IV. CHEMICAL RELEASE AND TRANSFER PROFILE

This section is designed to provide background information on the pollutant releases that are reported by this industry. The best source of comparative pollutant release information is the Toxic Release Inventory System (TRI). Pursuant to the Emergency Planning and Community Right-to-Know Act, TRI includes self-reported facility release and transfer data for over 600 toxic chemicals. Facilities within SIC Codes 20-39 (manufacturing industries) that have more than 10 employees, and that are above weight-based reporting thresholds are required to report TRI on-site releases and off-site transfers. The information presented within the sector notebooks is derived from the most recently available (1993) TRI reporting year (which then included 316 chemicals), and focuses primarily on the on-site releases reported by each sector. Because TRI requires consistent reporting regardless of sector, it is an excellent tool for drawing comparisons across industries.

Although this sector notebook does not present historical information regarding TRI chemical releases over time, please note that in general, toxic chemical releases have been declining. In fact, according to the 1993 Toxic Release Inventory Data Book, reported releases dropped by 42.7 percent between 1988 and 1993. Although on-site releases have decreased, the total amount of reported toxic waste has not declined because the amount of toxic chemicals transferred off-site has increased. Transfers have increased from 3.7 billion pounds in 1991 to 4.7 billion pounds in 1993. Better management practices have led to increases in off-site transfers of toxic chemicals for recycling. More detailed information can be obtained from EPA's annual Toxics Release Inventory Public Data Release book (which is available through the EPCRA Hotline at 1-800-535-0202), or directly from the Toxic Release Inventory System database (for user support call 202-260-1531).

Wherever possible, the sector notebooks present TRI data as the primary indicator of chemical release within each industrial category. TRI data provide the type, amount, and media receptor of each chemical released or transferred. When other sources of pollutant release data have been obtained, these data have been included to augment the TRI information.

TRI Data Limitations

The reader should keep in mind the following limitations regarding TRI data. Within some sectors, the majority of facilities are not subject to TRI reporting because they are not considered manufacturing industries, or because they are below TRI reporting thresholds. Examples are the mining, dry cleaning, printing, and transportation equipment cleaning sectors. For these sectors, release information from other sources has been included.

The reader should also be aware that TRI "pounds released" data presented within the notebooks is not equivalent to a "risk" ranking for each industry. Weighting each pound of release equally does not factor in the relative toxicity of each chemical that is released. The Agency is in the process of developing an approach to assign toxicological weightings to each chemical released so that one can differentiate between pollutants with significant differences in toxicity. As a preliminary indicator of the environmental impact of the industry's most commonly released chemicals, the notebook briefly summarizes the toxicological properties of the top five chemicals (by weight) reported by each industry.

Definitions Associated With Section IV Data Tables

General Definitions

SIC Code -- the Standard Industrial Classification (SIC) is a statistical classification standard used for all establishment-based Federal economic statistics. The SIC codes facilitate comparisons between facility and industry data.

TRI Facilities -- are manufacturing facilities that have 10 or more full-time employees and are above established chemical throughput thresholds. Manufacturing facilities are defined as facilities in Standard Industrial Classification primary codes 20-39. Facilities must submit estimates for all chemicals that are on the EPA's defined list and are above throughput thresholds.

Data Table Column Heading Definitions

The following definitions are based upon standard definitions developed by EPA's Toxic Release Inventory Program. The categories below represent the possible pollutant destinations that can be reported.

RELEASES -- are an on-site discharge of a toxic chemical to the environment. This includes emissions to the air, discharges to bodies of water, releases at the facility to land, as well as contained disposal into underground injection wells.

Releases to Air (Point and Fugitive Air Emissions) -- Include all air emissions from industry activity. Point emissions occur through confined air streams as found in stacks, ducts, or pipes. Fugitive emissions include losses from equipment leaks, or evaporative losses from impoundments, spills, or leaks.

Releases to Water (Surface Water Discharges) - encompass any releases going directly to streams, rivers, lakes, oceans, or other bodies of water. Any estimates for stormwater runoff and non-point losses must also be included.

Releases to Land -- includes disposal of waste to on-site landfills, waste that is land treated or incorporated into soil, surface impoundments, spills, leaks, or waste piles. These activities must occur within the facility's boundaries for inclusion in this category.

Underground Injection -- is a contained release of a fluid into a subsurface well for the purpose of waste disposal.

TRANSFERS -- is a transfer of toxic chemicals in wastes to a facility that is geographically or physically separate from the facility reporting under TRI. The quantities reported represent a movement of the chemical away from the reporting facility. Except for off-site transfers for disposal, these quantities do not necessarily represent entry of the chemical into the environment.

Transfers to POTWs -- are wastewaters transferred through pipes or sewers to a publicly owned treatments works (POTW). Treatment and chemical removal depend on the chemical's nature and treatment methods used. Chemicals not treated or destroyed by the POTW are generally released to surface waters or landfilled within the sludge.

Transfers to Recycling -- are sent off-site for the purposes of regenerating or recovering still valuable materials. Once these chemicals have been recycled, they may be returned to the originating facility or sold commercially.

Transfers to Energy Recovery -- are wastes combusted off-site in industrial furnaces for energy recovery. Treatment of a chemical by incineration is not considered to be energy recovery.

Transfers to Treatment -- are wastes moved off-site for either neutralization, incineration, biological destruction, or physical separation. In some cases, the chemicals are not destroyed but prepared for further waste management.

Transfers to Disposal -- are wastes taken to another facility for disposal generally as a release to land or as an injection underground.

IV.A. EPA Toxic Release Inventory for the Fabricated Metal Products Industry

TRI release amounts listed below are not associated with non-compliance with environmental laws. These facilities appear based on self-reported data submitted to the Toxic Release Inventory program.

The TRI database contains a detailed compilation of self-reported, facility-specific chemical releases. The top reporting facilities for this sector are listed below. Facilities that have reported only the SIC codes covered under this notebook appear in Exhibit 19. Exhibit 20 contains additional facilities that have reported the SIC code covered within this report, and one or more SIC codes that are not within the scope of this notebook. Therefore, Exhibit 20 includes facilities that conduct multiple operations — some that are under the scope of this notebook, and some that are not. Currently, the facility-level data do not allow pollutant releases to be broken apart by industrial process.

Exhibits 21 - 24 illustrate the TRI releases and transfers for the Fabricated Metal Products industry (SIC 34). For the industry as a whole, solvents comprise the largest number of TRI releases. This reflects the fact that solvents are used during numerous metal shaping, surface preparation, and surface finishing operations. For example, during metal shaping and surface preparation operations, solvents are used primarily to degrease metal. Solvents are also used during painting operations. All of the processes which use solvents generally result in air emissions, contaminated wastewater, and solid wastes.

Between 1988 and 1993, the Fabricated Metals Products industry substantially reduced its TRI transfers and releases (see section V. Pollution Prevention Opportunities). Exhibits 21 and 22 show the differences in transfers and releases over time, categorized by type of transfer or release.

Exhibit 19 lists the ten facilities with the highest total TRI releases, most of which are continuous coil manufacturers (e.g., facilities that manufacture aluminum cans from long strips of metal). The wastes generated by these manufacturers are not necessarily representative of the wastes generated by the metal fabricating and finishing industries as a whole.

Exhibit 19
Top 10 TRI Releasing Fabricated Metal Products Facilities

SIC Codes	Total TRI Releases in Pounds	Facility Name	City	State
3411	946,923	U.S. Can Co., Plant 20 Weirton	Weirton	WV
3411	880,500	Metal Container Corp., NWB	New Windsor	NY
3710, 3714, 3465	822,902	GMC NAO Flint OPS., BOC Flint Automotive Div.	Flint	MI
3471	708,285	Plastene Supply Co.	Portageville	MO
3731, 3441, 3443	688,540	Ingalls Shipbuilding, Inc.	Pascagoula	MS
3411	636,126	American National Can Co., Winston Salem Plant	Winston-Salem	NC
3411	624,250	Metal Container Corp. FTA	Fort Atkinson	WI
3479	619,436	Ken-Koat, Inc.	Huntington	IN
3714, 3471	618,359	Keeler Brass Automotive, Kentwood Plant	Grand Rapids	MI
3341, 3479, 3355	570,622	Commonwealth Aluminum Corp.	Lewisport	KY

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Note: Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

Exhibit 20
Top 10 TRI Releasing Metal Fabricating & Finishing Facilities (SIC 34)

Rank	Total TRI Releases in Pounds	Facility Name	City	State
1	946,923	U.S. Can Co., Plant 20, Weirton	Weirton	WV
2	880,500	Metal Container Corp., NWB	New Windsor	NY
3	708,285	Plastene Supply Co.	Portageville	MO
4	636,126	American National Can Co., Winston Salem Plant	Winston-Salem	NC
5	624,250	Metal Container Corp.	Fort Atkinson	WI
6	619,436	Ken-Koat, Inc.	Huntington	IN
7	545,505	Metal Container Corp.	Columbus	OH
8	541,654	Reynolds Metals Co.	Houston	TX
9	524,346	Hickory Springs Mfg. Co.	Fort Smith	AR
10	492,872	Tennessee Electroplating, Inc.	Ripley	TN

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Note: Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

Exhibit 21
Reductions in TRI Releases, 1988-1993 (SIC 34)

Releases	1988	1993	Percent Reduction
Total Air Emissions	131,296,827	90,380,667	31.2
Surface Water Discharges	1,516,905	101,928	93.3
Underground Injection	386,120	1,490	99.6
Releases to Land	4,202,919	660,072	84.4

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibit 22
Reductions in TRI Transfers, 1988-1993 (SIC 34)

Transfers	1988	1993	Percent Reduction
Recycling	213,214,641	244,278,696	-14.6
Energy	12,331,653	13,812,271	-12.0
Treatment	34,313,199	18,561,504	45.9
POTWs	17,149,495	3,809,715	77.8
Disposal	43,529,628	19,736,496	54.7
Other Off-Site Transfers	8,303,148	369,491	95.5

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibit 23
TRI Reporting Metal Fabricating & Finishing Facilities (SIC 34) by State

State	Number of Facilities	State	Number of Facilities
AL	54	MS	29
AR	25	NC	35
AS	1	NE	9
AZ	17	NH	5
CA	208	NJ	60
CO	19	NV	3
CT	83	NY	101
DE	2	OH	225
FL	36	OK	29
GA	42	OR	20
HI	2	PA	123
IA	30	PR	10
ID	1	RI	30
IL	230	SC	37
IN	111	SD	3
KS	16	TN	47
KY	41	TX	107
LA	12	UT	15
MA	76	VA	30
MD	17	WA	24
ME	5	WI	103
MI	159	WV	16
MN	59	WY	2
MO	54		

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibit 24
Releases for Metal Fabricating & Finishing Facilities (SIC 34) in TRI, by Number of Facilities (Releases reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	Fugitive Air	Point Air	Water Discharges	Under-ground Injection	Land Disposal	Total Releases	Average Releases per Facility
Sulfuric Acid	861	186135	149329	41032	547	54700	431743	501
Hydrochloric Acid	652	264628	265452	505	250	255	531090	815
Nitric Acid	390	81650	216384	1510	76	0	299620	768
Xylene (Mixed Isomers)	336	2982600	5985667	25	0	553	8968845	26693
Nickel	311	23285	8126	3558	0	6121	41090	132
Chromium	287	25150	6072	2162	0	30345	63729	222
Manganese	271	29884	9536	834	250	30994	71498	264
Glycol Ethers	269	4990228	13281181	5	0	5	18271419	67923
Copper	267	19231	20632	2795	0	763	43421	163
Methyl Ethyl Ketone	254	2134002	4511723	555	0	71335	6717615	26447
Zinc Compounds	228	87045	55641	13561	0	95457	251704	1104
N-Butyl Alcohol	215	3209678	7372875	0	0	5	10582558	49221
Toluene	205	1366663	3325311	7	0	300	4692281	22889
1-Trichloroethane	189	2046210	2727842	10	0	133	4774195	25260
Trichloroethylene	185	2410195	2903856	51	0	6600	5320702	28761
Chromium Compounds	176	7039	13687	1035	0	15574	37335	212
Phosphoric Acid	175	49587	32213	0	319	0	82119	469
Nickel Compounds	158	7538	9311	876	48	1530	19303	122
Methyl Isobutyl Ketone	114	501363	1156914	5	0	5	1658287	14546
Cyanide Compounds	103	7686	8960	298	0	283	17227	167
Copper Compounds	93	4912	6028	1398	0	256	12594	135
Lead	83	5758	4400	809	0	254	11221	135
Ammonia	79	87916	412960	250	0	0	501126	6343
Ethylbenzene	74	234540	308927	5	0	0	543472	7344
Hydrogen Fluoride	74	12924	27671	0	0	0	40595	549
Zinc (Fume Or Dust)	70	100770	41693	290	0	10146	152899	2184
Acetone	61	407417	1090972	0	0	0	1498389	24564
Manganese Compounds	58	2197	795	0	0	12785	15777	272
Dichloromethane	57	991302	1159594	5	0	6829	2157730	37855
4-Trimethylbenzene	53	255913	319541	5	0	0	575459	10858
Tetrachloroethylene	49	809152	434749	22	0	0	1243923	25386
Methanol	48	64182	182883	0	0	0	247065	5147
Chlorine	40	9181	1021	15	0	0	10217	255
Methylenebis(Phenylisocyanate)	35	2562	1179	0	0	0	3741	107
Naphthalene	33	57791	70271	0	0	0	128062	3881
Cobalt	28	1534	1608	755	0	500	4397	157
Barium Compounds	25	3606	803	250	0	3114	7773	311
Freon 113	19	282200	102624	0	0	0	384824	20254
Lead Compounds	19	967	1840	38	0	0	2845	150
Styrene	17	154377	25726	0	0	0	180103	10594
Cadmium	16	62	6	5	0	250	323	20
Formaldehyde	16	15561	9618	209	0	0	25388	1587
Aluminum (Fume Or Dust)	13	7042	506	0	0	0	7548	581

