IV. CHEMICAL RELEASE AND TRANSFER PROFILE

This section is designed to provide background information on the pollutant releases that are reported by this industry. For industries that are required to report, the best source of comparative pollutant release information is the Toxic Release Inventory (TRI). A component of 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 through 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 (1996) TRI reporting year (which includes over 600 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. TRI data provide the type, amount and media receptor of each chemical released or transferred.

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 1996 Toxic Release Inventory Public Data Release, reported onsite releases of toxic chemicals to the environment decreased by 5 percent (111.6 million pounds) between 1995 and 1996 (not including chemicals added and removed from the TRI chemical list during this period). Reported releases dropped by 48 percent between 1988 and 1996. Reported transfers of TRI chemicals to off-site locations increased by 5 percent (14.3 million pounds) between 1995 and 1996. 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 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

Certain limitations exist regarding TRI data. Within some sectors, (e.g. dry cleaning, printing and transportation equipment cleaning) 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. For these sectors, release information from other sources has been included.

Reported chemicals are limited to the approximately 600 TRI chemicals. A portion of the emissions from aerospace facilities, therefore, are not captured by TRI.

In addition, many facilities report more than one SIC code reflecting the multiple operations carried out on-site. Therefore, reported releases and transfers may or may not all be associated with the industrial operations described in this notebook.

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 or the potential exposure to surrounding populations. 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 the industry.

Definitions Associated With Section IV Data Tables

General Definitions

SIC Code -- is the Standard Industrial Classification (SIC) code, 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 on-site discharges 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, vents, ducts, or pipes. Fugitive emissions include equipment leaks, evaporative losses from surface impoundments and spills, and releases from building ventilation systems.

Releases to Water (Surface Water Discharges) -- encompass any releases going directly to streams, rivers, lakes, oceans, or other bodies of water. Releases due to runoff, including storm water runoff, are also reportable to TRI.

Releases to Land -- occur within the boundaries of the reporting facility. Releases to land include disposal of toxic chemicals in landfills, land treatment/application farming, surface impoundments, and other disposal on land (such as spills, leaks, or waste piles).

Underground Injection -- is a contained release of a fluid into a subsurface well for the purpose of waste disposal. Wastes containing TRI chemicals are injected into either Class I wells or Class V wells. Class I wells are used to inject liquid hazardous wastes or dispose of industrial and municipal wastewaters beneath the lowermost underground source of drinking water. Class V wells are generally used to inject non-hazardous fluid into or above an underground source of drinking water. TRI reporting does not currently distinguish between these two types of wells, although there are important differences in environmental impact between these two methods of injection.

Transfers -- are transfers of toxic chemicals in wastes to a facility that is geographically or physically separate from the facility reporting under TRI. Chemicals reported to TRI as transferred are sent to off-site facilities for the purpose of recycling, energy recovery, treatment, or disposal. The quantities reported represent a movement of the chemical away from the reporting facility. Except for off-site transfers for disposal, the reported quantities do not necessarily represent entry of the chemical into the environment.

Transfers to POTWs -- are wastewater transferred through pipes or sewers to a publicly owned treatments works (POTW). Treatment or removal of a chemical from the wastewater depends on the nature of the chemical, as well as the treatment methods present at the POTW. Not all TRI chemicals can be treated or removed by a POTW. Some chemicals, such as metals, may be removed but not destroyed and may be disposed of in landfills or discharged to receiving waters.

Transfers to Recycling -- are wastes sent off-site for the purposes of regenerating or recovery by a variety of recycling methods, including solvent recovery, metals recovery, and acid regeneration. 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 to be treated through a variety of methods, including 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 Aerospace Industry

This section summarizes TRI data of aerospace facilities reporting SIC codes within 372 and 376 as the primary SIC code for the facility.

According to the 1996 Toxics Release Inventory (TRI) data, 199 aerospace facilities released (to the air, water, or land) and transferred (shipped off-site or discharged to sewers) a total of approximately 27 million pounds of 65 different toxic chemicals during calendar year 1996. This represents approximately one half of one percent of the 5.6 billion pounds of releases and transfers from all manufacturers (SICs 20-39) reporting to TRI that year. Facilities released an average of 43,862 pounds per facility and transferred and average of 93,503 pounds per facility. The top four chemicals released by weight are solvents-- methyl ethyl ketone, 1,1,1-trichloroethane, trichloroethylene, and toluene. These four account for about 66 percent (5.8 million pounds) of the industry's total releases. Nickel, chromium, sulfuric acid, and methyl ethyl ketone were the four top chemicals transferred by weight. These four account for 55 percent (10.2 million pounds) of the total TRI chemicals transferred by the aerospace industry. Only 22 percent of the 65 chemicals reported to TRI as releases or transfers were reported by more than 10 facilities, evidence of the many different materials used by the industry and the variance between facilities on choice of these materials.

Releases

Table 8 presents the number and weights of chemicals released by aerospace facilities reporting SIC 372 and 376. The total quantity of releases was 8.7 million pounds or 32 percent of the total weight of chemicals released and transferred. The vast majority of air releases were solvents. Air emissions account for 98 percent of total releases, 44 percent as fugitive air emissions and 54 percent as point air releases. Methyl ethyl ketone was the top chemical released by the aerospace industry, accounting for 25 percent of total releases. Releases of 1,1,1-trichloroethane were the second greatest, representing 20 percent of the total. Twenty-four percent of fugitive air emissions were of 1,1,1-trichloroethane, and 32 percent of the point air releases were methyl ethyl ketone. Nitrate compounds accounted for 74 percent of water discharges.

Transfers

Table 9 presents the number and weights of chemicals transferred off-site by aerospace facilities reporting SIC 372 or 376 in 1996. The total amount of transfers was 18.6 million pounds or 68 percent of the total releases and transfers reported to the 1996 TRI by aerospace facilities. Transfers to recycling facilities accounted for the largest percentage, 70 percent, of transfers. The next greatest percentage was 17 percent to treatment facilities. The majority of transfers consisted of metals, spent acids, and solvents. Sixty-six percent (12.3 million pounds) of the total transfers were metals. Nickel represented the largest quantity of transfers, 5.3 million pounds or 29 percent of the total. Chromium composed the second largest quantity of transfers with 12 percent of the total. The chemical with the largest quantity of releases, methyl ethyl ketone, accounted for about 6 percent of the total transfers.

Table 8: 1996 TRI Releases for Aerospace Chemicals Facilities (SICs 372 or 376), By Number of Facilities Reporting (Releases Reported in Pounds/year)

Chemical Name	# Reporting Chemical	Fugitive Air	Point Air	Water Discharges	Underground Injection	Land Disposal	Total Releases	Avg. Releases Per Facility
Methyl Ethyl Ketone	67	704,499	1,484,499	505	0	0	2,189,503	32,679
Nitric Acid	58	7,530	57,219	165	0	0	64,914	1,119
Nickel	48	15,778	8,421	972	0	20,557	45,728	953
Chromium	39	12,829	2,813	1,322	0	3,343	20,307	521
1,1,1-trichloroethane	36	938,383	769,346	5	0	11,280	1,719,014	47,750
Trichloroethylene	29	671,880	268,358	11	0	2,640	942,889	32,513
Chromium Compounds	25	1,685	9,815	422	0	15,866	27,788	1,112
Toluene	23	129,305	776,295	260	0	4,128	909,988	39,565
Tetrachloroethylene	21	237,547	388,663	34	0	0	626,244	29,821
Dichloromethane	20	591,048	99,403	18	0	0	690,469	34,523
Cobalt	18	740	1,905	476	0	2,774	5,895	328
Hydrogen Fluoride	16	2,841	14,889	0	0	0	17,730	1,108
Ammonia	14	3,166	205,300	21,646	0	0	230,112	16,437
Copper	12	311	255	26	0	0	592	49
Nitrate Compounds	10	145	499	77,000	0	0	77,644	7,764
Xylene (Mixed Isomers)	10	15,356	211,057	55	0	0	226,468	22,647
Nickel Compounds	9	265	616	58	0	0	939	104
Phosphoric Acid	9	923	1,301	0	0	0	2,224	247
Methanol	8	13,247	32,566	0	0	0	45,813	5,727
Aluminum (Fume or Dust)	8	282	112	0	0	0	394	49
Sulfuric Acid (1994 and after "Acid Aerosols" Only)	8	16	331	0	0	0	347	43
Hydrochloric Acid (1995 and after "Acid Aerosols" Only)	7	190,257	54,062	0	0	0	244,319	34,903
Diisocyanates	6	390	230	0	0	0	620	103
Certain Glycol Ethers	6	11,170	10,785	0	0	0	21,955	3,659
Freon 113	6	114,487	34,782	0	0	0	149,269	24,878
Methyl Isobutyl Ketone	6	26,191	78,205	0	0	0	104,396	17,399
Phenol	6	118	2,997	0	0	0	3,115	519
Lead	6	0	200	4	0	0	204	34
Manganese	5	15	11	250	0	0	276	55
Copper Compounds	4	0	281	543	0	0	824	206
Cobalt Compounds	3	0	250	0	0	0	250	83
Cyanide Compounds	3	0	0	0	0	0	0	0
Lead Compounds	3	65	96	0	0	0	161	54
Benzene	3	16,997	119,768	0	0	0	136,765	45,588
Naphthalene	3	65,993	250	0	0	0	66,243	22,081
Aluminum Oxide (Fibrous Forms)	3	290	784	0	0	45,000	46,074	15,358
Chlorine	3	0	0	98	0	0	98	33
Manganese Compounds	2	15	45	0	0	0	60	30
Zinc Compounds	2	0	250	0	0	0	250	125
Methyl Methacrylate	2	2,951	1,400	0	0	0	4,351	2,176
Styrene	2	11,488	16,500	0	0	0	27,988	13,994
Antimony	2	0	0	0	0	0	0	0
Zinc (Fume or Dust)	2	5	5	18	0	0	28	14
Antimony Compounds	1	5	4	0	0	0	9	9
Barium Compounds	1	0	1	0	0	0	1	1
Polychlorinated Alkanes	1	0	0	0	0	0	0	0
Formaldehyde	1	0	0	0	0	0	0	0
Isopropyl Alcohol (Manufacturing, Strong-acid Process Only, No Supplies)	1	90	2,172	0	0	0	2,262	2,262
N,n-dimethylformamide	1	250	250	0	0	0	500	500
N-butyl Alcohol	1	0	15,233	0	0	0	15,233	15,233
Bromotrifluoromethane	1	1,641	0	0	0	0	1,641	1,641
Trichlorofluoromethane	1	3,500	430	0	0	0	3,930	3,930
Sec-butyl Alcohol	1	14,000	8,800	0	0	0	22,800	22,800
Picric Acid	1	0	0	0	0	0	0	0
Biphenyl	1	0	0	0	0	0	0	0
1,2-dichlorobenzene	1	0	1,400	0	0	0	1,400	1,400
Ethylbenzene	1	0	0	0	0	0	0	0
Ethylene Glycol	1	0	0	0	0	0	0	0
Cyclohexane	1	0	904	0	0	0	904	904
Methyl Tert-butyl Ether	1	1,200	0	0	0	0	1,200	1,200
1,1-dichloro-1-fluoroethane	1	22,000	0	0	0	0	22,000	22,000
Mercury	1	0	0	0	0	0	0	0
Silver	1	0	0	0	0	0	0	0
Sodium Nitrite	1	250	4,200	0	0	0	4,450	4,450
Aluminum Phosphide	1	0	0	0	0	0	0	0
	199**	3,831,144	4,687,958	103,888	0	105,588	8,728,578	43,862

**Total number of facilities (not chemical reports) reporting to TRI in this industry sector.

Table 9: 1996 TRI Transfers for Aerospace Chemicals Facilities (SICs 372 or 376), By Number of Facilities Reporting (Transfers Reported in Pounds/year)

