IN-DEPTH SURVEY REPORT

OF

SODUS HARDCHROME, INC.
SODUS, MICHIGAN

Survey Conducted By:
John W. Sheehy
Donald E. Hurley
John F. Frede

Date of Survey:
February 10-12, 1981

Report Written By:
John W. Sheehy

Date of Report:
March 8, 1982

National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
Engineering Control Technology Branch
4676 Columbia Parkway
Cincinnati, Ohio 45226

PURPOSE OF SURVEY:	To evaluate engineering control technology used in a hardchrome electroplating operation
EMPLOYER REPRESENTATIVES CONTACTED:	Tom Sosnowski, Owner
EMPLOYEE REPRESENTATIVES CONTACTED:	Non-union
STANDARD INDUSTRIAL CLASSIFICATION OF PLANT:	3471
ANALYTICAL WORK PERFORMED BY:	UBTL-Salt Lake City, Utah

ABSTRACT

High tensile strength steel parts used in machinery and heavy equipment are hard chrome plated in this small job shop employing 6 production workers. All operations are performed manually. The primary airborne hazards are chromic (hexavalent chromium) and sulfuric acids. The operation utilizes 5 plating tanks containing chromic acid solutions and one strip tank. All the plating tanks are equipped with push/pull ventilation.

INTRODUCTION

This hardchrome plating job shop was surveyed to evaluate push/pull exhaust ventilation. The survey was conducted during very cold weather (outside temperature of minus 15^{0} to 20^{0}F). The operation is housed in a 20-year-old building that was converted to hardchrome plating 9 years ago. The plant is a non-union shop with the workforce consisting of the owner, six production workers, and a maintenance man. Production covers 2 shifts, running 5 or 6 days per week.

Production involves strictly hardchrome plating of high-tensile strength steel parts, used in construction, materials handling, and other heavy equipment. The parts include hydraulic cylinders ranging in size from a few inches in length to cylinders 5-inches in diameter and 28-feet-long.

Four of the shops five hardchrome plating tanks were evaluated in the study to determine the effectiveness of engineering controls which consisted of push-pull local exhaust ventilation and tank covers.

PROCESS

The unplated steel parts are unloaded from trucks in the warehouse and transferred to the plating area. The parts are first hand wiped using a solvent to remove dirt, grease, and fingerprints. Rough spots are removed by rubbing with a fine abrasive. The parts are then manually loaded into the plating tanks using overhead hoists. Once plated, the parts are removed from the solution and the chromic acid is rinsed off and drained back into the tank.

The plating solutions in all of the chrome tanks contain 28 oz/gal chromic acid and are maintained at temperatures from 130 to 140^{0}F. Steam or cold water are used to heat and cool the solutions. The tanks are lined with an inorganic material (Koroseal) with fire brick covering the bottoms.

CONTROLS

All of the plating tanks are equipped with push/pull ventilation. One system serves tanks 1, 2, 3, and 5; a separate system serves tank 4. The push air is discharged from holes drilled in 4-inch diameter pipes running along the front flange on all tanks. This air jet is discharged at a downward angle under the anode bar.

The layout of the plating plant is shown in Figure 1. There are five hard-chrome plating tanks and one strip tank (which sees little use). Tanks 1 and 2 are served by the same rectifier while tanks #3, 4, and 5 each have a separate rectifier. Tanks 1, 2, 3, and 5 exhaust through a single wet scrubber which discharges through a 3-foot-square duct in the roof. Chromic acid mist is collected in the scrubber which contains a series of baffles. Chromic acid is periodically washed off the baffles and returned to the plating tanks. Tank 4 is exhausted by a slot hood vented to a mist eliminator and fan. The air is discharged through a vertical 15-inch pipe several feet above the roof line. All exhaust hoods are constructed of sheet metal and painted with epoxy inside and out.

A 5-HP blower supplies push air to tanks 1, 2, 3, and 5 through a series of pipes as shown in Figure 1. A small 1/2 HP blower supplies push air to tank 4. Make-up air is supplied by a 20-HP, 27,500 cfm unit located in the South wall of the building at a height of 10 feet (Figure 1). In addition to the make-up air, approximately 1,000 cfm of outside air is supplied by the push air blowers for a total supply of 28,500 cfm. Exhaust air discharged from the building was measured at 20,000 cfm for the main system and 4,100 cfm for tank 4 or 24,100 cfm. The net positive airflow to the building would be 4,400 cfm. Although this figure is approximate, it does indicate sufficient make-up air to preclude any interference with the local exhaust system.

HAZARD ANALYSIS

The primary hazards from the hardchrome plating operation are chromic and sulfuric acids. Chromic acid is chromium trioxide (chromic acid anhydride), and

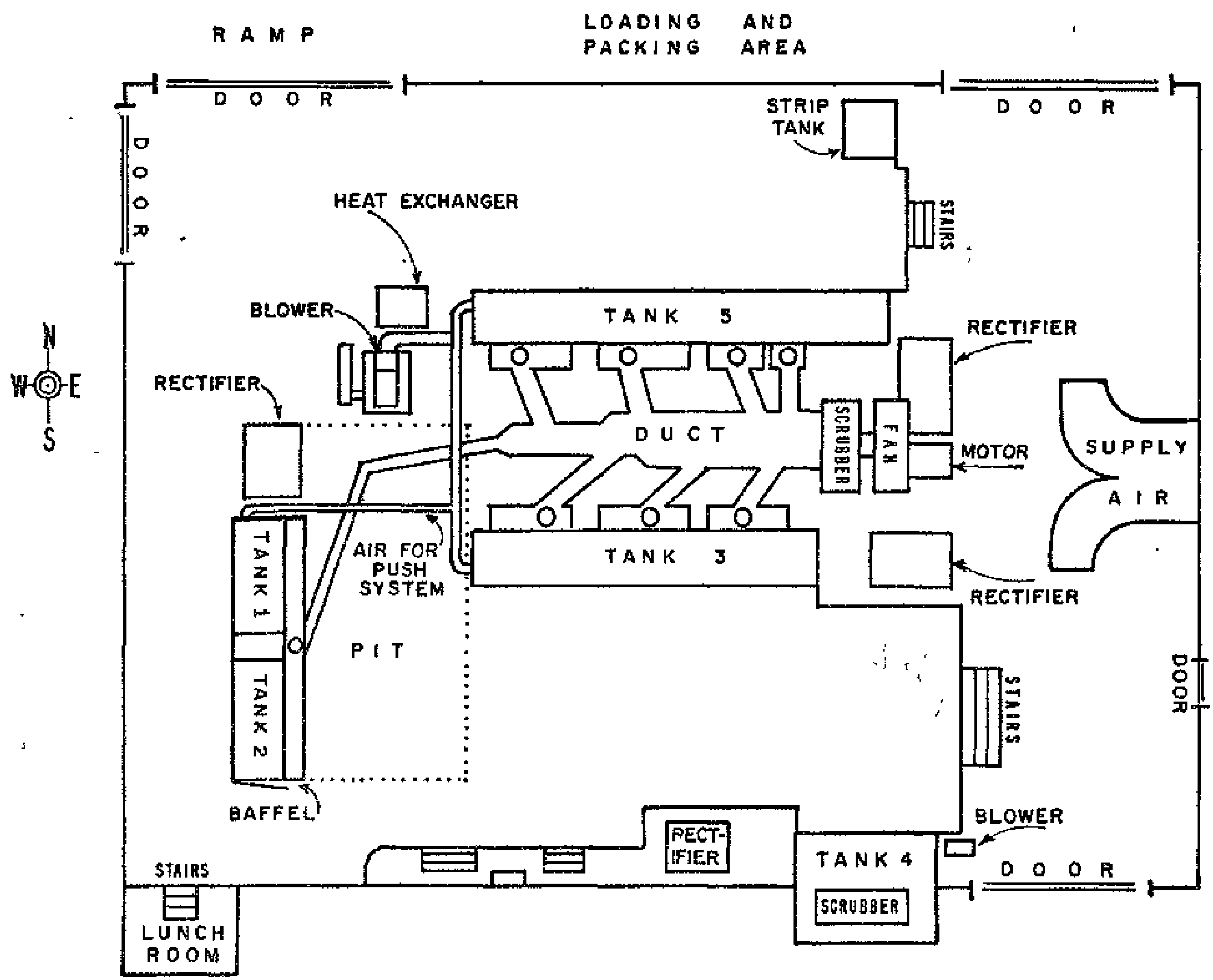


Figure 1. Floor plan - hardchrome plating area.

