Soladyne technician James Noell inspects electrodes in the division's electrowinning system. This system recovers copper from baths and rinse water.

I***n 1989,*** the Soladyne division of Rogers Corp. (San Diego, CA) decided to install an improved type of waste treatment equipment. The division had two reasons for undertaking such a project—it needed to handle increasing volumes of effluent as we1l as maintain compliance with ever-tightening environmental regulations.

The company, which manufactures microwave stripline and related circuit boards, defined the following chemical operations as those that generate effluent: photoresist developing, etching, photomask stripping, general cleaning, bond enhancement pretreating, copper plating, gold plating, nickel plating, solder plating, tin plating, electroless copper plating, and other deposition processes.

BACKGROUND

The original wastewater treatment approach at Soladyne was subject to occasional upset potentials and was too small to handle projected effluent flows. The division requested assistance from Rogers' Corporate Environmental Department for designing, specifying, procuring, and installing a new waste treatment system.

A Microwave Circuit Manufacturers Waste Treatment Installation

by Robert F. Lee and Rodger McMonagle

It took careful planning and a redesign of wet process areas to develop a suitable system.

Soladyne has operated for many years out of a three-building complex in San Diego, CA. As business developed, manufacturing expanded into available space in these buildings, but the expansion did not follow a master plan. f'reduction, in particular wet chemical processing, was scattered throughout the complex. This disorder created many problems poor work flow, fragmented process sequences, and excessive parts handling.

These problems, coupled with recent changes in environmental regulations governing effluent discharges, mandated the installation of more sophisticated treatment schemes, San Dicgo also faces water rationing with - in the industry. This possibility y had to be addressed.

Finally, severe site limitations had to be considered. The division needed space to expand production, place needed water pretreatment equipment, and locate new waste treatment equipment. A method was needed to collect effluent from processes and convey it to treatment. Site problems were further complicated because the buildings were leased and no vacant land was available.

From the onset of this project, a master plan for wet chemical processing and attendant waste treatment was developed for the division. A review of all wet chemical processes was conducted, not only of individual operations and chemistries, but also of their present locations within the plant. The division planned to segregate wastewater streams as much as possible so reclamation or recovery of metals could be accomplished where appropriate. Finally, provisions were made to recycle water for process reuse.

PLANNING

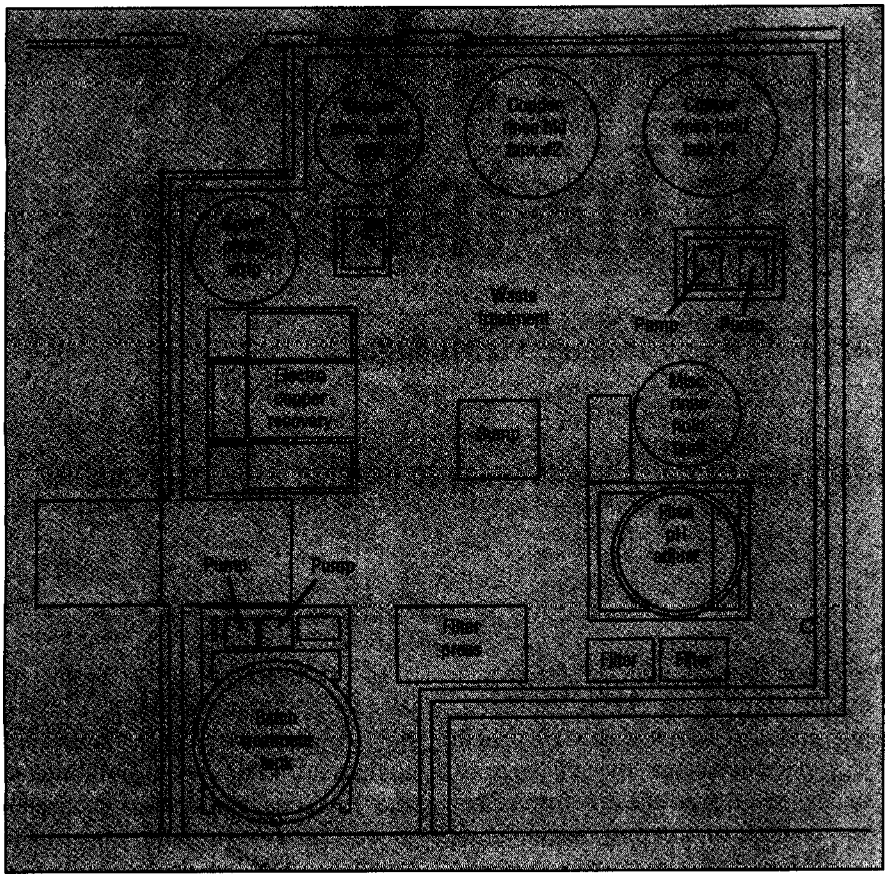
The division reviewed its entire manufacturing operation and developed layouts of optimal wet processing locations. Consideraton was given to work flow patterns and to the need to collect effluent and provide treatment and recovery of metals. The individual environmental needs for each process were evaluated as were techniques for improving such things as air ventilation, exhausts, air-borne dirt removals, humidity and temperature controls, and quality of process water.