Trichlorofluoro-methane	13	45312	122318	0	0	250	167880	12914
Cadmium Compounds	11	276	266	0	0	0	542	49
Ethylene Glycol	11	37417	160907	0	0	0	198324	18029
Propylene	11	25423	771	0	0	0	26194	2381
Cumene	9	10383	24238	5	0	0	34626	3847
2-Ethoxyethanol	8	14361	19390	0	0	0	33751	4219
Cyclohexane	7	611237	55929	0	0	0	667166	95309
Isopropyl Alcohol (Manufacturing	6	22111	29351	0	0	0	51462	8577
Antimony Compounds	5	4505	661	260	0	0	5426	1085
Cobalt Compounds	5	2	113	37	0	9	161	32
M-Xylene	5	898	12297	0	0	0	13195	2639
Antimony	4	0	423	0	0	0	423	106

Exhibit 24 (cont'd)
Releases for Metal Fabricating & Finishing Facilities (SIC 34) in TRI, by Number of Facilities (Releases reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	Fugitive Air	Point Air	Water Discharges	Underground Injection	Land Disposal	Total Releases	Average Releases per Facility
Bis(2-Ethylhexyl) Adipate	4	8850	14000	0	0	0	22850	5713
Dimethyl Phthalate	4	2407	6387	0	0	0	8794	2199
Phenol	4	12922	0	3	0	0	12925	3231
Sec-Butyl Alcohol	4	6350	19600	0	0	0	25950	6488
Aluminum Oxide (Fibrous Form)	3	250	250	0	0	0	500	167
Di(2-Ethylhexyl) Phthalate	3	250	3000	0	0	5	3255	1085
Dichlorodifluoro-methane	3	7406	16443	0	0	0	23849	7950
Silver	3	5	0	5	0	0	10	3
Asbestos (Friable)	2	10	0	0	0	0	10	5
Barium	2	5	0	0	0	0	5	3
Butyl Benzyl Phthalate	2	0	0	0	0	0	0	0
Diethyl Phthalate	2	255	250	0	0	0	505	253
Molybdenum Trioxide	2	250	0	0	0	2000	2250	1125
O-Xylene	2	0	37928	0	0	0	37928	18964
Phosphorus (Yellow Or White)	2	10	5	5	0	0	20	10
Toluenediisocyanate (Mixed Isomers)	2	5	148	0	0	0	153	77
2-Methoxyethanol	2	255	24825	0	0	0	25080	12540
Ammonium Nitrate (Solution)	1	0	0	0	0	0	0	0
Ammonium Sulfate (Solution)	1	0	0	0	0	0	0	0
Arsenic	1	5	0	0	0	0	5	5
Benzene	1	3122	836	0	0	0	3958	3958
Diethanolamine	1	0	0	0	0	0	0	0
Ethyl Acrylate	1	0	2578	0	0	0	2578	2578
Mercury	1	5	0	0	0	0	5	5
P-Xylene	1	0	22	0	0	0	22	22
Polychlorinated Biphenyls	1	0	0	0	0	0	0	0
Propane Sultone	1	250	0	0	0	0	250	250
Selenium	1	5	0	0	0	0	5	5
Silver Compounds	1	250	250	0	0	0	500	500
2-Dichlorobenzene	1	12000	0	0	0	0	12000	12000
2-Nitropropane	1	186	182	0	0	0	368	368
4'-Isopropylidenediphenol	1	0	250	0	0	0	250	250
Totals	----	24,768,891	46,819,995	73,195	1,490	351,356	72,014,927	----

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibit 25
Transfers for Metal Fabricating & Finishing Facilities (SIC 34) in TRI, by Number of Facilities (Transfers reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	POTW Discharges	Disposal	Recycling	Treatment	Energy Recovery	Total Transfers	Average Transfers per Facility
Sulfuric Acid	861	1132535	2871580	4011148	4636541	0	12651804	14694
Hydrochloric Acid	652	446440	2768870	1472808	3169967	0	7935080	12170
Nitric Acid	390	37256	309134	946756	623265	0	1916411	4914
Xylene (Mixed Isomers)	336	51	10852	1661765	332850	2139660	4151607	12356
Nickel	311	17355	367278	8848547	464008	0	9727271	31277
Chromium	287	30170	465237	10143210	422090	10	11121986	38753
Manganese	271	5093	834964	8774505	8299	0	9623861	35512
Glycol Ethers	269	385087	55411	824664	142591	2295807	3746528	13928
Copper	267	8784	653024	53401212	60924	667	54124861	202715
Methyl Ethyl Ketone	254	141	32971	2787367	268783	4002200	7107644	27983
Zinc Compounds	228	31969	4797726	23980836	2004640	3249	30847198	135295
N-Butyl Alcohol	215	13302	9306	100928	43711	306263	497761	2315
Toluene	205	93	31782	603704	277628	1892116	2805323	13685
1-Trichloroethane	189	65	34508	1342465	128708	101194	1606940	8502
Trichloroethylene	185	1083	34070	1045702	371432	102092	1554379	8402
Chromium Compounds	176	18099	721452	1222505	500300	2981	2490098	14148
Phosphoric Acid	175	268375	300139	5805346	280512	0	6669606	38112
Nickel Compounds	158	21635	463522	1839379	549790	6	2879204	18223
Methyl Isobutyl Ketone	114	5	1407	813193	30029	471629	1316263	11546
Cyanide Compounds	103	19581	17461	12188	140767	0	190497	1849
Copper Compounds	93	13826	341003	11781033	205196	7	12341065	132700
Lead	83	1160	78382	2392024	10184	281	2482031	29904
Ammonia	79	31527	1030	750	260	0	33567	425
Ethylbenzene	74	5	2	170492	14164	227471	412134	5569
Hydrogen Fluoride	74	382	2581	0	16618	0	19581	265
Zinc (Fume Or Dust)	70	75982	219289	666508	120336	61242	1143857	16341
Acetone	61	5	19917	705690	173168	134723	1033503	16943
Manganese Compounds	58	302	221084	1243001	1299	0	1465686	25270
Dichloromethane	57	647	5	289636	73238	26737	390263	6847
4-Trimethylbenzene	53	5	5	23532	10506	58127	92175	1739
Tetrachloroethylene	49	65	6344	555166	129891	6692	698158	14248
Methanol	48	29686	0	35726	34952	80494	180858	3768
Chlorine	40	4470	750	250	6226	0	11696	292
Methylenebis(Phenylisocyanate)	35	0	25420	250	7014	500	33184	948
Naphthalene	33	0	70	34926	14821	39431	89248	2704
Cobalt	28	319	10978	405387	753	0	440451	15730
Barium Compounds	25	12	56251	2079	20823	0	79165	3167
Freon 113	19	0	0	93230	21794	1917	116941	6155

Lead Compounds	19	797	198398	798893	1590	501	1000179	52641
Styrene	17	0	12000	1180	750	250	14180	834
Cadmium	16	1829	8006	9432	31506	0	50773	3173
Formaldehyde	16	41510	5	0	1611	7202	50328	3146
Aluminum (Fume Or Dust)	13	500	250	157757	5460	0	163967	12613
Trichlorofluoro-methane	13	0	7374	0	4263	0	11637	895
Cadmium Compounds	11	1288	65324	27000	42512	0	136124	12375
Ethylene Glycol	11	22685	86000	17100	19170	3110	148065	13460
Propylene	11	0	0	0	0	0	0	0
Cumene	9	5	0	2020	441	5618	8084	898
2-Ethoxyethanol	8	5	0	516	0	2600	3121	390
Cyclohexane	7	0	750	0	1250	255	2255	322

Exhibit 25 (cont'd)
Transfers for Metal Fabricating & Finishing Facilities (SIC 34) in TRI, by Number of Facilities (Transfers reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	POTW Discharges	Disposal	Recycling	Treatment	Energy Recovery	Total Transfers	Average Transfers per Facility
Isopropyl Alcohol (Manufacturing	6	0	613	97513	15	5688	103829	17305
Antimony Compounds	5	10	104158	0	1104	0	105272	21054
Cobalt Compounds	5	15	18403	41566	5	1	59990	11998
M-Xylene	5	0	0	0	109	3819	3928	786
Antimony	4	0	0	3187	375	0	3562	891
Bis(2-Ethylhexyl) Adipate	4	6400	3145	0	0	0	9545	2386
Dimethyl Phthalate	4	0	0	0	269	1802	2071	518
Phenol	4	250	1176	0	0	0	1426	357
Sec-Butyl Alcohol	4	0	0	0	840	250	1090	273
Aluminum Oxide (Fibrous Form)	3	0	0	25000	0	0	25000	8333
Di(2-Ethylhexyl) Phthalate	3	5	8440	0	0	0	8445	2815
Dichlorodifluoromethane	3	0	0	0	0	0	0	0
Silver	3	10	15	250	0	0	275	92
Asbestos (Friable)	2	0	73822	0	0	0	73822	36911
Barium	2	5	10	0	0	0	15	8
Butyl Benzyl Phthalate	2	0	0	0	0	0	0	0
Diethyl Phthalate	2	500	0	2052	2061	0	4613	2307
Molybdenum Trioxide	2	0	419	3900	0	0	4319	2160
O-Xylene	2	0	0	0	61	0	61	31
Phosphorus (Yellow Or White)	2	0	0	12250	0	0	12250	6125
Toluenediisocyanate (Mixed Isomers)	2	0	0	0	0	1374	1374	687
2-Methoxyethanol	2	5	0	0	0	8520	8525	4263
Ammonium Nitrate (Solution)	1	0	0	0	0	0	0	0
Ammonium Sulfate (Solution)	1	128241	0	0	0	0	128241	128241
Arsenic	1	5	10	0	0	0	15	15
Benzene	1	0	0	0	0	0	0	0
Diethanolamine	1	0	0	440	0	0	440	440
Ethyl Acrylate	1	0	0	0	0	0	0	0
Mercury	1	5	10	0	0	0	15	15
P-Xylene	1	0	0	0	51	0	51	51
Polychlorinated Biphenyls	1	0	0	0	2286	0	2286	2286
Propane Sultone	1	0	0	0	0	0	0	0
Selenium	1	5	10	0	0	0	15	15
Silver Compounds	1	250	0	4000	0	0	4250	4250
2-Dichlorobenzene	1	0	0	0	0	0	0	0
2-Nitropropane	1	0	0	0	95	103	198	198

4'-Isopropylidene-diphenol	1	0	250	0	0	0	250	250
Totals	**----**	**2,800,087**	**16,352,393**	**149,241,964**	**15,433,902**	**12,002,720**	**196,188,152**	**----**

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibits 26 - 29 illustrate the TRI releases and transfers for the coating, engraving, and allied services portion (SIC 347) of the fabricated metal products industry. For these activities, solvents, as well as acids, constitute the largest number of TRI releases. Solvents are primarily used during painting operations, while acids are used during most finishing operations (e.g., anodizing, chemical conversion coating, electroplating). The solvents usually produce air emissions, contaminated wastewater, and solid-phase wastes, while the acids generally result in contaminated wastewater. Because NPDES permits do not allow low PH levels, the wastewater is pretreated to reduce the acidity prior to being discharged from the facility.