Chemical Name	# Reporting Chemical	Potw Transfers	Disposal Transfers	Recycling Transfers	Treatment Transfers	Energy Recovery	Total Transfers	Avg Transfers Per Facility
Methyl Ethyl Ketone	67	10,350	2,368	85,457	98,407	905,400	1,101,982	16,447
Nitric Acid	58	50,018	13,963	122,824	741,790	0	928,595	16,010
Nickel	48	1,201	59,938	5,220,398	66,968	0	5,348,505	111,427
Chromium	39	906	23,073	2,130,107	46,840	423	2,201,349	56,445
1,1,1-trichloroethane	36	13	19,879	188,170	45,743	39,549	293,354	8,149
Trichloroethylene	29	10	215	154,717	55,071	5,542	215,555	7,433
Chromium Compounds	25	3,140	50,811	540,602	145,257	6,560	746,370	29,855
Toluene	23	25	5,244	13,660	18,302	153,115	190,346	8,276
Tetrachloroethylene	21	16	88	224,131	4,397	14,438	243,070	11,575
Dichloromethane	20	30	3,684	4,932	50,424	90,028	149,098	7,455
Cobalt	18	564	11,683	716,388	4,103	0	732,738	40,708
Hydrogen Fluoride	16	534	0	41,234	89,974	0	131,742	8,234
Ammonia	14	5	0	7,475	1,355	0	8,835	631
Copper	12	406	39,121	770,166	332	0	810,025	67,502
Nitrate Compounds	10	357,214	106,700	112	92,382	0	556,408	55,641
Xylene (Mixed Isomers)	10	0	160	7,420	27,148	26,723	61,451	6,145
Nickel Compounds	9	325	30,566	481,291	5,703	0	525,531	58,392
Phosphoric Acid	9	2,291	20,725	20,304	1,100	0	44,420	4,936
Methanol	8	0	2	24	295	25,192	25,513	3,189
Aluminum (Fume or Dust)	8	0	10,401	80,089	8,950	0	99,440	12,430
Sulfuric Acid (1994 and after "Acid Aerosols" Only)	8	250	55,261	0	1,490,000	0	1,545,511	193,189
Hydrochloric Acid (1995 and after "Acid Aerosols" Only)	7	250	77	0	250	0	577	82
Diisocyanates	6	0	0	51,000	15,050	0	66,050	11,008
Certain Glycol Ethers	6	23,200	505	2,505	925	15,113	42,248	7,041
Freon 113	6	0	0	2,224	5,900	690	8,814	1,469
Methyl Isobutyl Ketone	6	6	561	56	11,709	25,774	38,106	6,351
Phenol	6	15	939	0	16,859	16,487	34,300	5,717
Lead	6	250	2,543	942,255	3,550	5	948,603	158,101
Manganese	5	10	255	107,855	0	0	108,120	21,624
Copper Compounds	4	98	13,642	290,391	122	0	304,253	76,063
Cobalt Compounds	3	268	0	86,360	5	0	86,633	28,878
Cyanide Compounds	3	12	4,603	0	6,380	0	10,995	3,665
Lead Compounds	3	42	941	252,145	50,094	0	303,222	101,074
Benzene	3	0	0	0	0	0	0	0
Naphthalene	3	0	0	5	0	250	255	85
Aluminum Oxide (Fibrous Forms)	3	0	127,153	0	0	0	127,153	42,384
Chlorine	3	0	27	0	0	146	173	58
Manganese Compounds	2	0	3,600	170,481	6,550	0	180,631	90,316
Zinc Compounds	2	250	0	24,000	0	0	24,250	12,125
Methyl Methacrylate	2	0	0	16,000	0	0	16,000	8,000
Styrene	2	0	0	0	0	1,553	1,553	777
Antimony	2	0	5	135,000	1,958	0	136,963	68,482
Zinc (Fume or Dust)	2	251	90	14,000	0	0	14,341	7,171
Antimony Compounds	1	0	6,700	35,000	2	0	41,702	41,702
Barium Compounds	1	0	0	550	0	0	550	550
Polychlorinated Alkanes	1	0	0	0	23,495	15,079	38,574	38,574
Formaldehyde	1	0	0	0	0	0	0	0
Isopropyl Alcohol (Manufacturing, Strong-acid Process Only, No Supplies)	1	0	0	0	0	0	0	0
N,n-dimethylformamide	1	0	820	250	0	0	1,070	1,070
N-butyl Alcohol	1	0	209	0	460	5,025	5,694	5,694
Bromotrifluoromethane	1	0	0	0	0	0	0	0
Trichlorofluoromethane	1	0	0	8,300	0	0	8,300	8,300
Sec-butyl Alcohol	1	0	0	0	0	0	0	0
Picric Acid	1	0	0	0	0	0	0	0
Biphenyl	1	0	0	0	0	0	0	0
1,2-dichlorobenzene	1	0	0	0	9,200	0	9,200	9,200
Ethylbenzene	1	0	0	0	0	0	0	0
Ethylene Glycol	1	30,613	0	0	0	0	30,613	30,613
Cyclohexane	1	0	0	0	0	40,268	40,268	40,268
Methyl Tert-butyl Ether	1	0	0	0	0	0	0	0
1,1-dichloro-1-fluoroethane	1	0	0	0	460	0	460	460
Mercury	1	0	0	0	0	0	0	0
Silver	1	0	0	0	0	0	0	0
Sodium Nitrite	1	0	17,600	0	0	0	17,600	17,600
Aluminum Phosphide	1	0	0	0	0	0	0	0
	199**	482,563	634,152	12,947,878	3,147,510	1,387,360	18,607,109	93,503

**Total number of facilities (not chemical reports) reporting to TRI in this industry sector.

The TRI database contains a detailed compilation of self-reported, facility-specific chemical releases only and not transfers. The top reporting facilities for the aerospace industry are listed below in Tables 10 and 11. Facilities that have reported the primary SIC codes covered under this notebook appear on the first list. Table 11 contains additional facilities that have reported the SIC codes covered within this report, and one or more SIC codes that are not within the scope of this notebook. Therefore, the second list includes facilities that conduct multiple operations -- some that are under the scope of this notebook, and some that are not. However, only one additional facility appears on the second list, implying that the processes directly relating to the production of aerospace equipment is responsible for releases and transfers reported by aerospace facilities. Currently, the facility-level data do not allow pollutant releases to be broken apart by industrial process.

Table 10: Largest Quantity TRI Releasing Facilities Reporting Only 372 or 376 SIC Codes to TRI[1]

Rank	Facility	SIC Codes Reported in TRI	Total TRI Releases in Pounds
1	Boeing Commercial Airplane, Everett, WA	3721	784,581
2	Chem-fab Corp., Hot Springs, AR	3728	433,630
3	Raytheon Aircraft Co., Wichita, KS	3721	393,324
4	Douglas Aircraft Co.*, Long Beach, CA	3721	347,420
5	Pemco Aeroplex Inc., Birmingham, AL	3721	330,130
6	Thiokol Propulsion Group, Promontory,	3764	330,000
7	U.S. Air Force Plant 06 GA, Marietta, GA	3721	305,149
8	Cessna Aircraft, Wichita, KS	3721	266,709
9	Aerostructures Corp., Nashville, TN	3728, 3769	252,299
10	Menasco, Euless, TX	3728	240,000
	TOTAL		3,683,242

Source: *US EPA Toxics Release Inventory Database, 1996.*
*Douglas Aircraft Co. is now part of The Boeing Company.

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

Table 11: Largest Quantity TRI Releasing Facilities Reporting Aerospace SIC Codes to TRI[2]

Rank	Facility	SIC Codes Reported in TRI	Total TRI Releases in Pounds
1	Boeing Wichita, Wichita, KS	3728,3679,3721,3724	1,254,080
2	Boeing Commercial Airplane, Everett, WA	3721	784,581
3	Chem-fab Corp., Hot Springs, AR	3728	433,630
4	Raytheon Aircraft Co., Wichita, KS	3721	393,324
5	Douglas Aircraft Co., Long Beach, CA	3721	347,420
6	Pemco Aeroplex Inc., Birmingham, AL	3721	330,130
7	Thiokol Propulsion Group, Promontory,	3764	330,000
8	U.S. Air Force Plant 06 GA, Marietta, GA	3721	305,149
9	Cessna Aircraft, Wichita, KS	3721	266,709
10	Aerostructures Corp., Nashville, TN	3728, 3769	252,299
	TOTAL		4,697,322

Source: *US EPA Toxics Release Inventory Database, 1996.*
*Douglas Aircraft Co. is now part of The Boeing Company.

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

IV.B. Summary of 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 1995 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 reduction 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 these sources 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 Hazardous Substances Data Bank (HSDB) and the Integrated Risk Information System (IRIS). The discussions of toxicity describe the range of possible adverse health effects that have been found to be associated with exposure to these chemicals. These adverse effects may or may not occur at the levels released to the environment. Individuals interested in a more detailed picture of the chemical concentrations associated with these adverse effects should consult a toxicologist or the toxicity literature for the chemical to obtain more information. The effects listed below must be taken in context of these exposure assumptions that are explained more fully within the full chemical profiles in HSDB. For more information on TOXNET[3] , contact the TOXNET help line at 1-800-231-3766.

1,1,1-Trichloroethane (CAS: 71-55-6)

Sources. 1,1,1-Trichloroethane is used as an equipment and parts cleaning and degreasing solvent in aerospace manufacturing and is also used as a paint solvent.

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[3] TOXNET is a computer system run by the National Library of Medicine that includes a number of toxicological databases managed by EPA, National Cancer Institute, and the National Institute for Occupational Safety and Health. For more information on TOXNET, contact the TOXNET help line at 800-231-3766. Databases included in TOXNET are: CCRIS (Chemical Carcinogenesis Research Information System), DART (Developmental and Reproductive Toxicity Database), DBIR (Directory of Biotechnology Information Resources), EMICBACK (Environmental Mutagen Information Center Backfile), GENE-TOX (Genetic Toxicology), HSDB (Hazardous Substances Data Bank), IRIS (Integrated Risk Information System), RTECS (Registry of Toxic Effects of Chemical Substances), and TRI (Toxic Chemical Release Inventory). HSDB contains chemical-specific information on manufacturing and use, chemical and physical properties, safety and handling, toxicity and biomedical effects, pharmacology, environmental fate and exposure potential, exposure standards and regulations, monitoring and analysis methods, and additional references.

Toxicity. Repeated contact of 1,1,1-Trichloroethane (TCA) 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 TCA 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 TCA leads to light-headedness, throat irritation, headache, disequilibrium, impaired coordination, drowsiness, convulsion and mild changes in perception.

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

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

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

Physical Properties. TCA is a clear, colorless liquid with a mild, chloroform-like odor and slight solubility.

Methyl Ethyl Ketone (CAS: 78-93-3)

Sources. Methyl ethyl ketone (MEK) is used as an equipment and parts cleaning and degreasing solvent and as a paint solvent.

Toxicity. Breathing moderate amounts of methyl ethyl ketone 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. EPA does not consider methyl ethyl ketone to be a carcinogen.

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 clear, colorless, flammable liquid which decomposes explosively at 230°F. It has a fragrant mint-like odor detectable at 2 to 85 parts per million.

Trichloroethylene (CAS: 79-01-6)

Sources. Trichloroethylene is used extensively as an equipment and parts cleaning and degreasing solvent and as a paint solvent.

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-tern trichlorethylene 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 considered by EPA to be 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 land, trichloroethylene rapidly volatilizes from surface soils. Some of the remaining chemical may leach through the soil to groundwater.

Physical Properties. Trichloroethylene is a colorless liquid with a chloroform-like odor. It is a combustible liquid, but burns with difficulty, and it has a very low solubility.

Toluene (CAS: 108-88-3)

Sources. Toluene is used as an equipment and parts cleaning and degreasing solvent and as a paint solvent.

Toxicity. Inhalation or ingestion of toluene can cause headaches, confusion, weakness, and memory loss. Toluene may also effect 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, a volatile organic chemical (VOC), is a colorless liquid with a sweet, benzene-like odor. It is a Class IB flammable liquid.

IV.C. Other Data Sources

The toxic chemical release data obtained from TRI captures only about 237 of the facilities in the aerospace industry. However, it allows for a comparison across years and industry sectors. Reported chemicals are limited to the approximately 600 TRI chemicals. A significant portion of the emissions from aerospace facilities, therefore, are not captured by TRI. The EPA Office of Air Quality Planning and Standards has compiled air pollutant emission factors for determining the total air emissions of priority pollutants (e.g., total hydrocarbons, SOx, NOx, CO, particulates, etc.) from many manufacturing 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. Table 12 summarizes annual releases (from the industries for which a Sector Notebook Profile was prepared) 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).