its aqueous solutions. Airborne hexavalent chromium compounds can cause irritation of the respiratory tract, ulceration and perforation of the nasal septum, epistaxis, skin ulceration, chronic asthmatic bronchitis, and eye injury. Chromic acid can cause cracks or breaks in the skin which are commonly referred to as a "chrome holes" or "chrome ulcers". Chromic acid mist may also discolor the teeth and tongue.[1,2,3,4,5]

Certain forms of Chromium VI may cause increased respiratory cancer. Chromium (VI) oxide (chromium acid anhydride) used in plating baths is currently believed to be non-carcinogenic.[6]

Sulfuric acid (H_2SO_4) is a colorless, odorless liquid soluble in water and alcohol. Concentrated sulfuric acid can cause rapid damage to mucous membranes, is exceedingly dangerous to the eyes and can burn and char the skin and mouth. Dilute H_2SO_4 is irritating to the skin and may cause scarring of the skin and blindness. Inhaled sulfuric acid can cause etching of dental enamel, and edema of the lungs and throat. Chronic exposure can lead to health problems such as emphysema and rhinorrea.[7,8]

EVALUATION

To determine the effectiveness of the controls used in the hardchrome electroplating operations, personal and area air samples were collected for three consecutive days. Sample times were 4 to 7 hours. Breathing zone samples for hexavalent chromium and sulfuric acid were collected each day on the day-shift production workers. These workers were in the plating area except during lunch and occasional short breaks.

Area samples were placed at fixed locations next to the hardchrome plating tanks. These samples were analyzed for hexavalent chromium, total chromium, and sulfuric acid. Hexavalent chromium was collected using closed-faced cassettes with 37 mm polyvinylchloride filters of 5 um pore size and MSA and DuPont personal pumps operated at 1.5 Lpm, and analyzed colorimetrically using NIOSH method No. P&CAM 169.[9] Total chromium was collected using closed-faced cassettes with 37 mm mixed cellulose ester filters of 0.8 um pore size and MSA and DuPont personal pumps operated at a flow rate of 1.5 Lpm, and analyzed by atomic absorption spectrophotometer using NIOSH method P&CAM 173.[9] Sulfuric acid was collected using 7 mm diameter silica gel tubes and DuPont personal pumps operated at 200 cc/m, and analyzed by ion chromatography following NIOSH method P&CAM No. 310.[9]

Air velocity and total airflow was determined for each of the plating tanks. Air velocities were measured in the vertical plane at the front of the tank, at the centerline of the tank, and at the slots in the exhaust hoods using a Kurz Model No. 441 hotwire anemometer. Total airflow discharged from both exhaust systems and push air supplied to the blower for tanks 1, 2, 3, and 5 were measured using pitot tube and Kurz hot wire anemometer.

Tank operating parameters and parts plated during the study were recorded for purposes of comparison. This data included bath temperature, amperage, voltage, number of parts, and surface area plated. These parameters for the hard-chrome plating tanks are presented in Table 1.

Table 1. Tank parameters.

Tank No.	Date	Bath Temp°F	Volts	Amps	Surface Area (in^2)	Current Density (amp/in^2)	Thickness ea. face (in.)
1	2/10-2/12	132	8	2100	550	3.8	.0007
2	2/10-2/12	132	8	2100	550	3.8	.0007
4	2/10-2/12	137	8-1/2	3500	2530 to 3670	1.0 -1.4	.0008
5	2/10-2/11	130	10-3/4	6500	4272	1.5	.0008
5	2/11-2/12	--	11-3/4	6500	5121	1.3	.0010

ELECTROPLATING TANKS 1 AND 2

Tanks 1 and 2 are shown in Figures 2 and 3. The hood for each of these tanks 1 and 2 consists of an exhaust plenum with three adjustable slots. The top and middle slots are each 1/2-inch-wide and the bottom slot is 2-inches-wide. Contaminated air is exhausted from the plenum through a 14-inch duct to the fan. A blower supplies push air to the 4-inch-diameter manifold that extends across both tanks about 2 inches above the front edge of the tanks. The air jet is discharged below the anode bars at a downward angle toward the liquid surface. Both tanks are covered during plating process except when loading and unloading. The covers can be seen in Figure 3.

During the entire survey, 3-1/2-inch by 50-inch cylinders were plated in both tanks. Current density in each tank was 3.8 amps/sq in; total power input to each tank was 16,000 watts. Bath temperatures were 132^{o}F.

Airflow Measurements

Total airflow measurements for tanks 1 and 2 are shown in Table 2. Total air exhausted for tanks 1 and 2 were 370 cfm and 460 cfm, respectively. For tank 1, the exhaust rate was 31 cfm/ft^2 (250 cfm/ft^2 is recommended in Industrial Ventilation[10] for open surface tanks containing chromic acid). The exhaust rate for tank 2 is 46 cfm/ft^2. Control velocities averaged 80 fpm for both tanks 1 and 2 with the covers open. Control velocities at the sampling locations ranged from 50 fpm to 90 fpm.

The amount of push air (q_o) discharged to the blower pipe of tanks 1 and 2 was estimated at 30 cfm each. This discharge air jet entrains an increasing quantity of surrounding air as it moves the distance from the blower pipe to the exhaust hood resulting in a much higher airflow at the exhaust hood. According to Hemeon, the exhaust rate (Q) should always exceed the amount of induced air (q_x) in order to successfully operate a push/pull system. Using Hemeon's formula (presented in Table 2) the total airflow q_x reaching the exhaust hood as a result of the discharge air is calculated to be 330 cfm and 310 cfm for tanks 1 and 2, respectively. Thus, Q exceeds q_x for both tanks.