In the overall facility layout, the only space that was available to locate the required wastewater treatment equipment was between buildings #2 and #3. Thus, wet operations needed to be clustered around this site as much as possible. Significant time was spent developing process layout plans that made sense not only from a manufacturing viewpoint, but also from a waste collection and treatment perspective. A number of existing process lines would require redesign to increase productive output or to minimize effluent flows.

DESIGNING THE SYSTEM

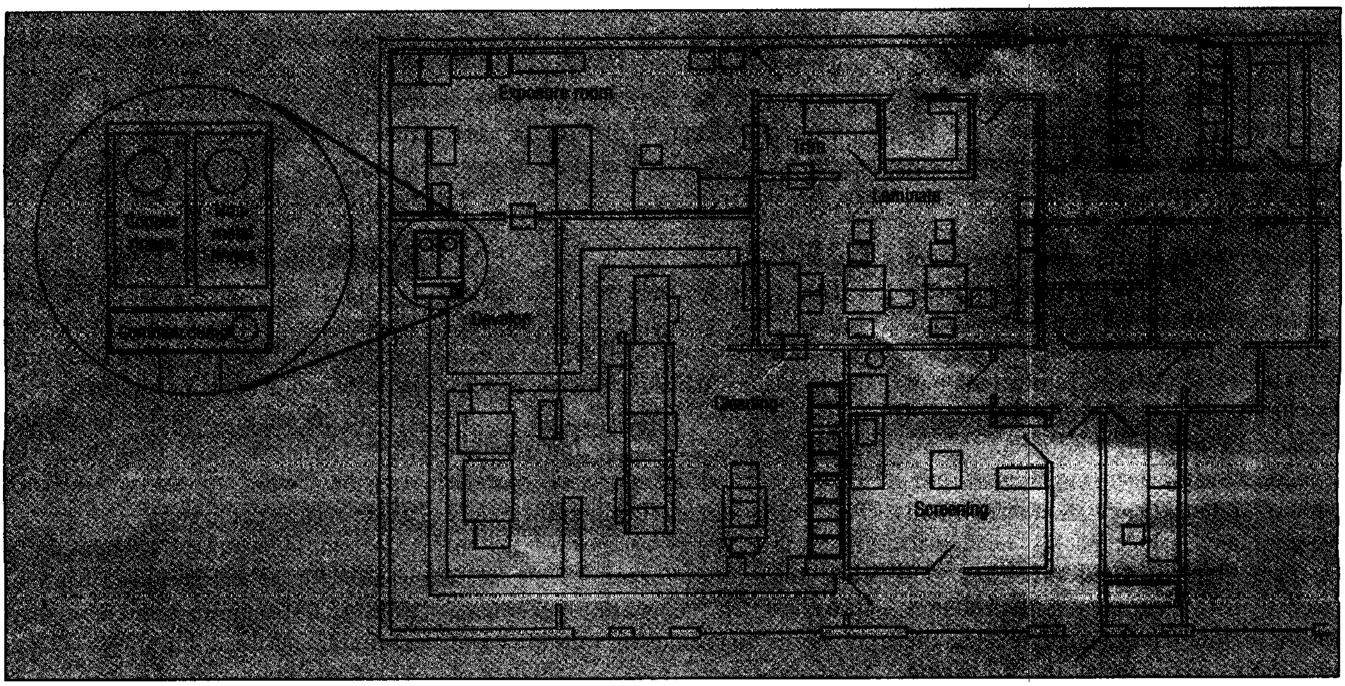
The division evaluated process effluent characterizations from existing production lines and, from this study, established a baseline that was relative to chemical loading and effluent flows, Armed with this data, the division began to design the new waste treatment system,

