Air Permits Division

Calculations Guidance Package

Chromium Plating & Anodizing Operations Using Chromic Acid

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I. INTRODUCTION

A. GENERAL

Plating and anodizing operations range in size from small shops, with one or two tanks that are operated only a few hours per week, to large shops with several tanks that are operated 24 hours per day, 7 days per week. Many plating and anodizing operations are captive shops that perform chromium electroplating or chromic acid anodizing as one operation within or for a manufacturing facility. Other facilities are job shops that provide custom plating or anodizing services for many different clients. The three primary operations performed are: hard chromium plating, decorative chrome plating, and chromic acid anodizing. Many facilities will have a combination of these processes. An understanding of the number and type of plating or anodizing operations being conducted at a facility is necessary to adequately identify emission points and emission rates. The following is a brief review of the hard and decorative chrome plating operations and chromic acid anodizing.

B. HARD CHROMIUM ELECTROPLATING OF METALS

A relatively thick layer of chromium (1.3-762 µm or 0.05-30 mils) is deposited directly on the base metal (usually steel) to provide a surface with wear resistance, low coefficient of friction, hardness, and corrosion resistance, or for surface build-up. Tanks used in hard chrome plating operations (hexavalent chromium) contain chromic acid, sulfuric acid, and water. The chromic acid is the source of the hexavalent chromium that reacts and deposits on the metal and that is emitted to the atmosphere. The sulfuric acid catalyzes the chromium deposition reactions. Insoluble anodes made of lead alloy that contain either tin or antimony are contained within the tank. The part to be plated is the cathode and is connected to the cathode bar of the rectifier. Chromium electroplating requires constant control of the plating bath temperature, current density, plating time, and bath composition.

C. DECORATIVE CHROMIUM ELECTROPLATING OF METALS

Decorative chromium plating uses a thinner layer of chromium (0.003-2.5 µm or 0.0001 0.1 mils) usually over a layer of nickel previously placed on the base material (e.g., brass, steel, aluminum, or plastic). Decorative electroplating baths operate on the same principle as the hard chromium plating process, but requires shorter plating times and operates at a lower current density. Some decorative chromium plating operations use fluoride catalysts instead of sulfuric acid because fluoride catalysts have been found to produce higher bath efficiencies.

D. DECORATIVE CHROMIUM ELECTROPLATING OF PLASTICS

Most plastics that are electroplated with chromium are formed from the polymer composed of acrylonitrile, butadiene, and styrene (ABS). The chroming of ABS plastic parts consists of several steps:

1. Chromic acid/sulfuric acid etch;
2. Dilute hydrochloric acid dip;
3. Colloidal palladium activation;
4. Dilute hydrochloric acid dip;
5. Electroless nickel plating or copper plating; and
6. Chromium electroplating cycle.

After each process the part is rinsed with water to prevent solution contamination. The chromic acid/sulfuric acid etch renders the ABS surface hydrophilic (having a strong tendency to bind or absorb water, which results in swelling and formation of reversible gels) and modifies the surface to provide adhesion for the metal coating. The dilute hydrochloric acid dips are used to clean the surface and remove palladium metal from the plating rack, which is insulated with a coating of polyvinyl chloride. The colloidal palladium activation solution deposits a thin layer of metallic palladium over the plastic surface. The metallic palladium induces the deposition of copper or nickel, which will not deposit directly onto plastic. The electroless nickel and copper plate are applied to impart electrical conductivity to the part; otherwise, the insulation surface of the plastic could not be electroplated with chromium.

E. CHROMIC ACID ANODIZING

Chromic acid anodizing is used primarily on aircraft parts and architectural structures that are subject to high stress and corrosion. Chromic acid anodizing is used to provide an oxide layer on aluminum that imparts the following properties:

1. Corrosion protection;
2. Electrical insulation;
3. Ease of coloring; and
4. Improved dielectric strength.

Chromic acid anodizing requires the rectifier to be fitted with a rheostat or other control mechanism to allow starting at about 5 volts, the anodizing tank is the cathode in the electrical circuit, the aluminum part to be anodized is the anode, and sidewall shields typically are used instead of a liner in the tank to minimize short circuits and to decrease the effective cathode area. Several pretreatment steps are used to clean the aluminum before anodizing:

1. Alkaline soak;
2. Desmut (remove soil or grease films that cleaners and etchants leave behind);
3. Etching; and
4. Vapor degreasing.

F. TRIVALENT CHROMIUM PLATING

Trivalent chromium electroplating baths have been developed primarily to replace hexavalent chromium plating baths. The advantages of the trivalent chromium processes over the hexavalent chromium process are (1) fewer environmental concerns, (2) higher productivity and (3) lower operating costs. The trivalent bath does not contain any appreciable amount of hexavalent chromium, which is more toxic than trivalent chromium. There are two types of trivalent chromium processes on the market; single-cell and double-cell. The major differences in the two processes are that (1) the double-cell process solution contains minimal-to-no chlorides whereas the single-cell process solution contains a high concentration of chlorides; and (2) the double-cell process utilizes lead anodes that are placed in anode boxes that contain a dilute sulfuric acid solution and are lined with a permeable membrane whereas the single-cell process utilizes carbon or graphite anodes that are placed in direct contact with the plating solution. As a result of the chemistry of the trivalent chromium electrolyte, misting does not occur during plating, as it does during hexavalent chromium plating. Use of trivalent chromium reduces waste disposal problems and costs.

II. INSTRUCTIONS

This guidance provides two methods of calculating emissions from a chromium plating process. The difference between the methods is whether the applicant chooses to calculate emission rates using the uncontrolled emission rate factors then apply specific emission abatement control efficiencies applicable to their facility; or the applicant chooses to select a controlled emission factor from an enclosed table based upon a proposed or existing abatement type. For calculations that will be done using the uncontrolled emission factors use steps 1 thru 13 (use TABLE 1 and 1a). For calculations using a controlled emission factor skip to step 14 and complete the instructions (use TABLE 2 and 2a). The calculations are made with data provided by the applicant. To assist in these calculations, tables are provided according to the calculation method chosen. A completed TABLE 1 and 1a or TABLE 2 and 2a, in addition to the applicant's calculations and supporting material, will serve to expedite the permit review process.

NOTE: If you use a trivalent chromium process at your facility do not use the following calculations. Contact the TCEQ, Air Permits Division, Mechanical/Agricultural Section for guidance.

1. Select the emission factor (EF_T and EF_1) appropriate to your chromium operation(s) (hard or decorative chromium plating) using the enclosed TABLE 1.

2. Calculate the total PM (ER_T) and the total chromium compounds (ER_1) for the uncontrolled emission rates, then enter their values into Table 1:

$ER_T = EF_T$ x A x lb/7000 grains (lbs/hr) Rate for total uncontrolled PM
$ER_1 = EF_1$ x A x lb/7000 grains (lbs/hr) Rate for uncontrolled chromium compounds

3. Do you use a suppressant (foam, fume, or mechanical) in your chromium plating tank? If yes, complete the following then go to 4.

FE = (1 - (%)/100), where % is the efficiency of the suppressant.
The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant.

Enter the value of FE into TABLE 1, then calculate the following (enter the value of ER_2 and ER_3 into TABLE 1a):

$ER_2 = ER_T$ x FE (lbs/hr)
$ER_3 = ER_1$ x FE (lbs/hr)

If you do not use a fume suppressant, complete the following (enter the value of ER_2 and ER_3 into TABLE 1a) then go to 4.

$ER_2 = ER_T$
$ER_3 = ER_1$

4. Do you use a capture hood on your chromium plating tank? If yes, complete the following calculation (enter the value of ER_4 and ER_5 into TABLE 1a). If not, go to 5.

$ER_4 = ER_2$ x CE/100 (lbs/hr)
$ER_5 = ER_3$ x CE/100 (lbs/hr)

NOTE: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

If you use a hood and a fume suppressant, go to 7.

If you use a hood and no fume suppressant, go to 8.

5. If you do not use a capture hood, but use a fume suppressant, complete the following (enter the values of ER_4 and ER_5 into TABLE 1a), then skip to 10.

$ER_4 = ER_2$ (lbs/hr) (No hood, but using a fume suppressant)
$ER_5 = ER_3$ (lbs/hr) (No hood, but using a fume suppressant)

If you do not use a capture hood, and also do not use a fume suppressant, then go to 6.

6. You will not be authorized to operate a chromium plating tank without the use of, as a minimum, a fume suppressant, and/or a capture hood with an abatement device.

7. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations enter the values of AE, ER_6 and ER_7 into TABLE 1, then skip to 11. If not, skip to 9.

The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly.

AE = [1 - (%)/100], where % is the abatement device efficiency.
$ER_6 = ER_4$ x AE (lbs/hr)
$ER_7 = ER_5$ x AE (lbs/hr)

8. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE, ER_6 and ER_7 into TABLE 1, then go to 11. If not, go back to 6.
The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly.

