Waste Minimization and Pollution Prevention At Pratt & Whitney Aircraft

By Peter Gallerani, CEF, and Rick McCarvill

Four years ago, Pratt & Whitney's North Haven, CT facility set an ambitious goal to create a ''zero discharge'' metal finishing operation. Metal finishing accounted for 400,000 gal/day of treated water waste, and an evolutionary program became necessary to reach the new goal. The plan has the added benefit of reducing the costs of raw materials, waste transportation and disposal.

In 1986, Pratt and Whitney's North Haven, CT facility (P&W) began to plan conceptually for a "zero-discharge" metal finishing capability. At that time P&W discharged about 1 million gal/day of treated waste water, of which approximately 400,000 gal/day were generated by metal finishing operations. Plating lines were of largely 1960s vintage. It was readily apparent that such a broad goal would require an evolutionary implementation program. Company-wide, Pratt & Whitney has committed". . . to reduce emissions of hazardous waste by 40 percent and toxic air by 50 percent by the year 1994," said Bob Daniel, chairman and CEO, United Technologies.

Pratt & Whitney and its parent corporation, United Technologies Corp., are involved in a corporate-wide waste minimization program which encompasses the following:

• To identify waste reduction opportunities which encompass good operating practices and proven technologies.

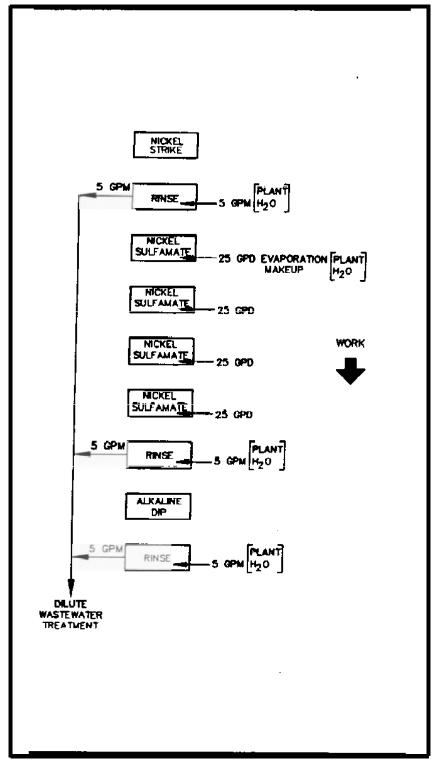

Fig. 1—Nickel plate schematic-present.

Pratt and Whitney's North Haven facility has a new nickel plating and titanium cleaning line.

tance, and the exterior skin is 40 percent thicker than comparable steel bodies. Despite that, the whole chassis weighs only 462 pounds complete, and that's 40 percent lighter than it would have been in steel.

Because aluminum is subject to some environmental corrosion, and to galvanic corrosion when in contact with other metals, it is first chromate-coated before having primer electrolytically applied. All steel parts are coated* to obviate the induced electrical current normally generated by these metals in close proximity. Finally, a 23-step paint process finishes the body, with a new waterborne final coat that dries from the surface down—the reverse of normal paint—claimed to enhance the appearance and durability.

No chassis is complete without a drive-train, and the engine in the NS) has it all. It's an all-alloy V-6 with four cams, steel cylinder liners, a forged crankshaft, molybdenum-coated pistons, and titanium connecting rods.

A direct ignition system is fitted to ensure hot, stable sparks, with a coil mounted directly atop each platinum-tipped spark plug and timing triggered by a sensor on one of the camshafts Oil circulation is handled by a high-volume pump that delivers 18 gallons per minute, with a water-jacketed oil cooler integrated with the base of the oil filter mounting boss. Careful oil pan baffling allows sustained 0.8 g cornering forces and brief peaks of 1.2 g's without oil starvation.