A challenge the designers faced was limiting the system to fit into an area of 650 square feet—the space available between buildings #2 and #3. Treatment modules had to be designed to fit within this area.



Effluent studies showed that total flows would average about 15 to 20 gpm, with a peak of 25 gpm. These studies al showed that copper represented about 85 to 90% of the total contained metal, with the remainder made up of lead, tin, and nickel. The new treatment system had to provide three primary functions: copper metal removal and recovery, batch neutralization a d removal of metal from non-copper-containing metal streams, and neutralization of non-metal-containing waste streams. Holding tanks and ancillary equipment were also needed. Figure 1 shows the layout of equipment for the new system.

In the system, segregated process effluents are directed to modules for treatment and then are recombined for final pH neutralization before being discharged to the city sewer system. In the future, effluent will be captured and redirected from anyone



or more of the modules to an activated carbon and deionization treatment module for the return of treated wastewater to the process.

A number of features designed into the system enhance operations and minimize operating costs.

Spent photoresist developing and stripping solutions, which are alkaline and contain no metals, are collected in a holding tank. They are then bled to the final pH neutralization module for alkaline neutralization. This process reduces the need for separate caustic chemical feed.

Copper metal is electrolytically recovered for resale from segregated copper-containing effluents.

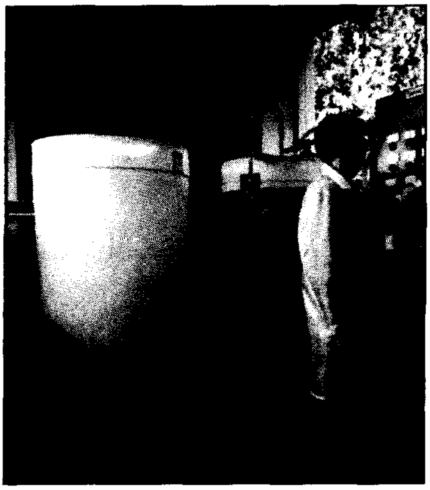
Most controls are housed in a central control panel for operator ease. This panel also has pH control recorders and appropriate alarms and warning lights to alert operators to abnormal operating conditions.

Batch pH neutralization of other metal-containing streams is equipped with a small filter press to remove metal precipitates, thereby reducing the volume of solid waste.

All waste streams, including those that have undergone pretreatment, are directed to a 500-gallon holding tank, which then overflows to the final pH neutralization tank. This arrangement provides for a buffering zone, minimizing slug episodes that cause wide pH swings in effluent going to final pH adjustment.

Effluent from final neutralization is pumped through precoated horizontal plate filters to remove solids prior to discharge to the sewer. The sewer discharge point is provided with a sampling port.

All these functions are housed in the area between the two buildings. The area is covered with a roof for rain and sun protection. It is curbed, diked, and chemically coated to contain any spillage, and the open ends (not butting against the buildings) are secured with chain link fencing. A safety shower and eye-wash station are provided within the area for employees in case of spillage.



All liquid byproducts of Soladyne's PCB operation are routed to a central waste treatment area where operators remove solids to produce wastewater that meets city safety regulations.