AE = (1 - (%)/100), where % is the abatement device efficiency.
$ER_6 = ER_4$ x AE (lbs/hr)
$ER_7 = ER_5$ x AE (lbs/hr)

9. Complete the following, then enter the values of ER_6 and ER_7 into TABLE 1, then skip to 11:

$ER_6 = ER_4$ (lbs/hr)
$ER_7 = ER_5$ (lbs/hr)

10. Calculate the total hourly fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 1, then skip to 12:
Fugitive emissions are those emissions that are not captured by a hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_4)$ (0.5) (lbs/hr) (Fume suppressant only)
$FUG_1 = (ER_5)$ (0.5) (lbs/hr) (Fume suppressant only)

11. Calculate the fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 1, then skip to 13:
Fugitive emissions are those emissions that are not captured by the hood system; and therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_2 - ER_4)$ (0.5) (lbs/hr)
$FUG_1 = (ER_3 - ER_5)$ (0.5) (lbs/hr)

12. Calculate your annual fugitive emission rate ($AFUG_T$ and $AFUG_1$) and enter their values of into TABLE 1:

$AFUG_T$ = (FUG_T x OY)/2000 (tons/year)
$AFUG_1$ = (FUG_1 x OY)/2000 (tons/year)

13. Calculate your annual emission rates (AER_T and AER_1) and the annual fugitive rates ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 1.

AER_T = (ER_6 x OY)/2000 (tons/year)
AER_1 = (ER_7 x OY)/2000 (tons/year)
$AFUG_T$ = (FUG_T x OY)/2000 (tons/year)
$AFUG_1$ = (FUG_1 x OY)/2000 (tons/year)

CHROMIUM PLATING EMISSIONS
UNCONTROLLED FACTOR METHOD

Table 1

Chromium Plating Tanks	**1**	**2**	**3**	**4**	**5**
EFT = Emission Factor Total PM Decorative Chrome (grains/amp-hr)	0.069	0.069	0.069	0.069	0.069
EF1 = Emission Factor Chromium Compounds Decorative Chromium (grains/amp-hr)	0.033	0.033	0.033	0.033	0.033
EFT = Emission Factor Total PM Hard Chrome (grains/amp-hr)	0.25	0.25	0.25	0.25	0.25
EF1 = Emission Factor Chromium Compounds Hard Chromium (grains/amp-hr)	0.12	0.12	0.12	0.12	0.12
A = Maximum Amperage of Chromium Tank Rectifier (amps)					
ERT = Emission Rate Total PM Uncontrolled (lbs/hr)					
ER1 = Emission Rate Chromium Compounds Uncontrolled (lbs/hr)					
FE= Suppressant Efficiency 1- (%)/100					
CE = Hood Capture Efficiency (%)					
AE= Abatement Device Efficiency 1- (%)/100					
ER6=Emission Rate Total PM Controlled (lbs/hr)					
ER7=Emission Rate Chromium Compounds Controlled (lbs/hr)					
FUGT = Total PM Fugitive Emissions Rate (lbs/hr)					
FUG1 = Chromium Compound Fugitive Emission Rate (lbs/hr)					
OY = Total Operating Hours Per Year					
AFUGT = Annual Total PM Fugitive Emission Rate (tons/year)					
AFUG1 = Annual Total Chromium Compounds Fugitive Emission Rate (tons/year)					
AERT = Annual Total PM Emission Rate (tons/yr)					
AER1 = Annual Chromium Compounds Emission Rate (tons/yr)					

CHROMIUM SUPPLEMENTARY TABLE UNCONTROLLED FACTOR METHOD

Table 1a

Chromium Plating Tanks	**1**	**2**	**3**	**4**	**5**
ER_2 (lbs/hr) Total PM					
ER_3 (lbs/hr) Chromium Compounds					
ER_4 (lbs/hr) Total PM					
ER_5 (lbs/hr) Chromium Compounds					
ER_2 - ER_4(lbs/hr)					
ER_3 - ER_5(lbs/hr)					

14. From the enclosed AP-42 Table 12-20-1 select the appropriate emission factor (EF_T) to determine the total controlled PM emissions according to the specific process and type of abatement equipment being used or planned on being used. Enter the value into Table 2.

15. From the same Table 12-20-1 used above, select the appropriate emission factor (EF_1) for chromium compounds according to the specific process and type of abatement equipment being used or planned on being used. Enter the value into Table 2.

16. Enter into Table 2 the rectifier amperage (A).

17. Enter into Table 2 the air flow rate (FR) expected from your system as dry standard cubic feet per minute (dscfm).

18. Calculate the total hourly controlled PM emissions using the following method:

$ER_T = EF_T$ (grains/dscf) x (lb/7000 grains) x FR (dscf/min) x (60 min/hour)

Enter the value of ER_T into Table 2.

19. Calculate the total hourly controlled chromium compound emission rate using the following method:
$ER_1 = EF_1$(grains/dscf) x (lb/7000 grains) x FR (dscf/min) x (60 min/hour)
Enter the value of ER_1 into Table 2.

20. Do you use only a fume suppressant with a capture hood on your chromium plating tank? If yes, complete the following calculation and instructions (enter the value of ER_2 and ER_3 into TABLE 2a), then go to 22. If not, go to 21.

$ER_2 = ER_T$ x CE/100 (lbs/hr)
$ER_3 = ER_1$ x CE/100 (lbs/hr)
Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with the Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

21. Do you use only a fume suppressant and no capture hood over your tank? If yes, complete the following calculation and instructions. If not, skip to 25. Calculate the hourly fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 2, then skip to 23:

$FUG_T = ER_T$ x (0.5) (lbs/hr)
$FUG_1 = ER_1$ x (0.5) (lbs/hr)

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

22. Calculate the fugitive emission rate from the tank and enter the values of FUG_T and FUG_1 into TABLE 2, then go to 24:
Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_T - ER_2)$ (0.5) (lbs/hr)
$FUG_1 = (ER_1 - ER_3)$ (0.5) (lbs/hr)

23. Calculate your annual total fugitive emission rates ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 2:

$AFUG_T = (FUG_T$ x OY)/2000 (tons/year)
$AFUG_1 = (FUG_1$ x OY)/2000 (tons/year)

24. Calculate your annual stack and fugitive emission rates (AER_T ,AER_1 ,$AFUG_T$ and $AFUG_1$) and enter their value into TABLE 2:

$AER_T = (ER_2$ x OY)/2000 (tons/year)
$AER_1 = (ER_3$ x OY)/2000 (tons/year)

$AFUG_T = (FUG_T$ x OY)/2000 (tons/year)
$AFUG_1 = (FUG_1$ x OY)/2000 (tons/year)

25. Calculate your annual emission rates (AER_T and AER_1) and enter their values into TABLE 2.

$AER_T = (ER_T$ x OY)/2000 (tons/year)
$AER_1 = (ER_1$ x OY)/2000 (tons/year)

CHROMIUM PLATING EMISSIONS CONTROLLED FACTORS

Table 2

Chromium Plating Tanks	**1**	**2**	**3**	**4**	**5**
EF_T = Controlled Total PM Emission Factor for Decorative Chromium (grains/dscf)					
EF_1 = Controlled Chromium Compounds Emission Factor for Decorative Chromium (grains/dscf)					
EF_T = Controlled Total PM Emission Factor for Hard Chromium (grains/dscf)					
EF_1 = Controlled Chromium Compounds Emission Factor for Hard Chromium (grains/dscf)					
Type of Control					
A = Maximum Amperage of Chromium Tank Rectifier (amps)					
FR= Flow Rate (dscf)					
ER_T = Emission Rate for Total PM (lbs/hr)					
ER_1 = Emission Rate for Chromium Compounds (lbs/hr)					
FUG_T = Total PM Fugitive Emissions (lbs/hr)					
FUG_1 = Chromium Compounds Fugitive Emissions (lbs/hr)					
OY = Total Operating Hours Per Year					
$AFUG_T$= Annual Total PM Fugitive Emission Rate (tons/year)					
$AFUG_1$= Annual Chromium Compounds Fugitive Emission Rate (tons/year)					
AER_T = Total PM Annual Emission Rate (tons/yr)					
AER_1 = Total Annual Chromium Compounds Emission Rate (tons/yr)					

CHROMIUM SUPPLEMENTARY TABLE

Table 2a

Chromium Plating Tanks	**1**	**2**	**3**	**4**	**5**
ER_2 (lbs/hr)					
ER_3 (lbs/hr)					
(ER_T - ER_2) (lbs/hr)					
(ER_1 - ER_3) (lbs/hr)					

Table 12.20-1. EMISSION FACTORS FOR CHROMIUM ELECTROPLATING: [a]