Massive 11.1 inch vented disc brakes stop the 3,010-pound NSX with unshakable confidence, backed by Honda's exclusive four-channel anti-lock mechanism. Dual-piston steel calipers were fitted after it was discovered that' alloy alternatives needed to be a larger size, which in turn would have meant larger wheels and an increased amount of kingpin offset. A new disc pad material was developed in conjunction with friction material specialist Akebono. This material was found to have surpassingly good performance with leading competitive brands.

In their unrelenting pursuit of light weight, Honda's engineers opted for forged aluminum wheels. These are formed in a dual-heat, three-stamp process wherein the billet is heated in *an* oil bath and then stamped and finally spun to its final dimensions in a forming roller. The weight saved over conventional cast alloy wheels is 13.2 pounds.

As you can see, the details are almost endless. We can only hope that all of this gives you some impression of the ferocious intensity of the NSX's development. It brings to mind Honda's Formula 1 exercise, with technicians swarming all over the engines with masses of telemetry devices and analytical computers. And it gives you an idea of how thorough and meticulous modern car development must be to be competitive. With that image in mind, I asked how many of the NSX team had been involved in Honda's F1 program. The answer came back in an instant not one of them.

Chew on that a while, car guys. •I

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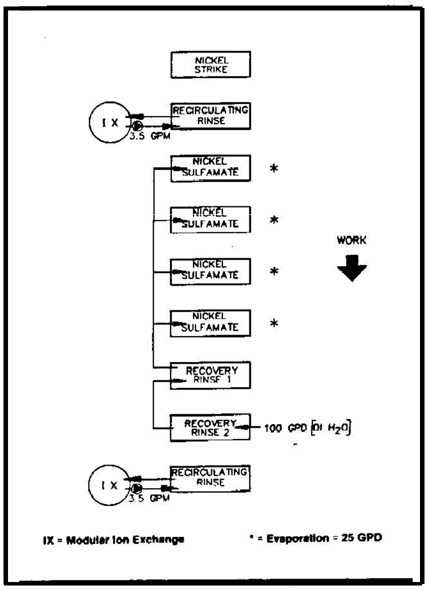

Fig. 2—Nickel plate schematic-optimized.

The end view of the new plating lines at Pratt & Whitney's North Haven facility. Note the modular ion exchange regeneration system in the foreground. Atmospheric evaporators are located on the mezzanine.

• To work with the chemical processing industry to investigate emerging waste reduction technologies which can be piloted and evaluated.

• To determine new hazardous waste reduction areas for research that can meet specific corporate needs.

PWA's North Haven facility has taken a jump ahead of other P&W and UTC divisions and has already "closed the loop" on key processes including: Woods nickel strike, sulfamate nickel plating, hard chromium, cadmium plating, chromating, and cadmium, chromium and nickel stripping. Where metal finishing once contributed 40 percent of total wastestream volume, that contribution has been reduced to approximately 5 percent.

Pratt & Whitney's accomplishments required extensive conceptual planning, many visitations to other plating facilities, attendance at many industry conferences such as the AESF/EPA conference, and extensive assistance from consultants. However, the bottom line is an anticipated return on investment of less than two years, and enhanced production capacity and product quality. Through waste minimization efforts, raw material costs have been reduced by about 80 percent and water usage by 95 percent.

Transportation and disposal costs and associated liabilities have been reduced by the same order of magnitude as a result of decreased sludge production and decreased shipments of concentrated solution wastes to Pratt & Whitney's East Hartford facility for treatment.

Facility Description

The North Haven facility encompasses 1 million square feet and produces parts and spare parts for Pratt & Whitney engines. The metal finishing facility processes major rotating parts such as discs, hubs and shafts.

Implementation

Pratt & Whitney's "zero-discharge" program has been organized around the following implementation hierarchy:

Phase One defines good operating practices. The following is a summary of Pratt & Whitney's efforts to this end:

• Define minimum water quality standards. All water now used at North Haven is either deionized (critical) or softened (noncritical).

• Use countercurrent rinses to reduce water usage.