Exhibit 26
Top 10 TRI Releasing Metal Finishing Facilities (SIC 347)

Rank	Total TRI Releases in Pounds	Facility Name	City	State
1	708,285	Plastene Supply Co.	Portageville	MO
2	619,436	Ken-Koat, Inc.	Huntington	IN
3	492,872	Tennessee Electroplating, Inc.	Ripley	TN
4	430,781	SR of Tennessee	Ripley	TN
5	418,912	Ken-Koat of Tennessee, Inc., Plant 1	Lewisburg	TN
6	408,628	Anomatic Corp.	Newark	OH
7	406,419	Roll Coater, Inc.	Greenfield	IN
8	381,788	Reynolds Metals Co., Sheffield Plant	Sheffield	AL
9	368,014	Roll Coater, Inc.	Kingsbury	IN
10	344,572	Mottley Foils, Inc.	Farmville	VA

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Note: Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

Exhibit 27
TRI Reporting Metal Finishing Facilities (SIC 347) by State

State	Number of Facilities	State	Number of Facilities
AL	19	MO	23
AR	4	MS	6
AZ	9	NC	11
CA	117	NE	1
CO	11	NH	1
CT	36	NJ	27
DE	1	NY	43
FL	14	OH	112
GA	14	OK	9
HI	1	OR	11
IA	6	PA	41
IL	121	PR	4
IN	49	RI	23
KS	7	SC	9
KY	13	TN	17
LA	5	TX	48
MA	39	UT	4
MD	7	VA	7
ME	1	WA	14
MI	109	WI	35
MN	36	WV	4

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibit 28
Releases for Metal Finishing (SIC 347) in TRI, by Number of Facilities
(Releases reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	Fugitive Air	Point Air	Water Discharges	Under-ground Injection	Land Disposal	Total Releases	Average Releases per Facility
Sulfuric Acid	577	159575	103935	38232	0	54450	356192	617
Hydrochloric Acid	490	229596	186461	505	250	255	417067	851
Nitric Acid	290	51229	140639	1510	0	0	193378	667
Zinc Compounds	158	75329	23316	12202	0	93054	203901	1291
Phosphoric Acid	120	24772	26993	0	0	0	51765	431
Methyl Ethyl Ketone	103	945484	2251059	555	0	71335	3268433	31732
Chromium Compounds	101	4572	10765	625	0	15	15977	158
Nickel Compounds	95	5821	4572	564	0	0	10957	115
Cyanide Compounds	87	6759	4098	224	0	283	11364	131
Nickel	87	4685	3257	1433	0	500	9875	114
Trichloroethylene	81	844061	847701	20	0	0	1691782	20886
Xylene (Mixed Isomers)	79	395089	1226943	5	0	0	1622037	20532
1,1,1-Trichloroethane	73	763993	817417	5	0	0	1581415	21663
Toluene	69	375222	1566048	5	0	300	1941575	28139
Glycol Ethers	59	344040	1463579	0	0	0	1807619	30638
Copper	54	880	3508	1646	0	0	6034	112
Chromium	48	2517	2372	131	0	255	5275	110

N-Butyl Alcohol	44	114102	188305	0	0	0	302407	6873
Copper Compounds	43	2874	1955	207	0	0	5036	117
Ammonia	35	75738	11644	0	0	0	87382	2497
Chlorine	32	5828	1011	5	0	0	6844	214
Lead	31	89	1715	536	0	0	2340	75

Exhibit 28 (cont'd)
Releases for Metal Finishing (SIC 347) in TRI, by Number of Facilities
(Releases reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	Fugitive Air	Point Air	Water Discharges	Under-ground Injection	Land Disposal	Total Releases	Average Releases per Facility
Methyl Isobutyl Ketone	30	127088	269586	0	0	0	396674	13222
Tetrachloroethylene	25	401718	211664	0	0	0	613382	24535
Acetone	21	166232	250318	0	0	0	416550	19836
Ethylbenzene	20	46499	68675	0	0	0	115174	5759
Naphthalene	20	25677	52326	0	0	0	78003	3900
Zinc (Fume Or Dust)	20	14713	405	0	0	0	15118	756
1,2,4-Trimethylbenzene	20	87617	118935	0	0	0	206552	10328
Dichloromethane	15	420391	395882	5	0	0	816278	54419
Formaldehyde	15	14409	8992	209	0	0	23610	1574
Methanol	15	53243	138202	0	0	0	191445	12763
Cadmium	13	57	6	0	0	0	63	5
Barium Compounds	12	1601	482	0	0	0	2083	174
Hydrogen Fluoride	10	6216	3208	0	0	0	9424	942
Cadmium Compounds	9	266	11	0	0	0	277	31
Manganese	8	21	69	0	0	0	90	11
Cumene	7	9178	18933	0	0	0	28111	4016
Cobalt	6	12	542	5	0	0	559	93
Freon 113	6	93785	0	0	0	0	93785	15631
Lead Compounds	5	255	500	0	0	0	755	151
Manganese Compounds	4	15	5	0	0	0	20	5
Methylenebis (Phenylisocyanate)	4	5	150	0	0	0	155	39
Aluminum (Fume Or Dust)	3	250	250	0	0	0	500	167
Antimony	3	0	418	0	0	0	418	139
Dimethyl Phthalate	3	2407	5438	0	0	0	7845	2615
Ethylene Glycol	3	1160	18552	0	0	0	19712	6571
Propylene	3	503	516	0	0	0	1019	340
Aluminum Oxide (Fibrous Form)	2	0	0	0	0	0	0	0
Isopropyl Alcohol (Manufacturing)	2	250	15000	0	0	0	15250	7625
M-Xylene	2	0	6109	0	0	0	6109	3055
Sec-Butyl Alcohol	2	1000	3000	0	0	0	4000	2000
Silver	2	5	0	0	0	0	5	3
2-Methoxyethanol	2	255	24825	0	0	0	25080	12540
Ammonium Nitrate (Solution)	1	0	0	0	0	0	0	0
Arsenic	1	5	0	0	0	0	5	5
Barium	1	0	0	0	0	0	0	0
Bis(2-Ethylhexyl) Adipate	1	0	0	0	0	0	0	0
Ethyl Acrylate	1	0	2578	0	0	0	2578	2578
Mercury	1	5	0	0	0	0	5	5
O-Xylene	1	0	37911	0	0	0	37911	37911
Phenol	1	12000	0	0	0	0	12000	12000
Selenium	1	5	0	0	0	0	5	5
Silver Compounds	1	250	250	0	0	0	500	500
Trichlorofluoromethane	1	5	12000	0	0	0	12005	12005
1,2-Dichlorobenzene	1	12000	0	0	0	0	12000	12000
2-Ethoxyethanol	1	250	7000	0	0	0	7250	7250
2-Nitropropane	1	186	182	0	0	0	368	368
4,4-Isopropylidenediphenol	1	0	250	0	0	0	250	250

Total	**----**	**5,931,789**	**10,560,463**	**58,629**	**250**	**220,447**	**16,771,578**	**----**

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

Exhibit 29
Transfers for Metal Finishing (SIC 347) in TRI, by Number of Facilities
(Transfers reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	POTW Discharges	Disposal	Recycling	Treatment	Energy Recovery	Total Transfers	Average Transfers per Facility
Sulfuric Acid	577	804908	1947304	3112900	2266082	0	8131194	14092
Hydrochloric Acid	490	382255	2691567	1467208	3058084	0	7676109	15666
Nitric Acid	290	32756	274177	822830	562997	0	1692760	5837
Zinc Compounds	158	25225	4286331	16726872	1865137	2994	22906591	144978
Phosphoric Acid	120	160428	296366	5126632	120242	0	5718883	47657
Methyl Ethyl Ketone	103	10	0	2060497	110831	1994068	4181588	40598
Chromium Compounds	101	14423	594848	249365	364291	2980	1244457	12321
Nickel Compounds	95	17937	375149	1171327	501971	0	2066384	21751
Cyanide Compounds	87	18577	16451	12127	126143	0	173798	1998
Nickel	87	12239	255282	777750	399252	0	1445523	16615
Trichloroethylene	81	353	4873	214013	103537	63712	386488	4771
Xylene (Mixed Isomers)	79	10	2465	373083	110740	499378	985676	12477
1,1,1-Trichloroethane	73	45	1090	359456	30856	25528	416975	5712
Toluene	69	6	3248	323174	212714	912937	1452079	21045
Glycol Ethers	59	206381	4168	209411	44590	530166	994966	16864
Copper	54	3810	215903	4247604	14524	0	4481841	82997
Chromium	48	4297	253964	245168	402593	0	923657	19243
N-Butyl Alcohol	44	13300	1615	19334	19951	68165	122365	2781
Copper Compounds	43	8404	109090	3397732	118222	0	3633448	84499
Ammonia	35	19727	260	0	255	0	20242	578
Chlorine	32	4210	750	250	6221	0	11431	357
Lead	31	61	10814	428225	7169	0	446269	14396
Methyl Isobutyl Ketone	30	0	0	467583	8208	70164	545955	18199
Tetrachloroethylene	25	20	0	198381	10999	4542	213942	8558
Acetone	21	5	0	482911	134524	37649	655089	31195
Ethylbenzene	20	0	0	95670	2795	67994	166459	8323
Naphthalene	20	0	0	1000	7046	23833	31879	1594
Zinc (Fume Or Dust)	20	4580	9250	181479	75065	0	270624	13531
1,2,4-Trimethylbenzene	20	0	0	12825	8538	37488	58851	2943
Dichloromethane	15	377	0	92499	22453	15138	130467	8698
Formaldehyde	15	41510	5	0	1588	7202	50305	3354
Methanol	15	29686	0	1513	34930	56354	122483	8166
Cadmium	13	1814	6186	9432	31256	0	48688	3745
Barium Compounds	12	5	26665	29	7756	0	34455	2871
Hydrogen Fluoride	10	0	2581	0	16618	0	19199	1920
Cadmium Compounds	9	1287	65319	27000	250	0	93856	10428
Manganese	8	889	851	113	1751	0	3604	451
Cumene	7	0	0	2020	400	5618	8038	1148
Cobalt	6	30	7590	1431	193	0	9244	1541
Freon 113	6	0	0	3900	0	0	3900	650
Lead Compounds	5	751	1520	42677	319	0	45267	9053
Manganese Compounds	4	5	22024	87789	0	0	109818	27455
Methylenebis (Phenylisocyanate)	4	0	0	0	0	0	0	0
Aluminum (Fume Or Dust)	3	250	0	0	5460	0	5710	1903
Antimony	3	0	0	1955	375	0	2330	777
Dimethyl Phthalate	3	0	0	0	269	1802	2071	690
Ethylene Glycol	3	5	0	0	250	994	1249	416
Propylene	3	0	0	0	0	0	0	0

Aluminum Oxide (Fibrous Form)	2	0	0	25000	0	0	25000	12500
Isopropyl Alcohol (Manufacturing)	2	0	0	87932	0	2300	90232	45116
M-Xylene	2	0	0	0	0	0	0	0
Sec-Butyl Alcohol	2	0	0	0	0	0	0	0
Silver	2	5	10	250	0	0	265	133
2-Methoxyethanol	2	5	0	0	0	8520	8525	4263

Exhibit 29 (cont'd)
Transfers for Metal Finishing (SIC 347) in TRI, by Number of Facilities
(Transfers reported in pounds/year)

Chemical Name	# Facilities Reporting Chemical	POTW Discharges	Disposal	Recycling	Treatment	Energy Recovery	Total Transfers	Average Transfers per Facility
Ammonium Nitrate (Solution)	1	0	0	0	0	0	0	0
Arsenic	1	5	10	0	0	0	15	15
Barium	1	5	10	0	0	0	15	15
Bis(2-Ethylhexyl) Adipate	1	0	250	0	0	0	250	250
Ethyl Acrylate	1	0	0	0	0	0	0	0
Mercury	1	5	10	0	0	0	15	15
O-Xylene	1	0	0	0	20	0	20	20
Phenol	1	0	0	0	0	0	0	0
Selenium	1	5	10	0	0	0	15	15
Silver Compounds	1	250	0	4000	0	0	4250	4250
Trichlorofluoromethane	1	0	3400	0	0	0	3400	3400
1,2-Dichlorobenzene	1	0	0	0	0	0	0	0
2-Ethoxyethanol	1	5	0	0	0	750	755	755
2-Nitropropane	1	0	0	0	95	103	198	198
4,4-Isopropylidenediphenol	1	0	250	0	0	0	250	250
Totals	**----**	**1,810,861**	**11,491,656**	**43,172,347**	**10,817,560**	**4,440,379**	**71,879,412**	**---**

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

IV.B. Summary of the Selected Chemicals Released

The following is a synopsis of current scientific toxicity and fate information for the top chemicals (by weight) that facilities within this sector self-reported as released to the environment based upon 1993 TRI data. Because this section is based upon self-reported release data, it does not attempt to provide information on management practices employed by the sector to reduce the release of these chemicals. Information regarding pollutant release reductions over time may be available from EPA's TRI and 33/50 programs, or directly from the industrial trade associations that are listed in Section IX of this document. Since these descriptions are cursory, please consult the sources referenced below for a more detailed description of both the chemicals described in this section, and the chemicals that appear on the full list of TRI chemicals appearing in Section IV.A.