Process	Chromium Compounds		Emission Factor Rating	Total PM [c]		Emission Factor Rating
	grains/A-hr	grains/dscf		grains/ A-hr	grains/dscf	
Hard Chromium Electroplating [d]	0.12	N/A	B	0.25	N/A	C
-- with moisture extractor [e]	N/A	0.00014	D	N/A	0.00028	E
-- with polypropylene balls [f]	N/A	0.00042	D	N/A	0.00088	E
-- with fume suppressant [g]	N/A	0.00016	D	N/A	0.00034	E
-- with fume suppressant and polypropylene balls [h]	N/A	3.0×10^{-5}	D	N/A	6.3×10^{-5}	E
-- with packed-bed scrubber [j]	N/A	2.1×10^{-5}	D	N/A	4.4×10^{-5}	E
-- with packed-bed scrubber, fume suppressant, and polypropylene balls [k]	N/A	2.6×10^{-6}	D	N/A	5.5×10^{-6}	E
-- with chevron-blade mist eliminator [m]	N/A	8.8×10^{-5}	D	N/A	0.00018	E
-- with mesh-pad mist eliminator [n]	N/A	1.2×10^{-5}	D	N/A	2.6×10^{-5}	E
-- with packed-bed scrubber and mesh-pad eliminator [p]	N/A	3.2×10^{-8}	E	N/A	6.7×10^{-8}	E
-- with composite mesh-pad mist eliminator [q]	N/A	3.8×10^{-6}	D	N/A	8.0×10^{-6}	E
Decorative Chromium Electroplating [r] (SCC 3-09-010-28)	0.033	N/A	D	0.069	N/A	E
-- with fume suppressant [s]	N/A	1.2×10^{-6}	D	N/A	2.5×10^{-6}	E

a For chromium electroplating tanks only. Factors represent uncontrolled emissions unless otherwise noted. Emission factors based on total energy input in units of grains per ampere-hour (grains/A-hr) and based on concentrations in units of grains per dry standard cubic foot (grains/dscf). To convert from grains/A-hr to mg/A-hr multiply by 64.8. To convert grains/dscf to mg/dscm, multiply by 2,290. To convert grains/A-hr to grains/dscf, multiply by 0.01. To convert grains/dscf to grains/A-hr multiply by 100. Note that there is considerable uncertainty in these latter two conversion factors because of differences in tank geometry, ventilation, and control device performance. For controlled emissions, factors based on concentration should be used whenever possible. SCC = Source Classification Code. NA = units not applicable.

b Comprised almost completely of hexavalent chromium.

c Total PM includes filterable and condensible PM. However, condensible PM is likely to be negligible. All PM from chromium electroplating sources is likely to be emitted as PM-10. Factors estimated based on assumption that PM consists entirely of chromic acid mist.

d, e, f, g, h, j, k, m, n, p, q, r, s - AP-42 References

CHROMIC ACID ANODIZING

This guidance provides methods of calculating emissions from a chromic acid anodizing process. The difference between the methods is whether the applicant chooses to calculate emission rates using the uncontrolled emission rate factors then applying specific emission abatement control efficiencies applicable to their facility; or the applicant chooses to select a controlled emission factor from an enclosed table based upon a proposed or existing abatement type. For calculations that will be done using the uncontrolled emission factors use the following steps 1 thru 13 (use Table 4 and 4a). For calculations using a controlled emission factor skip to step 14 and complete the instructions (use Table 5 and 5a). The calculations are made with data provided by the applicant. To assist in these calculations, tables are provided according to the calculation method chosen. A completed TABLE 4 and 4a or TABLE 5 and 5a, in addition to the applicant's calculations and supporting material, will serve to expedite the permit review process.

1. Select the emission factor (EF_T and EF_1) appropriate to your chromic acid anodizing from TABLE 12.20-2 attached. If you use the uncontrolled emission factors listed then go to step 2. If you use a controlled emission factor from the TABLE then skip to step 14.

2. Calculate the total PM (ER_T) and the total chromium compounds (ER_1) for the uncontrolled emission rates, then enter their values into Table 4:

Calculate the surface area (A) of your anodizing tank(s) by multiplying the length by the width. Enter the value (A in ft^2) into Table 4.

$ER_T = EF_T$ x A x lb/7000 grains (lbs/hr) Rate for total uncontrolled PM
$ER_1 = EF_1$ x A x lb/7000 grains (lbs/hr) Rate for uncontrolled chromium compounds

3. Do you use a suppressant (foam, fume, or mechanical) in your anodizing tank? If yes, complete the following then go to 4.

FE = (1 - (%)/100), where % is the efficiency of the suppressant.

The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant.

Enter the value of FE into TABLE 4, then calculate the following (enter the value of ER_2 and ER_3 into TABLE 4a):

$ER_2 = ER_T$ x FE (lbs/hr)
$ER_3 = ER_1$ x FE (lbs/hr)

If you do not use a fume suppressant, complete the following (enter the value of ER_2 and ER_3 into TABLE 4a) then go to 4.

$ER_2 = ER_T$
$ER_3 = ER_1$

4. Do you use a capture hood on your anodizing tank? If yes, complete the following calculation (enter the value of ER_4 and ER_5 into TABLE 4a). If not, go to 5.

$ER_4 = ER_2 \times CE/100$ (lbs/hr)
$ER_5 = ER_3 \times CE/100$ (lbs/hr)

Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

If you use a hood and a fume suppressant, go to 7.

If you use a hood and no fume suppressant, go to 8.

5. If you do not use a capture hood, but use a fume suppressant complete the following calculation (enter the values of ER_4 and ER_5 into TABLE 4a), then skip to 10.

$ER_4 = ER_2$ (lbs/hr) (No hood, but using a fume suppressant)
$ER_5 = ER_3$ (lbs/hr) (No hood, but using a fume suppressant)

If you do not use a capture hood, and also do not use a fume suppressant, then go to 6.

6. You will not be authorized to operate a chromic acid anodizing tank without the use of, as a minimum, a fume suppressant, and/or a capture hood with an abatement device.

7. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE, ER_6 and ER_7 into TABLE 4, then skip to 11. If not, skip to 9.

The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly.

AE = (1 - (%)/100), where % is the abatement device efficiency.
$ER_6 = ER_4 \times AE$ (lbs/hr)
$ER_7 = ER_5 \times AE$ (lbs/hr)

8. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE, ER_6 and ER_7 into TABLE 4, then go to 11. If not, go back to 6.

The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly.

AE = [1 - (%)/100], where % is the abatement device efficiency.
$ER_6 = ER_4 \times AE$ (lbs/hr)
$ER_7 = ER_5 \times AE$ (lbs/hr)

9. Complete the following, then enter the values of ER_6 and ER_7 into TABLE 4, then go to 11:

$ER_6 = ER_4$ (lbs/hr)
$ER_7 = ER_5$ (lbs/hr)

10. Calculate the total hourly fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 4, then skip to 12:

Fugitive emissions are those emissions that are not captured by a hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_4)(0.5)$ (lbs/hr) (Fume suppressant only)
$FUG_1 = (ER_5)(0.5)$ (lbs/hr) (Fume suppressant only)

11. Calculate the fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 4, then skip to 13:

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_2 - ER_4)(0.5)$ (lbs/hr)
$FUG_1 = (ER_3 - ER_5)(0.5)$ (lbs/hr)

12. Calculate your annual fugitive emission rate ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 4:

$AFUG_T = (FUG_T \times OY)/2000$ (tons/year)
$AFUG_1 = (FUG_1 \times OY)/2000$ (tons/year)

13. Calculate your annual emission rates (AER_T and AER_1) and the annual fugitive rates ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 4
.
$AER_T = (ER_6 \times OY)/2000$ (tons/year)
$AER_1 = (ER_7 \times OY)/2000$ (tons/year)
$AFUG_T = (FUG_T \times OY)/2000$ (tons/year)
$AFUG_1 = (FUG_1 \times OY)/2000$ (tons/year)

Table 12.20-2. EMISSION FACTORS FOR CHROMIC ACID ANODIZING [a]

Process	Chromium Compounds[b], grains/hr-ft^2	Emission Factor Rating	Total PM[c] grains/hr-ft^2	Emission Factor Rating
Chromic Acid Anodizing [d] (SCC 3-09-010-38)	2.0	D	4.2	E
-- *with polypropylene balls [e]*	1.7	D	3.6	E
-- *with fume suppressant [f]*	0.064	D	0.13	E
-- *with fume suppressant and polypropylene balls [g]*	0.025	D	0.053	E
-- *with packed-bed scrubber [h]*	0.0096	D	0.02	E
-- *with packed-bed scrubber and fume suppressant [d]*	0.00075	D	0.0016	E
-- *with mesh-pad mist eliminator [k]*	0.0051	E	0.011	E
-- *with packed-bed scrubber and mesh pad mist eliminator [m]*	0.00054	D	0.0011	E
-- *with wet scrubber, moisture extractor, and high efficiency particulate air filter [n]*	0.00048	D	0.001	E

a For chromium electroplating tanks only. Factors represent uncontrolled emissions unless otherwise noted. Factors are in units of grains per hour per square foot (grains/hr-ft2) of tank surface area. SCC = Source Classification Code. To convert from grains/hr-ft2 to mg/hr-m2, multiply by 0.70.

b Comprised almost completely of hexavalent chromium.

c Total PM includes filterable and condensible PM. However, condensible PM is likely to be negligible.
All PM from chromium electroplating sources is likely to be emitted as PM-10. Factors estimated based on assumption that PM consists entirely of chromic acid mist.