Table 12: Air Pollutant Releases by Industry Sector (tons/year)

Industry Sector	CO	NO_2	PM10	PT	SO_2	VOC
Metal Mining	4,951	49,252	21,732	9,478	1,202	119,761
Oil and Gas Extraction	132,747	389,686	4,576	3,441	238,872	114,601
Non-Fuel, Non-Metal Mining	31,008	21,660	44,305	16,433	9,183	138,684
Textiles	8,164	33,053	1,819	38,505	26,326	7,113
Lumber and Wood Products	139,175	45,533	30,818	18,461	95,228	74,028
Wood Furniture and Fixtures	3,659	3,267	2,950	3,042	84,036	5,895
Pulp and Paper	584,817	365,901	37,869	535,712	177,937	107,676
Printing	8,847	3,629	539	1,772	88,788	1,291
Inorganic Chemicals	242,834	93,763	6,984	150,971	52,973	34,885
Plastic Resins and Man-made Fibers	15,022	36,424	2,027	65,875	71,416	7,580
Pharmaceuticals	6,389	17,091	1,623	24,506	31,645	4,733
Organic Chemicals	112,999	177,094	13,245	129,144	162,488	17,765
Agricultural Chemicals	12,906	38,102	4,733	14,426	62,848	8,312
Petroleum Refining	299,546	334,795	25,271	592,117	292,167	36,421
Rubber and Plastic	2,463	10,977	3,391	24,366	110,739	6,302
Stone, Clay, Glass and Concrete	92,463	335,290	58,398	290,017	21,092	198,404
Iron and Steel	982,410	158,020	36,973	241,436	67,682	85,608
Metal Castings	115,269	10,435	14,667	4,881	17,301	21,554
Nonferrous Metals	311,733	31,121	12,545	303,599	7,882	23,811
Fabricated Metal Products	7,135	11,729	2,811	17,535	108,228	5,043
Electronics and Computers	27,702	7,223	1,230	8,568	46,444	3,464
Motor Vehicle Assembly	19,700	31,127	3,900	29,766	125,755	6,212
Aerospace	**4,261**	**5,705**	**890**	**757**	**3,705**	**10,804**
Shipbuilding and Repair	109	866	762	2,862	4,345	707
Ground Transportation	153,631	594,672	2,338	9,555	101,775	5,542
Water Transportation	179	476	676	712	3,514	3,775
Air Transportation	1,244	960	133	147	1,815	144
Fossil Fuel Electric Power	399,585	5,661,468	221,787	13,477,367	42,726	719,644
Dry Cleaning	145	781	10	725	7,920	40

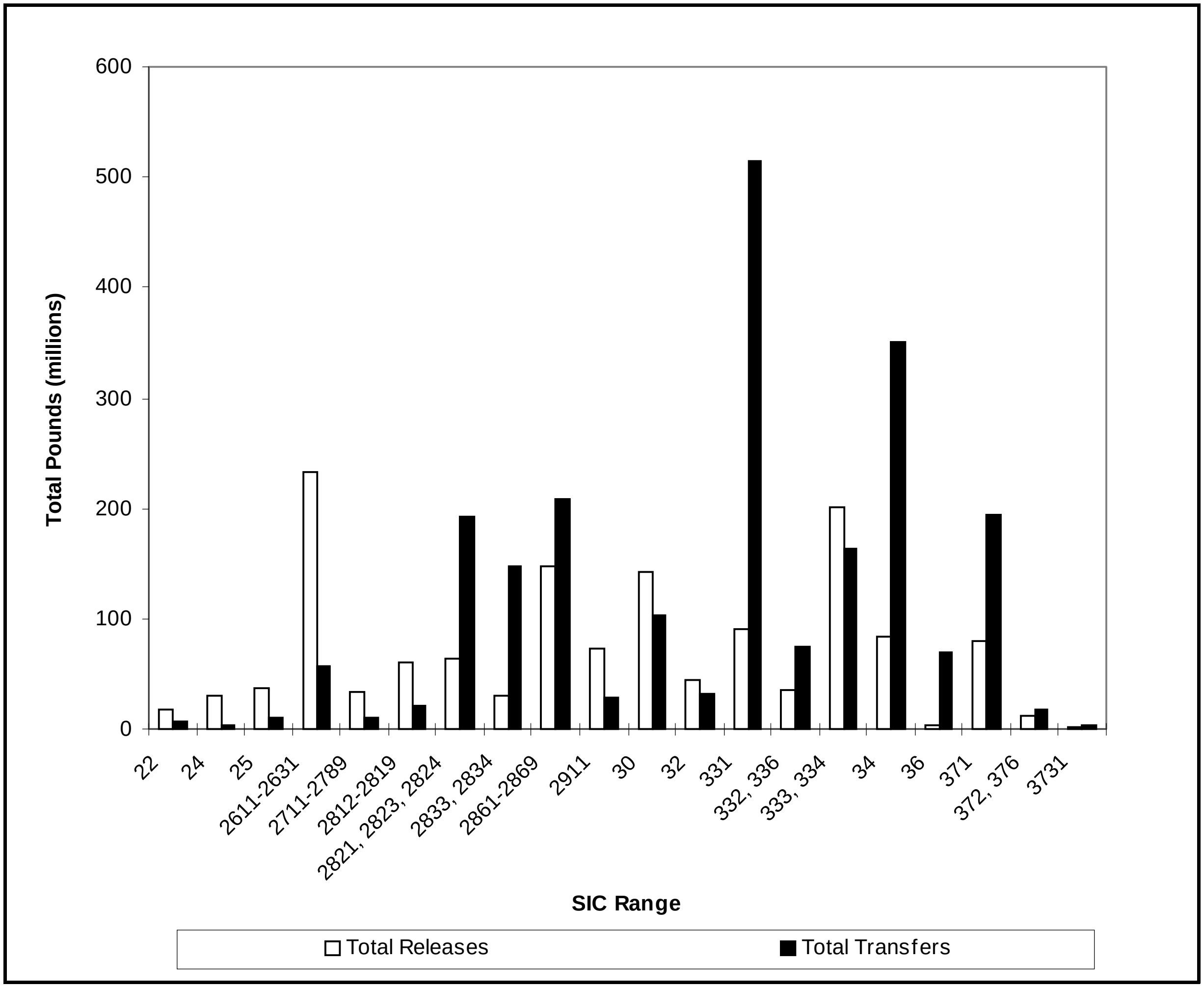
Source: U.S. EPA Office of Air and Radiation, AIRS Database, 1997.

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 TRI releases and transfers within each sector profiled under this project. Please note that the following figures and tables do 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.

Figure 7 is a graphical representation of a summary of the TRI data for the aerospace industry and the other sectors profiled in separate notebooks. The bar graph presents the total TRI releases and total transfers on the vertical axis. Industry sectors are presented in the order of increasing SIC code. The graph is based on the data shown in Table 13 and is meant to facilitate comparisons between the relative amounts of releases and transfers both within and between these sectors. Table 13 also presents the average releases per facility in each industry. The reader should note 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 the aerospace industry, the 1995 TRI data presented here covers 237 facilities. These facilities listed SIC 3721, 3724, 3728, 3761, 3764, or 3769 (aerospace industry) as a primary SIC code(s).

Figure 7: Summary of TRI Releases and Transfers by Industry



Source: US EPA 1995 Toxics Release Inventory Database.

Key to Standard Industrial Classification Codes

SIC Range	Industry Sector	SIC Range	Industry Sector	SIC Range	Industry Sector
22	Textiles	2833, 2834	Pharmaceuticals	333, 334	Nonferrous Metals
24	Lumber and Wood Products	2861-2869	Organic Chem. Mfg.	34	Fabricated Metals
25	Furniture and Fixtures	2911	Petroleum Refining	36	Electronic Equip. and Comp.
2611-2631	Pulp and Paper	30	Rubber and Misc. Plastics	371	Motor Vehicles, Bodies, Parts, and Accessories
2711-2789	Printing	32	Stone, Clay, and Concrete	372, 376	Aerospace
2812-2819	Inorganic Chemical Manufacturing	331	Iron and Steel	3731	Shipbuilding and Repair
2821, 2823, 2824	Resins and Plastics	332, 336	Metal Casting		

Table 13: 1995 Toxics Release Inventory Data for Selected Industries

Industry Sector	SIC Range	# TRI Facilities	TRI Releases		TRI Transfers		Total Releases + Transfers (million lbs.)	Average Releases + Transfers per Facility (lbs.)
			Total Releases (million lbs.)	Average Releases per Facility (lbs.)	Total Transfers (million lbs.)	Average Transfers per Facility (lbs.)		
Textiles	22	339	17.8	53,000	7.0	21,000	24.8	74,000
Lumber and Wood Products	24	397	30.0	76,000	4.1	10,000	34.1	86,000
Furniture and Fixtures	25	336	37.6	112,000	9.9	29,000	47.5	141,000
Pulp and Paper	2611-2631	305	232.6	763,000	56.5	185,000	289.1	948,000
Printing	2711-2789	262	33.9	129,000	10.4	40,000	44.3	169,000
Inorganic Chem. Mfg.	2812-2819	413	60.7	468,000	21.7	191,000	438.5	659,000
Resins and Plastics	2821,2823, 2824	410	64.1	156,000	192.4	469,000	256.5	625,000
Pharmaceuticals	2833, 2834	200	29.9	150,000	147.2	736,000	177.1	886,000
Organic Chemical Mfg.	2861-2869	402	148.3	598,000	208.6	631,000	946.8	1,229,000
Agricultural Chemicals	287	236	77.1	327,000	11.4	48,000	88.5	375,000
Petroleum Refining	2911	180	73.8	410,000	29.2	162,000	103.0	572,000
Rubber and Misc. Plastics	30	1,947	143.1	73,000	102.6	53,000	245.7	126,000
Stone, Clay, and Concrete	32	623	43.9	70,000	31.8	51,000	75.7	121,000
Iron and Steel	331	423	90.7	214,000	513.9	1,215,000	604.6	1,429,000
Metal Casting	332, 336	654	36.0	55,000	73.9	113,000	109.9	168,000
Nonferrous Metals	333, 334	282	201.7	715,000	164	582,000	365.7	1,297,000
Fabricated Metals	34	2,676	83.5	31,000	350.5	131,000	434.0	162,000
Electronic Equip. and Comp.	36	407	4.3	11,000	68.8	169,000	73.1	180,000
Motor Vehicles, Bodies, Parts, and Accessories	371	754	79.3	105,000	194	257,000	273.3	362,000
Aerospace	**372, 376**	**237**	**12.5**	**53,000**	**17.1**	**72,000**	**29.6**	**125,000**
Shipbuilding	3731	43	2.4	56,000	4.1	95,000	6.5	151,000

Source: *US EPA Toxics Release Inventory Database, 1995.*

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.

The Pollution Prevention Act of 1990 established a national policy of managing waste through source reduction, which means preventing the generation of waste. The Pollution Prevention Act also established as national policy a hierarchy of waste management options for situations in which source reduction cannot be implemented feasibly. In the waste management hierarchy, if source reduction is not feasible the next alternative is recycling of wastes, followed by energy recovery, and waste treatment as a last alternative.

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 aerospace 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. 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 technique can be used effectively. 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.

Pollution Prevention Techniques

This section lists many pollution prevention techniques geared toward the aerospace industry and its related processes. Some techniques may be applicable to a number of different processes such as materials substitution of low-solvent and less hazardous materials exist, while others are specific to a single phase of aerospace manufacturing. Many of the techniques discussed below were obtained from the *Profile of the Shipbuilding and Repair Industry*, EPA, 1997. It is important to note that the FAA places very strict "airworthiness" guidelines on manufacturing and rework facilities for safety and quality control purposes, thus new pollution prevention alternatives may require a full evaluation and permitting process before they may be used.

Because military facilities are not subject to FAA guidelines, they have a greater opportunity to implement P2 alternatives. As a result, studies have been conducted at various Air Force, Coast Guard, and Naval facilities which are referenced in Section IX. Excellent information on military facility P2 activities can be found at web sites of the Air Force Center for Environmental Excellence (http://www.afcee.brooks.af.mil), and at the Navy's P2 Library web site (http://enviro.nfesc.navy.mil/p2library).

V.A. Machining and Metalworking

Coolant, or metalworking, fluids account for the largest waste stream generated by machining operations. Waste metalworking fluids are created when the fluids are no longer usable due to contamination by oils or chemical additives. If the contamination rate of the metalworking fluids is reduced, the need to replace them will be less frequent. This will reduce the waste generated.

Preventing Fluid Contamination

Fluid can become hazardous waste if it is contaminated. Although it is not possible to eliminate contamination, it is possible to reduce the rate of contamination and thereby prolong its use.

The primary contaminant in these waste fluids is tramp oil. One way to postpone contamination is to promote better maintenance of the wipers and seals. A preventative maintenance program should be installed and enforced in the machine shop. Scheduled sump and machine cleaning as well as periodic inspections of the wipers and oil seals should be carried out. The responsibility for this should be assigned to some person or group in a position of authority to ensure its success.

Synthetic Fluids

Synthetic fluids have many advantages over their non-synthetic counterparts. Usually the synthetic varieties do not lubricate as effectively, but they are less susceptible to contamination and highly resistant to biological breakdown. Most synthetic fluids have superior longevity and can operate over a large temperature range without adverse side effects. Straight oils should be replaced with synthetic ones when possible.

Recycling Fluids

Once all of the source reduction options have been considered, it is time to explore the possibilities of reuse. It should be noted that in many cases, after the majority of the contaminants have been removed, further treatment with chemicals or concentrated fluid is necessary before the fluids can be recirculated through the machines.