The brief descriptions provided below were taken from the *1993 Toxics Release Inventory Public Data Release* (EPA, 1994), the Hazardous Substances Data Bank (HSDB), and the Integrated Risk Information System (IRIS), both accessed via TOXNET[1]. The information contained below is based upon exposure assumptions that have been conducted using standard scientific procedures. The effects listed below must be taken in context of these exposure assumptions that are more fully explained within the full chemical profiles in HSDB.

The top ten TRI releases for the Fabricated Metal Products industry (SIC_34) as a whole include: glycol ethers, n-butyl, xylene, methyl ethyl ketone, trichloroethylene, toluene-1, dichloromethane, methyl isobutyl ketone, acetone, and tetrachloroethylene. The top ten TRI releases for the coating, engraving, and allied services portion of the fabricated metal products industry (SIC 347) include: methyl ethyl ketone, toluene, glycol ethers, trichloroethylene, xylene (mixed isomers), 1,1,1-trichloroethane, dichloromethane, tetrachloroethylene, hydrochloric acid, and methyl isobutyl ketone. Summaries of most of these chemicals follow.

Acetone

Toxicity**.** Acetone is irritating to the eyes, nose, and throat. Symptoms of exposure to large quantities of acetone may include headache, unsteadiness, confusion, lassitude, drowsiness, vomiting, and respiratory depression.

Reactions of acetone (see environmental fate) in the lower atmosphere contribute to the formation of ground-level ozone. Ozone (a major component of urban smog) can affect the respiratory system, especially in sensitive individuals such as asthmatics or allergy sufferers.

Carcinogenicity**.** There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate**.** If released into water, acetone will be degraded by microorganisms or will evaporate into the atmosphere. Degradation by microorganisms will be the primary removal mechanism.

Acetone is highly volatile, and once it reaches the troposphere (lower atmosphere), it will react with other gases, contributing to the formation of ground-level ozone and other air pollutants. EPA is reevaluating acetone's reactivity in the lower atmosphere to determine whether this contribution is significant.

Physical Properties. Acetone is a volatile and flammable organic chemical.

Note: Acetone was removed from the list of TRI chemicals on June 16, 1995 (60 FR 31643) and will not be reported for 1994 or subsequent years.

Glycol Ethers

Due to data limitations, data on diethylene glycol (glycol ether) are used to represent all glycol ethers.

Toxicity. Diethylene glycol is only a hazard to human health if concentrated vapors are generated through heating or vigorous agitation or if appreciable skin contact or ingestion occurs over an extended period of time. Under normal occupational and ambient exposures, diethylene glycol is low in oral toxicity, is not irritating to the eyes or skin, is not readily absorbed through the skin, and has a low vapor pressure so that toxic concentrations of the vapor can not occur in the air at room temperatures.

At high levels of exposure, diethylene glycol causes central nervous depression and liver and kidney damage. Symptoms of moderate diethylene glycol poisoning include nausea, vomiting, headache, diarrhea, abdominal pain, and damage to the pulmonary and cardiovascular systems. Sulfanilamide in diethylene glycol was once used therapeutically against bacterial infection; it was withdrawn from the market after causing over 100 deaths from acute kidney failure.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Diethylene glycol is a water-soluble, volatile organic chemical. It may enter the environment in liquid form via petrochemical plant effluents or as an unburned gas from combustion sources. Diethylene glycol typically does not occur in sufficient concentrations to pose a hazard to human health.

Hydrochloric Acid

Toxicity. Hydrochloric acid is primarily a concern in its aerosol form. Acid aerosols have been implicated in causing and exacerbating a variety of respiratory ailments. Dermal exposure and ingestion of highly concentrated hydrochloric acid can result in corrosivity.

Ecologically, accidental releases of solution forms of hydrochloric acid may adversely affect aquatic life by including a transient lowering of the pH (i.e., increasing the acidity) of surface waters.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Releases of hydrochloric acid to surface waters and soils will be neutralized to an extent due to the buffering capacities of both systems. The extent of these reactions will depend on the characteristics of the specific environment.

Physical Properties. Concentrated hydrochloric acid is highly corrosive.

Methylene Chloride (Dichloromethane)

Toxicity. Short-term exposure to dichloromethane (DCM) is associated with central nervous system effects, including headache, giddiness, stupor, irritability, and numbness and tingling in the limbs. More severe neurological effects are reported from longer-term exposure, apparently due to increased carbon monoxide in the blood from the break down of DCM. Contact with DCM causes irritation of the eyes, skin, and respiratory tract.

Occupational exposure to DCM has also been linked to increased incidence of spontaneous abortions in women. Acute damage to the eyes and upper respiratory tract, unconsciousness, and death were reported in workers exposed to high concentrations of DCM. Phosgene (a degradation product of DCM) poisoning has been reported to occur in several cases where DCM was used in the presence of an open fire.

Populations at special risk from exposure to DCM include obese people (due to accumulation of DCM in fat), and people with impaired cardiovascular systems.

Carcinogenicity. DCM is a probable human carcinogen via both oral and inhalation exposure, based on inadequate human data and sufficient evidence in animals.

Environmental Fate. When spilled on land, DCM is rapidly lost from the soil surface through volatilization. The remainder leaches through the subsoil into the groundwater.

Biodegradation is possible in natural waters but will probably be very slow compared with evaporation. Little is known about bioconcentration in aquatic organisms or adsorption to sediments but these are not likely to be significant processes. Hydrolysis is not an important process under normal environmental conditions.

DCM released into the atmosphere degrades via contact with other gases with a half-life of several months. A small fraction of the chemical diffuses to the stratosphere where it rapidly degrades through exposure to ultraviolet radiation and contact with chlorine ions. Being a moderately soluble chemical, DCM is expected to partially return to earth in rain.

Methyl Ethyl Ketone

Toxicity. Breathing moderate amounts of methyl ethyl ketone (MEK) for short periods of time can cause adverse effects on the nervous system ranging from headaches, dizziness, nausea, and numbness in the fingers and toes to unconsciousness. Its vapors are irritating to the skin, eyes, nose, and throat and can damage the eyes. Repeated exposure to moderate to high amounts may cause liver and kidney effects.

Carcinogenicity. No agreement exists over the carcinogenicity of MEK. One source believes MEK is a possible carcinogen in humans based on limited animal evidence. Other sources believe that there is insufficient evidence to make any statements about possible carcinogenicity.

Environmental Fate. Most of the MEK released to the environment will end up in the atmosphere. MEK can contribute to the formation of air pollutants in the lower atmosphere. It can be degraded by microorganisms living in water and soil.

Physical Properties. Methyl ethyl ketone is a flammable liquid.

Toluene

Toxicity. Inhalation or ingestion of toluene can cause headaches, confusion, weakness, and memory loss. Toluene may also affect the way the kidneys and liver function.

Reactions of toluene (see environmental fate) in the atmosphere contribute to the formation of ozone in the lower atmosphere. Ozone can affect the respiratory system, especially in sensitive individuals such as asthma or allergy sufferers.

Some studies have shown that unborn animals were harmed when high levels of toluene were inhaled by their mothers, although the same effects were not seen when the mothers were fed large quantities of toluene. Note that these results may reflect similar difficulties in humans.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. The majority of releases of toluene to land and water will evaporate. Toluene may also be degraded by microorganisms. Once volatized, toluene in the lower atmosphere will react with other atmospheric components contributing to the formation of ground-level ozone and other air pollutants.

Physical Properties. Toluene is a volatile organic chemical.

1,1,1-Trichloroethane

Toxicity. Repeated contact of 1,1,1-trichloroethane (TCE) with skin may cause serious skin cracking and infection. Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations.

Exposure to high concentrations of TCE causes reversible mild liver and kidney dysfunction, central nervous system depression, gait disturbances, stupor, coma, respiratory depression, and even death. Exposure to lower concentrations of TCE leads to light-headedness, throat irritation, headache, disequilibrium, impaired coordination, drowsiness, convulsions and mild changes in perception.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. Releases of TCE to surface water or land will almost entirely volatilize. Releases to air may be transported long distances and may partially return to earth in rain. In the lower atmosphere, TCE degrades very slowly by photooxidation and slowly diffuses to the upper atmosphere where photodegradation is rapid.

Any TCE that does not evaporate from soils leaches to groundwater. Degradation in soils and water is slow. TCE does not hydrolyze in water, nor does it significantly bioconcentrate in aquatic organisms.

Trichloroethylene

Toxicity. Trichloroethylene was once used as an anesthetic, though its use caused several fatalities due to liver failure. Short term inhalation exposure to high levels of trichloroethylene may cause rapid coma followed by eventual death from liver, kidney, or heart failure. Short-term exposure to lower concentrations of trichloroethylene causes eye, skin, and respiratory tract irritation. Ingestion causes a burning sensation in the mouth, nausea, vomiting and abdominal pain. Delayed effects from short-term trichloroethylene poisoning include liver and kidney lesions, reversible nerve degeneration, and psychic disturbances. Long-term exposure can produce headache, dizziness, weight loss, nerve damage, heart damage, nausea, fatigue, insomnia, visual impairment, mood perturbation, sexual problems, dermatitis, and rarely jaundice. Degradation products of trichloroethylene (particularly phosgene) may cause rapid death due to respiratory collapse.

Carcinogenicity. Trichloroethylene is a probable human carcinogen via both oral and inhalation exposure, based on limited human evidence and sufficient animal evidence.

Environmental Fate. Trichloroethylene breaks down slowly in water in the presence of sunlight and bioconcentrates moderately in aquatic organisms. The main removal of trichloroethylene from water is via rapid evaporation.

Trichloroethylene does not photodegrade in the atmosphere, though it breaks down quickly under smog conditions, forming other pollutants such as phosgene, dichloroacetyl chloride, and formyl chloride. In addition, trichloroethylene vapors may be decomposed to toxic levels of phosgene in the presence of an intense heat source such as an open arc welder.

When spilled on the land, trichloroethylene rapidly volatilizes from surface soils. The remaining chemical leaches through the soil to groundwater.

Xylene (Mixed Isomers)

Toxicity. Xylenes are rapidly absorbed into the body after inhalation, ingestion, or skin contact. Short-term exposure of humans to high levels of xylenes can cause irritation of the skin, eyes, nose, and throat, difficulty in breathing, impaired lung function, impaired memory, and possible changes in the liver and kidneys. Both short- and long-term exposure to high concentrations can cause effects such as headaches, dizziness, confusion, and lack of muscle coordination. Reactions of xylenes (see environmental fate) in the atmosphere contribute to the formation of ozone in the lower atmosphere. Ozone can affect the respiratory system, especially in sensitive individuals such as asthma or allergy sufferers.

Carcinogenicity. There is currently no evidence to suggest that this chemical is carcinogenic.

Environmental Fate. The majority of releases to land and water will quickly evaporate, although some degradation by microorganisms will occur.

Xylenes are moderately mobile in soils and may leach into groundwater, where they may persist for several years.

Xylenes are volatile organic chemicals. As such, xylenes in the lower atmosphere will react with other atmospheric components, contributing to the formation of ground-level ozone and other air pollutants.

IV.C. Other Data Sources

The Aerometric Information Retrieval System (AIRS) contains a wide range of information related to stationary sources of air pollution, including the emissions of a number of air pollutants which may be of concern within a particular industry. With the exception of volatile organic compounds (VOCs), there is little overlap with the TRI chemicals reported above. Exhibit 30 summarizes annual releases of carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter of 10 microns or less (PM10), total particulates (PT), sulfur dioxide (SO_2), and volatile organic compounds (VOCs).

Exhibit 30
Pollutant Releases (Short Tons/Years)

Industry	CO	NO_2	PM_{10}	PT	SO_2	VOC
U.S. Total	97,208,000	23,402,000	45,489,000	7,836,000	21,888,000	23,312,000
Metal Mining	5,391	28,583	39,359	140,052	84,222	1,283
Nonmetal Mining	4,525	28,804	59,305	167,948	24,129	1,736
Lumber and Wood Products	123,756	42,658	14,135	63,761	9,149	41,423
Wood Furniture and Fixtures	2,069	2,981	2,165	3,178	1,606	59,426
Pulp and Paper	624,291	394,448	35,579	113,571	341,002	96,875
Printing	8,463	4,915	399	1,031	1,728	101,537
Inorganic Chemicals	166,147	108,575	4,107	39,082	182,189	52,091
Organic Chemicals	146,947	236,826	26,493	44,860	132,459	201,888
Petroleum Refining	419,311	380,641	18,787	36,877	648,153	309,058
Rubber and Misc. Plastic Products	2,090	11,914	2,407	5,355	29,364	140,741
Stone, Clay, Glass, and Concrete	58,043	338,482	74,623	171,853	339,216	30,262
Iron and Steel	1,518,642	138,985	42,368	83,017	238,268	82,292

Nonferrous Metals	448,758	55,658	20,074	22,490	373,007	27,375
Fabricated Metals	**3,851**	**16,424**	**1,185**	**3,136**	**4,019**	**102,186**
Electronics	367	1,129	207	293	453	4,854
Motor Vehicles, Bodies, Parts, and Accessories	35,303	23,725	2,406	12,853	25,462	101,275
Dry Cleaning	101	179	3	28	152	7,310

Source U.S. EPA Office of Air and Radiation, AIRS Database, May 1995.