d, e, f, g, h, j, k, m, n - AP-42 References

CHROMIC ACID ANODIZING UNCONTROLLED FACTOR METHOD

TABLE 4

Chrome Acid Anodizing Tanks	**1**	**2**	**3**	**4**	**5**
EF_T = Emission Factor Total PM Uncontrolled (grains/hr-ft_2)	**4.2**	**4.2**	**4.2**	**4.2**	**4.2**
EF_1 = Emission Factor Chromium Compounds Uncontrolled (grains/hr-ft_2)	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**
EF_T = Emission Factor Total PM Controlled (grains/hr-ft_2)					
EF_1 = Emission Factor Chromium Compounds Controlled (grains/hr-ft_2)					
A = Anodizing Tank Surface Area (Length x Width ft_2)					
ER_T = Emission Rate Total PM Uncontrolled (lbs/hr)					
ER_1 = Emission Rate Chromium Compounds Uncontrolled (lbs/hr)					
FE= Suppressant Efficiency 1- (%)/100					
CE = Hood Capture Efficiency (%)					
AE= Abatement Device Efficiency 1- (%)/100					
ER_6=Emission Rate Total PM Controlled (lbs/hr)					
ER_7=Emission Rate Chromium Compounds Controlled (lbs/hr)					
FUG_T = Total PM Fugitive Emissions Rate (lbs/hr)					
FUG_1 = Chromium Compound Fugitive Emission Rate (lbs/hr)					
OY = Total Operating Hours Per Year					
$AFUG_T$ = Annual Total PM Fugitive Emission Rate (tons/year)					
$AFUG_1$ = Annual Total Chromium Compounds Fugitive Emission Rate (tons/year)					
AER_T = Annual Total PM Emission Rate (tons/yr)					
AER_1 = Annual Chromium Compounds Emission Rate (tons/yr)					

CHROMIC ACID ANODIZING SUPPLEMENTARY TABLE UNCONTROLLED FACTOR METHOD

TABLE 4a

Anodizing Tanks	**1**	**2**	**3**	**4**	**5**
ER_2 (lbs/hr) Total PM					
ER_3 (lbs/hr) Chromium Compounds					
ER_4 (lbs/hr) Total PM					
ER_5 (lbs/hr) Chromium Compounds					
ER_2 - ER_4 (lbs/hr)					
ER_3 - ER_5(lbs/hr)					

14. From the enclosed AP-42 Table 12-20-20 select the appropriate emission factor (EF_T) to determine the total controlled PM emissions according to the specific process and type of abatement equipment being used or planned on being used. Enter the value into Table 5.

15. From the same Table 12-20-20 used above, select the appropriate emission factor (EF_1) for chromium compounds according to the specific process and type of abatement equipment being used or planned on being used. Enter the value into Table 5.

16. Enter into Table 5 the anodizing tank(s) surface area (A).

17. Calculate the total hourly controlled PM emissions using the following method:

$ER_T = EF_T$ (grains/hr-ft^2) x (lb/7000 grains) x A (ft^2)

Enter the value of ER_T into Table 5.

18. Calculate the total hourly controlled chromium compound emission rate using the following method:

$ER_1 = EF_1$ (grains/hr-ft^2) x (lb/7000 grains) x A (ft^2)

Enter the value of ER_1 into Table 5.

19. Do you use only a fume suppressant with a capture hood on your chromium plating tank? If yes, complete the following calculation and instructions (enter the value of ER_2 and ER_3 into TABLE 5a), then go to 21. If not, go to 20.

$ER_2 = ER_T$ x CE/100 (lbs/hr)
$ER_3 = ER_1$ x CE/100 (lbs/hr)

Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

20. Do you use only a fume suppressant and no capture hood over your tank? If yes, complete the following calculation and instructions. If not, skip to 24. Calculate the hourly fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 5, then skip to 22:

$FUG_T = ER_T$ x (0.5) (lbs/hr)
$FUG_1 = ER_1$ x (0.5) (lbs/hr)

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

21. Calculate the fugitive emission rate from the tank and enter the values of FUG_T and FUG_1 into TABLE 5, then go to 23:

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_T - ER_2)$ (0.5) (lbs/hr)
$FUG_1 = (ER_1 - ER_3)$ (0.5) (lbs/hr)

22. Calculate your annual total fugitive emission rates ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 5:

$AFUG_T = (FUG_T \text{ x } OY)/2000$ (tons/year)
$AFUG_1 = (FUG_1 \text{ x } OY)/2000$ (tons/year)

23. Calculate your annual stack and fugitive emission rates (AER_T ,AER_1 ,$AFUG_T$ and $AFUG_1$) and enter their value into TABLE 5:

$AER_T = (ER_2 \text{ x } OY)/2000$ (tons/year)
$AER_1 = (ER_3 \text{ x } OY)/2000$ (tons/year)

$AFUG_T = (FUG_T \text{ x } OY)/2000$ (tons/year)
$AFUG_1 = (FUG_1 \text{ x } OY)/2000$ (tons/year)

24. Calculate your annual emission rates (AER_T and AER_1) and enter their values into TABLE 5.

$AER_T = (ER_T \text{ x } OY)/2000$ (tons/year)
$AER_1 = (ER_1 \text{ x } OY)/2000$ (tons/year)

CHROMIC ACID ANODIZING EMISSIONS
CONTROLLED FACTOR METHOD

TABLE 5

Chromic Anodizing Tanks	**1**	**2**	**3**	**4**	**5**
EF_T = Controlled Total PM Emission Factor (grains/hr-ft_2)					
EF_1 = Controlled Chromium Compounds Emission Factor (grains/hr-ft_2)					
Type of Control					
A = Anodizing Tanks Surface Area (length x width ft_2)					
ER_T = Emission Rate for Total PM (lbs/hr)					
ER_1 = Emission Rate for Chromium Compounds (lbs/hr)					
FUG_T = Total PM Fugitive Emissions (lbs/hr)					
FUG_1 = Chromium Compounds Fugitive Emissions (lbs/hr)					
OY = Total Operating Hours Per Year					
$AFUG_T$= Annual Total PM Fugitive Emission Rate (tons/year)					
$AFUG_1$= Annual Chromium Compounds Fugitive Emission Rate (tons/year)					
AER_T = Total PM Annual Emission Rate (tons/yr)					
AER_1 = Total Annual Chromium Compounds Emission Rate (tons/yr)					

CHROMIC ACID ANODIZING SUPPLEMENTARY TABLE

TABLE 5a

Anodizing Tanks	**1**	**2**	**3**	**4**	**5**
ER_2 (lbs/hr)					
ER_3 (lbs/hr)					
(ER_T - ER_2) (lbs/hr)					
(ER_1 - ER_3) (lbs/hr)					

Table 12.20-3. SUMMARY OF PARTICLE SIZE DISTRIBUTIONS FOR CHROMIUM ELECTROPLATING [a]

Uncontrolled			Controlled [b]		
Diameter, µm	*Cumulative Percent Less Than*		Diameter, µm	*Cumulative Percent Less Than*	
	Total PM [c]	Chromium Compounds [d]		Total PM [c]	Chromium Compounds [d]
<0.5	0	0	<0.49	0	0
0.5	9.1	6.9	0.49	18.5	20.4
2.4	48.3	67.7	2.35	94.7	97.5
8.0	59.3	82.6	7.9	100	99.2

a Reference 6. Based on C-rated emission data for hard chromium electroplating tanks - Source Classification Code 3 09-010-18.

b Controlled with chevron-blade mist eliminators.

c Total PM consists of filterable and condensible PM. However, condensible PM is likely to be negligible.

d Comprised almost completely of hexavalent chromium.

Table 12.20-4. EMISSION FACTORS FOR ELECTROPLATING--OTHER METALS [a] EMISSION FACTOR RATING: E

Source	Pollutant	Emission Factor		Ref.
		grains/A-hr	grains/dscf	
Copper cyanide electroplating tank with mesh-pad mist eliminator (SCC 3-09-010-42)	Cyanide	N/A	2.7×10^{-6}	21
Copper sulfate electroplating tank with wet scrubber (SCC 3-09-010-45)	Copper	N/A	8.1×10^{-5}	31
Cadmium cyanide electroplating tank (SCC 3-09-010-52)	Cadmium	0.04	N/A	31
-- *with mesh-pad mist eliminator*	Cyanide	N/A	1.0×10^{-4}	21
-- *with mesh-pad mist eliminator*	Cadmium	N/A	1.4×10^{-7}	21
-- *with packed-bed scrubber*	Cyanide	N/A	5.9×10^{-5}	22
-- *with packed-bed scrubber*	Cadmium	N/A	1.7×10^{-6}	22, 31
-- *with packed-bed scrubber*	Ammonia	N/A	4.2×10^{-5}	22
Nickel electroplating tank (SCC 3-09-010-68)	Nickel	0.63	N/A	31
-- *with wet scrubber*	Nickel	N/A	6.7×10^{-6}	31

a Factors represent uncontrolled emissions unless noted. All emission factors in units of grains per ampere-hour (grains/A-hr) and as concentrations in units of grains per dry standard cubic foot (grains/dscf). To convert from grains/A-hr to mg/A-hr multiply by 64.8. To convert grains/dscf to mg/dscm, multiply by 2,290. To convert grains/A-hr to grains/dscf, multiply by 0.01. To convert grains/dscf to grains/A-hr multiply by 100. Note that there is considerable uncertainty in these latter two conversion factors because of differences in tank geometry, ventilation, and control device performance. SCC = Source Classification Code. NA = units not applicable.