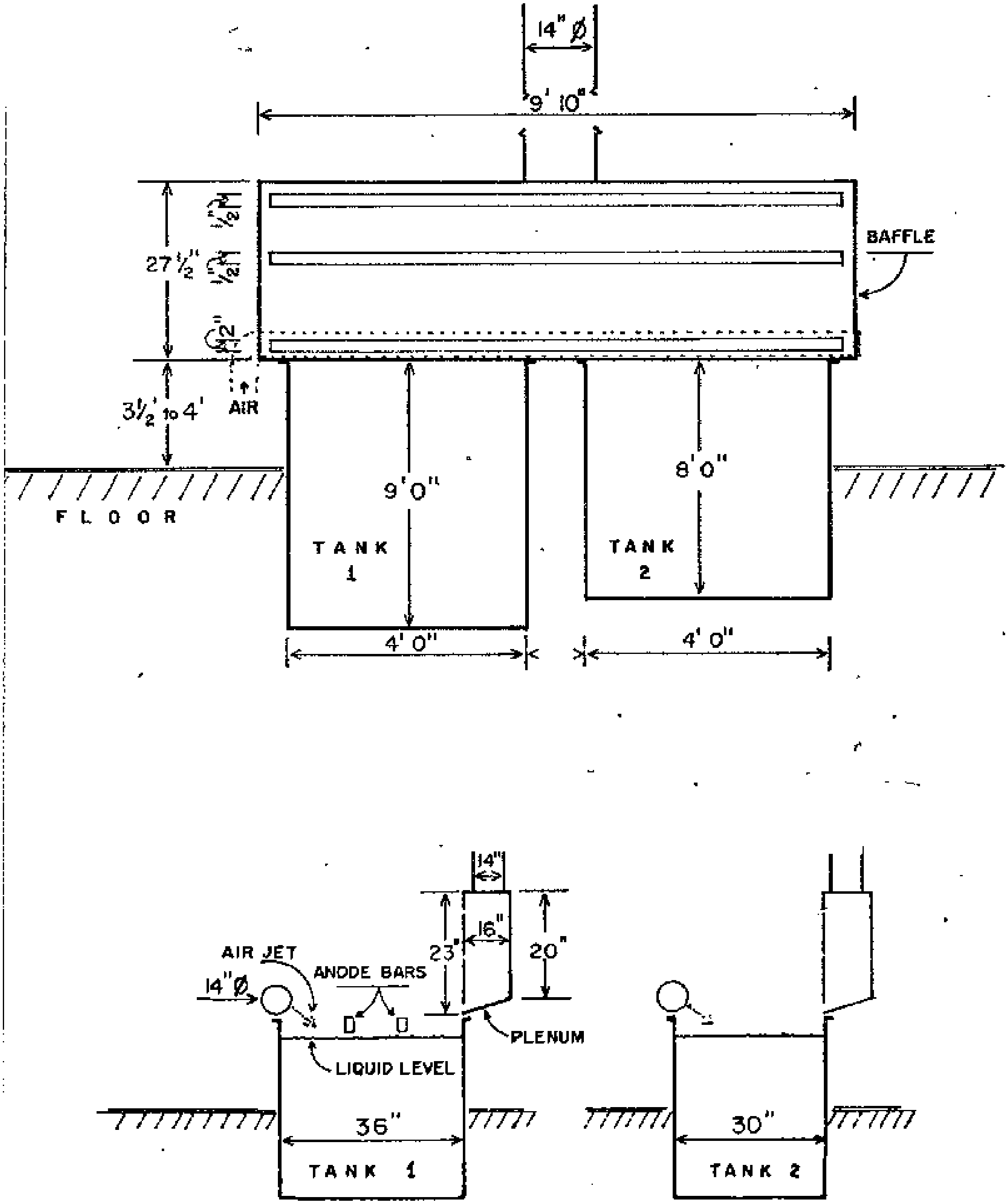


Figure 2. Hardchrome plating tanks 1 and 2.

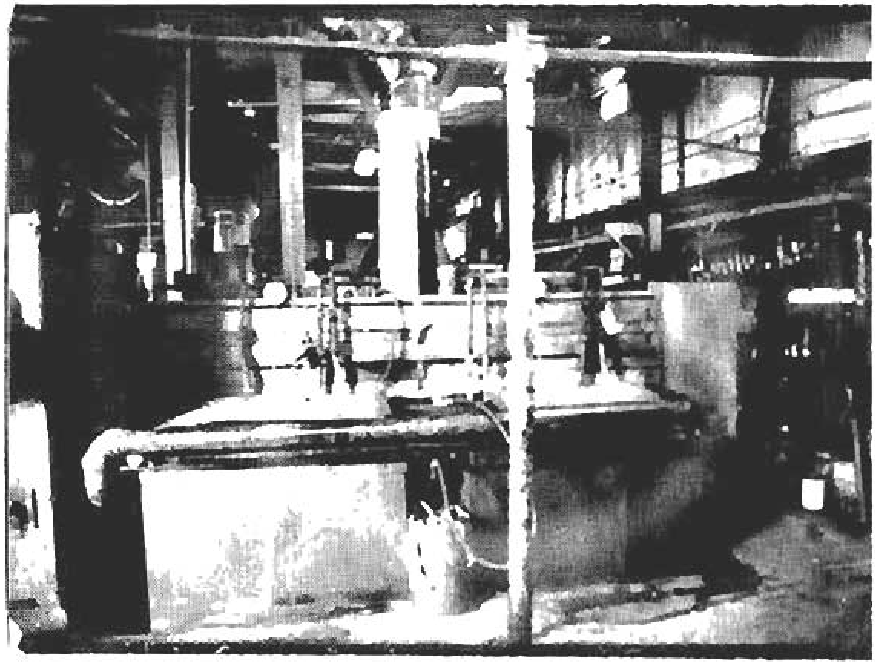


Figure 3. Chrome plating tanks 1 and 2.

Table 2. Airflow measurements.

Tank	Q Exhaust Air (cfm)	Q/A Exhaust Rate (cfm/ft^2)	Control Velocity (f/m)	q_o Airflow from Blower Pipe (cfm)	q_x* Total Airflow from blower pipe reaching exhaust hood	Q q_x
1	370	31	80	30	330	Yes
2	460	46	80	30	310	Yes
4	4100	175	70	--	--	--
5	9400	87	100	300	3300	Yes

*q_x is calculated from Hemeon's formula $q_x/q_o = 0.83\ (X/W)\ 0.36$;
x = distance from blower pipe to exhaust hood; w = slot width (ft).[11]

Air Sampling Results

Personal sampling results for hexavalent chromium and sulfuric acid are shown in Table 3. Mean concentrations for all 8 personal samples was 0.004 mg/m^3 for Chrome VI and 0.2 mg/m^3 for sulfuric acid.

Employee "A", working at Tanks 1 and 2, had an average Chrome VI exposure of 0.002 mg/m^3 for the 3 days sampled. This concentration is 2 percent of the OSHA PEL for hexavalent chromium (0.1 mg/m^3), and is less than 10 percent of the NIOSH recommended level of 0.025 mg/m^3 for non-carcinogenic hexavalent chromium. Sulfuric acid exposures for employee A were all below the detectable limit which, in this case, is less than 0.2 mg/m^3. The standard for sulfuric acid is 1.0 mg/m^3.

Table 3. Employee exposure (mg/m^3).

Employee	Location	Date	Chrome VI	Sulfuric Acid
A	Tanks 1 and 2	2/10	<0.001	<0.2
		2/11	0.003	<0.2
		2/12	0.003	<0.2
B	Tank 4	2/10	0.008	<0.2
		2/11	0.002	0.4
		2/12	0.010	<0.2
C	Tank 5	2/10	0.003	0.3
		2/11	0.003	<0.2
Mean			0.004	0.2
OSHA PEL[1]			0.100	1.0
ACGIH TLV[2]			0.050	1.0
NIOSH REC.[3]			0.025	1.0

1. (29 CFR 1910)
2. TLV Book
3. NIOSH/OSHA Pocketguide

Area samples for hexavalent chromium, total chromium, and sulfuric acid collected near tanks 1 and 2 are shown in Table 4. Concentrations of hexavalent chromium ranged from less than 0.001 mg/m^3 to 0.047 mg/m^3 with an overall mean concentration of 0.012 mg/m^3. Chrome VI concentrations on the right location of tank 2 were approximately 10 times Chrome VI levels at the other three stations.

Table 4. Workplace air concentrations (mg/m^3).
Area samples - tanks 1 and 2

Sample Location	Date	Chrome VI	Total Chromium	Sulfuric Acid
Tank 1-Left	2/10	0.001	<0.007	0.4
	2/11	0.002	<0.008	0.4
	2/12	0.008	0.010	0.3
Mean		0.004	<0.008	0.4
Tank 1-Right	2/10	<0.001	<0.007	0.3
	2/11	0.003	--	0.2
	2/12	0.006	0.008	0.6
Mean		0.003	0.007	0.4
Tank 2-Left	2/10	<0.001	<0.007	0.4
	2/11	0.003	0.019	0.3
	2/12	0.008	0.008	0.2
Mean		0.004	0.011	0.3
Tank 2-Right	2/10	0.025	0.043	0.3
	2/11	0.034	0.057	0.7
	2/12	0.047	0.025	0.3
Mean		0.035	0.027	0.4
Overall Mean		0.012	0.018	0.4
OSHA PEL		0.100	0.5	1.0

Area samples for total chromium ranged from less than 0.007 mg/m^3 to 0.057 mg/m^3. The overall mean total chromium concentration for 11 samples on tanks 1 and 2 was 0.018 mg/m^3. All the values for total chromium are far below the allowable limit for total chromium of 0.5 mg/m^3 (although area samples can not readily be used to estimate compliance with the legal standard, they are a valuable indicator of effectiveness of control system for the plating tanks).