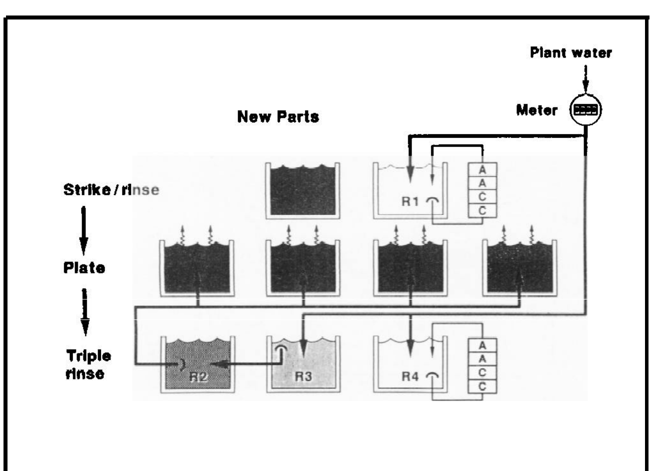

Fig. 3—Schematic of nickel plating line.

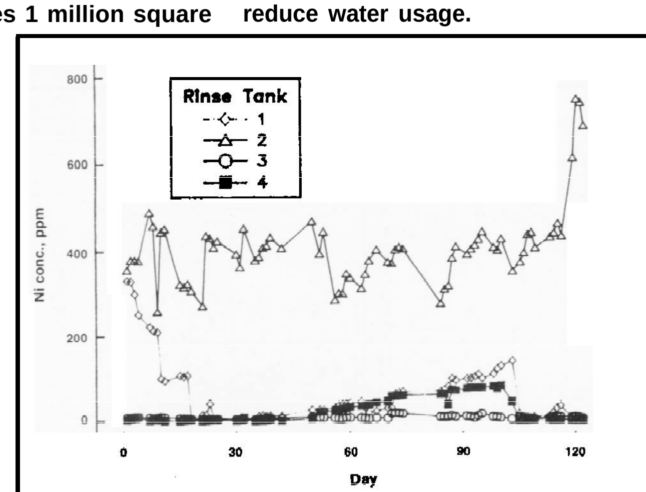

Fig. 4—The graph shows the nickel concentration in each 01 tour rinses over time. During the study, we learned that our design had a great deal of forgiveness incorporated into if. Despite the ion exchange columns receiving no service for approximate y 45 days while the regeneration area was moves, rinse quality remained satisfactory. Time period: May 15-Sept. 14, 1990.

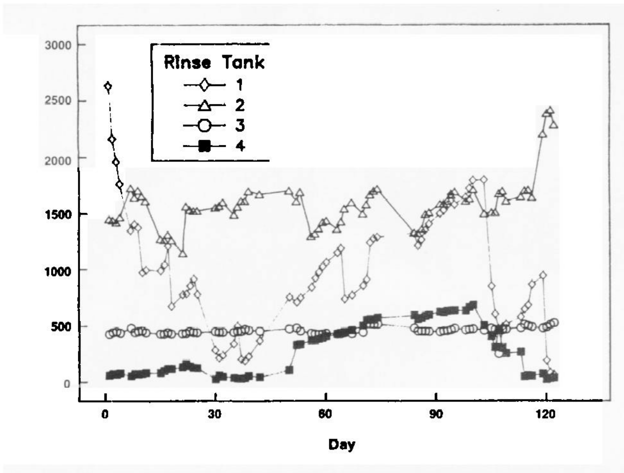

Fig. 5—Conductivity of each of four rinses over time. Nickel concentration can be closely correlated to conductivity.