Effluent is pumped to the various waste treatment modules from processes via in-floor trenches. Piping is mounted on the trench walls. All piping is labeled as to contents, and each module is clearly identified as to function. All of the equipment is skid mounted, so that if future needs dictate, equipment can be moved with minimal problems.

INSTALLATION

There were a variety of reasons to relocate the wet processes near the waste treatment equipment installation area: process effluents had to be conveyed to treatment with minimal difficulty process work flow patterns had to be optimized; and space had to be provided for new process layouts. A major consideration during this project was to minimize disruption to

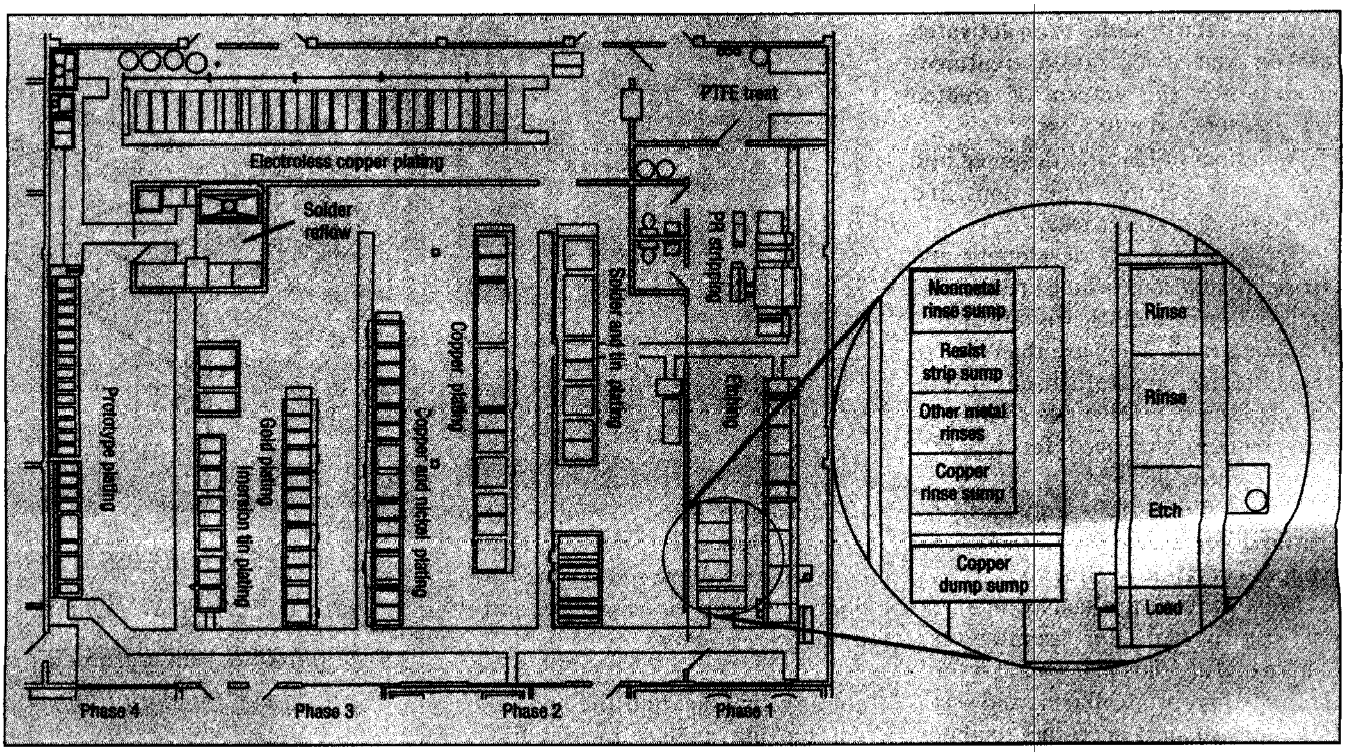


Figure 3. *Process relayout for building #2, with a detail of the wastewater containment sump.* *I*

production. Hence, it was necessary to break the project down into a number of phases.