Sulfuric acid concentrations ranged from 0.2 mg/m^3 to 0.7 mg/m^3 with an average concentration for 12 area samples of 0.4 mg/m^3. The allowable limit for personal exposure to sulfuric acid is 1.0 mg/m^3. The sulfuric acid data presents no significant trends.

Discussion

The sampling data demonstrates that the chemical hazards from tanks 1 and 2 were satisfactorily controlled. This control can be attributed to a combination of the following: (1) covers on both tank 1 and 2 and a baffle on the left side of tank 2 contained the mist in spite of the low exhaust rate; (2), the quantity of air supplied by the blowers did not exceed the capacity of the exhaust hood to remove the air; and (3) make-up air to the building was sufficient to prevent disruptive cross drafts in the building.

Poor air distribution at the hood resulted in non-uniform control velocities. The higher hexavalent chromium and total chromium concentrations on the right side of tank 2 may be due to the lower control velocity at that point (see Table 4 and Figure 4).

ELECTROPLATING TANK 4

Tank 4 is shown schematically in Figures 5 and 6. The exhaust hood has three slots: the top slot is 1-1/4-inches-wide, the middle slot is 1-inch, and bottom slot is 4-inches-wide. Exhaust air is vented through the plenum to a mist eliminator and discharged through a 15-inch exhaust stack. A 1/2-HP blower supplies push air to the 4-inch manifold located alongside and about 2 inches above the front flange. The supplied air is discharged toward the liquid through 3/16-inch orifices spaced every inch at a downward surface angle.

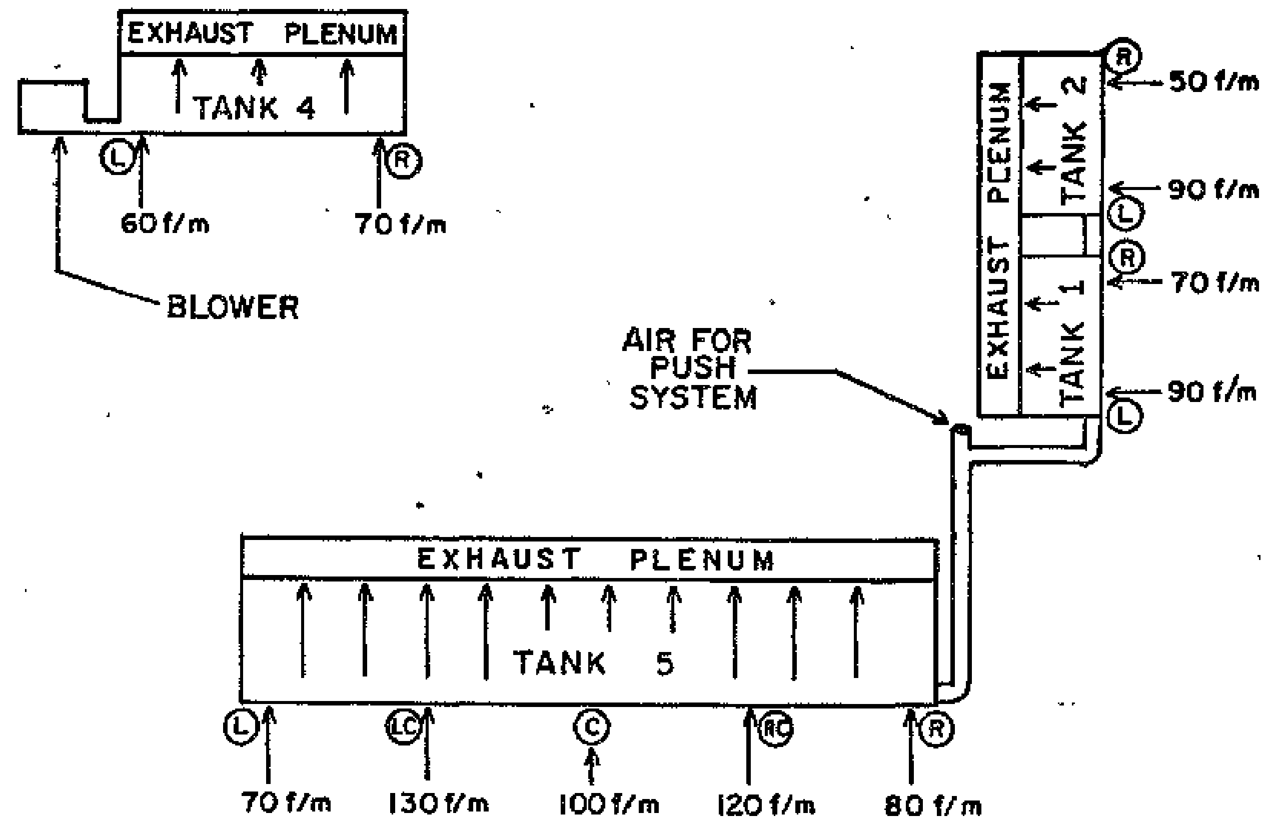


Figure 4. Control velocities at sampling locations.

Spherically-shaped polypropylene balls (3/4-inch) are used in tank 4. The balls float on the chromic acid bath and cover the entire surface.

The following parts were plated in tank 4 during the survey: four 2.65-inch diameter, 76-inch-long cylinders and four 3.4-inch, 86-inch-long cylinders. The parts were plated at 3500 amps to a thickness of 0.008 inches per face. Current densities were 1.4 amps/in^2 for the smaller part and 1.0 amp/in^2 for the larger part.

Airflow measurements

Airflow measurements are presented in Table 2 for tank 4. Total exhaust volume was 4100 cfm or 175 cfm/ft^2 (<u>Industrial Ventilation</u> recommends 225 cfm/ft^2 for tanks with width/length ratios of 0.25 to 0.49). Control velocities averaged 70 fpm, which is less than half the recommended velocity of 150 fpm for electroplating baths containing chromic acid. The exhaust rate for tank 4 (175 cfm/ft^2) was four times the exhaust rate for tank 2 (46 cfm/ft^2). Despite the higher exhaust rate at tank 4, control velocities for tanks 4 and 2 are virtually the same.