Filtration Filtration is a common way to remove particles from the fluid as well as tramp oils or other contaminants. Many different types of filters can be used depending on the medium to be filtered and the amount of filtration desired. Contaminated cutting fluids can be passed through a bag, disc, or cartridge filter or separated in a centrifuge.

Skimming and Flotation Although it is a slow process, skimming of contaminants is inexpensive and can be very effective. The principle is to let the fluid sit motionless in a sump or a tank, and after a predetermined amount of time, the unwanted oils are skimmed off the surface and the heavier particulate matter is collected off the bottom. A similar technique, flotation, injects high pressure air into contaminated cutting fluid. As the air comes out of solution and bubbles to the surface, it attaches itself to suspended contaminants and carries them up to the surface. The resulting sludge is skimmed off the surface and the clean fluid is reused.

Centrifugation Centrifugation uses the same settling principles as flotation, but the effects of gravity are multiplied thousands of times due to the spinning action of the centrifuge. This will increase the volume of fluids which can be cleaned in a given amount of time.

Pasteurization Pasteurization uses heat treatment to kill microorganisms in the fluid and reduce the rate at which rancidity (biological breakdown) will occur. Unfortunately, heat can alter the properties of the fluid and render it less effective. Properties lost in this way are usually impossible to recover.

Downgrading Sometimes it is possible to use high quality hydraulic oils as cutting fluids. After the oils have reached their normal usable life, they no longer meet the high standards necessary for hydraulic components. At this time they are still good enough to be used for the less demanding jobs. It may be necessary to treat the fluid before it can be reused, but changing fluid's functions in this manner has proven successful in the past.

V.B. Surface Preparation

The majority of wastes generated during surface preparation are spent abrasives and solvents mixed with paint chips. One way the volume of waste generated can be reduced is by using blast media that is relatively easy to reuse.

Improving Recyclability of Abrasive Blasting Media

Often, air powered cleaning equipment is used to screen abrasive to separate it from large paint particles. These systems may also remove lighter dust from the heavy abrasive. This media separation can be especially important when the paint being removed contains heavy metals. An alternative to on-site reclamation is to send it for processing off-site. It is very important that waste streams, especially hazardous waste, are not mixed with used blasting media. Outside debris and other waste could render the media unfit for reuse.

Plastic Media Blasting

As a substitute for other blast media, the military has experimented extensively with plastic media stripping. This process is particularly good for stripping coatings from parts with fragile substrates often found in the aerospace industry such as zinc, aluminum, and fiberglass. It can be a lengthy process because it strips paint layer by layer. The same types and quantities of waste are generated as with grit blasting, but the plastic medium is more recyclable with the use of pneumatic media classifiers that are part of the stripping equipment. The only waste requiring disposal is the paint waste itself. However, the use of plastic media is fairly limited. Plastic blasting media do not work well on epoxy paints. In addition, the blasting equipment is expensive and requires trained operators.

Water Jet Stripping (Hydroblasting)

Hydroblasting is a cavitating high pressure water jet stripping system that can remove most paints. These system may use pressures as high as 50,000 psig. Hydroblasting is an excellent method for removing even hard coatings from metal substrates. Some systems automatically remove the paint chips or stripped material from the water and reuse the water for further blasting. By recirculating the water in this manner, the amount of waste is greatly reduced. Wastewater from this process is usually suitable for sewer disposal after the paint particles are removed. Although this process produces very little waste, it is not always as efficient as other blasting methods, has relatively high capital and maintenance costs, and may not be adequate for fragile substrates.

V.C. Solvent Cleaning and Degreasing

Aerospace manufacturers often use large quantities of solvents in a variety of cleaning and degreasing operations including parts cleaning, process equipment cleaning, and surface preparation for coating applications. The final cost of solvent used for various cleanup operations is nearly twice the original purchase price of the virgin solvent. The additional cost is primarily due to the fact that for each drum purchased, extra disposal cost, hazardous materials transportation cost, and manifesting time and expense are incurred. With the rising cost of solvents and waste disposal services, combined with continuously developing regulation, reducing the quantities of solvents used and solvent wastes generated can be extremely cost effective.

Eliminating the Use of Solvents

Eliminating the use of solvents avoids any waste generation associated with spent solvent. Elimination can be achieved by utilization of non-solvent cleaning agents or eliminating the need for cleaning altogether. Solvent elimination applications include the use of water-soluble cutting fluids, protective peel coatings, aqueous cleaners, and mechanical cleaning systems (USEPA/OECA, 1997).

Water-soluble Cutting Fluids Water-soluble cutting fluids can often be used in place of oil-based fluids. The cutting oils usually consist of an oil-in-water emulsion used to reduce friction and dissipate heat. If these fluids need to be removed after the machining process is complete, solvents may be needed.

In efforts to eliminate solvent degreasing and its subsequent waste, special water-soluble cutting fluids have been developed. Systems are available that can clean the cutting fluid and recycle the material back to the cutting operation. Obstacles to implementing this method are: cost (water-soluble fluids are generally more expensive), procurement (there are only a few suppliers available), and the inability to quickly switch between fluid types without thoroughly cleaning the equipment (USEPA/OECA, 1997).

Aqueous Cleaners Aqueous cleaners, such as alkali, citric, and caustic base, are often useful substitutes for solvents. There are many formulations that are suited for a variety of cleaning requirements. Many aqueous cleaners have been found to be as effective as the halogenated solvents that are commonly employed.

Aqueous stripping agents, such as caustic soda (NaOH), are often employed in place of methylene chloride based strippers. Caustic solutions have the advantage of eliminating solvent vapor emissions. A typical caustic bath consists of about 40 percent caustic solution heated to about 200 degrees Fahrenheit. Caustic stripping is generally effective on alkyl resins and oil paints (EPA, March 1997).

The Douglas Aircraft Division of McDonnell Douglas used a chromic acid solution to clean aluminum parts. However, the solution began to corrode the steel cleaning equipment parts. A scientist at McDonnell Douglas developed a sodium hydroxide-based process which cleaned parts sufficiently to detect cracks in the aluminum parts during testing. The new process saves an estimated $28,000 per year in chemical costs (Boeing, 1998).

In 1990, the Martin Marietta Astronautics Group (now Lockheed Martin) eliminated the use of 1,1,1-trichloroethane (TCA) and methyl ethyl ketone (MEK) for vapor degreasing. Six alternative aqueous cleaners were subjected to a screening process that evaluated health hazards, treatability of wastewater, corrosion potential, degreasing performance, and salt fog corrosion resistance. From this study, Lockheed Martin selected a nontoxic aqueous terpene cleaner. The substitution of this cleaner saves hundreds of thousands of dollars every year in material cost savings and ozone depletion taxes (Dykema, 1993).

Lockheed Martin Tactical Aircraft Systems in Fort Worth, Texas, has substituted low vapor pressure solvent and aqueous cleaning for CFC-113 in all aspects of aircraft manufacturing. The low vapor pressure solvent is a blend of propylene glycol methyl ether acetate, isoparaffins, and butyl acetate. The solvent is effective on a variety of organic soils and is used for wiping the surfaces of aircraft components and assemblies. The substitution of this cleaner completely eliminated CFC emissions and reduced solvent use, solvent cost, VOC emissions, and total air emissions (Evanoff, 1993).

The advantages of substituting aqueous cleaners include minimizing worker's exposure to solvent vapors, reducing liability and disposal problems associated with solvent use, and cost. Aqueous cleaners do not volatilize as quickly as other solvents, thereby reducing losses due to evaporation. Since most aqueous cleaners are biodegradable, disposal is not a problem once the organic or inorganic contaminants are removed (USEPA, March 1997).

The use of aqueous cleaners can also result in cost savings. Although some aqueous cleaners may cost less than an equivalent amount of solvent, the purchase price of each is about the same. The cost of disposal, loss due to evaporation, and associated liabilities, however, favor aqueous cleaners.

The disadvantages of aqueous cleaners in place of solvents may include: possible incompatibilities with FAA guidelines, possible inability of the aqueous cleaners to provide the degree of cleaning required, incompatibility between the parts being cleaned and the cleaning solution, need to modify or replace existing equipment, longer required cleaning time, and problems associated with moisture left on parts being cleaned. Oils removed from the parts during cleaning may float on the surface of the cleaning solution and may interfere with subsequent cleaning. Oil skimming is usually required (USEPA/OECA, 1997).

<u>Mechanical Cleaning Systems</u> Utilizing mechanical cleaning systems can also replace solvents in degreasing and cleaning operations. In many cases, a high pressure steam gun or high pressure parts washer can clean parts and surfaces quicker and to the same degree of cleanliness as that of the solvents they replace. Light detergents can be added to the water supply for improved

cleaning. The waste produced by these systems is usually oily wastewater. This wastewater can be sent through an oil/water separator, the removed water discharged to the sewer, and the oil residue sent to a petroleum recycler. Some hot water wash and steam systems can be supplemented by emulsifying solutions to speed the process. Although these additives speed the cleaning process, they can make separation of the oil from the water very difficult and create problems with disposal of the waste.

Cryogenic stripping utilizes liquid nitrogen and non-abrasive plastic beads as blasting shot. This method relies on the freezing effect of the liquid nitrogen and the impact of the plastic shot. Subjecting the surface to extremely low temperatures creates stress between the coating and the substrate causing the coating to become brittle. When the plastic shot hits the brittle coating, debonding occurs. The process is non-abrasive, and will not damage the substrate, but effects of the metal shrinkage, due to extremely low temperatures, should be monitored. The process does not produce liquid wastes, and nitrogen, chemically inert, is already present in the atmosphere (USEPA/OECA, 1997).

Thermal stripping methods can be useful for objects that cannot be immersed. In this process, superheated air is directed against the surface of the object. The high temperatures cause some paints to flake off. The removal results from the drying effects of the air and the uneven expansion of the paint and the substrate. Some paints will melt at high temperatures, allowing the paint to be scraped off manually or with abrasives. Hand-held units are available that produce a jet of hot air. Electric units and open flame or torch units are also used. While this system is easy to implement, it is limited to items that are not heat sensitive and to coatings that are affected by the heat (USEPA/OECA, 1997).

McDonnell Douglas has developed two thermal stripping techniques. The first one, known as FLASHJET™, uses a high-intensity xenon lamp to heat the surface paint and disintegrate it. A stream of dry ice pellets follows to carry away the paint chips. FLASHJET™ was developed for use and tested on helicopters at the McDonnell Douglas Helicopter Systems plant in Mesa, Arizona. FLASHJET™ reduced the manual work required by 10 to 15 percent (Boeing, 1998).

The second technique was adapted from a technique to remove hydrocarbons from engines. The Hot Gaseous Nitrogen (GN2) Purge heats the critical engine surfaces, driving off the volatile hydrocarbons, which then leave the engine through the flow of nitrogen. This method eliminates the use of 1,1,1-trichloroethane for this type of engine cleaning (Boeing, 1998).

Hughes Aircraft Company developed a supercritical carbon dioxide ($SCCO_2$) cleaning system to be used in many cleaning applications in the aerospace industry. At temperatures and pressures close to or above its critical point (88°F and 1,073 psia), CO_2 acts as an ideal solvent. It is also inexpensive and inert, non-combustible, naturally occurring, and does not contribute to smog. Efficient removal of oils, greases, fingerprints, solder flux residues have been achieved by the SUPERSCRUB™ unit at Hughes (Chao).

Reducing the Use of Solvent

By eliminating the use or need for solvent cleaning, the problems associated with disposal of spent solvent are also eliminated. In cases where the elimination of solvent use is not possible or practical, utilization of various solvent waste reduction techniques can lead to a substantial savings in solvent waste.

Methods of reducing solvent usage can be divided into three categories: source control of air emissions, efficient use of solvent and equipment, and maintaining solvent quality. Source control of air emissions addresses ways in which more of the solvent can be kept inside a container or cleaning tank by reducing the chances for evaporation loss. Efficient use of solvent and equipment through better operating procedures can reduce the amount of solvent required for cleaning. Maintaining the quality of solvent will extend the life cycle effectiveness of the solvent.

<u>Source Control of Air Emissions</u> Source control of air emissions can be achieved through equipment modification and proper operation of equipment. Some simple control measures include installation and use of lids, an increase of freeboard height of cleaning tanks, installation of freeboard chillers, and taking steps to reduce solvent drag-out.

All cleaning units, including cold cleaning tanks and dip tanks, should have some type of lid installed. When viewed from the standpoint of reducing air emissions, the roll-type cover is preferable to the hinge type. Lids that swing down can cause a piston effect and force the escape of solvent vapor. In operations such as vapor degreasing, use of lids can reduce solvent loss from 24 percent to 50 percent. For tanks that are continuously in use, covers have been designed that allow the work pieces to enter and leave the tank while the lid remains closed.