The first task was to clear out the northern half of building #3, about 3,000 square feet, and construct a new photoresist processing area. Figure 2 shows the layout of this area, which contains the panel cleaning, resist lamination, resist exposure, resist develop, and inspection processes. The large room with the trenches houses the panel cleaning lines (conveyorized scrubbing and manual chemical cleaning) and the photoresist developing machine. This room is equipped with yellow light and temperature controls.

From cleaning, panels are transferred to the laminating area through pass-through windows. This transfer is possible because the laminating, exposure, and inspection areas are equipped with temperature and humidity controls as well as filtered air recirculation. From lamination, panels are again transferred through pass-through windows to a trim room where they are cut to size. Then the panels are transferred through windows to the exposure room. This room has the cleanest air and tightest environmental controls. After exposure, panels are sent to the developing area. Within all of these controlled areas, storage is provided for artwork, film, and parts so that materials are under optimal conditions prior to and during processing.

First, the photoresist processing area was prepared, and existing production equipment was then moved from building #2 to this new area over a weekend. This method kept production downtime to a minimum.

All process effluents are segregated according to chemistry and are directed to one of three sumps by gravity. The pipes located in the floor trench help handle spills, keep floors clean, and act as a secondary containment device. The below grade sumps pump various waste streams to appropriate treatment modules located just outside the north wall of building #3.

Moving the photoimaging operations to the new area opened up space for redoing the process layout in building #2. Construction had to be broken into four phases so that production impact could be reduced, The first phase of this segment involved construct g new etching, photomask stripping, and substrate bond enhancement treatment areas. Figure 3 shows the new process layout for building #2 with the various phases of construction delineated.

The first phase was completed and equipment installed and started. Because of the required trench layouts, effluent from the first part of this segment had to be temporarily directed to the in-floor sump with tubing. The installation of this equipment vacated space in production so phase two of construction in this segment could begin. When this phase was completed, the trenching could allow permanent hookups of effluent lines to sump from phase one.

The area was now ready to receive newly designed plating lines. Copper, solder, and tin, as well as solder-stripping operations were installed. Again, to minimize disruption to production, new tanks were designed, purchased, and installed before existing plating operations were relocated. Many of the existing rectifiers, filters, pumps, and other ancillary equipment were kept and reused. Production downtime was reduced by having the new tanks installed and ready when the move was begun. Solutions were moved and rectifiers and pumps were hooked up over an extended weekend.

Moving these processes vacated space for phase three of the work. This task was accomplished in the same way as phase two. Newly designed gold, nickel, copper, and immersion tin tanks were installed before the move. Then, production was moved to new lines, and space for phase four was created. Phase four was completed, and prototype process lines from other parts of building #3 were relocated.

The completed process areas are equipped with suspended ceilings and overhead lighting. Air ventilation is supplied by a number of evaporative coolers that add 30,000 cfm of makeup air to offset the approximate 30,000 cfm of exhaust from tanks. Tanks that were originally electrically heated were replaced with low-pressure hot water heaters fed from a boiler outside the plating room.

During various phases of construction, several pieces of ancillary equipment were relocated. The low-pressure hot water boiler was installed. DI water columns were relocated and expanded. A carbon treatment station for copper-plating solutions was put in place. A distillation setup was incorporated for recovering alcohol and recirculating alcohol from process to reclamation station. Also, a hazardous waste storage area was relocated and upgraded, and a close-loop chilled water system was installed as well.

SUMMARY

The entire project took approximately 18 months to complete, from concept to installation and startup of major modules. Total expenditures were approximately $760,000; about $350,000 of that was spent on wastewater treatment equipment and installation. With this expenditure, Soladyne received a totally new and significantly upgraded photoimaging area, a completely revamped etching area, a new conveyorized photoresist stripping machine, brand new plating lines for copper, solder, tin, gold, and immersion tin, and more efficient and safer operating areas.

Now, all operations in building #3 (photoresist and screening), etching and photoresist shipping operations, and waste treatment operations are fully functional. Most plating processes are also operational, but some ancillary operations are still being installed. ■

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