IV.D. Comparison of Toxic Release Inventory Between Selected Industries

The following information is presented as a comparison of pollutant release and transfer data across industrial categories. It is provided to give a general sense as to the relative scale of releases and transfers within each sector profiled under this project. Please note that the following table does not contain releases and transfers for industrial categories that are not included in this project, and thus cannot be used to draw conclusions regarding the total release and transfer amounts that are reported to TRI. Similar information is available within the annual TRI Public Data Release book.

Exhibit 31 is a graphical representation of a summary of the 1993 TRI data for the Fabricated Metals Products industry and the other sectors profiled in separate notebooks. The bar graph presents the total TRI releases and total transfers on the left axis and the triangle points show the average releases per facility on the right axis. Industry sectors are presented in the order of increasing total TRI releases. The graph is based on the data shown in Exhibit 32 and is meant to facilitate comparisons between the relative amounts of releases, transfers, and releases per facility both within and between these sectors. The reader should note, however, that differences in the proportion of facilities captured by TRI exist between industry sectors. This can be a factor of poor SIC matching and relative differences in the number of facilities reporting to TRI from the various sectors. In the case of Fabricated Metal Products industry, the 1993 TRI data presented here covers 2,363 facilities. These facilities listed SIC 34 (Fabricated Metal Products industry) as a primary SIC code.

Exhibit 31 Bar graph
Summary of 1993 TRI Data

Exhibit 32
Toxic Release Inventory Data for Selected Industries

Industry Sector	SIC Range	# TRI Facilities	Releases: Total Releases (10^6 pounds)	Releases: Average Releases per Facility (pounds)	Transfers: 1993 Total (10^6 pounds)	Transfers: Average Transfers per Facility (pounds)	Total Releases + Transfers (10^6 pounds)	Average Release+ Transfers per Facility (pounds)
Stone, Clay, and Concrete	32	634	26.6	41,895	2.2	3,500	28.2	46,000
Lumber and Wood Products	24	491	8.4	17,036	3.5	7,228	11.9	24,000
Furniture and Fixtures	25	313	42.2	134,883	4.2	13,455	46.4	148,000
Printing	2711-2789	318	36.5	115,000	10.2	732,000	46.7	147,000
Electronics /Computers	36	406	6.7	16,520	47.1	115,917	53.7	133,000
Rubber and Misc. Plastics	30	1,579	118.4	74,986	45.0	28,537	163.4	104,000
Motor Vehicle, Bodies, Parts and Accessories	371	609	79.3	130,158	145.5	238,938	224.8	369,000
Pulp and paper	2611-2631	309	169.7	549,000	48.4	157,080	218.1	706,000
Inorganic Chem. Mfg.	2812-2819	555	179.6	324,000	70.0	126,000	249.7	450,000
Petroleum Refining	2911	156	64.3	412,000	417.5	2,676,000	481.9	3,088,000
Fabricated Metals	34	2,363	72.0	30,476	195.7	82,802	267.7	123,000
Iron and Steel	3312-3313 3321-3325	381	85.8	225,000	609.5	1,600,000	695.3	1,825,000
Nonferrous Metals	**333, 334**	**208**	**182.5**	**877,269**	**98.2**	**472,335**	**280.7**	**1,349,000**
Organic Chemical Mfg.	2861-2869	417	151.6	364,000	286.7	688,000	438.4	1,052,000
Metal Mining	10	Industry sector not subject to TRI reporting						
Nonmetal Mining	14	Industry sector not subject to TRI reporting						
Dry Cleaning	7215, 7216, 7218	Industry sector not subject to TRI reporting						

Source: U.S. EPA, Toxics Release Inventory Database, 1993.

V. POLLUTION PREVENTION OPPORTUNITIES

The best way to reduce pollution is to prevent it in the first place. Some companies have creatively implemented pollution prevention techniques that improve efficiency and increase profits while at the same time minimizing environmental impacts. This can be done in many ways such as reducing material inputs, re-engineering processes to reuse by-products, improving management practices, and employing substitution of toxic chemicals. Some smaller facilities are able to actually get below regulatory thresholds just by reducing pollutant releases through aggressive pollution prevention policies.

In order to encourage these approaches, this section provides both general and company-specific descriptions of some pollution prevention advances that have been implemented within the Fabricated Metal Products industry. While the list is not exhaustive, it does provide core information that can be used as the starting point for facilities interested in beginning their own pollution prevention projects. When possible, this section provides information from real activities that can, or are being implemented by this sector -- including a discussion of associated costs, time frames, and expected rates of return. This section provides summary information from activities that may be, or are being implemented by this sector. When possible, information is provided that gives the context in which the techniques can be effectively used. Please note that the activities described in this section do not necessarily apply to all facilities that fall within this sector. Facility-specific conditions must be carefully considered when pollution prevention options are evaluated, and the full impacts of the change must examine how each option affects, air, land, and water pollutant releases.

V.A. Identification of Pollution Prevention Activities in Use and Environmental and Economic Benefits of Each Pollution Prevention Activity

Pollution prevention (sometimes referred to as source reduction) is the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the source. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water or other resources, and practices that protect natural resources through conservation or more efficient use.

EPA and the Fabricated Metal Products industry are working together to promote pollution prevention because it is often the most cost-effective way to reduce pollution and the associated risks to human health and the environment. Pollution prevention is often cost effective because it may reduce raw material losses; reduce reliance on expensive "end-of-pipe" treatment technologies and disposal practices; conserve energy, water, chemicals, and other inputs; and mitigate the potential liability associated with waste generation and disposal. Pollution prevention often involves complex re-engineering however, and companies must balance the desired savings in materials and benefits to the environment against the cost of changing operating practices.

All companies in the Fabricated Metal Products industry, regardless of their size, must comply with environmental regulations related to metal fabricating and/or metal finishing processes. Therefore, all companies benefit from the knowledge of pollution prevention techniques which, if implemented, may increase a company's ability to meet these requirements. Many large companies have been successful in identifying and implementing pollution prevention and other techniques allowing them to operate in an efficient and environmentally protective manner. This capability may be due in part because large companies often have resources to devote to tracking and implementing pollution prevention techniques, and maintaining an awareness and understanding of regulations that apply to their facilities.

Smaller companies may have limited resources to devote to these activities, which may make monitoring and understanding regulations more difficult and may result in limited pollution prevention participation. Increased awareness and publication of pollution prevention techniques improve the ability of companies to comply with regulations. Pollution prevention techniques also permit industrial processes to be more efficient and less costly, providing all companies with an opportunity to maximize the efficiency of their operations and reduce their costs while protecting the environment.

Pollution Prevention techniques and processes currently used by the metal fabricating and finishing industry can be grouped into seven general categories:

- Production planning and sequencing
- Process or equipment modification
- Raw material substitution or elimination
- Loss prevention and housekeeping
- Waste segregation and separation
- Closed-loop recycling
- Training and supervision.

Each of these categories is discussed briefly below. Refer to Section V.D. for a list of specific pollution prevention techniques and associated costs, savings, and other information. It should be kept in mind that every pollution prevention option may not be available for each facility.

Production planning and sequencing is used to ensure that only necessary operations are performed and that no operation is needlessly reversed or obviated by a following operation. One example is to sort out substandard parts prior to painting or electroplating. A second example is to reduce the frequency with which equipment requires cleaning by painting all products of the same color at the same time. A third example is to schedule batch processing in a manner that allows the wastes or residues from one batch to be used as an input for the subsequent batch (e.g., to schedule paint formulation from lighter shades to darker) so that equipment need not be cleaned between batches.

Process or equipment modification is used to reduce the amount of waste generated. For example, manufacturers can change to a paint application technique that is more efficient than spray painting, reduce overspray by reducing the atomizing air pressure, reduce drag-out by reducing the withdrawal speed of parts from plating tanks, or improve a plating line by incorporating drag-out recovery tanks or reactive rinsing.

Raw material substitution or elimination is the replacement of existing raw materials with other materials that produce less waste, or a non-toxic waste. Examples include substituting alkali washes for solvent degreasers, and replacing oil with lime or borax soap as the drawing agent in cold forming.

Loss prevention and housekeeping is the performance of preventive maintenance and equipment and materials management so as to minimize opportunities for leaks, spills, evaporative losses, and other releases of potentially toxic chemicals. For example, spray guns can be cleaned in a manner that does not damage leather packings and cause the guns to leak; or drip pans can be placed under leaking machinery to allow recovery of the leaking fluid.

Waste segregation and separation involves avoiding the mixture of different types of wastes and avoiding the mixture of hazardous wastes with non-hazardous wastes. This makes the recovery of hazardous wastes easier by minimizing the number of different hazardous constituents in a given waste stream. It also prevents the contamination of non-hazardous wastes. Specific examples include segregating scrap metal by metal type, and segregating different kinds of used oils.

Closed-loop recycling is the on-site use or reuse of a waste as an ingredient or feedstock in the production process. For example, in-plant paper fiber waste can be collected and recycled to make pre-consumer recycled paper products.

Training and supervision provides employees with the information and the incentive to minimize waste generation in their daily duties. This might include ensuring that employees know and practice proper and efficient use of tools and supplies, and that they are aware of, understand, and support the company's pollution prevention goals.

V.B. Possible Pollution Prevention Future Trends

There are numerous pollution prevention trends in the metal fabrication and finishing industry. These include recycling liquids, employing better waste control techniques, using mechanical forms of surface preparation, and/or substituting raw materials. One major trend is the increased recycling (e.g., reuse) of most process liquids (e.g., rinse water, acids, alkali cleaning compounds, solvents, etc.) used during the metal forming and finishing processes. For instance, instead of discarding liquids, companies are containing them and reusing them to cut down on the volume of process liquids that must eventually be disposed of. Also, many companies are replacing aqueous plating with ion vapor deposition.

Another common approach to reducing pollution is to reduce rinse contamination via drag-out by slowing and smoothing the removal of parts (rotating them if necessary), maximizing drip time, using drainage boards to direct dripping solutions back to process tanks, and/or installing drag-out recovery tanks to capture dripping solutions. By slowing down the processes and developing structures to contain the dripping solutions, a facility can better control the potential wastes emitted.

To reduce the use of acids when cleaning parts, the industry is using and encouraging the use of mechanical scraping/scrubbing techniques to clean and prepare the metal surface. Emphasizing mechanical approaches would greatly diminish the need for acids, solvents, and alkalis. In addition to the mechanical technique for cleaning surfaces, companies are encouraged to substitute acids and solvents with less harmful liquids (e.g., alcohol). Section V.D. lists numerous specific pollution prevention techniques that have been employed in the industry.

V.C. Pollution Prevention Case Studies

Numerous pollution prevention case histories have been documented for the metal fabricating and finishing industries. Many of these have dealt primarily with electroplating or general finishing operations. The Eastside Plating case, presented in this section, is a classic example of the numerous pollution prevention techniques that can be implemented at an electroplating company. For other pollution prevention case studies, see section V.D. Pollution Prevention Options, and the list of pollution prevention contacts in section V.E.

Eastside Plating, an Oregon-based company, has made money complying with new environmental regulations. Under the direction of its Maintenance and Water Treatment Manager, the electroplating firm implemented operational changes that save more than $300,000 annually. Eastside Plating management made the commitment to implement a hazardous waste reduction program in 1982. By changing rinsing techniques, substituting materials, and segregating wastes for treatment, the firm has become a more cost-effective operation.

By setting priorities and upgrading in phases, the firm was able to work toward compliance yet meet increased demand for services during a period of rapid growth. The first operational modification addressed counterflow and cascade rinsing systems. The changes decreased water used for rinsing, a process that accounts for 90 percent of all water used in electroplating. In counterflow rinsing, water is used a number of times, thus dramatically reducing volume. Cascade rinsing requires only one tank with a center divider which allows water to spill into the other side. The filling/draining process is continuous and very slow to reduce the amount of water used. Both systems cut water bills and wastewater treatment costs.

Management next searched for waste treatment chemicals that decreased, rather than increased, the production of sludge. Total chromium and cyanide wastes were cut in half simply by changing reducing agents. Chromium acid wastes are now oxidized by using sodium bisulfite and sulfuric acid instead of ferrous sulfate, while cyanide reduction is now accomplished more efficiently with gaseous, instead of liquid, chlorine.