HYDROCHLORIC (HCl) ACID TANK TABLE

TABLE 3

HCl Pickle Tanks	**1**	**2**	**3**	**4**	**5**
A = Surface area of tank (ft^2)					
T = Operating temperature (C°)					
Conc. = Percent concentration of HCL by weight (% w/w)					
V = Air velocity across surface of tank (fps)					
P_v= Vapor pressure of HCl (mmHg from Table 3)					
E = Evaporation rate from tank (lb/hr-ft^2)					
ER_1 = Emission rate Uncontrolled (lb/hr)					
FE = Suppressant efficiency 1 - (%)/100					
CE = Hood capture efficiency (%)					
AE= Abatement device efficiency 1 - (%)/100					
ER_4= Emission rate Controlled (lb/hr)					
FUG = Fugitive emissions (lb/hr)					
OY= Annual operating hours					
AFUG = Annual HCl fugitive emission rate (tons/year)					
AER = Annual HCl emission rate (tons/year)					

HYDROCHLORIC ACID SUPPLEMENTARY TABLE

TABLE 3a

HCl Pickle Tanks	**1**	**2**	**3**	**4**	**5**
ER_1 (enter into TABLE 2) (lbs/hr)					
ER_2 (lbs/hr)					
ER_3 (lbs/hr)					
(ER_2 - ER_3) (lbs/hr)					
ER_4 (enter into TABLE 2) (lbs/hr)					

HYDROCHLORIC (HCl) ACID TANK EMISSIONS CALCULATIONS

The following calculations are made with data provided by the applicant. To assist in these calculations, TABLE 3, TABLE 3a, and TABLEs 3-1 thru 3-4 (regarding partial pressures of HCl over aqueous solutions of HCl located in the Appendix) are provided for your use. A completed TABLE 3 and TABLE 3a, in addition to the applicant's calculations, will serve to expedite the permit review process.

1. Calculate the surface area (A) of each tank in square feet and enter the value of A into TABLE 3.

2. Enter the operating temperature (T) in degrees centigrade (C°), acid concentration (Conc.) by weight percent, and air velocity (V) in feet per second (fps)) across the surface of each tank into TABLE 3.

3. Determine the vapor pressure (P_v) of the HCl solution from the attached TABLE 4. Using the temperature (T, C°) and the percent acid concentration (Conc.) determine the partial pressure of the solution in mmHg and enter the value of P_v into TABLE 3.

4. Calculate the evaporation rate of HCl from the tank using the following equation and enter the value of E (lb/hr-ft_2) into TABLE 3 (Requires a calculator with logarithmic functions):

$E = 25(0.46 + 0.117(V))\log[(760 - P_a)/(760 - P_v)]$ (lb/hr-ft_2)
$P_a = 0$ for this calculation

5. Calculate and enter into TABLE 3 and 3a the uncontrolled emission rate, ER_1:
$ER_1 = E \times A$ (lb/hr)

6. Do you use a suppressant (foam, fume, or mechanical) in your HCl tank? If yes, complete the following then go to 7.

FE = (1 - (%)/100), where % is the efficiency of the suppressant.

The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant. If you cannot determine the efficiency of your suppressant contact the TCEQ, Mechanical Section for guidance. Enter the value of FE into TABLE 3, then calculate the following (enter the value of ER_2 into TABLE 3a):

$ER_2 = ER_1 \times FE$ (lbs/hr)

If you do not use a fume suppressant, complete the following (enter the value of ER_2 into TABLE 2a) then go to 7.
$ER_2 = ER_1$

7. Do you use a capture hood on your HCl tank? If yes, complete the following appropriate calculation, then go to 10. If no, skip to 8.

If you use a hood, and do not use a fume suppressant, calculate the following (enter the value of ER_3 into TABLE 3a), then go to 10:

$ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood, no fume suppressant)

Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency. If you use a hood, and also use a fume suppressant, calculate the following (enter the value of ER_3 into TABLE 3a), then go to 10:

$ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood and a fume suppressant)

8. If you do not use a capture hood, but use a fume suppressant use the following (enter the value of ER_3 into TABLE 3a), then go to 12.

$ER_3 = ER_2$ (lbs/hr) (No hood, use a fume suppressant)

If you do not use a capture hood, and also do not use a fume suppressant, then go to 9.

9. You will not be authorized to operate a HCl pickle tank without the use of, as a minimum, a fume suppressant or a capture hood.

10. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE and ER_4 into TABLE 3, then go to 13. If not, then go to 11.

The efficiency of the abatement device you propose to use or are using, can be determined from the manufacturer's literature or by contacting the manufacturer directly. If the efficiency of your abatement device cannot be determined, contact the TCEQ Mechanical Section for guidance.

$AE = (1-(\%)/100)$, where % is the abatement device efficiency.
$ER_4 = ER_3 \times AE$ (lbs/hr)

11. Without an abatement device your hourly emission rate is the same as calculated in 7. Complete the following, enter the value of ER_4 into TABLEs 3 and 3a, then go to 13:

$ER_4 = ER_3$ (lbs/hr)

12. Calculate the hourly fugitive emission rate from the tank and enter the value of FUG into TABLE 3, then go to 14:

Fugitive emissions are those emissions that are not captured by a hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

FUG = (ER_3) (0.5) (lbs/hr) (Fume suppressant only)

13. Calculate the fugitive emission rate from the tank and enter the value of FUG into TABLE 3, then go to 15:

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

FUG = (ER_2 - ER_3) (0.5) (lbs/hr)

14. Calculate your annual fugitive emission rate (AFUG) and enter the value of AFUG into TABLE 2:

AFUG = (FUG x OY)/2000 (tons/year)

15. Calculate your annual emission rate (AER) and the annual fugitive rate (AFUG) and enter the values of AER and AFUG into TABLE 3.

AER = (ER_4 x OY)/2000 (tons/year)
AFUG = (FUG x OY)/2000 (tons/year)

CHROMIUM PLATING
EXAMPLE CALCULATIONS

III. INSTRUCTIONS

A. This guidance package provides two methods of calculating emissions from a chromium plating process. The difference between the methods is whether the applicant chooses to calculate emission rates using the uncontrolled emission rate factors then applying specific emission abatement control efficiencies applicable to their facility; or the applicant chooses to select a controlled emission factor from an enclosed table based upon a proposed or existing abatement type. For calculations that will be done using the uncontrolled emission factors use steps 1 thru 13 (use TABLE 1 and 1a). For calculations using a controlled emission factor skip to step 14 and complete the instructions (use TABLE 2 and 2a). The calculations are made with data provided by the applicant. To assist in these calculations, tables are provided according to the calculation method chosen. A completed TABLE 1 and 1a or TABLE 2 and 2a, in addition to the applicant's calculations and supporting material, will serve to expedite the permit review process.

NOTE: If you use a trivalent chromium process at your facility do not use the following calculations. Contact the TCEQ, Air Permits Division, Mechanical Section for guidance on trivalent chromium permitting.

1. Select the emission factor (EF_T and EF_1) appropriate to your chromium operation(s) (hard or decorative chromium plating) using the enclosed TABLE 1.

2. Calculate the total PM (ER_T) and the total chromium compounds (ER_1) for the uncontrolled emission rates, then enter their values into Table 1:

$ER_T = EF_T$ x A x lb/7000 grains (lbs/hr) Rate for total uncontrolled PM
$ER_1 = EF_1$ x A x lb/7000 grains (lbs/hr) Rate for uncontrolled chromium compounds

ER_T = 0.069 gr/amp-hr x 1000amps x lb/7000 = 0.0099; ER_1 = 0.033 x 1000 x lb/7000=0.0047

3. Do you use a suppressant (foam, fume, or mechanical) in your chromium plating tank? If yes, complete the following then go to 4. **<u>Yes; 98% efficient</u>**

FE = (1 - (%)/100), where % is the efficiency of the suppressant.

FE = (1 - (98%)/100) = 0.02

The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant.

Enter the value of FE into TABLE 1, then calculate the following (enter the value of ER_2 and ER_3 into TABLE 1a):

$ER_2 = ER_T$ x FE (lbs/hr); ER_2 = (0.0099)(.02) = 1.98 x 10^{-4} (lbs/hr)
$ER_3 = ER_1$ x FE (lbs/hr); ER_3 = (0.0047)(.02) = 9.4 x 10^{-5} (lbs/hr)

If you do not use a fume suppressant, complete the following (enter the value of ER_2 and ER_3 into TABLE 1a) then go to 4.

$ER_2 = ER_T$
$ER_3 = ER_1$

4. Do you use a capture hood on your chromium plating tank? If yes, complete the following calculation (enter the value of ER_4 and ER_5 into TABLE 1a). If not, go to 5.
Yes; CE = 98% efficient

$ER_4 = ER_2$ x CE/100 (lbs/hr); ER_4 = (1.98 x 10^{-4} (lbs/hr)(98/100) = 1.94 x 10^{-4} (lbs/hr)
$ER_5 = ER_3$ x CE/100 (lbs/hr); ER_5 = (9.4 x 10^{-5} (lbs/hr)(98/100)= 9.2 x 10^{-5} (lbs/hr)

NOTE: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with the Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

If you use a hood and a fume suppressant, go to 7.

