emission Standards for Hazardous Air Pollutants (NESHAP), which became effective in January 1995, to regulate industrial air emissions. One part of NESHAP mandates that all hard chrome electroplating facilities meet several requirements established to minimize chromium emissions in plating operations involving chrome. Hard chrome electroplaters have been able to meet these requirements by discontinuing the use of air bubbles and implementing fume suppression systems made up of plastic balls or foam that float on the surface of the plating solution.

**Cooled Hard Chrome Electroplating Solutions**

To maintain plating solutions that are well mixed and at the correct temperatures without the use of air bubbles, most facilities have opted to install cooling coils on the interior walls of their plating tanks. Figure 1 shows an internal cooling system with this type. However, internal cooling systems have drawbacks. For example, slower plating rates, increased downtime, and higher reject rates have been experienced after installing such systems. Parts are considered rejects by the electroplater after plating, they do not meet specifications because of discoloration, poor adhesion, roughness, lack of hardness, or high porosity.

**Figure 1: An Internal Cooling System**

The use of reject rates causes more waste generation (see Figure 2) and increases operation and maintenance (O&M) activities and repair costs. These increases hit hard at electroplaters' bottom lines.