Eastside Plating also upgraded its three major waste treatment components: the cyanide oxidation tank, the chromium reduction tank, and the acid/alkaline neutralizing tank. The goal was to separate tank flow, eliminate contamination of the acid/alkaline neutralizing tank, and increase efficiency. Automated metering equipment reduced the quantity of costly caustic chemicals needed to treat acid wastes by 50 percent. To eliminate the risks associated with pump failure and the equalize flow rate, cyanide and chromic acid oxidation and reduction tanks were redesigned as gravity flow systems. Additionally, plumbing was segregated to prevent cross-contamination. These simple solutions saved Eastside Plating hundreds of thousands of dollars.

Next, management consulted with suppliers when they modified the company's mixing sump (sometimes called a reaction tank) and a flocculent mix tank (sometimes called a neutralizing tank). The modification to each prohibits 'indigestion' in the mixing sump interfering with the neutralization process. The suppliers helped resolve the problems of inadequate mixing by baffling the neutralization tank.

Since employees can make or break the best anti-pollution plan, Eastside Plating offers an extensive employee education program. The company says "it's a matter of changing how we do business." In addition, Eastside Plating's Safety Committee helps all employees work together more safely. Additionally, the company reported that working with regulators helped the company make the move toward compliance: "The City of Portland and the Department of Environmental Quality were more interested in helping us solve our problems than in blaming us."

Industry Pollution Prevention Activities

Several pollution prevention initiatives focus on the fabricated metal products industry. As identified below, some efforts include Georgia's Pollution Prevention Assistance Division (P^2AD) strategy, the Industrial Technology Corporation collaborative effort, and the Merit Partnership.

Georgia Department of Natural Resources

A core strategy of the Pollution Prevention Assistance Division (P^2AD) of the Georgia Department of Natural Resources (DNR) is to focus technical assistance efforts on Georgia manufacturers that release chemicals posing the greatest risk to the public and the environment. After reviewing those industries which provide significant opportunities for pollution prevention, various strategies will be developed, including on-site technical assistance, financial assistance, fact sheets, workshops, and other outreach activities that will help manufacturers reduce their generation of toxic chemicals. The first phase is an on-going targeting effort, which evaluates waste generation characteristics of Georgia manufacturers producing toxic and hazardous wastes. The fabricated metal products industry was selected as a high priority manufacturing sector, along with the paper and paper products industry, chemical and allied products industry, transportation equipment industry, rubber and plastic products, and printing and publishing.

ITAC

The Industrial Technology Assistance Corporation (ITAC), in collaboration with the New York Branch of the AESF, the New York Masters Association of Metal Finishers, Utility Metal Research Corporation, and ten electroplating companies applied for and received funding to deliver a program coordinated and written by the Wastewater Technology Center of Canada. This is an industry-specific hands on 24 hour training session that integrates the assessment and incorporation of pollution prevention techniques into all types of electroplating and metal finishing operations. The training also includes an economic evaluation of the benefits of resource recovery on a multi-media basis.

Merit Partnership

The Merit Partnership brings industry and government representatives together to identify pollution prevention needs and accelerate pollution prevention technology diffusion. Merit partners and participants include EPA Region 9, The Metal Finishing Association of Southern California (MFASC), the National Institute of Standards and Testing/California Manufacturing Technology Center, EPA's Office of Research and Development/Risk Reduction Engineering Lab, large companies processing pollution prevention technologies applicable to the metal finishing industry, local regulatory agencies, and participating companies. The Merit Partnership is working closely with its members to develop metal finishing projects that are transferable to small businesses. There is an emphasis on having large companies that are involved with metal finishing share their proven metal finishing methods with smaller companies. The Merit Partnership and MFASC have already begun to identify programmatic areas for metal plating pollution prevention opportunities, from which potential projects will be chosen.

V.D. Pollution Prevention Options

The following sections list numerous pollution prevention techniques that may be useful to companies specializing in metal fabrication and finishing operations. These are options available to facilities, but are not to be construed as requirements. The information is organized by metal shaping, surface preparation, plating, and other finishing operations.

V.D.1. Metal Shaping Operations

Technique - Production Planning and Sequencing

Option 1 - Improve scheduling of processes that require use of varying oil types in order to reduce the number of cleanouts.

Technique - Process or Equipment Modification

Option 1 - Standardize the oil types used for machining, turning, lathing, etc. This reduces the number of equipment cleanouts, and the amount of leftovers and mixed wastes.

Option 2 - Use specific pipes and lines for each set of metals or processes that require a specific oil in order to reduce the amount of cleanouts.

Option 3 - Save on coolant costs by extending machine coolant life through the use of a centrifuge and the addition of biocides. **Costs and Savings:** Waste Savings/Reductions: 25 percent reduction in plant-wide waste coolant generation. Product/Waste Throughput Information: based on handling 20,600 gallons of coolant per year.

Option 4 - Install a second high speed centrifuge on a system already operating with a single centrifuge to improve recovery efficiency even more. **Costs and Savings:** Capital Investment: $126,000. Payback Period: 3.1 years. Product/Waste Throughput Information: based on handling 20,600 gallons of coolant per year.

Option 5 - Install a chip wringer to recover excess coolant on aluminum chips. **Costs and Savings**: Capital Investment: $11,000 to $23,000 (chip wringer and centrifuge system).Payback Period: 0.9 years. Product/Waste Throughput Information: based on handling 20,600 gallons of coolant per year.

Option 6 - Install a coolant recovery system and collection vehicle for machines not on a central coolant sump. **Costs and Savings:** Capital Investment: $104,000. Payback Period: 1.9 years. Product/Waste Throughput Information: based on handling 20,600 gallons of coolant per year.

Option 7 - Use a coolant analyzer to allow better control of coolant quality. **Costs and Savings:** Capital Investment: $5,000. Payback Period: 0.7 years. Product/Waste Throughput Information: based on handling 20,600 gallons of coolant per year.

Option 8 - Use an ultrafiltration system to remove soluble oils from wastewater streams. **Costs and Savings:** Annual Savings: $200,000 (in disposal costs). Product/Waste Throughput Information: based on a wastewater flow rate of 860 to 1,800 gallons per day.

Option 9 - Use disk or belt skimmers to remove oil from machine coolants and prolong coolant life. Also, design sumps for ease of cleaning. **Costs and Savings:** Waste Savings/Reduction: coolant is now disposed once per year rather than 3-6 times per year.

Technique - Raw Material Substitution

Option 1 - In cold forming or other processes where oil is used only as a lubricant, substitute a hot lime bath or borax soap for oil.

Option 2 - Use a stamping lubricant that can remain on the piece until the annealing process, where it is burned off. This eliminates the need for hazardous degreasing solvents and alkali cleaners. **Costs and Savings:** Annual Savings: $12,000 (results from reduced disposal, raw material, and labor costs). Waste Throughput Information: The amount of waste solvents and cleaners was reduced from 30,000 pounds in 1982 to 13,000 pounds in 1986. Employee working conditions were also improved by removing vapors associated with the old cleaners.

Technique - Waste Segregation and Separation

Option 1 - If filtration or reclamation of oil is required before reuse, segregate the used oils in order to prevent mixing wastes.

Option 2 - Segregation of metal dust or scrap by type often increases the value of metal for resale (e.g., sell metallic dust to a zinc smelter instead of disposing of it in a landfill). **Costs and Savings**: Capital Investment: $0. Annual Savings: $130,000. Payback Period: immediate. Waste Savings/Reduction: 2,700 tons per year. (Savings will vary with metal type and market conditions.)

Option 3 - Improve housekeeping techniques and segregate waste streams (e.g., use care when cleaning cutting equipment to prevent the mixture of cutting oil and cleaning solvent). **Costs and Savings:** Capital Investment: $0. Annual Savings: $3,000 in disposal costs. Waste Savings/Reduction: 66 percent (30 tons reduced to 10 tons).

Technique - Recycling

Option 1 - Where possible, recycle oil from cutting/machining operations. Often oils need no treatment before recycling. **Costs and Savings:** Capital Investment: $1,900,000. Annual Savings: $156,000. Waste Throughput Information: 2 million gallons per year. Facility reclaims oil and metal from process water.

Option 2 - Oil scrap mixtures can be centrifuged to recover the bulk of the oil for reuse.

Option 3 - Follow-up magnetic and paper filtration of cutting fluids with ultrafiltration. By so doing, a much larger percentage of cutting fluids can be reused. **Costs and Savings:** Capital Investment: $42,000 (1976). Annual Savings: $33,800 (1980).

Option 4 - Perform on-site purification of hydraulic oils using commercial “off-the-shelf” cartridge filter systems. **Costs and Savings:** Capital Investment: $28,000. Annual Savings: $17,800/year based on operating costs, avoided new oil purchase, and lost resale revenues. Payback Period: less than 2 years. Product/Waste Throughput Information: example facility handles 12,300 gallons/year of waste hydraulic oil.

Option 5 - Use a continuos flow treatment system to regenerate and reuse aluminum chemical milling solutions. **Costs and Savings:** Capital Investment: $465,000. Annual Savings: $342,000. Payback Period: less than 2 years. Waste Savings/Reduction: 90 percent

Option 6 - Use a settling tank (to remove solids) and a coalescing unit (to remove tramp oils) to recover metal-working fluids. **Costs and Savings:** Annual Savings: $26,800 (resulting from reduced material, labor, and disposal costs).

V.D.2. Surface Preparation Operations

SOLVENT CLEANING

Technique - Training and Supervision

Option 1 - Improve solvent management by requiring employees to obtain solvent through their shop foreman. Also, reuse "waste" solvents from cleaner up-stream operations in down-stream, machines shop-type processes. **Costs and Savings:** Capital Investment: $0. Annual Savings: $7,200. Waste Savings/Reduction 49 percent (310 tons reduced to 152 tons). Product/Waste Throughput Information: original waste stream history: reactive anions (6,100 gallons/year), waste oils (1,250 gallons/year), halogenated solvents (500 gallons/year).

Technique - Production Planning and Sequencing

Option 1 - Pre-cleaning will extent the life of the aqueous or vapor degreasing solvent (wipe, squeeze, or blow part with air, shot, etc.). **Costs and Savings:** Annual Savings: $40,000. Payback Period: 2 years. Waste Savings/Reduction: 48,000 gallons of aqueous waste. Aluminum shot was used to preclean parts.

Option 2 - Use countercurrent solvent cleaning (i.e., rinse initially in previously used solvent and progress to new, clean solvent).

Options 3 - Cold clean with a recycled mineral spirits stream to remove the bulk of oil before final vapor degreasing.

Option 4 - Only degrease parts that must be cleaned. Do not routinely degrease all parts.

Technique - Process or Equipment Modification

Option 1 - The loss of solvent to the atmosphere from vapor degreasing equipment can be reduced by:

- increasing the freeboard height above the vapor level to 100 percent of tank width;
- covering the degreasing unit (automatic covers are available);
- installing refrigerator coils (or additional coils) above the vapor zone;
- rotating parts before removal from the vapor degreaser to allow all condensed solvent to return to degreasing unit;
- controlling the speed at which parts are removed (10 feet or less per minute is desirable) so as not to disturb the vapor line;
- installing thermostatic heating controls on solvent tanks; and
- adding in-line filters to prevent particulate buildup in the degreaser.

Option 2 - Reduce grease accumulation by adding automatic oilers to avoid excess oil applications.

Option 3 - Use plastic blast media for paint stripping rather than conventional solvent stripping techniques. **Costs and Savings:** Waste Savings/Reduction: volume of waste sludge is reduced by as much as 99 percent over chemical solvents; wastewater fees are eliminated.

Technique - Raw Material Substitution

Option 1 - Use less hazardous degreasing agents such as petroleum solvents or alkali washes. For example, replace halogenated solvents (e.g., trichloroethylene) with liquid alkali cleaning compounds. (Note that compatibility of aqueous cleaners with wastewater treatment systems should be ensured.) **Costs and Savings:** Capital Investment: $0. Annual Savings: $12,000. Payback Period: immediate. Waste Savings/Reduction: 30 percent of 1,1,1-trichloroethane replaced with an aqueous cleaner.

Option 2 - Substitute chromic acid cleaner with non-fuming cleaners such as sulfuric acid and hydrogen peroxide. **Costs and Savings:** Annual Savings: $10,000 in treatment equipment costs and $2.50/lb. of chromium in treatment chemical costs. Product/Waste Throughput Information: rinse water flowrate of 2 gallons per minute.

Option 3 - Substitute less polluting cleaners such as trisodium phosphate or ammonia for cyanide cleaners. **Costs and Savings:** Annual Savings: $12,000 in equipment costs and $3.00/lb. of cyanide in treatment chemical costs. Product/Waste Throughput Information: rinse water flowrate of 2 gallons per minute.

Technique - Recycling

Option 1 - Recycle spent degreasing solvents on site using batch stills. **Costs and Savings:** Capital Investment: $2,600-$4,100 and $4,200-$17,000. Product Throughput Information: 35-60 gallons per hour and 0.6-20 gallons per hour, respectively. Two cost and throughput estimates for distillation units from two vendors.