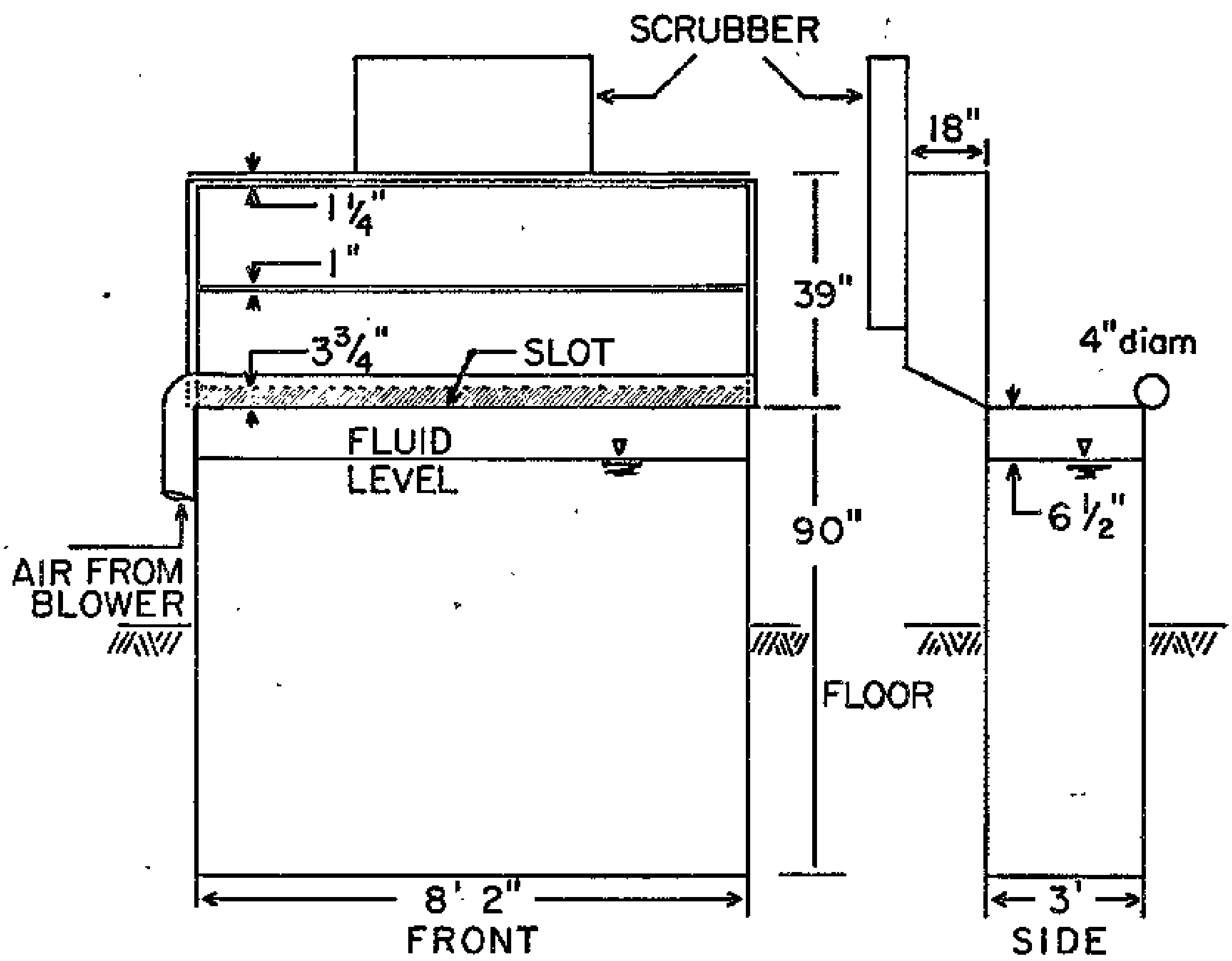


Figure 5. Tank 4.

A vertical profile of tank 4 control velocities show the highest velocity of 100 fpm 6 inches above the tank flange, 60 fpm at 12 inches, and 50 fpm at 1/2-inch. Control velocities along the front of the tank near the sampling locations are shown in Figure 5. The quantity of push air supplied to tank 4 is not known.

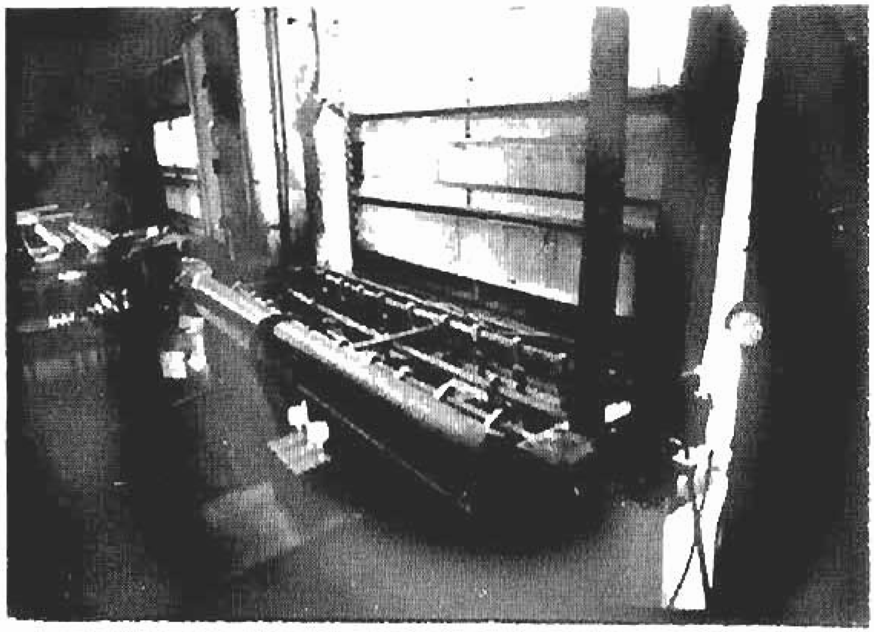


Figure 6. Chrome plating tank 4.

Air Sampling Results

Personal sampling results are shown in Table 3. Employee "B" working at tank 4 had an exposure to hexavalent chromium ranging from 0.002 to 0.01 mg/m^3 (average 0.007 mg/m^3). These levels are far below the OSHA PEL for hexavalent chromium of 0.100 mg/m. Sulfuric acid levels ranged from less than 0.2 mg/m^3 to 0.4 mg/m^3, also well below allowable concentrations.

Results of area samples for hexavalent chromium, total chromium, and sulfuric acid collected at tank 4 are shown in Table 5. Chrome VI levels ranged from less than 0.001 to 0.082 mg/m^3. Total chromium concentrations ranged from less than 0.008 to 0.077 mg/m^3. Both hexavalent chromium and total chromium concentrations were much higher on the left side of tank 4 than the right. All the area sample results were below the allowable limits for personal exposures. Sulfuric acid concentrations at tank 4 ranged from 0.3 to 0.5 mg/m^3. These area sample data are well within the allowable limit for sulfuric acid of 1.0 mg/m^3.

Table 5. Workplace air concentrations (mg/m^3).
Tank 4

Sample Location	Date	Chrome VI	Total Chromium	Sulfuric Acid
Tank 4-Left	2/10	0.022	0.033	0.3
	2/11	0.029	0.077	0.5
	2/12	0.082	0.028	0.3
Mean		0.044	0.046	0.4
Tank 4-Right	2/10	0.005	0.009	0.4
	2/11	0.001	0.008	0.4
	2/12	0.010	0.008	0.4
Mean		0.005	0.008	0.4
Grand Mean		0.025	0.027	0.4
OSHA PEL		0.1	0.5	1.0

Discussion

Personal exposure data for worker "B" indicates good control of chemical emissions from tank 4. The area sampling data also shows good control although chromic acid levels on the left side of the tank were much higher than on the right. Control velocities along the front of the tank including the left sampling location (Figure 5) are almost the same. Thus, differences in ventilation do not explain the higher levels found on the left side.

Good control of mist from tank 4 results from the push/pull ventilation system with a fair exhaust rate (175 cfm/ft^2). The the use of plastic balls may help reduce emissions but to what extent is not clear. The possible advantage of a triple slot hood versus a double or single slot hood can not be determined from the data.

ELECTROPLATING TANK 5

Tank 5 (shown in Figures 7 and 8) is equipped with a push/pull ventilation system. The exhaust hood has a single adjustable slot which was opened to a width of 10 inches during the survey. The hood runs the entire length of the tank. Push air is supplied by the same blower that also serves tank 1, 2, and 3. The push air manifold is similar in design to that used on the other tanks. The air jet is discharged at a downward angle between the anode bar and the front edge of the tank as shown in Figure 8. Tank 5 is not covered and uses no plastic chips or balls.

Operating parameters for tank 5 are given in Table 1. During the first 1-1/2 day of the survey, 10 pieces, each 40-inches-long and 3.4-inches in diameter were plated to a thickness of .008 inches per face. The current was 6500 amps and current density was 1.5 amps/sq in. During the remainder of the survey, a cylinder 5-inches wide and 326-inches long was plated to a thickness of 0.001 inch per face at 6500 amps and a current density of 1.3 amps/sq ft.