In an open top vapor degreaser, freeboard is defined as the distance from the top of the vapor zone to the top of the tank. Increasing the freeboard will substantially reduce the amount of solvent loss. A freeboard chiller may also be installed above the primary condenser coil. This refrigerated coil, much like the cooling jacket, chills the air above the vapor zone and creates a secondary barrier to vapor loss. Reduction in solvent usage, by use of freeboard chillers, can be as high as 60 percent. The major drawback with a freeboard chiller is that it can introduce water (due to condensation from air) into the tank.

In addition to measures that reduce air emissions through equipment modification, it is also possible to reduce emissions through proper equipment layout, operation, and maintenance. Cleaning tanks should be located in areas where air turbulence and temperature do not promote vapor loss.

Maximize the Dedication of the Process Equipment In addition to reduction in vapor loss, reducing the amount of solvent used can be achieved through better operating practices that increase the efficiency of solvent cleaning operations. Maximizing the dedication of the process equipment reduces the need for frequent cleaning. By using a mix tank consistently for the same formulation, the need to clean equipment between batches is eliminated.

Avoid Unnecessary Cleaning Avoiding unnecessary cleaning also offers potential for waste reduction. For example, paint mixing tanks for two-part paints are often cleaned between batches of the same product. The effect of cross-contamination between batches should be examined from a product quality control viewpoint to see if the cleaning step is always necessary.

Proper Production Scheduling Proper production scheduling can reduce cleaning frequency by eliminating the need for cleaning between the conclusion of one task and the start of the next. A simple example of this procedure is to have a small overlap between shifts that perform the same operation with the same equipment. This allows the equipment that would normally be cleaned and put away at the end of each shift, such as painting equipment, to be taken over directly by the relief.

Clean Equipment Immediately Cleaning equipment immediately after use prevents deposits from hardening and avoids the need for consuming extra solvent. Letting dirty equipment accumulate and be cleaned later can also increase the time required for cleaning.

Better Operating Procedures Better operating procedures can minimize equipment clean-up waste. Some of the methods already discussed are examples of better operating procedures. Better operator training, education, closer supervision, improved equipment maintenance, and increasing the use of automation are very effective in waste minimization.

Reuse Solvent Waste Reuse of solvent waste can reduce or eliminate waste and result in a cost savings associated with a decrease in raw material consumption. The solvent from cleaning operations can be reused in other cleaning processes in which the degree of cleanliness required is much less. This will be discussed in more detail in the next section.

Solvent Recycling

Although not as preferable as source reduction, solvent recycling may be a viable alternative for some facilities. The goal of recycling is to recover from the waste solvent, a solvent of a similar purity to that of the virgin solvent for eventual reuse in the same operation, or of a sufficient purity to be used in another application. Recycling can also include the direct use of solvent waste from one waste stream in another operation. There are a number of techniques that facilities can use onsite to separate solvents from contaminants including distillation, evaporation, sedimentation, decanting, centrifugation, filtering, and membrane separation.

V.D. Metal Plating and Surface Finishing

Pollution prevention opportunities in metal plating and surface finishing operations are discussed in the *Profile of the Fabricated Metal Products Industry Sector Notebook*. Readers are encouraged to consult this document for pollution prevention information relating to metal plating and surface finishing. An additional resource for pollution prevention information regarding metal finishing can be found at the National Metal Finishing Resource Center (http://www.nmfrc.org).

V.E. Painting and Coating

Painting and coating operations are typically the largest single source of VOC emissions from aerospace manufacturing and rework facilities. In addition, paint waste can account for more than half of the total hazardous waste generated. Paint waste may include leftover paint in containers, overspray, paint that is no longer usable (Non-spec paint), and rags and other materials contaminated with paint. In many cases, the amount of paint waste generated can be reduced through the use of improved equipment, alternative coatings, and good operating practices. An additional resource for pollution prevention information regarding painting and coating can be found at the Paint and Coatings Resource Center (http://www.paintcenter.org).

Application Equipment

In order to effectively reduce paint waste and produce a quality coating, proper application techniques should be supplemented with efficient application equipment. Through the use of equipment with high transfer efficiencies, the amount of paint lost to overspray is minimized.

High Volume Low Pressure (HVLP) Spray Guns The HVLP spray gun is basically a conventional air spray gun with modifications and special nozzles that atomize the paint at very low air pressures. The atomizing pressure of HVLP systems is often below 10 psi. The design of this gun allows better transfer efficiency and reduced overspray than that of conventional air guns. The low application pressure decreases excessive bounceback and allows better adhesion of the coating to the substrate.

Although improvements are consistently being made to overcome its limitations, most HVLP systems have some definite drawbacks, including difficulty atomizing viscous coatings, sensitivity to variations in incoming pressure, sensitivity to wind, and slow application rates.

Airless Spray Guns Instead of air passing through the spray gun, an airless system applies static pressure to the liquid paint. As the paint passes through the nozzle, the sudden drop in pressure atomizes the paint and it is carried to the substrate by its own momentum. Pressure is applied to the paint by a pump located at a remote supply. These systems have become favorable over conventional air-spray systems for three main reasons:

1) reduced overspray and rebound,
2) high application rates and transfer efficiency,
3) permits the use of high-build coatings with the result that fewer coats are required to achieve specific film thickness.

One major disadvantage of some airless spray systems is the difficulty applying very thin coats. If coatings with less than a millimeter in thickness are required, such as primers applied to objects that require weldability, it may be difficult to use an airless system.

Electrostatic Spray Electrostatic spray systems utilize paint droplets that are given a negative charge in the vicinity of a positively charged substrate. The droplets are attracted to the substrate and a uniform coating is formed. This system works well on cylindrical and rounded objects due to its "wrap-around" effect that nearly allows the object to be coated from one side. Very little paint is lost to overspray, and it has been noted to have a transfer efficiency of over 95%.

In order for an electrostatic system to operate properly, the correct solvent balance is needed. The evaporation rate must be slow enough for the charged droplets to reach the substrate in a fluid condition to flow out into a smooth film, but fast enough to avoid sagging. The resistivity of the paint must also be low enough to enable the paint droplets to acquire the maximum charge.

Although the operating costs of electrostatic spray systems are relatively low, the initial capital investment can be high. This system has been found to work extremely well in small parts painting applications. Sometimes the installation of an electrostatic powder coating system can replace a water curtain spray paint booth.

Heated Spray When paint is heated, its viscosity is reduced allowing it to be applied with a higher solids content, thus requiring less solvent. When the paint is heated in a special container and supplied to the gun at 140° to 160°F, coatings of 2 to 4 millimeters dry-film thickness can be applied in one operation, resulting in considerable savings in labor cost. In addition, much of the associated solvent emissions are eliminated.

Heating the coating prior to application can be used with both conventional and airless spray applications. An in-line heater is used to heat the coating before it reaches the gun. As the coating is propelled through the air, it cools rapidly and increases viscosity after it hits the surface, allowing for better adhesion to the substrate.

Plural Component Systems A common problem that facilities face when working with two-part coatings is overmixing. Once the component parts of a catalyst coating are mixed, the coating must be applied. Otherwise, the excess unused coating will cure and require disposal. Additionally, the coating equipment must be cleaned immediately after use.

One large advantage of plural component technology is the elimination of paint waste generated by mixing an excess amount of a two part coating. This is achieved through the use of a special mixing chamber that mixes the pigment and catalyst seconds before the coating is applied. Each component is pumped through a device that controls the mixing ratio and then is combined in a mixing chamber. From the mixing chamber, the mixed coating travels directly to the spray guns. The only cleaning that is required is the mixing chamber, gun, and the length of supply hose connecting them.

Wet Booth Generally, small-volume painting operations will find the lower purchase cost of a dry filter booth will meet their requirements. One disadvantage in the use of a dry-filter booth is in the disposal of the waste. Typically the majority of this waste is the filter media itself which has been contaminated by a relatively small amount of paint. Reusable filters may decrease waste volume and reduce disposal cost. In some applications, overspray can be collected for reuse.

If overall painting volume can justify the investment, a wet booth eliminates disposal of filter media and allows waste to be reduced in weight and volume. This is achieved by separating the paint from the water through settling, drying, or using a centrifuge or cyclone (Ohio EPA, 1994).

Recycle Paint Booth Water Various methods and equipment are used to reduce or eliminate the discharge of the water used in water-wash booths (water curtain). These methods and equipment prevent the continuous discharge of booth waters by conditioning (i.e., adding detacifiers and paint-dispersing polymers) and removing paint solids. The most basic form of water maintenance is the removal of paint solids by manual skimming and/or raking. This can be performed without water conditioning since some portion of solvent-based paints usually float and/or sink. With the use of detacifiers and paint-dispersing polymer treatments, more advanced methods of solids removal can be implemented. Some common methods are discussed below.

Wet-Vacuum Filtration Wet-vacuum filtration units consist of an industrial wet-vacuum head on a steel drum containing a filter bag. The unit is used to vacuum paint sludge from the booth. The solids are filtered by the bag and the water is returned to the booth. Large vacuum units are also commercially available that can be moved from booth to booth by forklift or permanently installed near a large booth.

Tank-Side Weir A weir can be attached to the side of a side-draft booth tank, allowing floating material to overflow from the booth and be pumped to a filtering tank for dewatering.

Consolidator A consolidator is a separate tank into which booth water is pumped. The water is then conditioned by the introduction of chemicals. Detacified paint floats to the surface of the tank, where it is skimmed by a continuously moving blade. The clean water is recycled to the booth.

Filtration Various types of filtration units are used to remove paint solids from booth water. This is accomplished by pumping the booth water to the unit where the solids are separated and returning the water to the booth. The simplest filtration unit consists of a gravity filter bed utilizing paper or cloth media. Vacuum filters are also employed, some of which require precoating with diatomaceous earth.

Centrifuge Methods Two common types of centrifugal separators are the hydrocyclone and the centrifuge. The hydrocyclone is used to concentrate solids. The paint booth water enters a cone-shaped unit under pressure and spins around the inside surface. The spinning imparts an increased force of gravity, which causes most of the solid particles to be pulled outward to the walls of the cone. Treated water exits the top of the unit and the solids exit from the bottom. Some systems have secondary filtration devices to further process the solids. The centrifuge works in a similar manner, except that the booth water enters a spinning drum, which imparts the centrifugal force needed for separating the water and solids. Efficient centrifugation requires close control of the booth water chemistry to ensure a uniform feed. Also, auxiliary equipment such as booth water agitation equipment may be needed (EPA, 1995).

Alternative Coatings

The use of solvent-based coatings can lead to high costs to meet air and water quality regulations. In efforts to reduce the quantity and toxicity of waste paint disposal, alternative coatings have been developed that do not require the use of solvents and thinners. FAA guidelines may prohibit use of such coatings.

Powder Coatings Metal substrates can be coated with certain resins by applying the powdered resin to the surface, followed by application of heat. The heat melts the resin, causing it to flow and form a uniform coating. The three main methods in use for applying the powder coating are fluidized bed, electrostatic spray, and flame spraying.

In flame spraying, the resin powder is blown through the gun by compressed air. The particles are melted in a high temperature flame and propelled against the substrate. This process is used widely with epoxy powders for aluminum surfaces.

The electrostatic application method uses the same principles as the electrostatic spray. The resin powder is applied to the surface electrostatically. Heat is applied to the covered surface and the powder melts to form the coating. The transfer efficiency and recyclability of this method is very high.

The elimination of environmental problems associated with many liquid based systems is one of the major advantages of powder coatings. The use of powder coatings eliminates the need for solvents and thereby emits negligible volatile organic compounds (VOCs). Powder coatings also reduce the waste associated with unused two-part coatings that have already been mixed. Since powder overspray can be recycled, material utilization is high and solid waste generation is low. Recent case studies demonstrate that powder coating systems can be cleaner, more efficient, and more environmentally acceptable, while producing a higher quality finish than many other coating systems.

Water-Based Paints Water-based coatings are paints containing a substantial amount of water instead of volatile solvents. Alkyd, polyester, acrylic, and epoxy polymers can be dissolved and dispersed by water. In addition to reduction in environmental hazards due to substantially lower air emissions, a decrease in the amount of hazardous paint sludge generated can reduce disposal cost.

UV / EB Coatings Powder coatings require high temperatures for their cure and hence are not applicable to temperature sensitive substrates, such as paper, wood or plastics. For such materials, the use of coatings systems curable by ultra violate light or electron beams (UV/EB) have been developed. The resins used in these coatings are basically the same as those used in conventional high performance coatings which have been modified to make them polymerizable by UV or EB energy. Thus they are liquids that can be applied by conventional techniques such as spraying, roller coating, curtain coating, etc. (in contrast to powder coating which requires specialized application techniques). When exposed to the low level radiant energy, they are instantly and completely cured with no heat application. Because of the diversity of raw materials that can be adapted to this technology, a tremendous range of performance characteristics can be achieved. In addition, because no solvents are used in the coating formulations, there are virtually no volatile organic compounds (VOCs) emitted, making them ecologically preferred. Other advantages include the elimination of curing ovens and incinerators which further aid the cleansing of the air as well as substantial savings of space and fuel costs. The rapid curing cycle without the need of a cool-down cycle allows for higher production rates and therefore lower costs. UV/EB coatings can be used on metals, and are especially useful when coating complex metal products that might contain paper, plastic or wood parts, because of the low temperature curing required by UV/EB. In addition, these, and other advantages which UV/EB provides, have led to rapid increase in their use in the manufacture of electronic components.