Option 2 - Use simple batch distillation to extend the life of 1,1,1-trichloroethane. **Costs and Savings:** Capital Investment: $3,500 (1978). Annual Savings: $50,400. Product/Waste Throughput Information: facility handles 40,450 gallons 1,1,1-trichloroethane per year.

Option 3 - When on-site recycling is not possible, agreements can be made with supply companies to remove old solvents. **Costs and Savings:** Capital Investment: $3,250 for a temporary storage building. Annual Savings: $8,260. Payback Period: less than 6 months. Waste Savings/Reduction: 38,000 pounds per year of solvent sent off site for recycling.

Option 4 - Arrange a cooperative agreement with other small companies to centrally recycle solvent.

CHEMICAL TREATMENT

Technique - Process or Equipment Modification

Option 1- Increase the number of rinses after each process bath and keep the rinsing counter-current in order to reduce drag-out losses.

Option 2 - Recover unmixed acids in the wastewater by evaporation.

Option 3 - Reduce rinse contamination via drag-out by:
- slowing and smoothing removal of parts, rotating them if necessary;
- using surfactants and other wetting agents;
- maximizing drip time;
- using drainage boards to direct dripping solutions back to process tanks;
- installing drag-out recovery tanks to capture dripping solutions;
- using a fog spray rinsing technique above process tanks;
- using techniques such as air knives or squeegees to wipe bath solutions off of the part; and
- changing bath temperature or concentrations to reduce the solution surface tension.

Option 4 - Instead of pickling brass parts in nitric acid, place them in a vibrating apparatus with abrasive glass marbles or steel balls. A slightly acidic additive is used with the glass marbles, and a slightly basic additive is used with the steel balls. **Costs and Savings:** Capital Investment: $62,300 (1979); 50 percent less than conventional nitric acid pickling.

Option 5 - Use mechanical scraping instead of acid solution to remove oxides of titanium. **Costs and Savings:** Annual Savings: $0; cost of mechanical stripping equals cost of chemical disposal. Waste Savings/Reduction: 100 percent. Waste Throughput Information: previously disposed 15 tons/year of acid with metals.

Option 6 - For cleaning nickel and titanium alloy, replace alkaline etching bath with a mechanical abrasive system that uses a silk and carbide pad and pressure to clean or "brighten" the metal. **Costs and Savings:** Capital Investment: $3,250. Annual Savings: $7,500. Waste Savings/Reduction: 100 percent. Waste Throughput Information: previous etching bath waste total was 12,000 gallons/year.

Option 7 - Clean copper sheeting mechanically with a rotating brush machine that scrubs with pumice, instead of cleaning with ammonium persulfate, phosphoric acid, or sulfuric acid; may generate non-hazardous waste sludge. **Costs and Savings:** Capital Investment: $59,000. Annual Savings: more than $15,000. Payback Period: 3 years. Waste Savings/Reduction: 40,000 pounds of copper etching waste reduced to zero.

Option 8- Reduce molybdenum concentration in wastewaters by using a reverse osmosis/precipitation system. **Costs and Savings:** Capital Investment: $320,000. Waste Throughput Information: permeate capacity of 18,000 gallons per day. Savings Relative to an Evaporative System: installed capital cost savings: $150,000; annual operating cost savings: $90,000.

Option 9 - When refining precious metals, reduce the acid/metals waste stream by maximizing reaction time in the gold and silver extraction process. **Costs and Savings:** Capital Investment: $0. Annual Savings:

$9,000. Waste Savings/Reduction: 70 percent (waste total reduced from 50 tons to 15 tons).

Technique - Raw Material Substitution

Option 1 - Change copper bright-dipping process from a cyanide dip and chromic acid dip to a sulfuric acid/hydrogen peroxide dip. The new bath is less toxic and copper can be recovered.

Option 2 - Use alcohol instead of sulfuric acid to clean copper wire. One ton of wire requires 4 liters of alcohol solution, versus 2 kilograms of sulfuric acid. **Costs and Savings:** Capital Investment: $0.

Option 3 - Replace caustic wire cleaner with a biodegradable detergent.

Option 4 - Replace chromated desmutting solutions with nonchromated solutions for alkaline etch cleaning of wrought aluminum. **Costs and Savings:** Annual Savings: $44,541. Waste Savings/Reduction: sludge disposal costs reduced by 50 percent.

Option 5 - Replace barium and cyanide salt heat treating with a carbonate/chloride carbon mixture, or with furnace heat treating.

Option 6 - Replace thermal treatment of metals with condensation of saturated chlorite vapors on the surface to be heated. **Costs and Savings:** Waste Savings/Reduction: this process is fast, nonoxidizing, and uniform; pickling is no longer necessary.

Technique - Recycling

Option 1 - Sell waste pickling acids as feedstock for fertilizer manufacture or neutralization/precipitation.

Option 2 - Recover metals from solutions for resale. **Costs and Savings:** Annual Savings: $22,000. Payback Period: 14 months. Company sells copper recovered from a bright-dip bath regeneration process employing ion exchange and electrolytic recovery.

Option 3 - Send used copper pickling baths to a continuous electrolysis process for regeneration and copper recovery. **Costs and Savings:** Capital Investment: $28,500 (1977). Product Throughput Information: pickling 12,000 tons of copper; copper recovery is at the rate of 200 gallons/ton of processed copper.

Option 4 - Recover copper from brass bright dipping solutions using a commercially available ion exchange system. **Costs and Savings:** Annual Savings: $17,047; based on labor savings, coppers sulfate elimination, sludge reduction, copper metal savings, and bright dip chemicals savings. Product Throughput Information: example facility processes approximately 225,000 pounds of brass per month.

Option 5 - Treat industrial wastewater high in soluble iron and heavy metals by chemical precipitation. **Costs and Savings:** Annual Savings: $28,000; based on reduced water and sewer rates. Waste Throughput Information: wastewater flow from facility's "patening" line is 100 gallons per minute.

Option 6 - Oil quench baths may be recycled on site by filtering out the metals.

Option 7 - Alkaline wash life can be extended by skimming the layer of oil (the skimmed oil may be reclaimed).

V.D.3. <u>Plating Operations</u>

Technique - Training and Supervision

Option 1 - Educate plating shop personnel in the conservation of water during processing and in material segregation.

Technique - Production Planning and Sequencing

Option 1 - Preinspect parts to prevent processing of obvious rejects.

Technique - Process or Equipment Modification

Option 1 - Modify rinsing methods to control drag-out by:
- Increasing bath temperature
- Decreasing withdrawal rate of parts from plating bath
- Increasing drip time over solution tanks; racking parts to avoid cupping solution within part cavities
- Shaking, vibrating, or passing the parts through an air knife, angling drain boards between tanks
- Using wetting agents to decrease surface tension in tank.

Contact: Braun Intertec Environmental, Inc., and MN Office of Waste Management (612)_649-5750.

Option 2 - Utilize water conservation methods including:
- Flow restrictors on flowing rinses
- Counter current rinsing systems
- Fog or spray rinsing
- Reactive rinsing
- Purified or softened water
- Dead rinses
- Conductivity controllers
- Agitation to assure adequate rinsing and homogeneity in rinse tank
- Flow control valves.

Contact: Braun Intertec Environmental, Inc., and MN Office of Waste Management (612)_649-5750.

Option 3 - Implement counter flow rinsing and cascade rinsing systems to conserve consumption of water. **Costs and Savings:** Costs: $75,000 to upgrade existing equipment and purchasing new and used equipment. Waste Savings/Reduction: reduce water use and wastewater treatment costs. **Contact:** Eastside Plating and OR Department of Environmental Quality (800)452-4011**.**
Option 4 - Use drip bars to reduce drag-out. **Costs and Savings:** Capital Investment: $100 per tank. Savings: $600. **Contact:** NC Department of Natural Resources & Community Development, Gary Hunt (919) 733-7015.

Option 5 - Use drain boards between tanks to reduce generations of drag-out. **Costs and Savings:** Capital Investment: $25 per tank. Savings: $450. **Contact:** NC Department of Natural Resources & Community Development, Gary Hunt (919) 733-7015.

Option 6 - Install racking to reduce generations of drag-out. **Costs and Savings:** Capital Investment: zero dollars. Operating Costs: minimal. Savings: $600. **Contact:** NC Department of Natural Resources & Community Development, Gary Hunt (919) 733-7015.

Option 7 - Employ drag out recovery tanks to reduce generations of drag-out. **Costs and Savings:** Capital Investment: $500 per tank. Savings: $4,700. **Contact:** NC Department of Natural Resources & Community Development, Gary Hunt (919) 733-7015.

Option 8 - Install counter-current rinsing operation to reduce water consumption. **Costs and Savings:**

Capital Investment: $1,800-2,300. Savings: $1,350 per year. Waste Savings/Reductions: reduce water use by 90-99 percent. **Contact:** NC Department of Natural Resources & Community Development, Gary Hunt (919) 733-7015.

Option 9 - Redesign rinse tank to reduce water conservation. **Costs and Savings:** Capital Investment: $100. Savings: $750 per year. **Contact:** NC Department of Natural Resources & Community Development, Gary Hunt (919) 733-7015.

Option 10 - Increase parts drainage time to reduce drag-out. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 11 - Regenerate plating bath by activated carbon filtration to remove built up organic contaminants. **Costs and Savings:** Capital Investment: $9,192. Costs: $7,973. Savings: $122,420. Waste Savings/Reduction: 10,800 gallons. Reduce volume of plating baths disposed and requirements for virgin chemicals. **Contact:** EPA Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, Harry Freeman.

Option 12 - Install pH controller to reduce the alkaline and acid concentrations in tanks. **Contact:** Securus, Inc., and DBA Hubbard Enterprises.

Option 13 - Install atmospheric evaporator to reduce metal concentrations. **Contact:** Securus, Inc., and DBA Hubbard Enterprises.

Option 14 - Install process (e.g., CALFRAN) to reduce pressure to vaporize water at cooler temperatures and recycle water by condensing the vapors in another container, thus concentrating and precipitating solutes out. **Costs and Savings:** Waste Savings/Reduction: reduce volume and quantity of aqueous waste solutions by recovering pure water. **Contact**: CALFRAN International, Inc., (413) 525-4957.

Option 15 - Use reactive rinsing and multiple drag-out baths. **Costs and Savings:** Savings: Reduce cost of treating spent process baths and rinse waters. Waste Savings/Reduction: increase lifetime of process baths and reduce the quantity or rinse water requiring treatment. **Contact:** SAIC, Edward R. Saltzberg.

Option 16 - Improve control of water level in rinse tanks, improve sludge separation, and enhance recycling of supernatant to the process by aerating the sludge. **Costs and Savings:** Savings: $2,000. Waste Savings/Reduction: reduce sludge generation by 32 percent. **Contact:** NJ Hazardous Waste Facilities Siting Commission, Hazardous Waste Source Reduction and Recycling Task Force.

Option 17 - Install system (e.g., Low Solids Fluxer) that applies flux to printed wiring boards, leaving little residue and eliminates the need for cleaning CFCs. **Costs and Savings:** Waste Savings/Reduction: reduce CFC emissions over 50 percent. **Contact:** AT&T Bell Laboratories, Princeton, NJ.

Technique - Raw Material Substitution

Option 1 - Substitute cyanide plating solutions with alkaline zinc, acid zinc, acid sulfate copper, pyrophosphate copper, alkaline copper, copper fluoborate, electroless nickel, ammonium silver, halide silver, methanesulfonate-potassium iodide silver, amino or thio complex silver, no free cyanide silver, cadmium chloride, cadmium sulfate, cadmium fluoborate, cadmium perchlorate, gold sulfite, and cobalt harden gold. **Contact:** Braun Intertec Environmental Inc., and MN Office of Waste Management (612) 649-5750.

Option 2 - Substitute sodium bisulfite and sulfuric acid for ferrous sulfate in order to oxidize chromic acid wastes, and substitute gaseous chlorine for liquid chlorine in order to reduce cyanide reduction. **Costs and Savings:** Savings: $300,000 per year. Waste Savings/Reduction: reduces feedstock by 50 percent. **Contact:** Eastside Plating and OR Department of Environmental Quality (800) 452-4011.

Option 3 - Replace hexavalent chromium with trivalent chromium plating systems. **Contact:** City of Los Angeles Hazardous and Toxic Material Project. Board of Public Works (213)_237-1209.

Option 4 - Replace cyanide with non-cyanide baths. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 5 - Replace conventional chelating agents such as tartarates, phosphates, EDTA, and ammonia with sodium sulfides and iron sulfates in removing metal from rinse water which reduces the amount of waste generated from precipitation of metals from aqueous wastestreams. **Costs and Savings:** Costs: $178,830 per year. Savings: $382,995 per year. Waste Savings/Reduction: 496 tons of sludge per year. **Contact:** Tyndall Air Force Base, FL, (904) 283-2942, Charles Carpenter, Dan Sucia, Penny Wilcoff; and John Beller at EG&G (108) 526-1149.