Airflow Measurements

Airflow measurements for tank 5 are presented in Table 2. Exhaust airflow was 9400 cfm or 87 cfm/ft^2. Control velocity at the outside edge of the tank averaged 100 fpm. Control velocities were nearly uniform in the vertical profile from 1/2 inch to 12 inches above front flange of the tank. A horizontal profile of control velocities (Figure 5) shows a range of 70 fpm to 130 fpm (left center sample location).

The push air supplied to tank 5 was estimated to be 300 cfm. Based on Hemeons formula, total airflow in the push air jet stream (including entrained air) at the exhaust hood would be 3300 cfm. This is much less than exhaust airflow of 9400 cfm and thus satisfies the requirement that the exhaust rate exceed the total entrained airflow.

Air Sampling Results

Hexavalent chromium and sulfuric acid exposures are shown in Table 3 for employee "C" who works near tank 5. Exposures to hexavalent chromium (0.003 mg/m^3) were 1/30 the OSHA PEL. The exposure of worker "C" was half the average exposure for worker "B" (tank 4). Worker "C" sulfuric acid exposures were well below tha allowable limit.

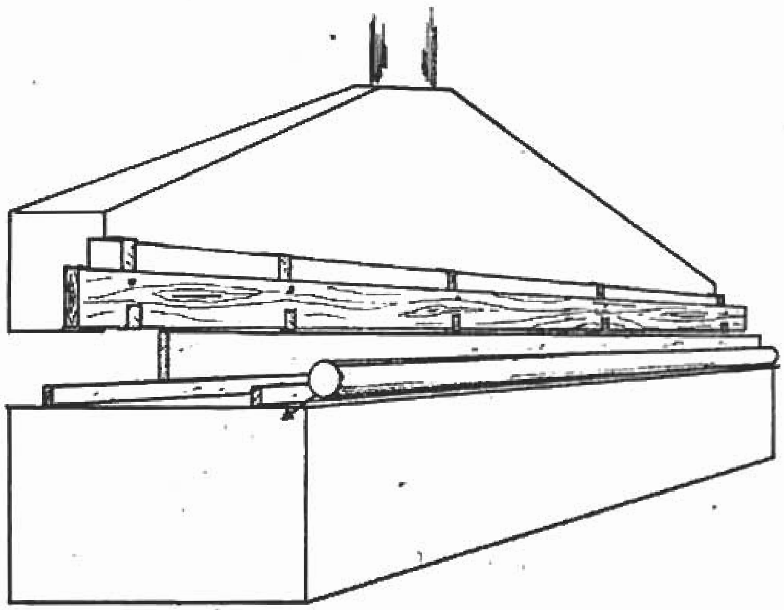


Figure 7. Schematic of tank 5.

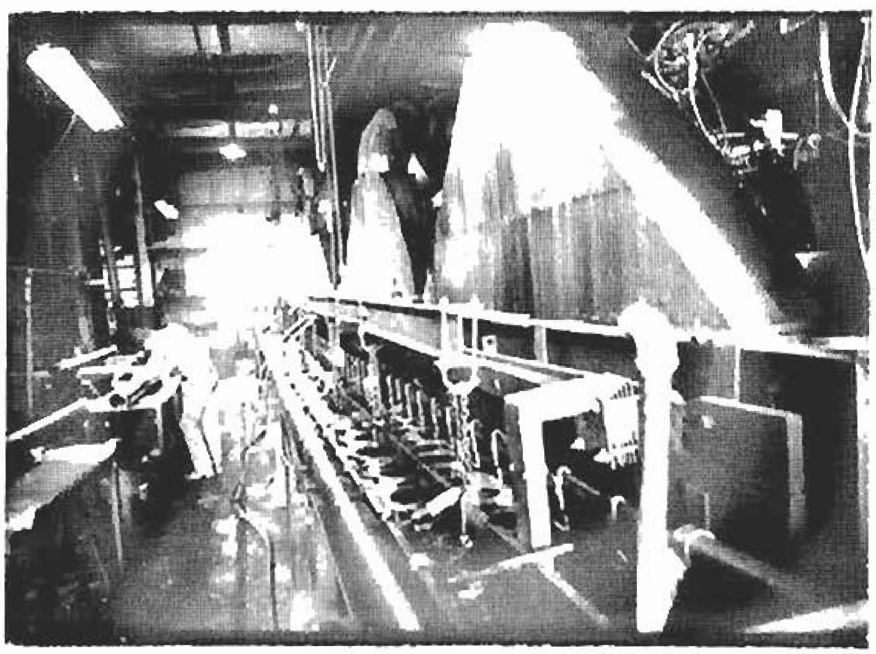


Figure 8. Chrome plating tank 5.

The results of area samples for hexavalent chromium, total chromium and sulfuric acid are presented in Table 6. Hexavalent chromium concentrations ranged from 0.002 to 2.07 mg/m^3. (The value 2.07 mg/m^3 was excluded from summary data because chromic acid was observed to drain onto the filter at the center station). Five of the 11 area samples for hexavalent chromium exceeded the OSHA PEL of 0.1 mg/m^3, indicating a potential for overexposure to the operator at these locations. The average hexavalent chromium concentration for tank 5 was 0.097 mg/m^3.

Samples for total chromium were collected at three locations: left, center, and right of tank 5. Average total chromium concentration ranged from less than 0.008 to 0.380 mg/m^3 and averaged 0.098 mg/m^3 for the six included samples. None of these area samples were in excess of the allowable limit of 0.5 mg/m^3 for personal exposures. Some very high levels at the center location were measured. One sample on 2/12 (4.06 mg/m^3) was forty times as high as the average (.097 mg/m^3) of the six included samples. The 4.06 mg/m^3 value and two other samples for total chromium were excluded from the data summarys because chromic acid was observed to drain onto the filters on 2/11 and 2/12. Operating procedures required that one part be hoisted out of the tank and the chromic acid solution rinsed off, resulting in frequent splashing of the filter cassettes at the center location, which caused artificially high chromium levels. The total chrome sample (0.902 mg/m^3) on 2/10/81 at the right location was also splashed by chromic acid rinse. By re-orientation of the samplers at this location splashes from the chromic acid rinse were avoided on subsequent days 2/11 and 2/12. It was not possible to reorientate samples at the center location to prevent chromic acid from being splashed on the cassettes.

Sulfuric acid levels ranged from 0.2 to 0.8 mg/m^3 and averaged 0.4 mg/m^3. The highest sulfuric acid concentration (0.8 mg/m^3) occurred at the center of the tank on 2/12, and may be attributed to the operating procedure described above. Although unlikely, some sulfuric acid may have been splashed directly on the inlet of the silica gel tube. Sulfuric acid levels averaged 0.5, 0.3, and 0.4 mg/m^3 on 2//10, 2/11, and 2/12, respectively.

Table 6. Airborne concentrations at tank 5.
Area samples - mg/m³

Sample Location	Date	Chrome VI	Total Chromium	Sulfuric Acid
Left	2/10	0.053	0.380	0.5
	2/11	0.020	0.021	0.4
	2/12	0.168	0.148	0.2
Mean		0.080	0.183	0.4
Left center	2/10	0.015	--	0.5
	2/11	0.181	--	0.3
	2/12	0.167	--	0.2
Mean		0.121	--	0.3
Center	2/10	0.075	0.012	0.5
	2/11	--	1.27*	0.4
	2/12	2.07*	4.06*	0.8
Mean		--	--	0.6
Right Center	2/10	--	--	0.5
	2/11	0.207	--	0.2
	2/12	0.159	--	0.5
Mean		0.183	--	0.4
Right	2/10	0.193*	0.902*	0.3
	2/11	0.002	<0.008	0.4
	2/12	0.023	0.016	0.2
Mean		0.013	0.012	0.3
Overall Mean - Tank 5		0.097	0.098	0.4
OSHA PEL		0.100	0.5	1.0

*Chromic acid rinsed on to filter - values not included in average.