If you use a hood and no fume suppressant, go to 8.

5. If you do not use a capture hood, but use a fume suppressant complete the following (enter the values of ER_4 and ER_5 into TABLE 1a), then skip to 10.

$ER_4 = ER_2$ (lbs/hr) (No hood, but using a fume suppressant)
$ER_5 = ER_3$ (lbs/hr) (No hood, but using a fume suppressant)

If you do not use a capture hood, and also do not use a fume suppressant, then go to 6.

6. You will not be authorized to operate a chromium plating tank without the use of, as a minimum, a fume suppressant, and/or a capture hood with an abatement device.

7. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE, ER_6 and ER_7 into TABLE 1, then skip to 11. If not, skip to 9. **Yes; 98% efficient hood**

The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly. If the efficiency of your abatement device cannot be determined contact the TCEQ, Mechanical Section for guidance.

AE = [1 - (%)/100], where % is the abatement device efficiency. AE = [1 - (98%)/100]=0.02
$ER_6 = ER_4$ x AE (lbs/hr); ER_6 = (1.94 x 10^{-4} lbs/hr) (0.02) = 3.89 x 10^{-6} (lbs/hr)
$ER_7 = ER_5$ x AE (lbs/hr); ER_7 = (9.2 x 10^{-5}) (0.02) = 1.84 x 10-6 (lbs/hr)

8. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE, ER_6 and ER_7 into TABLE 1, then go to 11. If not, go back to 6.

The efficiency of the abatement device you propose to use, or you are using, can be determined from the manufacturers literature or by contacting the manufacturer directly. If the efficiency of your abatement device cannot be determined contact the TCEQ, Mechanical Section for guidance.

AE = [1 - (%)/100], where % is the abatement device efficiency.
$ER_6 = ER_4 \times AE$ (lbs/hr)
$ER_7 = ER_5 \times AE$ (lbs/hr)

9. Complete the following, then enter the values of ER_6 and ER_7 into TABLE 1, then skip to 11:

$ER_6 = ER_4$ (lbs/hr)
$ER_7 = ER_5$ (lbs/hr)

10. Calculate the total hourly fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 1, then skip to 12:

Fugitive emissions are those emissions that are not captured by a hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_4)(0.5)$ (lbs/hr) (Fume suppressant only)
$FUG_1 = (ER_5)(0.5)$ (lbs/hr) (Fume suppressant only)

11. Calculate the fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 1, then skip to 13:

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_2 - ER_4)(0.5)$ (lbs/hr); $FUG_T = (4 \times 10^{-6})(0.5) = 2 \times 10^{-6}$ (lbs/hr)
$FUG_1 = (ER_3 - ER_5)(0.5)$ (lbs/hr); $FUG_1 = (2 \times 10^{-6})(0.5) = 1 \times 10^{-6}$ (lbs/hr)

12. Calculate your annual fugitive emission rate ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 1:

$AFUG_T = (FUG_T \times OY)/2000$ (tons/year)
$AFUG_1 = (FUG_1 \times OY)/2000$ (tons/year)

13. Calculate your annual emission rates (AER_T and AER_1) and the annual fugitive rates ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 1.

AER_T = (ER_6 x OY)/2000 (tons/year) = (3.89×10^{-6}) (4800 hrs/yr) (ton/2000 lbs) = 9.34×10^{-6}
AER_1 = (ER_7 x OY)/2000 (tons/year) = (1.84×10^{-6}) (4800 hrs/yr) (ton/2000 lbs) = 4.42×10^{-6}

$AFUG_T$ = (FUG_T x OY)/2000(tons/year) = (2×10^{-6}) (4800 hrs/yr) (ton/2000 lbs) = 4.8×10^{-6}
$AFUG_1$ = (FUG_1 x OY)/2000 (tons/year) = (1×10^{-6}) (4800 hrs/yr) (ton/2000 lbs) = 2.4×10^{-6}

CHROMIUM PLATING EMISSIONS
UNCONTROLLED FACTOR METHOD

Table 1

Chrome Plating Tanks	**1**	**2**	**3**	**4**	**5**
EF_T = Emission Factor Total PM Decorative Chrome (grains/amp-hr)	**0.069**	**0.069**	**0.069**	**0.069**	**0.069**
EF_1 = Emission Factor Chromium Compounds Decorative Chromium (grains/amp-hr)	**0.033**	**0.033**	**0.033**	**0.033**	**0.033**
EF_T = Emission Factor Total PM Hard Chrome (grains/amp-hr)	**0.25**	**0.25**	**0.25**	**0.25**	**0.25**
EF_1 = Emission Factor Chromium Compounds Hard Chromium (grains/amp-hr)	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**
A = Maximum Amperage of Chromium Tank Rectifier (amps)	**1000**				
ER_T = Emission Rate Total PM Uncontrolled (lbs/hr)	**0.0099**				
ER_1 = Emission Rate Chromium Compounds Uncontrolled (lbs/hr)	**0.0047**				
FE= Suppressant Efficiency 1- (%)/100	**0.02**				
CE = Hood Capture Efficiency (%)	**98%**				
AE= Abatement Device Efficiency 1- (%)/100	**None**				
ER_6=Emission Rate Total PM Controlled (lbs/hr)	**3.89×10^{-4}**				
ER_7=Emission Rate Chromium Compounds Controlled (lbs/hr	**1.84×10^{-6}**				
FUG_T = Total PM Fugitive Emissions Rate (lbs/hr)	**2×10^{-6}**				
FUG_1 = Chromium Compound Fugitive Emission Rate (lbs/hr)	**1×10^{-6}**				
OY = Total Operating Hours Per Year	**4800**				
$AFUG_T$ = Annual Total PM Fugitive Emission Rate (tons/year)	**4.8×10^{-6}**				
$AFUG_1$ = Annual Total Chromium Compounds Fugitive Emission Rate (tons/year)	**2.4×10^{-6}**				
AER_T = Annual Total PM Emission Rate (tons/yr)	**9.34×10^{-6}**				
AER_1 = Annual Chromium Compounds Emission Rate (tons/yr)	**4.42×10^{-6}**				

CHROMIUM SUPPLEMENTARY TABLE
UNCONTROLLED FACTOR METHOD

TABLE 1a

Chromium Plating Tanks	**1**	**2**	**3**	**4**	**5**
ER_2 (lbs/hr)	**1.98×10^{-4}**				
ER_3 (lbs/hr) Chromium Compounds	**9.4×10^{-5}**				
ER_4 (lbs/hr) Total PM	**1.94×10^{-4}**				
ER_5 (lbs/hr) Chromium Compounds	**9.2×10^{-5}**				
ER_2 - ER_4(lbs/hr)	**4×10^{-6}**				
ER_3 - ER_5 (lbs/hr)	**2×10^{-6}**				

14. From the enclosed AP-42 Table 12-20-1 select the appropriate emission factor (EF_T) to determine the total controlled PM emissions according to the specific process and type of abatement equipment being used or planned on being used. Enter the value into Table 2.

6.7×10^{-8} grains/dscf

15. From the same Table 12-20-1 used above, select the appropriate emission factor (EF_1) for chromium compounds according to the specific process and type of abatement equipment being used or planned on being used. Enter the value into Table 2.

3.2×10^{-8} grains/dscf

16. Enter into Table 2 the rectifier amperage (A).

3000 amps

17. Enter into Table 2 the air flow rate (FR) expected from your system as dry standard cubic feet per minute (dscfm).

15,000

18. Calculate the total hourly controlled PM emissions using the following method:

$ER_T = EF_T$ (grains/dscf) x (lb/7000 grains) x FR (dscf/min) x (60 min/hour)

= (6.7×10^{-8} grains/dscf)(lb/7000 grains)(15,000 dscf/min)(60min/hr) = 8.743×10^{-6}

Enter the value of ER_T into Table 2.

19. Calculate the total hourly controlled chromium compound emission rate using the following method:

$ER_1 = EF_1$(grains/dscf) x (lb/7000 grains) x FR (dscf/min) x (60 min/hour)

= (3.2×10^{-8} grains/dscf)(lb/7000 grains)(15,000 dscf/min)(60min/hr) = 4.11×10^{-6}

Enter the value of ER_1 into Table 2.

20. Do you use only a fume suppressant with a capture hood on your chromium plating tank? If yes, complete the following calculation and instructions (enter the value of ER_2 and ER_3 into TABLE 2a), then go to 22. If not, go to 21. **No.**

$ER_2 = ER_T$ x CE/100 (lbs/hr)
$ER_3 = ER_1$ x CE/100 (lbs/hr)

Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency.