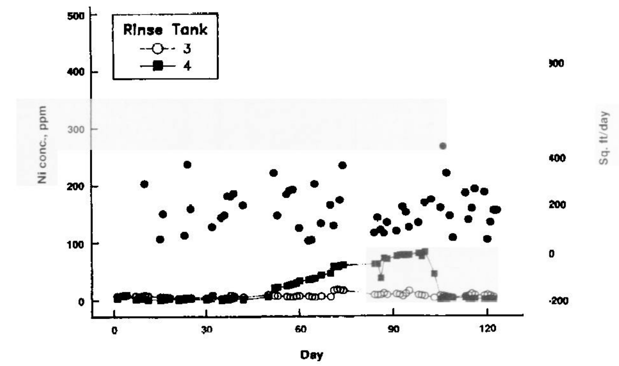

Fig. 6—Nickel concentration versus work load.

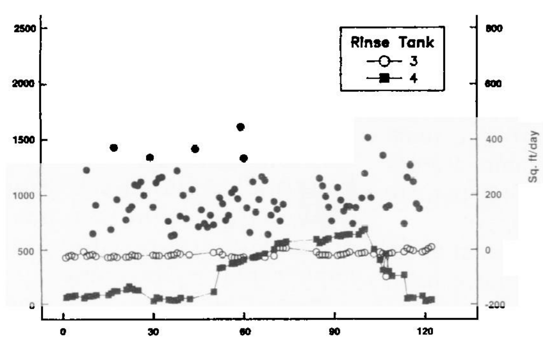

Fig. 7—Conductivity versus work load.

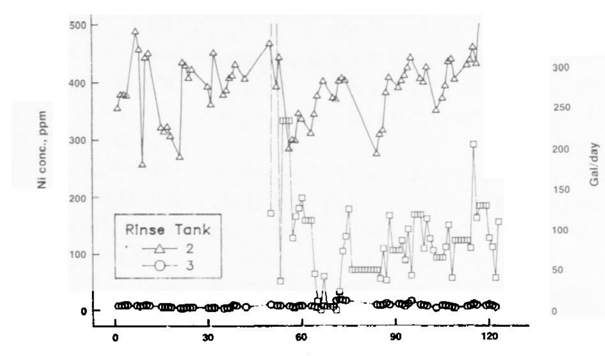

Fig. 8—Nickel concentration versus water usage.

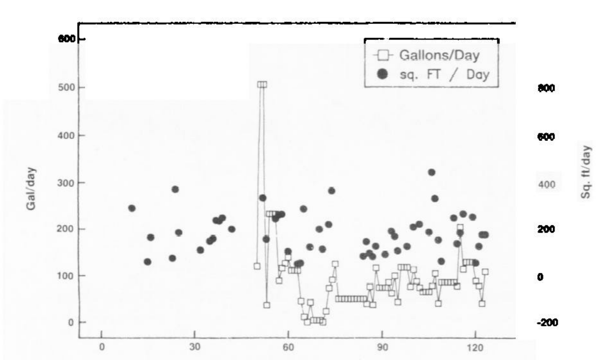

Fig. 9—Water usage versus work load.

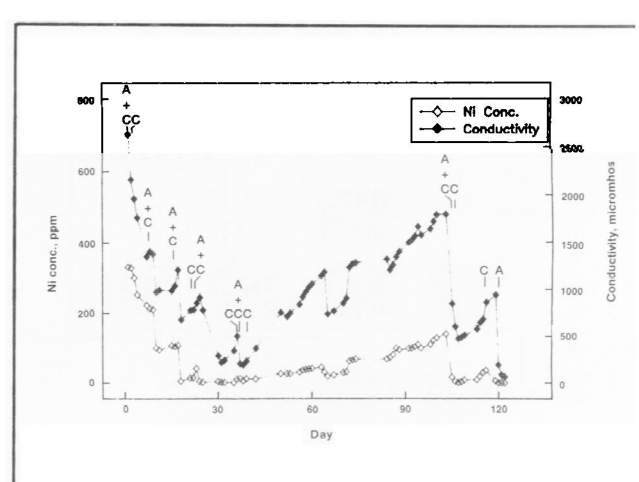

Fig. 10—Nickel concentration and conductivity in rinse one (nickel strike) with resin cartridge changes noted.