Discussion

The limited personal sampling results for worker "C" on 2/10 and 2/11 indicates the ventilation system for tank 5 is adequate. The hexavalent chromium levels were only 3 percent of the OSHA PEL and sulfuric acid levels were less than 1/3 the standard. Conversely, the area sampling data indicates the ventilation system may be inadequate for controlling hexavalent chromium in all cases. The ventilation system appeared adequate when plating the smaller cylinders (the average hexavalent chromium area sample concentration was 0.05 mg/m^3). While plating the long cylinder, the average hexavalent chromium concentration was 0.13 mg/m^3 indicating fairly poor control. One possibility is the higher power used to plate the long cylinders increased mist generation.

Control velocity measurements (Figure 4) failed to correlate with Chrome VI area sample results. The highest control velocities were measured at left center and right center locations corresponding to the highest average levels of hexavalent chromium. Factors other than the control velocity appear to be involved.

The exhaust rate for tank 5 was 87 cfm/ft^2 (approximately 1/3 the recommended rate of 225 cfm/ft^2), and may need to be increased during certain plating operations, particularly at higher powers.

The high hexavalent chromium levels (in excess of 0.1 mg/m^3) also appear to be caused by the work practice of rapidly and somewhat haphazardly rinsing the chromic acid.

In summary, control of emissions (primarily hexavalent chromium) for tank 5 could be improved by increasing the exhaust rate and more careful operating procedure for rinsing chromic acid off the plated parts. The results for tank 5 also indicate increased power may have increased mist generation.

REFERENCES

1. Criteria for a Recommended Standard...Occupational Exposure to Chromic Acid. DHEW Publ. No. HSM 73-11021, NIOSH, Cincinnati, OH (1973).

2. Cohen, S. R. et al.: Health Hazard Evaluation/Toxicity Determination. Marsh Plating Corporation, Ypsilanti, Michigan. NIOSH No. 72-118-104, Cincinnati, OH (1973).

3. Jager, L. E.: Hazards in the Plating Industry. Occupational Health Review, Vol. 18, pp 3-10(1966).

4. Young, M. A.: Health Hazards of Electroplating. Journal of Occupational Medicine, Vol. 7, pp 348-52 (1965).

5. Anon.: The Occupational Health Bulletin-Electroplating. Occupational Health Branch, Department of Health, Wellington, New Zealand. No. 3. New Series (1969).

6. Occupational Health Guidelines for Chemical Hazards. DHHS (NIOSH) DOL (OSHA). DHHS (NIOSH 81-123 (1981). Cincinnati, OH (1977).

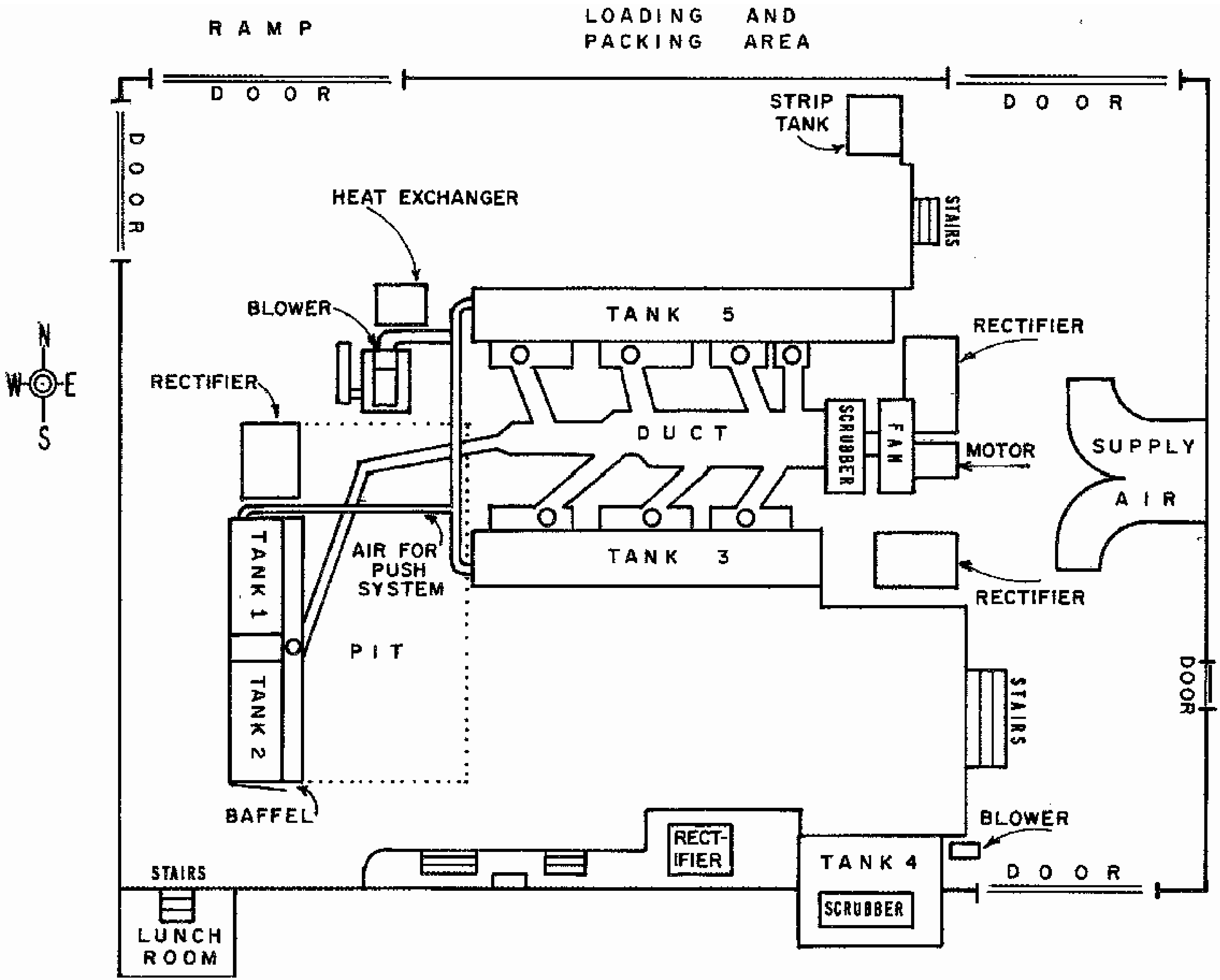
7. Occupational Diseases - A Guide to Their Recognition. DHEW (NIOSH) 77-181. NIOSH, Cincinnati, OH (1977).

8. Pocket Guide to Chemical Hazards. NIOSH/OSHA. DHEW (NIOSH) 78-210. Cincinnati, OH. (1978).

9. NIOSH Manual of Analtyical Methods. DHEW(NIOSH) 78-175 (2nd Ed.). NIOSH, Cincinnati, OH (1978).

10. Industrial Ventilation: A Manual of Recommended Practice (15th Ed.). Committee on Industrial Ventilation. American Conference of Governmental Industrial Hygienists, Lansing, Michigan (1978).