Good Operating Practices

In many cases, simply altering a painting process can reduce wastes through better management.

A good manual coating application technique is very important in reducing waste. If not properly executed, spraying techniques have a high potential for creating waste; therefore, proper application techniques are very important.

<u>Reducing Overspray</u> One of the most common means of producing paint waste at facilities is overspray. Overspray not only wastes some of the coating, it also presents environmental and health hazards. It is important that facilities try to reduce the amount of overspray as much as possible. Techniques for reducing overspray include:

1) triggering the paint gun at the end of each pass instead of carrying the gun past the edge of the surface before reversing directions,
2) avoiding excessive air pressure,
3) keeping the gun perpendicular to the surface being coated.

<u>Uniform Finish</u> Application of a good uniform finish provides the surface with quality coating with a higher performance than an uneven finish. An uneven coating does not dry evenly and commonly results in using excess paint.

<u>Overlap</u> An overlap of 50 percent can reduce the amount of waste by increasing the production rate and overall application efficiency. Overlap of 50 percent means that for every pass that the operator makes with the spray

gun, 50 percent of the area covered by the previous pass is also sprayed. If less than a 50 percent overlap is used, the coated surface may appear streaked. If more than a 50 percent overlap is used, the coating is wasted and more passes are required to coat the surface.

Paint Proportioning Mixing batches of paint on an as-needed basis, whether through the use of a paint proportioning machine or otherwise, can reduce the amount of paint wasted. Recordkeeping requirements to track the amount of paint and thinner used can also help conserve materials and prevent waste.

General Housekeeping Small quantities of paint and solvents are frequently lost due to poor housekeeping techniques. There are a variety of ways that can be implemented to control and minimize spills and leaks. Specific approaches to product transfer methods and container handling can effectively reduce product loss.

The potential for accidents and spills is at the highest point when thinners and paints are being transferred from bulk drum storage to the process equipment. Spigots, pumps, and funnels should be used whenever possible.

Evaporation can be controlled by using tight fitting lids, spigots, and other equipment. The reduction in evaporation will increase the amount of available material and result in lower solvent purchase cost.

Paint Containers A significant portion of paint waste is the paint that remains inside a container after the container is emptied, and paint that is placed in storage, not used, and becomes outdated or non-spec. By consolidating paint use and purchasing paint in bulk, large bulk containers have less surface area than an equivalent volume of small cans, and the amount of drag-on paint waste is reduced. Large bulk containers can sometimes be returned to the paint supplier to be cleaned for reuse.

If the purchase of paint in bulk containers is not practical, the paint should be purchased in the smallest amount required to minimize outdated or non-spec paint waste. Workers should not have to open a gallon can when only a quart is required. Usually, any paint that is left in the can will require disposal as hazardous waste.

VI. SUMMARY OF FEDERAL STATUTES AND REGULATIONS

This section discusses the Federal regulations that may apply to this sector. The purpose of this section is to highlight and briefly describe the applicable Federal requirements, and to provide citations for more detailed information. The three following sections are included:

- Section VI.A. contains a general overview of major statutes
- Section VI.B. contains a list of regulations specific to this industry
- Section VI.C. contains a list of pending and proposed regulations

The descriptions within Section VI are intended solely for general information. Depending upon the nature or scope of the activities at a particular facility, these summaries may or may not necessarily describe all applicable environmental requirements. Moreover, they do not constitute formal interpretations or clarifications of the statutes and regulations. For further information, readers should consult the Code of Federal Regulations and other state or local regulatory agencies. EPA Hotline contacts are also provided for each major statute.

VI.A. General Description of Major Statutes

Resource Conservation and Recovery Act

The Resource Conservation And Recovery Act (RCRA) of 1976 which amended the Solid Waste Disposal Act, addresses solid (Subtitle D) and hazardous (Subtitle C) waste management activities. The Hazardous and Solid Waste Amendments (HSWA) of 1984 strengthened RCRA's waste management provisions and added Subtitle I, which governs underground storage tanks (USTs).

Regulations promulgated pursuant to Subtitle C of RCRA (40 CFR Parts 260-299) establish a "cradle-to-grave" system governing hazardous waste from the point of generation to disposal. RCRA hazardous wastes include the specific materials listed in the regulations (commercial chemical products, designated with the code "P" or "U"; hazardous wastes from specific industries/sources, designated with the code "K"; or hazardous wastes from non-specific sources, designated with the code "F") or materials which exhibit a hazardous waste characteristic (ignitability, corrosivity, reactivity, or toxicity and designated with the code "D").

Regulated entities that generate hazardous waste are subject to waste accumulation, manifesting, and record keeping standards. Facilities must obtain a permit either from EPA or from a State agency which EPA has authorized to implement the permitting program if they store hazardous wastes for more than 90 days before treatment or disposal. Facilities may treat hazardous wastes stored in less-than-ninety-day tanks or containers without a permit. Subtitle C permits contain general facility standards such as contingency plans, emergency procedures, record keeping and reporting requirements, financial assurance mechanisms, and unit-specific standards. RCRA also contains provisions (40 CFR Part 264 Subpart S and §264.10) for conducting corrective actions which govern the cleanup of releases of hazardous waste or constituents from solid waste management units at RCRA-regulated facilities.

Although RCRA is a Federal statute, many States implement the RCRA program. Currently, EPA has delegated its authority to implement various provisions of RCRA to 47 of the 50 States and two U.S. territories. Delegation has not been given to Alaska, Hawaii, or Iowa.

Most RCRA requirements are not industry specific but apply to any company that generates, transports, treats, stores, or disposes of hazardous waste. Here are some important RCRA regulatory requirements:

•**Identification of Solid and Hazardous Wastes** (40 CFR Part 261) lays out the procedure every generator must follow to determine whether the material in question is considered a hazardous waste, solid waste, or is exempted from regulation.

•**Standards for Generators of Hazardous Waste** (40 CFR Part 262) establishes the responsibilities of hazardous waste generators including obtaining an EPA ID number, preparing a manifest, ensuring proper packaging and labeling, meeting standards for waste accumulation units, and recordkeeping and reporting requirements. Generators can accumulate hazardous waste for up to 90 days (or 180 days depending on the amount of waste generated) without obtaining a permit.

•**Land Disposal Restrictions** (LDRs) (40 CFR Part 268) are regulations prohibiting the disposal of hazardous waste on land without prior treatment. Under the LDRs program, materials must meet LDR treatment standards prior to placement in a RCRA land disposal unit (landfill, land treatment unit, waste pile, or surface impoundment). Generators of waste subject to the LDRs must provide notification of such to the designated TSD facility to ensure proper treatment prior to disposal.

•**Used Oil Management Standards** (40 CFR Part 279) impose management requirements affecting the storage, transportation, burning, processing, and re-refining of the used oil. For parties that merely generate used oil, regulations establish storage standards. For a party considered a used oil processor, re-refiner, burner, or marketer (one who generates and sells off-specification used oil directly to a used oil burner), additional tracking and paperwork requirements must be satisfied.

- RCRA contains unit-specific standards for all units used to store, treat, or dispose of hazardous waste, including **Tanks and Containers**. Tanks and containers used to store hazardous waste with a high volatile organic concentration must meet emission standards under RCRA. Regulations (40 CFR Part 264-265, Subpart CC) require generators to test the waste to determine the concentration of the waste, to satisfy tank and container emissions standards, and to inspect and monitor regulated units. These regulations apply to all facilities that store such waste, including large quantity generators accumulating waste prior to shipment off-site.

- **Underground Storage Tanks** (USTs) containing petroleum and hazardous substances are regulated under Subtitle I of RCRA. Subtitle I regulations (40 CFR Part 280) contain tank design and release detection requirements, as well as financial responsibility and corrective action standards for USTs. The UST program also includes upgrade requirements for existing tanks that must be met by December 22, 1998.

- **Boilers and Industrial Furnaces** (BIFs) that use or burn fuel containing hazardous waste must comply with design and operating standards. BIF regulations (40 CFR Part 266, Subpart H) address unit design, provide performance standards, require emissions monitoring, and restrict the type of waste that may be burned.

***EPA's RCRA, Superfund and EPCRA Hotline,** at (800) 424-9346, responds to questions and distributes guidance regarding all RCRA regulations. The RCRA Hotline operates weekdays from 9:00 a.m. to 6:00 p.m., ET, excluding Federal holidays.*

Comprehensive Environmental Response, Compensation, and Liability Act

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a 1980 law known commonly as Superfund, authorizes EPA to respond to releases, or threatened releases, of hazardous substances that may endanger public health, welfare, or the environment. CERCLA also enables EPA to force parties responsible for environmental contamination to clean it up or to reimburse the Superfund for response costs incurred by EPA. The Superfund Amendments and Reauthorization Act (SARA) of 1986 revised various sections of CERCLA, extended the taxing authority for the Superfund, and created a free-standing law, SARA Title III, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).

The CERCLA hazardous substance release reporting regulations (40 CFR Part 302) direct the person in charge of a facility to report to the National Response Center (NRC) any environmental release of a hazardous substance which equals or exceeds a reportable quantity. Reportable quantities are listed in 40 CFR §302.4. A release report may trigger a response by EPA, or by one or more Federal or State emergency response authorities.

EPA implements hazardous substance responses according to procedures outlined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300). The NCP includes provisions for permanent cleanups, known as remedial actions, and other cleanups referred to as removals. EPA generally takes remedial actions only at sites on the National Priorities List (NPL), which currently includes approximately 1300 sites. Both EPA and states can act at sites; however, EPA provides responsible parties the opportunity to conduct removal and remedial actions and encourages community involvement throughout the Superfund response process.

EPA's RCRA, Superfund and EPCRA Hotline, at (800) 424-9346, answers questions and references guidance pertaining to the Superfund program. The CERCLA Hotline operates weekdays from 9:00 a.m. to 6:00 p.m., ET, excluding Federal holidays.

Emergency Planning And Community Right-To-Know Act

The Superfund Amendments and Reauthorization Act (SARA) of 1986 created the Emergency Planning and Community Right-to-Know Act (EPCRA, also known as SARA Title III), a statute designed to improve community access to information about chemical hazards and to facilitate the development of chemical emergency response plans by State and local governments. EPCRA required the establishment of State emergency response commissions (SERCs), responsible for coordinating certain emergency response activities and for appointing local emergency planning committees (LEPCs).

EPCRA and the EPCRA regulations (40 CFR Parts 350-372) establish four types of reporting obligations for facilities which store or manage specified chemicals:

•**EPCRA §302** requires facilities to notify the SERC and LEPC of the presence of any extremely hazardous substance (the list of such substances is in 40 CFR Part 355, Appendices A and B) if it has such substance in excess of the substance's threshold planning quantity, and directs the facility to appoint an emergency response coordinator.

•**EPCRA §304** requires the facility to notify the SERC and the LEPC in the event of a release equaling or exceeding the reportable quantity of a CERCLA hazardous substance or an EPCRA extremely hazardous substance.

•**EPCRA §311 and §312** require a facility at which a hazardous chemical, as defined by the Occupational Safety and Health Act, is present in an amount exceeding a specified threshold to submit to the SERC, LEPC and local fire department material safety data sheets (MSDSs) or lists of MSDS's and hazardous chemical inventory forms (also known as Tier I and II forms). This information helps the local government respond in the event of a spill or release of the chemical.

•**EPCRA §313** requires manufacturing facilities included in SIC codes 20 through 39, which have ten or more employees, and which manufacture, process, or use specified chemicals in amounts greater than threshold quantities, to submit an annual toxic chemical release report. This report, known commonly as the Form R, covers releases and transfers of toxic chemicals to various facilities and environmental media, and allows EPA to compile the national Toxic Release Inventory (TRI) database.

All information submitted pursuant to EPCRA regulations is publicly accessible, unless protected by a trade secret claim.

EPA's RCRA, Superfund and EPCRA Hotline, at (800) 424-9346, answers questions and distributes guidance regarding the emergency planning and community right-to-know regulations. The EPCRA Hotline operates weekdays from 9:00 a.m. to 6:00 p.m., ET, excluding Federal holidays.

Clean Water Act

The primary objective of the Federal Water Pollution Control Act, commonly referred to as the Clean Water Act (CWA), is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority.