Option 6 - Replace methylene chloride, 1,1,1-trichloroethane, and perchloroethylene (solvent-based photochemical coatings) with aqueous base coating of 1 percent sodium carbonate. **Costs and Savings:** Waste Savings/Reduction: reduce solvent use by 60 tons per year. **Contact:** American Etching and Manufacturing, Pacoima, CA.

Option 7 - Replace methanol with nonflammable alkaline cleaners. **Costs and Savings:** Waste Savings/Reduction: eliminate 32 tons per year of flammable methyl alcohol. **Contact:** American Etching and Manufacturing, Pacoima, CA.

Option 8 - Substitute a non-cyanide for a sodium cyanide solution used in copper plating baths. **Costs and Savings:** Waste Savings/Reduction: reduce 7,630 pounds per year. **Contact:** Highland Plating Company, Los Angeles, CA.

Technique - Waste Segregation and Separation

Option 1 - Wastewaters containing recoverable metals should be segregated from other wastewater streams.

Technique - Recycling

Option 1 - Install ion exchange system to reduce generation of drag-out. **Costs and Savings:** Capital Investment: $78,000. Operating Costs: $3,200 per year. **Contact:** NC Department of Natural Resources & Community Development; Gary Hunt (919) 733-7015.

Option 2 - Employ reverse osmosis system to reduce generation of drag-out. **Costs and Savings:** Savings: $40,000 per year. Capital Investment: $62,000. **Contact:** NC Department of Natural Resources & Community Development; Gary Hunt (919)_733-7015.

Option 3 - Use electrolytic metal recovery to reduce generation of drag-out. **Costs and Savings:** Capital Investment: $1,000. **Contact:** NC Department of Natural Resources & Community Development; Gary Hunt (919) 733-7015.

Option 4 - Utilize electrodialysis to reduce generation of drag-out. **Costs and Savings:** Capital Investment: $50,000. **Contact:** NC Department of Natural Resources & Community Development; Pollution Prevention Pays Program Gary Hunt (919) 733-7015.

Option 5 - Implement evaporative recovery to reduce generation of drag-out. **Costs and Savings:** Capital Investment: $2,500. **Contact:** NC Department of Natural Resources & Community Development; Gary Hunt (919) 733-7015.

Option 6- Reuse rinse water. **Costs and Savings:** Savings: $1,500 per year. Capital Investment: $340 per tank. No direct costs. **Contact:** NC Department of Natural Resources & Community Development; Gary Hunt (919) 733-7015.

Option 7- Reuse drag-out waste back into process tank. **Contact:** NC Department of Natural Resources & Community Development; Gary Hunt (919)_733-7015.

Option 8- Recover process chemicals with fog rinsing parts over plating bath. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 9- Evaporate and concentrate rinse baths for recycling. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 10 - Use ion exchange and electrowinning, reverse osmosis, and thermal bonding when possible. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 11 - Use sludge slagging techniques to extract and recycle metals. **Costs and Savings:** Capital Investment: $80,000 for 80 tons/year and $400,000 for 1,000 tons/year. Operating Costs: $18,000 per year for an 80 ton facility. Waste Savings/Reduction: reduces volume of waste by 94 percent. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 12 - Use hydrometallurgical processes to extract metals from sludge. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 13- Convert sludge to smelter feed. **Contact:** City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works (213) 237-1209.

Option 14- Remove and recover lead and tin from boards by electrolysis or chemical precipitation. **Contact:** Control Data Corporation and MN Office of Waste Management (612) 649-5750.

Option 15 - Install a closed loop batch treatment system for rinse water to reduce water use and waste volume. **Costs and Savings:** Savings: $58,460 per year. Capital Investment: $210,000. Waste Savings/Reduction: 40,000 gallons per year (40 percent). **Contact:** Pioneer Metal Finishing, Inc., Harry Desoi (609) 694-0400.

Option 16 - Install an electrolytic cell which recovers 92 percent of dissolved copper in drag-out rinses and atmospheric evaporator to recover 95 percent of chromatic acid drag-out, and recycle it into chromic acid etch line. **Contact:** Digital Equipment Corporation and Lancy International Consulting Firm, William McLay (412) 452-9360.

Option 17 - Implement the electrodialysis reversal process for metal salts in wastewater. **Costs and Savings**: Savings: $40,100 per year in operating costs. **Contact:** Ionics, Inc., Separations Technology Division.

Option 18 - Oxidize cyanide and remove metallic copper to reduce metal concentrations. **Contact:** Securus, Inc. and DBA Hubbard Enterprises.

V.D.4. Other Finishing Operations

FINISHING OPERATIONS

Technique - Training and Supervision

Option 1 - Always use proper spraying techniques.

Option 2 - Improved paint quality, work efficiency, and lower vapor emissions can be attained by formal training of operators.

Option 3 - Avoid buying excess finishing material at one time due to its short shelf-life.

Technique - Production Planing and Sequencing

Option 1 - Use the correct spray gun for particular applications:
- conventional air spray gun for thin-film-build requirements
- airless gun for heavy film application
- air assisted airless spray gun for a wide range of fluid output.

Option 2 - Preinspect parts to prevent painting of obvious rejects.

Technique - Process or Equipment Modification

Option 1 - Ensure the spray gun air supply is free of water, oil, and dirt.

Option 2 - Replace galvanizing processes requiring high temperature and flux with one that is low temperature and does not require flux. **Costs and Savings:** Capital Investment: $900,000. Annual Savings: 50 percent (as compared to conventional galvanizing). Product Throughput Information: 1,000 kg/h.

Option 3 - Investigate use of transfer methods that reduce material loss such as:
- dip and flow coating
- electrostatic spraying
- electrodeposition.

Option 4 - Change from conventional air spray to an electrostatic finishing system. **Costs and Savings:** $15,000 per year. Payback Period: less than 2 years.

Option 5 - Use solvent recovery or incineration to reduce the emissions of volatile organics from curing ovens. **Costs and Savings:** Annual Savings: $400,000.

Option 6 - Regenerate anodizing and alkaline silking baths with contemporary recuperation of aluminum salts. **Costs and Savings:** $0.20 per meter of aluminum treated per year. Waste Throughput Information: based on an example plant that previously disposed 180,000 liters of acid solution per year at $0.07 per litre.

Technique - Raw Material Substitution

Option 1 - Use alternative coatings for solvent based paints to reduce volatile organic materials use and emissions, such as:

- high solids coatings (this may require modifying the painting process; including high speed/high pressure equipment, a paint distributing system, and paint heaters); **Costs and Savings:** Waste Savings/Reduction: 30 percent net savings in applied costs per square foot.

- water based coatings **- Costs and Savings:** Waste Savings/Reduction: 87 percent drop in solvent emissions and decreased hazardous waste production;

- powder coatings **- Costs and Savings:** Capital Investment: $1.5 million. Payback Period: 2 years. Example is for a large, wrought iron patio furniture company.

Technique - Waste Segregation and Separation

Option 1 - Segregate non-hazardous paint solids from hazardous paint solvents and thinners.

Technique - Recycling

Option 1 - Do not dispose of extended shelf life items that do not meet your facility's specifications. They may be returned to the manufacturer, or sold or donated as a raw material.

Option 2 - Recycle metal sludges through metal recovery vendors.

Option 3 - Use activated carbon to recover solvent vapors, then recover the solvent from the carbon by steam stripping, and distill the resulting water/solvent mixture. **Costs and Savings:** Capital Investment: $817,000 (1978). Waste Savings/Reduction: releases of solvent to the atmosphere were reduced from 700 kg/ton of solvent used to 20 kg/ton.

Option 4 - Regenerate caustic soda etch solution for aluminum by using hydrolysis of sodium aluminate to liberate free sodium hydroxide and produce a dry, crystalline hydrate alumina byproduct. **Costs and Savings:** Capital Investment: $260,000. Savings: $169,282 per year; from reduced caustic soda use, income from the sale of the byproduct, and a reduction in the cost of solid waste disposal. Payback Period: 1.54 years. Product/Waste Throughput Information: anodizing operation for which the surface area is processed at a rate of 200 M^2/hour.

PAINT CLEANUP

Technique - Production Planning and Sequencing

Option 1 - Reduce equipment cleaning by painting with lighter colors before darker ones.

Option 2 - Reuse cleaning solvents for the same resin system by first allowing solids to settle out of solution.

Option 3 - Flush equipment first with dirty solvent before final cleaning with virgin solvent. **Costs and Savings:** Waste Savings/Reduction: 98 percent; from 25,000 gallons of paint cleanup solvents to 400 gallons. Company uses cleanup solvents in formulation of subsequent batches.

Option 4 - Use virgin solvents for final equipment cleaning, then as paint thinner.

Option 5 - Use pressurized air mixed with a mist of solvent to clean equipment.

Technique - Raw Material Substitution

Option 1 - Replace water-based paint booth filters with dry filters. Dry filters will double paint booth life and allow more efficient treatment of wastewater. **Costs and Savings:** Savings per year: $1,500. Waste Savings/Reduction: 3,000 gallons/year.

Technique - Loss Prevention and Housekeeping

Option 1 - To prevent spray gun leakage, submerge only the front end (or fluid control) of the gun into the cleaning solvent.

Technique - Waste Segregation and Separation

Option 1 - Solvent waste streams should be kept segregated and free from water contamination.

Technique - Recycling

Option 1 - Solvent recovery units can be used to recycle spent solvents generated in flushing operations.

- Install a recovery system for solvents contained in air emissions. **Costs and Savings:** Savings: $1,000 per year.
- Use batch distillation to recover isopropyl acetate generated during equipment cleanup. **Costs and Savings:** Payback Period: 2 years.
- Use batch distillation to recover xylene from paint equipment cleanup. **Costs and Savings:** Payback Period: 13 months. Savings: $5,000 per year.
- Use a small solvent recovery still to recover spent paint thinner from spray gun cleanups and excess paint batches. **Costs and Savings:** Capital Investment: $6,000 for a 15 gallons capacity still. Savings: $3,600 per year in new thinner savings; $5,400 in disposal savings. Payback Period: less than 1 year. Waste Savings/Reduction: 75 percent (745 gallons of thinner recovered from 1,003 gallons). Product/Waste Throughput Information: 1,500 gallons of spent thinner processed per year.
- Install a methyl ethyl ketone solvent recovery system to recover and reuse waste solvents. **Costs and Savings:** Savings: $43,000 per year; MEK recovery rate: 20 gallons per day, reflecting a 90 percent reduction in waste.

Option 2 - Arrange an agreement with other small companies to jointly recycle cleaning wastes.

V.E. Pollution Prevention Contacts

Organization	Technique(s) to Promote Pollution Prevention Plating Operations	Telephone Number
Braun Intertec Environmental, Inc. Minnesota Office of Waste Management	Process or Equipment Modification Raw Material Substitution	(612) 649-5750
Eastside Plating Oregon Department of Environmental Quality	Process or Equipment Modification Raw Material Substitution	(800) 452-4011
North Carolina Department of Natural Resources & Community Development (Gary Hunt)	Process or Equipment Modification Recycling	(919) 733-7015
City of Los Angeles Hazardous and Toxic Material Project, Board of Public Works	Process or Equipment Modification Raw Material Substitution Recycling	(213) 237-1209
EPA Hazardous Waste Engineering Research Laboratory, Cincinnati, OH (Harry Freeman)	Process or Equipment Modification	
Securus, Inc. DBA Hubbard Enterprises	Process or Equipment Modification Recycling	

Organization	Technique(s) to Promote Pollution Prevention Plating Operations	Telephone Number
CALFRAN International, Inc.	Process or Equipment Modification	(413) 525-4957
SAIC (Edward R. Saltzberg)	Process or Equipment Modification	
New Jersey Hazardous Waste Facilities Siting Commission, Hazardous Waste Source Reduction and Recycling Task Force	Process or Equipment Modification	
AT&T Bell Laboratories, Princeton, NJ	Process or Equipment Modification	
Tyndall Air Force Base (Charles Carpenter)	Raw Material Substitution	(904) 283-2942
EG&G Idaho (Dan Sucia, Penny Wilcoff, John Beller)		(208) 526-1149
American Etching and Manufacturing, Pacoima, CA	Raw Material Substitution	
Highland Plating Company, Los Angeles, CA	Raw Material Substitution	
Control Data Corporation Minnesota Office of Waste Management	Recycling	(612) 649-5750
Pioneer Metal Finishing, Inc. (Harry Desoi)	Recycling	(609) 694-0400
Digital Equipment Corporation Lancy International Consulting Firm (William McLay)	Recycling	(412) 452-9360
Ionics, Inc., Separations Technology Division	Recycling	