21. Do you use only a fume suppressant and no capture hood over your tank? If yes, complete the following calculation and instructions. If not, skip to 25.
Calculate the hourly fugitive emission rates from the tank and enter their values (FUG_T and FUG_1) into TABLE 2, then skip to 23:

$FUG_T = ER_T$ x (0.5) (lbs/hr)
$FUG_1 = ER_1$ x (0.5) (lbs/hr)

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

22. Calculate the fugitive emission rate from the tank and enter the values of FUG_T and FUG_1 into TABLE 2, then go to 24:

Fugitive emissions are those emissions that are not captured by the hood system and therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

$FUG_T = (ER_T - ER_2)$ (0.5) (lbs/hr)
$FUG_1 = (ER_1 - ER_3)$ (0.5) (lbs/hr)

23. Calculate your annual total fugitive emission rates ($AFUG_T$ and $AFUG_1$) and enter their values into TABLE 2:

$AFUG_T = (FUG_T$ x OY)/2000 (tons/year)
$AFUG_1 = (FUG_1$ x OY)/2000 (tons/year)

24. Calculate your annual stack and fugitive emission rates (AER_T, AER_1, $AFUG_T$, and $AFUG_1$) and enter their value into TABLE 2:

$AER_T = (ER_2$ x OY)/2000 (tons/year)
$AER_1 = (ER_3$ x OY)/2000 (tons/year)

$AFUG_T = (FUG_T$ x OY)/2000 (tons/year)
$AFUG_1 = (FUG_1$ x OY)/2000 (tons/year)

25. Calculate your annual emission rates (AER_T and AER_1) and enter their values into TABLE 2.

$AER_T = (ER_T \times OY)/2000$ (tons/year);

$AER_T = (8.743 \times 10^{-6})(4800 \text{ hrs/yr})(\text{ton}/2000 \text{ lbs}) = 2.1 \times 10^{-5}$ (tons/year)

$AER_1 = (ER_1 \times OY)/2000$ (tons/year)

$AER_1 = (4.11 \times 10^{-6})(4800 \text{ hrs/yr})(\text{ton}/2000 \text{ lbs}) = 9.86 \times 10^{-6}$ (tons/year)

CHROMIUM PLATING EMISSIONS CONTROLLED FACTORS

Table 2

Chrome Plating Tanks	**1**	**2**	**3**	**4**	**5**
EF_T = Controlled Total PM Emission Factor for Decorative Chromium (grains/dscf)					
EF_1 = Controlled Chromium Compounds Emission Factor for Decorative Chromium (grains/dscf)					
EF_T = Controlled Total PM Emission Factor for Hard Chromium (grains/dscf)	6.7×10^{-8} grains/dscf				
EF_1 = Controlled Chromium Compounds Emission Factor for Hard Chromium (grains/dscf)	3.2×10^{-8} grains/dscf				
Type of Control	Packed Bed Scrubber & Mist Eliminator				
A = Maximum Amperage of Chromium Tank Rectifier (amps)	3,000				
FR = Flow Rate (dscf/min)	15,000				
ER_T = Emission Rate for Total PM (lbs/hr)	8.743×10^{-6}				
ER_1 = Emission Rate for Chromium Compounds (lbs/hr)	4.11×10^{-6}				
FUG_T = Total PM Fugitive Emissions (lbs/hr)					
FUG_1 = Chromium Compounds Fugitive Emissions (lbs/hr)					
OY = Total Operating Hours Per Year	4,800				
$AFUG_T$= Annual Total PM Fugitive Emission Rate (tons/year)					
$AFUG_1$= Annual Chromium Compounds Fugitive Emission Rate (tons/year)					
AER_T = Total PM Annual Emission Rate (tons/yr)	2.1×10^{-5}				
AER_1 = Total Annual Chromium Compounds Emission Rate (tons/yr)	9.86×10^{-5}				

CHROMIUM SUPPLEMENTARY TABLE

TABLE 2a

Chromium Plating Tanks	**1**	**2**	**3**	**4**	**5**
ER_2 (lbs/hr)					
ER_3 (lbs/hr)					
$(ER_T - ER_2)$ (lbs/hr)					
$(ER_1 - ER_3)$ (lbs/hr)					

EMISSION FACTORS FOR CHROMIUM ELECTROPLATING [a]:
Table 12.20-1.

Process	Chromium Compounds		Emission Factor Rating	Total PM [c]		Emission Factor Rating
	grains/A-hr	grains/dscf		grains/ A-hr	grains/dscf	
Hard Chromium Electroplating [d]	0.12	N/A	B	0.25	N/A	C
-- with moisture extractor [e]	N/A	0.00014	D	N/A	0.00028	E
-- with polypropylene balls [f]	N/A	0.00042	D	N/A	0.00088	E
-- with fume suppressant [g]	N/A	0.00016	D	N/A	0.00034	E
-- with fume suppressant and polypropylene balls [h]	N/A	3.0×10^{-5}	D	N/A	6.3×10^{-5}	E
-- with packed-bed scrubber [j]	N/A	2.1×10^{-5}	D	N/A	4.4×10^{-5}	E
-- with packed-bed scrubber, fume suppressant, and polypropylene balls [k]	N/A	2.6×10^{-6}	D	N/A	5.5×10^{-6}	E
-- with chevron-blade mist eliminator [m]	N/A	8.8×10^{-5}	D	N/A	0.00018	E
-- with mesh-pad mist eliminator [n]	N/A	1.2×10^{-5}	D	N/A	2.6×10^{-5}	E
-- with packed-bed scrubber and mesh-pad eliminator [p]	N/A	3.2×10^{-8}	E	N/A	6.7×10^{-8}	E
-- with composite mesh-pad mist eliminator [q]	N/A	3.8×10^{-6}	D	N/A	8.0×10^{-6}	E
Decorative Chromium Electroplating [r] (SCC 3-09-010-28)	0.033	N/A	D	0.069	N/A	E
-- with fume suppressant [s]	N/A	1.2×10^{-6}	D	N/A	2.5×10^{-6}	E

a For chromium electroplating tanks only. Factors represent uncontrolled emissions unless otherwise noted. Emission factors based on total energy input in units of grains per ampere-hour (grains/A-hr) and based on concentrations in units of grains per dry standard cubic foot (grains/dscf). To convert from grains/A-hr to mg/A-hr multiply by 64.8. To convert grains/dscf to mg/dscm, multiply by 2,290. To convert grains/A-hr to grains/dscf, multiply by 0.01. To convert grains/dscf to grains/A-hr multiply by 100. Note that there is considerable uncertainty in these latter two conversion factors because of differences in tank geometry, ventilation, and control device performance. For controlled emissions, factors based on concentration should be used whenever possible. SCC = Source Classification Code. NA = units not applicable.

b Comprised almost completely of hexavalent chromium.

c Total PM includes filterable and condensible PM. However, condensible PM is likely to be negligible. All PM from chromium electroplating sources is likely to be emitted as PM-10. Factors estimated based on assumption that PM consists entirely of chromic acid mist.

d, e, f, g, h, j, k, m, n, p, q, r, s - AP-42 References

HYDROCHLORIC (HCl) ACID TANK TABLE

TABLE 3

HCl Pickle Tanks	**1**	**2**	**3**	**4**	**5**
A = Surface area of tank (ft^2)	15				
T = Operating temperature (C°)	24				
Conc. = Percent concentration of HCL by weight (% w/w)	13				
V = Air velocity across surface of tank (fps)	0.084				
P_v= Vapor pressure of HCl (mmHg from Table 3)	0.0235				
E = Evaporation rate from tank (lb/hr-ft^2)	1.547×10^{-4}				
ER_1 = Emission rate Uncontrolled (lb/hr)	2.32×10^{-3}				
FE = Suppressant efficiency 1 - (%)/100	0.05				
CE = Hood capture efficiency (%)	None				
AE= Abatement device efficiency 1 - (%)/100	None				
ER_4= Emission rate Controlled (lb/hr)					
FUG = Fugitive emissions (lb/hr)	5.8×10^{-5}				
OY= Annual operating hours	4,800				
AFUG = Annual HCl fugitive emission rate (tons/year)	1.39×10^{-4}				
AER = Annual HCl emission rate (tons/year)					

HYDROCHLORIC ACID SUPPLEMENTARY TABLE

TABLE 3a

HCl Pickle Tanks	**1**	**2**	**3**	**4**	**5**
ER_1 (enter into TABLE 2) (lbs/hr)	2.32×10^{-4}				
ER_2 (lbs/hr)	1.16×10^{-4}				
ER_3 (lbs/hr)	1.16×10^{-4}				
(ER_2 - ER_3) (lbs/hr)					
ER_4 (enter into TABLE 2) (lbs/hr)					

HYDROCHLORIC (HCl) ACID TANK EMISSIONS CALCULATIONS

The following calculations are made with data provided by the applicant. To assist in these calculations, TABLE 3, TABLE 3a, and TABLEs 3-1 thru 3-4 (regarding partial pressures of HCl over aqueous solutions of HCl located in the Appendix) are provided for your use. A completed TABLE 3 and TABLE 3a, in addition to the applicant's calculations, will serve to expedite the permit review process.

1. Calculate the surface area (A) of each tank in square feet and enter the value of A into TABLE 3.

3ft x 5ft = 15ft^2

2. Enter the operating temperature (T) in degrees centigrade (C°), acid concentration (Conc.) by weight percent, and air velocity (V) in feet per second (fps)) across the surface of each tank into TABLE 3.