11. Hemeon (1963): Plant and Process Ventilation. Industrial Press Inc., New York, NY, page 481 (1963).


RAMP
LOADING AND
PACKING AREA
DOOR
DOOR
DOOR
STRIP
TANK
STAIRS
HEAT EXCHANGER
BLOWER
RECTIFIER
TANK 5
RECTIFIER
DUCT
SCRUBBER
FAN
MOTOR
SUPPLY
AIR
TANK 3
RECTIFIER
AIR FOR
PUSH
SYSTEM
TANK 1
TANK 2
PIT
BAFFEL
STAIRS
DOOR
BLOWER
RECT-
IFIER
TANK 4
SCRUBBER
DOOR
STAIRS
LUNCH
ROOM
N
W
E
S

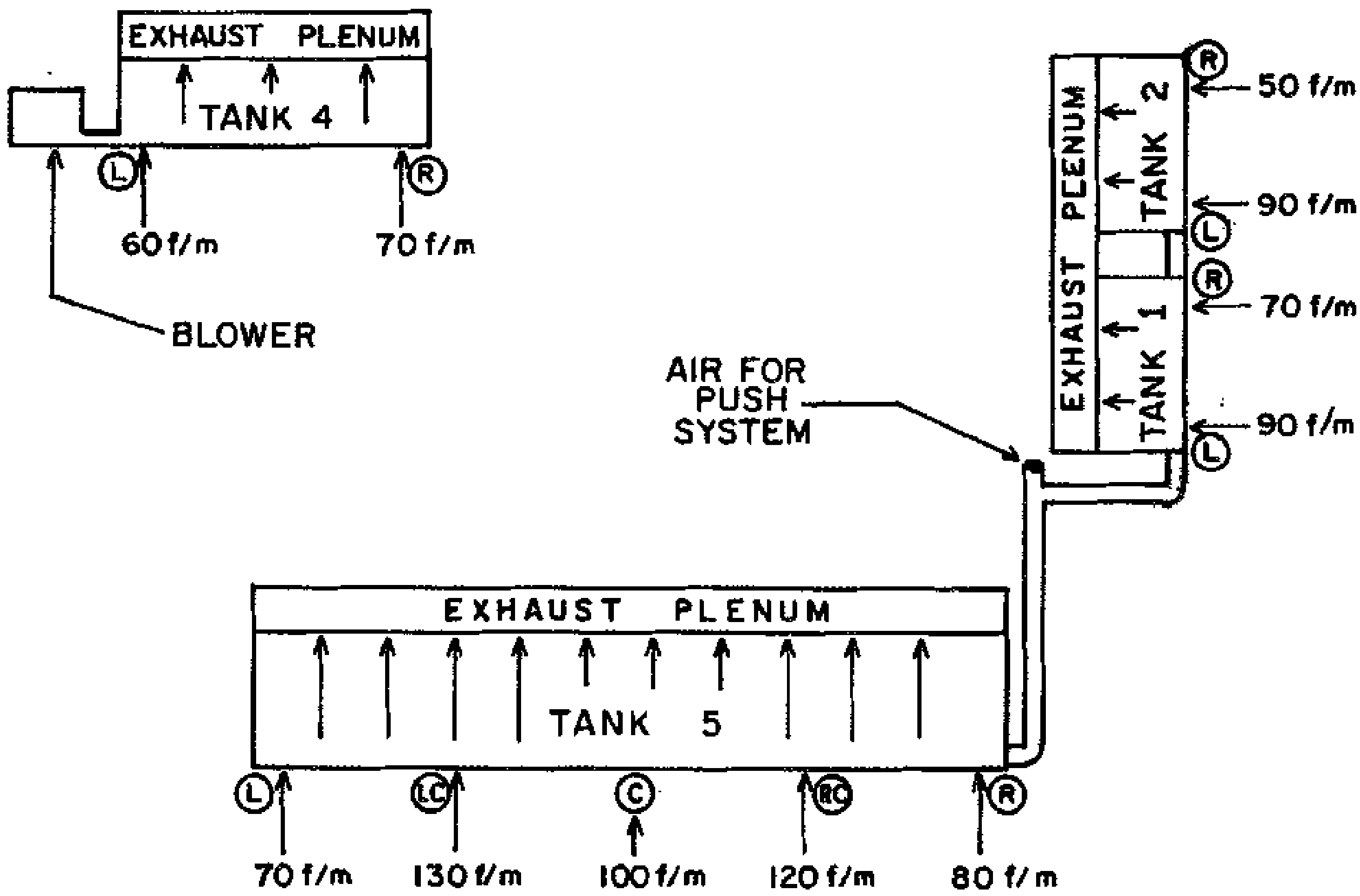


Figure 4. Control velocities at sampling locations.

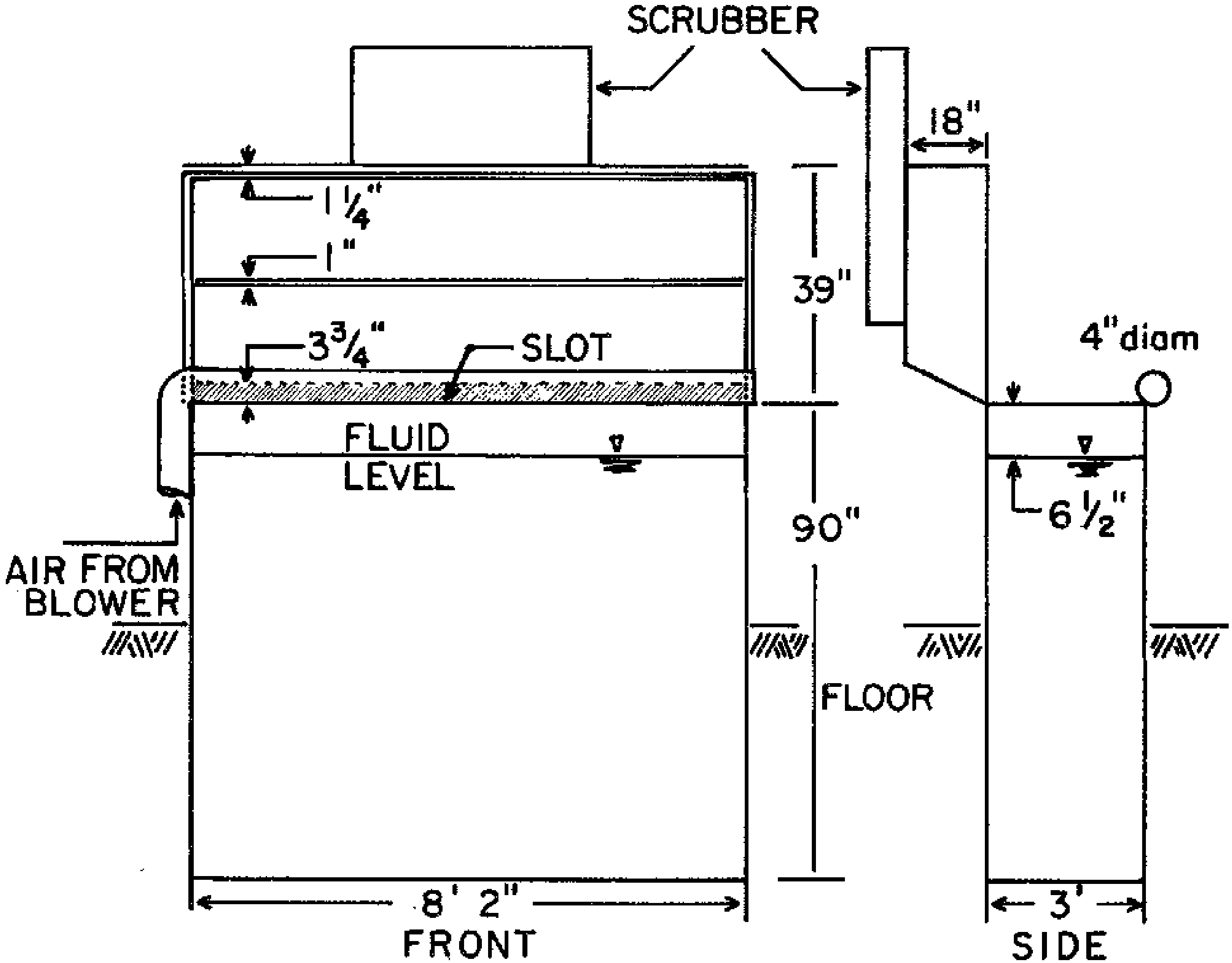


Figure 5. Tank 4.