The CWA regulates both direct and indirect discharges. The National Pollutant Discharge Elimination System (NPDES) program (CWA §502) controls direct discharges into navigable waters. Direct discharges or "point source" discharges are from sources such as pipes and sewers. NPDES permits, issued by either EPA or an authorized State (EPA has authorized 42 States to administer the NPDES program), contain industry-specific, technology-based and/or water quality-based limits, and establish pollutant monitoring requirements. A facility that intends to discharge into the nation's waters must obtain a permit prior to initiating its discharge. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set the conditions and effluent limitations on the facility discharges.

A NPDES permit may also include discharge limits based on Federal or State water quality criteria or standards, that were designed to protect designated uses of surface waters, such as supporting aquatic life or recreation. These standards, unlike the technological standards, generally do not take into account technological feasibility or costs. Water quality criteria and standards vary from State to State, and site to site, depending on the use classification of the receiving body of water. Most States follow EPA guidelines which propose aquatic life and human health criteria for many of the 126 priority pollutants.

Storm Water Discharges

In 1987 the CWA was amended to require EPA to establish a program to address storm water discharges. In response, EPA promulgated the NPDES storm water permit application regulations. These regulations require that facilities with the following storm water discharges apply for an NPDES permit: (1) a discharge associated with industrial activity; (2) a discharge from a large or medium municipal storm sewer system; or (3) a discharge which EPA or the State determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

The term "storm water discharge associated with industrial activity" means a storm water discharge from one of 11 categories of industrial activity defined at 40 CFR 122.26. Six of the categories are defined by SIC codes while the other five are identified through narrative descriptions of the regulated industrial activity. If the primary SIC code of the facility is one of those identified in the regulations, the facility is subject to the storm water permit application requirements. If any activity at a facility is covered by one of the five narrative categories, storm water discharges from those areas where the activities occur are subject to storm water discharge permit application requirements.
Those facilities/activities that are subject to storm water discharge permit application requirements are identified below. To determine whether a particular facility falls within one of these categories, consult the regulation.

Category i: Facilities subject to storm water effluent guidelines, new source performance standards, or toxic pollutant effluent standards.

Category ii: Facilities classified as SIC 24-lumber and wood products (except wood kitchen cabinets); SIC 26-paper and allied products (except paperboard containers and products); SIC 28-chemicals and allied products (except drugs and paints); SIC 291-petroleum refining; and SIC 311-leather tanning and finishing.

Category iii: Facilities classified as SIC 10-metal mining; SIC 12-coal mining; SIC 13-oil and gas extraction; and SIC 14-nonmetallic mineral mining.

Category iv: Hazardous waste treatment, storage, or disposal facilities.

Category v: Landfills, land application sites, and open dumps that receive or have received industrial wastes.

Category vi: Facilities classified as SIC 5015-used motor vehicle parts; and SIC 5093-automotive scrap and waste material recycling facilities.

Category vii: Steam electric power generating facilities.

Category viii: Facilities classified as SIC 40-railroad transportation; SIC 41-local passenger transportation; SIC 42-trucking and warehousing (except public warehousing and storage); SIC 43-U.S. Postal Service; SIC 44-water transportation; SIC 45-transportation by air; and SIC 5171-petroleum bulk storage stations and terminals.

Category ix: Sewage treatment works.

Category x: Construction activities except operations that result in the disturbance of less than five acres of total land area.

Category xi: Facilities classified as SIC 20-food and kindred products; SIC 21-tobacco products; SIC 22-textile mill products; SIC 23-apparel related products; SIC 2434-wood kitchen cabinets manufacturing; SIC 25-furniture and fixtures; SIC 265-paperboard containers and boxes; SIC 267-converted paper and paperboard products; SIC 27-printing, publishing, and allied industries; SIC 283-drugs; SIC 285-paints, varnishes, lacquer, enamels, and allied products; SIC 30-rubber and plastics; SIC 31-leather and leather products (except leather and tanning and finishing); SIC 323-glass products; SIC 34-fabricated metal products (except fabricated structural metal); SIC 35-industrial and commercial machinery and computer equipment; SIC 36-electronic and other electrical equipment and components; SIC 37-transportation equipment (except ship and boat building and repairing); SIC 38-measuring, analyzing, and controlling instruments; SIC 39-miscellaneous manufacturing industries; and SIC 4221-4225-public warehousing and storage.

Pretreatment Program

Another type of discharge that is regulated by the CWA is one that goes to a publicly-owned treatment works (POTWs). The national pretreatment program (CWA §307(b)) controls the indirect discharge of pollutants to POTWs by "industrial users." Facilities regulated under §307(b) must meet certain pretreatment standards. The goal of the pretreatment program is to protect municipal wastewater treatment plants from damage that may occur when hazardous, toxic, or other wastes are discharged into a sewer system and to protect the quality of sludge generated by these plants. Discharges to a POTW are regulated primarily by the POTW itself, rather than the State or EPA.

EPA has developed technology-based standards for industrial users of POTWs. Different standards apply to existing and new sources within each category. "Categorical" pretreatment standards applicable to an industry on a nationwide basis are developed by EPA. In addition, another kind of pretreatment standard, "local limits," are developed by the POTW in order to assist the POTW in achieving the effluent limitations in its NPDES permit.

Regardless of whether a State is authorized to implement either the NPDES or the pretreatment program, if it develops its own program, it may enforce requirements more stringent than Federal standards.

Spill Prevention, Control and Countermeasure Plans

The 1990 Oil Pollution Act requires that facilities that could reasonably be expected to discharge oil in harmful quantities prepare and implement more rigorous Spill Prevention Control and Countermeasure (SPCC) Plan required under the CWA (40 CFR §112.7). There are also criminal and civil penalties for deliberate or negligent spills of oil. Regulations covering response to oil discharges and contingency plans (40 CFR Part 300), and Facility Response Plans to oil discharges (40 CFR §112.20) and for PCB transformers and PCB-containing items were revised and finalized in 1995.

EPA's Office of Water, at (202) 260-5700, will direct callers with questions about the CWA to the appropriate EPA office. EPA also maintains a bibliographic database of Office of Water publications which can be accessed through the Ground Water and Drinking Water resource center, at (202) 260-7786.

Safe Drinking Water Act

The Safe Drinking Water Act (SDWA) mandates that EPA establish regulations to protect human health from contaminants in drinking water. The law authorizes EPA to develop national drinking water standards and to create a joint Federal-State system to ensure compliance with these standards. The SDWA also directs EPA to protect underground sources of drinking water through the control of underground injection of liquid wastes.

EPA has developed primary and secondary drinking water standards under its SDWA authority. EPA and authorized States enforce the primary drinking water standards, which are, contaminant-specific concentration limits that apply to certain public drinking water supplies. Primary drinking water standards consist of maximum contaminant level goals (MCLGs), which are non-enforceable health-based goals, and maximum contaminant levels (MCLs), which are enforceable limits set as close to MCLGs as possible, considering cost and feasibility of attainment.

The SDWA Underground Injection Control (UIC) program (40 CFR Parts 144-148) is a permit program which protects underground sources of drinking water by regulating five classes of injection wells. UIC permits include design, operating, inspection, and monitoring requirements. Wells used to inject hazardous wastes must also comply with RCRA corrective action standards in order to be granted a RCRA permit, and must meet applicable RCRA land disposal restrictions standards. The UIC permit program is primarily State-enforced, since EPA has authorized all but a few States to administer the program.

The SDWA also provides for a Federally-implemented Sole Source Aquifer program, which prohibits Federal funds from being expended on projects that may contaminate the sole or principal source of drinking water for a given area, and for a State-implemented Wellhead Protection program, designed to protect drinking water wells and drinking water recharge areas.

EPA's Safe Drinking Water Hotline, at (800) 426-4791, answers questions and distributes guidance pertaining to SDWA standards. The Hotline operates from 9:00 a.m. through 5:30 p.m., ET, excluding Federal holidays.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) granted EPA authority to create a regulatory framework to collect data on chemicals in order to evaluate, assess, mitigate, and control risks which may be posed by their manufacture, processing, and use. TSCA provides a variety of control methods to prevent chemicals from posing unreasonable risk.

TSCA standards may apply at any point during a chemical's life cycle. Under TSCA §5, EPA has established an inventory of chemical substances. If a chemical is not already on the inventory, and has not been excluded by TSCA, a premanufacture notice (PMN) must be submitted to EPA prior to manufacture or import. The PMN must identify the chemical and provide available information on health and environmental effects. If available data are not sufficient to evaluate the chemicals effects, EPA can impose restrictions pending the development of information on its health and environmental effects. EPA can also restrict significant new uses of chemicals based upon factors such as the projected volume and use of the chemical.

Under TSCA §6, EPA can ban the manufacture or distribution in commerce, limit the use, require labeling, or place other restrictions on chemicals that pose unreasonable risks. Among the chemicals EPA regulates under §6 authority are asbestos, chlorofluorocarbons (CFCs), and polychlorinated biphenyls (PCBs).

EPA's TSCA Assistance Information Service, at (202) 554-1404, answers questions and distributes guidance pertaining to Toxic Substances Control Act standards. The Service operates from 8:30 a.m. through 4:30 p.m., ET, excluding Federal holidays.

Clean Air Act

The Clean Air Act (CAA) and its amendments, including the Clean Air Act Amendments (CAAA) of 1990, are designed to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population." The CAA consists of six sections, known as Titles, which direct EPA to establish national standards for ambient air quality and for EPA and the States to implement, maintain, and enforce these standards through a variety of mechanisms. Under the CAAA, many facilities will be required to obtain permits for the first time. State and local governments oversee, manage, and enforce many of the requirements of the CAAA. CAA regulations appear at 40 CFR Parts 50-99.

Pursuant to Title I of the CAA, EPA has established national ambient air quality standards (NAAQSs) to limit levels of "criteria pollutants," including carbon monoxide, lead, nitrogen dioxide, particulate matter, VOCs, ozone, and sulfur dioxide. Geographic areas that meet NAAQSs for a given pollutant are classified as attainment areas; those that do not meet NAAQSs are classified as non-attainment areas. Under section 110 of the CAA, each State must develop a State Implementation Plan (SIP) to identify sources of air pollution and to determine what reductions are required to meet Federal air quality standards. Revised NAAQSs for particulates and ozone were proposed in 1996 and will become effective in 2001.

Title I also authorizes EPA to establish New Source Performance Standards (NSPSs), which are nationally uniform emission standards for new stationary sources falling within particular industrial categories. NSPSs are based on the pollution control technology available to that category of industrial source (see 40 CFR 60).

Under Title I, EPA establishes and enforces National Emission Standards for Hazardous Air Pollutants (NESHAPs), nationally uniform standards oriented towards controlling particular hazardous air pollutants (HAPs). Title I, section 112(c) of the CAA further directed EPA to develop a list of sources that emit any of 189 HAPs, and to develop regulations for these categories of sources. To date EPA has listed 174 categories and developed a schedule for the establishment of emission standards. The emission standards will be developed for both new and existing sources based on "maximum achievable control technology" (MACT). The MACT is defined as the control technology achieving the maximum degree of reduction in the emission of the HAPs, taking into account cost and other factors.

Title II of the CAA pertains to mobile sources, such as cars, trucks, buses, and planes. Reformulated gasoline, automobile pollution control devices, and vapor recovery nozzles on gas pumps are a few of the mechanisms EPA uses to regulate mobile air emission sources.

Title IV of the CAA establishes a sulfur dioxide nitrous oxide emissions program designed to reduce the formation of acid rain. Reduction of sulfur dioxide releases will be obtained by granting to certain sources limited emissions allowances, which, beginning in 1995, will be set below previous levels of sulfur dioxide releases.

Title V of the CAA of 1990 created a permit program for all "major sources" (and certain other sources) regulated under the CAA. One purpose of the operating permit is to include in a single document all air emissions requirements that apply to a given facility. States are developing the permit programs in accordance with guidance and regulations from EPA. Once a State program is approved by EPA, permits will be issued and monitored by that State.

Title VI of the CAA is intended to protect stratospheric ozone by phasing out the manufacture of ozone-depleting chemicals and restrict their use and distribution. Production of Class I substances, including 15 kinds of chlorofluorocarbons (CFCs) and chloroform, were phased out (except for essential uses) in 1996.

EPA's Control Technology Center, at (919) 541-0800, provides general assistance and information on CAA standards. The Stratospheric Ozone Information Hotline, at (800) 296-1996, provides general information about regulations promulgated under Title VI of the CAA, and EPA's EPCRA Hotline, at (800) 535-0202, answers questions about accidental release prevention under CAA §112(r). In addition, the Technology Transfer Network Bulletin Board System (modem access (919) 541-5742)) includes recent CAA rules, EPA guidance documents, and updates of EPA activities.