3. Determine the vapor pressure (P_v) of the HCl solution from the attached TABLE 4. Using the temperature (T, C°) and the percent acid concentration (Conc.) determine the partial pressure of the solution in mmHg and enter the value of P_v into TABLE 3.

Interpolate between 12 & 14% @ 25° C = 0.0235

4. Calculate the evaporation rate of HCl from the tank using the following equation and enter the value of E (lb/hr-ft$_2$) into TABLE 3 (Requires a calculator with logarithmic functions):

$E = 25(0.46 + 0.117(V))\log[(760 - P_a)/(760 - P_v)]$ (lb/hr-ft$_2$)

$= (0.46+0.117)(0.084))\log[(760-0)/(760-0.02305)]=0.0001547$

$P_a = 0$ for this calculation

5. Calculate and enter into TABLE 3 and 3a the uncontrolled emission rate, ER_1:

$ER_1 = E \times A$ (lb/hr)

$ER_1 = 0.0001547 \times 15 = 2.3205 \times 10^{-3}$ (lb/hr)

6. Do you use a suppressant (foam, fume, or mechanical) in your HCl tank? If yes, complete the following then go to 7. **Yes: 95% Efficient**

FE = (1 - (%)/100), where % is the efficiency of the suppressant.

= (1-95/100) = 0.05

The efficiency of the suppressant can usually be found in the manufacturer's literature or by contacting the manufacturer of your particular suppressant. If you cannot determine the efficiency of your suppressant contact the TCEQ, Mechanical Section for guidance. Enter the value of FE into TABLE 3, then calculate the following (enter the value of ER_2 into TABLE 3a):

$ER_2 = ER_1 \times FE$ (lbs/hr)

$ER_2 = (2.3205 \times 10^{-3}$ lb/hr) (0.05) = 1.1603×10^{-4} (lbs/hr)

If you do not use a fume suppressant, complete the following (enter the value of ER_2 into TABLE 2a) then go to 7.

$ER_2 = ER_1$

7. Do you use a capture hood on your HCl tank? If yes, complete the following appropriate calculation, then go to 10. If no, skip to 8. **No.**

If you use a hood, and do not use a fume suppressant, calculate the following (enter the value of ER_3 into TABLE 3a), then go to 10:

$ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood, no fume suppressant)

Note: CE is the percent capture efficiency of your hood design. Hoods designed in accordance with Industrial Ventilation, A Manual of Recommended Practice, can be conservatively considered to have 98% capture efficiency. If you use a hood, and also use a fume suppressant, calculate the following (enter the value of ER_3 into TABLE 3a), then go to 10:

$ER_3 = ER_2 \times CE/100$ (lbs/hr) (Hood and a fume suppressant)

8. If you do not use a capture hood, but use a fume suppressant use the following (enter the value of ER_3 into TABLE 3a), then go to 12.

$ER_3 = ER_2$ (lbs/hr) (No hood, use a fume suppressant)

$= 1.1603 \times 10^{-4}$ (lbs/hr)

If you do not use a capture hood, and also do not use a fume suppressant, then go to 9.

9. You will not be authorized to operate a HCl pickle tank without the use of, as a minimum, a fume suppressant or a capture hood.

10. Do you have an abatement device that controls the emissions from your hood exhaust? If yes, complete the following calculations, enter the values of AE and ER_4 into TABLE 3, then go to 13. If not, then go to 11.

The efficiency of the abatement device you propose to use or are using, can be determined from the manufacturer's literature or by contacting the manufacturer directly. If the efficiency of your abatement device cannot be determined, contact the TCEQ Mechanical Section for guidance.

AE = [1-(%)/100], where % is the abatement device efficiency.

$ER_4 = ER_3 \times AE$ (lbs/hr)

11. Without an abatement device your hourly emission rate is the same as calculated in 7. Complete the following, enter the value of ER_4 into TABLEs 3 and 3a, then go to 13:

$ER_4 = ER_3$ (lbs/hr)

12. Calculate the hourly fugitive emission rate from the tank and enter the value of FUG into TABLE 3, then go to 14:

Fugitive emissions are those emissions that are not captured by a hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

FUG = (ER_3) (0.5) (lbs/hr) (Fume suppressant only)
= (1.1603×10^{-4} lbs/hr)(0.5) = 5.8×10^{-5}(lbs/hr)

13. Calculate the fugitive emission rate from the tank and enter the value of FUG into TABLE 3, then go to 15:

Fugitive emissions are those emissions that are not captured by the hood system and; therefore, escape into the building. These emissions are eventually emitted to the atmosphere through a building vent (exhaust fan, open door, window, etc.). You are given a 50% capture efficiency for the building.

FUG = (ER_2 - ER_3) (0.5) (lbs/hr)

14. Calculate your annual fugitive emission rate (AFUG) and enter the value of AFUG into TABLE 2:

AFUG = (FUG x OY)/2000 (tons/year)
= (5.8×10^{-5}) (4800 hrs/yr) (ton/2000 lbs) = 1.39×10^{-4} tpy

15. Calculate your annual emission rate (AER) and the annual fugitive rate (AFUG) and enter the values of AER and AFUG into TABLE 3.

AER = (ER_4 x OY)/2000 (tons/year)
AFUG = (FUG x OY)/2000 (tons/year)

APPENDIX:

PARTIAL PRESSURES (P_V) OF HCl OVER AQUEOUS SOLUTIONS OF HCl

PARTIAL PRESSURES (P_v) OF HCl OVER AQUEOUS SOLUTIONS OF HCl

Table 3-4

Note: %HCL, weight percent; Temperature, centigrade (C°); partial pressures, mmHg.

% HCl	0°	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	60°	70°	80°	90°	100°	110°
2	...	...	0.0000117	0.000023	0.000044	0.000084	0.000151	0.000275	0.00047	0.00083	0.00104	0.0038	0.01	0.0245	0.058	0.132	0.28
4	0.000018	0.000036	0.000069	0.000131	0.00024	0.00044	0.00077	0.00134	0.0023	0.00385	0.0064	0.0165	0.0405	0.095	0.21	0.46	0.93
6	0.000066	0.000125	0.000234	0.000425	0.00076	0.00131	0.00225	0.0038	0.0062	0.0102	0.0163	0.04	0.094	0.206	0.44	0.92	1.78
8	0.000118	0.000323	0.000583	0.00104	0.00178	0.0031	0.00515	0.0085	0.0136	0.022	0.0344	0.081	0.183	0.39	0.82	1.64	3.1
10	0.00042	0.00075	0.00134	0.0232	0.00395	0.0067	0.0111	0.0178	0.0282	0.045	0.069	0.157	0.35	0.73	1.48	2.9	5.4
12	0.00099	0.00175	0.00305	0.0052	0.008	0.0145	0.0234	0.037	0.058	0.091	0.136	0.305	0.66	1.34	2.65	5.1	9.3
14	0.0024	0.00415	0.0071	0.0118	0.0196	0.0316	0.05	0.078	0.121	0.185	0.275	0.6	1.25	2.5	4.8	9	16
16	0.0056	0.0095	0.0016	0.0265	0.0428	0.0685	0.106	0.163	0.247	0.375	0.55	1.17	2.4	4.66	8.8	16.1	28
18	0.0135	0.0225	0.037	0.06	0.095	0.148	0.228	0.345	0.515	0.77	1.11	2.3	4.55	8.6	15.7	28	48
20	0.0316	0.052	0.084	0.132	0.205	0.32	0.48	0.72	1.06	1.55	2.21	4.4	8.5	15.6	28.1	49	83
22	0.0734	0.119	0.187	0.294	0.45	0.68	1.02	1.5	2.18	3.14	4.42	8.6	16.3	29.3	52	90	146
24	0.175	0.277	0.43	0.66	1	1.49	2.17	3.14	4.5	6.4	8.9	16.9	31	54.5	94	157	253
26	0.41	0.64	0.98	1.47	2.17	3.2	4.56	6.5	9.2	12.7	17.5	32.5	58.5	100	169	276	436
28	1	1.52	2.27	3.36	4.9	7.05	9.9	13.8	19.1	26.4	35.7	64	112	188	309	493	760
30	2.4	3.57	5.23	7.6	10.6	15.1	21	28.6	39.4	53	71	124	208	340	542	845	...
32	5.7	8.3	11.8	16.8	23.5	32.5	44.5	60	81	107	141	238	390	623	970	...	...
34	13.1	18.8	26.4	36.8	50.5	68.5	92	122	161	211	273	450	720	...	...	...	...
36	29	41	56.4	78	105.5	142	188	246	322	416	535	860	...	...	...	...	...
38	63	87	117	158	210	277	360	464	598	758	955	...	...	...	...	...	...
40	130	176	233	307	399	515	627	830	...	...	...	...	...	...	...	...	...
42	253	332	430	560	709	900	...	...	...	...	...	...	...	...	...	...	...
44	510	655	840	...	...	...	...	...	...	...	...	...	...	...	...	...	...
46	940	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...