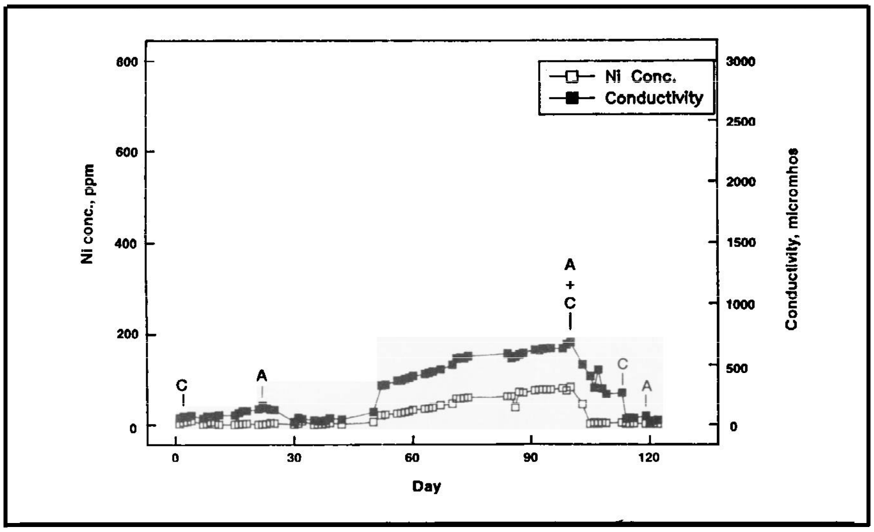

Fig. 11 —Nickel concentration and conductivity in rinse four (nickel plate) with resin cartridge changes noted.

- Utilize continuous process purification, as opposed to batch purification, to maintain consistent process quality. This includes dummy plating and carbon and particulate filtration.
- Utilize on-line process monitors to control solution additions.
- Optimize process solutions to control dragout (for example, reduce concentration and increase temperature).
- Optimize preplate rinsing to control drag-in of contaminants.
- Install automatic level controls on all heated processes.
- Train operators to understand proper rinsing and work transfer techniques to reduce dragout and drag-in.
- Treatment of small concentrated batches is preferable to high volume dilute wastestreams.

Phase Two implements procedural changes based upon established good operating practices.

Phase Three verifies closed-loop technology on a single process. For this phase, Pratt & Whitney chose an existing nickel plating process encompassing a Woods nickel strike and four sulfamate nickel plating tanks. Figures 1 and 2 show the before and after process schematics respectively. Pratt & Whitney wanted to evaluate implementation factors, product quality and operator acceptance and training. A modularized approach has allowed the fine tuning of designs, and disruption of production capabilities has been minimized. Operator acceptance has been very good, despite some initial skepticism. Product quality has improved. Implementation was completed in August of 1989 and followed with an extensive study completed in October 1990 (See figures 3-11).

Phase Four incorporates good operating practices and closed-loop technologies in the design of planned and appropriated new plating lines. New plating lines encompassing nickel and chromium plating, cadmium, chromium, and nickel stripping, and titanium descaling were already on the drawing boards. Initial plans were revised to incorporate the following changes:

- Countercurrent rinses;
- Ion exchange: nickel strike, nickel, cadmium and chromium stripping;
- Atmospheric evaporation: hard chromium, sulfamate nickel;
- Deionized water in all critical rinses and softened water in all noncritical rinses and noncritical evaporation makeup.

Phase Five involves installing new plating lines. This was completed in October 1990.

Phase Six is the renovation of remaining existing processes, including cadmium cyanide plating and chromating.

Future Plans

Pratt and Whitney has outlined several goals for future waste minimization efforts:

- Implementation of continuous process purification technologies to include the following processes: chromium and cadmium plating, acids, alkaline cleaners, chromating and stripping.
- Implementation of closed-loop technologies on preplate rinses (acids and alkaline cleaners).
- Implementation of on-line process monitoring. •I

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