VI.B. Industry Specific Requirements

The aerospace industry is affected by several major federal environmental statutes. A summary of the major federal regulations affecting the aerospace industry follows. Other resources which are useful in understanding industry specific requirements are:

1. The Paint and Coatings Resource Center web page (http://www.paintcenter.org)
2. The Self Audit & Inspection Guide; For Facilities Conducting Cleaning, Preparation, and Organic Coating of Metal Parts, published by the EPA.
3. California EPA Air Resources Board Web Pages;
   Compliance Handbooks and Pamphlets
   - http://www.arb.ca.gov/cd/cap/handbks.htm

   Compliance Training Courses
   - http://www.arb.ca.gov/cd/training.htm
   - http://www.arb.ca.gov/html/all.htm

Resource Conservation and Recovery Act (RCRA)

The Resource Conservation and Recovery Act (RCRA) was enacted in 1976 to address problems related to hazardous and solid waste management. RCRA gives EPA the authority to establish a list of solid and hazardous wastes and to establish standards and regulations for the treatment, storage, and disposal of these wastes. Regulations in Subtitle C of RCRA address the identification, generation, transportation, treatment, storage, and disposal of hazardous wastes. These regulations are found in 40 CFR Part 124 and 40 CFR Parts 260-279. Under RCRA, persons who generate waste must determine whether the waste is defined as solid waste or hazardous waste. Solid wastes are considered hazardous wastes if they are listed by EPA as hazardous or if they exhibit characteristics of a hazardous waste: toxicity, ignitability, corrosivity, or reactivity.

Some wastes potentially generated at aerospace facilities that are considered hazardous wastes are listed in 40 CFR Part 261. Some of the handling and treatment requirements for RCRA hazardous waste generators are covered under 40 CFR Part 262 and include the following: determining what constitutes a RCRA hazardous waste (Subpart A); manifesting (Subpart B); packaging, labeling, and accumulation time limits (Subpart C); and record keeping and reporting (Subpart D).

Several common aerospace manufacturing operations have the potential to generate RCRA hazardous wastes. Some of these wastes are identified below by process.

Machining and Other Metalworking
- Metalworking fluids contaminated with oils, phenols, creosol, alkalies, phosphorus compounds, and chlorine

Cleaning and Degreasing
- Solvents (F001, F002, F003, F004, F005)
- Alkaline and Acid Cleaning Solutions (D002)
- Cleaning filter sludges with toxic metal concentrations

Metal Plating and Surface Finishing and Preparation
- Wastewater treatment sludges from electroplating operations (F006)
- Spent cyanide plating bath solutions (F007)
- Plating bath residues from the bottom of cyanide plating baths (F008)
- Spent stripping and cleaning bath solutions from cyanide plating operations (F009)

Surface Preparation, Painting and Coating
- Paint and paint containers containing paint sludges with solvents or toxic metals concentrations
- Solvents (F002, F003)
- Paint chips with toxic metal concentrations
- Blasting media contaminated with paint chips

Aerospace manufacturing and rework facilities may also generate used lubricating oils which are regulated under RCRA but may or may not be considered a hazardous waste (40 CFR 266).

Many aerospace facilities store some hazardous wastes at the facility for more than 90 days, and are therefore, a storage facility under RCRA. Storage facilities are required to have a RCRA treatment, storage, and disposal facility (TSDF) permit (40 CFR Part 262.34). Some aerospace facilities are considered TSDF facilities and therefore may be subject to the following regulations covered under 40 CFR Part 264: contingency plans and emergency procedures (40 CFR Part 264 Subpart D); manifesting, record keeping, and reporting (40 CFR Part 264 Subpart E); use and management of containers (40 CFR Part 264 Subpart I); tank systems (40 CFR Part 264 Subpart J); surface impoundments (40 CFR Part 264 Subpart K); land treatment (40 CFR Part 264 Subpart M); corrective action of hazardous waste releases (40 CFR Part 264 Subpart S); air emissions standards for process vents of processes that process or generate hazardous wastes (40 CFR Part 264 Subpart AA); emissions standards for leaks in hazardous waste handling equipment (40 CFR Part 264 Subpart BB); and emissions standards for containers, tanks, and surface impoundments that contain hazardous wastes (40 CFR Part 264 Subpart CC).

Many aerospace manufacturing and rework facilities are also subject to the underground storage tank (UST) program (40 CFR Part 280). The UST regulations apply to facilities that store either petroleum products or hazardous substances (except hazardous waste) identified under the Comprehensive Environmental Response, Compensation, and Liability Act. UST regulations address design standards, leak detection, operating practices, response to releases, financial responsibility for releases, and closure standards.

A number of RCRA wastes have been prohibited from land disposal unless treated to meet specific standards under the RCRA Land Disposal Restriction (LDR) program. The wastes covered by the RCRA LDRs are listed in 40 CFR Part 268 Subpart C and include a number of wastes that could potentially be generated at aerospace manufacturing facilities. Standards for the treatment and storage of restricted wastes are described in Subparts D and E, respectively.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA) provide the basic legal framework for the federal "Superfund" program to clean up abandoned hazardous waste sites (40 CFR Part 305). Metals and metal compounds often found in the aerospace industry's air emissions, water discharges, or waste shipments for off-site disposal include chromium, manganese, aluminum, nickel, copper, zinc, and lead. Metals are frequently found at CERCLA's problem sites. When Congress ordered EPA and the Public Health Service's Agency for Toxic Substances and Disease Registry (ATSDR) to list the hazardous substances most commonly found at problem sites and that pose the greatest threat to human health, lead, nickel, and aluminum were all included.

Title III of the 1986 SARA amendments (also known as Emergency Response and Community Right-to-Know Act, EPCRA) requires all manufacturing facilities, including aerospace facilities, to report annual information to the public about over 600 toxic substances as well as release of these substances into the environment (42 U.S.C. 9601). This is known as the Toxic Release Inventory (TRI). EPCRA also establishes requirements for Federal, State, and local governments regarding emergency planning.

Clean Air Act (CAA)

Under Title III of the 1990 Clean Air Act Amendments (CAAA), EPA is required to develop national emission standards for 189 hazardous air pollutants (NESHAP). EPA is developing maximum achievable control technology (MACT) standards for all new and existing sources. The National

Emission Standards for Aerospace Manufacturing and Rework Facilities (40 CFR Part 63 Subpart GG) were finalized in 1996 and apply to major source aerospace manufacturing and rework facilities. Facilities that emit ten or more tons of any one HAP or 25 or more tons of two or more HAPs combined are major sources, and therefore are subject to the MACT (NESHAP) requirements. The MACT requirements apply to solvent cleaning operations, primer and topcoat application operations, depainting operations, chemical milling maskant application operations, and handling and storage of waste. The standards set VOC emissions and content limits for different types of solvents, chemical strippers and coatings. In addition, performance standards are set to reduce spills, leaks, and fugitive emissions. Aerospace facilities may also be subject to National Emissions Standards for: Chromium Emissions From Hard and Decorative Chromium Electroplating and Chromium Anodizing Tanks (40 CFR Part 63 Subpart N) if they perform chromium electroplating or anodizing; and Halogenated Solvent Cleaning if they operate a solvent cleaning machine using a halogenated HAP solvent. These NESHAPs require emission limits, work practice standards, record keeping, and reporting.

Under Title V of the CAAA 1990 (40 CFR Parts 70-72) all of the applicable requirements of the Amendments are integrated into one federal renewable operating permit. Facilities defined as "major sources" under the Act must apply for permits within one year from when EPA approves the state permit programs. Since most state programs were not approved until after November 1994, Title V permit applications, for the most part, began to be due in late 1995. Due dates for filing complete applications vary significantly from state to state, based on the status of review and approval of the state’s Title V program by EPA.

A facility is designated as a major source for Title V if it releases a certain amount of any one of the CAAA regulated pollutants (SOx, NOx, CO, VOC, PM_{10}, hazardous air pollutants, extremely hazardous substances, ozone depleting substances, and pollutants covered by NSPSs) depending on the region's air quality category. Title V permits may set limits on the amounts of pollutant emissions; require emissions monitoring, and record keeping and reporting. Facilities are required to pay an annual fee based on the magnitude of the facility's potential emissions. It is estimated that as many as 2,869 aerospace facilities will be designated as major sources and therefore must apply for a Title V permit.

Under section 112(r) of CAA, owners and operators of stationary sources who produce, process, handle, or store substances listed under CAA section 112(r)(3) or any other extremely hazardous substance have a “general duty” to initiate specific activities to prevent and mitigate accidental releases. Since the general duty requirements apply to stationary sources regardless of the quantity of substances managed at the facility, many aerospace manufacturing and reworking facilities are subject. Activities such as identifying hazards which may result from accidental releases using appropriate hazard assessment techniques; designing, maintaining and operating a safe facility; and minimizing the consequences of accidental releases if they occur are considered essential activities to satisfy the general duty requirements. These statutory requirements have been in affect since the passage of the Clean Air Act Amendments in 1990. Although there is no list of "extremely hazardous substances," EPA's Chemical Emergency Preparedness and Prevention Office provides some guidance at its website: http://www.epa.gov/swercepp.html.

Also under section 112(r), EPA was required to develop a list of at least 100 substances that, in the event of an accidental release, could cause death, injury, or serious adverse effects to human health or the environment. The list promulgated by EPA is contained in 40 CFR 68.130 and includes acutely toxic chemicals, flammable gases and volatile flammable liquids, and Division 1.1 high explosive substances as listed by DOT in 49 CFR 172.101. Under section 112(r)(7), facilities handling more than a threshold quantity (ranging from 500 to 20,000 pounds) of these substances are subject to chemical accident prevention provisions including the development and implementation of a risk management program (40 CFR 68.150-68.220). The requirements in 40 CFR Part 68 begin to go into effect in June 1999. Some of the chemicals on the 112(r) list could be handled by aerospace manufacturers and reworkers in quantities greater than the threshold values.

Clean Water Act

Aerospace manufacturing and rework facility wastewater released to surface waters is regulated under the CWA. National Pollutant Discharge Elimination System (NPDES) permits must be obtained to discharge wastewater into navigable waters (40 Part 122). Facilities that discharge to a POTW may be required to meet National Pretreatment Standards for some contaminants. General pretreatment standards applying to most industries discharging to a POTW are described in 40 CFR Part 403. In addition, effluent limitation guidelines, new source performance standards, pretreatment standards for new sources, and pretreatment standards for existing sources may apply to some aerospace manufacturing and rework facilities that carry out electroplating or metal finishing operations. Requirements for the Electroplating Point Source Category and the Metal Finishing Point Source Category are listed under 40 CFR Part 413 and 40 CFR Part 433, respectively.

Storm water rules require certain facilities with storm water discharge from any one of 11 categories of industrial activity defined in 40 CFR 122.26 be subject to the storm water permit application requirements (see Section VI.A). Many aerospace facilities fall within these categories. To determine whether a particular facility falls within one of these categories, the regulation should be consulted.

VI.C. Pending and Proposed Regulatory Requirements

Clean Water Act

Effluent limitation guidelines for wastewater discharges from metal products and machinery (MP&M) industries are being developed. MP&M industries have been divided into two groups that originally were to be covered under two separate phases of the rulemaking. Effluent guidelines for Phase I industries and Phase II industries (which includes the aerospace industry) will now be covered under a single regulation to be proposed in October 2000 and finalized in December 2002. (Steven Geil, U.S. EPA, Office of Water, Engineering and Analysis Division, (202)260-9817, email: geil.steve@epamail.epa.gov)

Clean Air Act

In December 1997, EPA published Control Technique Guidelines (CTG) for the control of VOC emissions from coating operations at aerospace manufacturing and rework operations. The CTG was issued to assist states in analyzing and determining reasonably available control technology (RACT) standards for major sources of VOCs in the aerospace manufacturing and rework operations located within ozone NAAQS nonattainment areas. EPA estimates that there are approximately 2,869 facilities that could fall within this category. Within one year of the publication of the CTG, states must adopt a RACT regulation at least as stringent as the limits recommended in the CTG. Under Section 183(b)(3) of the Clean Air Act, EPA is required to issue the CTG for aerospace coating and solvent application operations based on “best available control measures” (BACM) for emissions of VOCs. (Barbara Driscoll, U.S. EPA, Office of Air Quality Planning and Standards, (919) 541-0164)

Several National Emission Standards for Hazardous Air Pollutants (NESHAPs) relating to the aerospace industry are being developed for promulgation by November of 2000. They include: Rocket Engine Test Firing, Engine Test Facilities, Miscellaneous Metal Parts and Products, and Plastic Parts and Products. (Contact: In the U.S. EPA Office of Air Quality Planning and Standards, George Smith for information pertaining to the former two, (919)541-1549; and Bruce Moore for the latter two, (919)541-5460)