

#### IV. CHEMICAL RELEASE AND TRANSFER PROFILE

This section is designed to provide background information on the pollutant releases that are reported by this industry. The best source of comparative pollutant release information is the Toxic Release Inventory (TRI). Pursuant to the Emergency Planning and Community Right-to-Know Act, TRI includes self-reported facility release and transfer data for over 600 toxic chemicals. Facilities within SIC Codes 20 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 (1995) 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 1995 Toxic Release Inventory Public Data Release, reported onsite releases of toxic chemicals to the environment decreased by 5 percent (85.4 million pounds) between 1994 and 1995 (not including chemicals added and removed from the TRI chemical list during this period). Reported releases dropped by 46 percent between 1988 and 1995. Reported transfers of TRI chemicals to off-site locations increased by 0.4 percent (11.6 million pounds) between 1994 and 1995. 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. Release and transfer reporting are limited to the approximately 600 chemicals on the TRI list. Therefore, a large portion of the emissions from industrial facilities are not captured by TRI. 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. In addition, many facilities report more than one SIC code reflecting the multiple operations carried out onsite. 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. The Agency is in the process of developing an approach to assign toxicological weightings to each chemical released so that one can differentiate between pollutants with significant differences in toxicity. As a preliminary indicator of the environmental impact of the industry's most commonly released chemicals, the notebook briefly summarizes the toxicological properties of the top five chemicals (by weight) reported by each industry.

## Definitions Associated With Section IV Data Tables

### General Definitions

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

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

### Data Table Column Heading Definitions

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

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

**Releases to Air (Point and Fugitive Air Emissions)** -- Include all air emissions from industry activity. Point emissions occur through confined air streams as found in stacks, 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 land disposal methods (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 wastewater 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**-- is a transfer 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 depend 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 are not destroyed and may be disposed of in landfills or discharged to receiving waters.

**Transfers to Recycling** -- are 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 Metal Casting Industry

This section summarizes TRI data of ferrous and nonferrous foundries reporting SIC codes 332, 3365, 3366, and 3369, and ferrous and nonferrous die casting facilities reporting SIC codes 3363 and 3364 as the primary SIC code for the facility. Of the 2,813 metal casting establishments reported by the *1992 Census of Manufacturers*, 654 reported to TRI in 1995.

Ferrous and nonferrous foundries made up 85 percent (554 facilities) of metal casting facilities reporting to TRI and accounted for about 89 percent of the total metal casting TRI releases and transfers for metal casting facilities in 1995. Die casters made up 15 percent (100 facilities) of metal casting facilities and reported the remaining 11 percent of the total releases and transfers. Because the TRI information differs for foundries and die casters, the releases and transfers for these two industry segments are presented separately below.

##### IV.A.1. Toxic Release Inventory for Ferrous and Nonferrous Foundries

According to the 1995 TRI data, the reporting ferrous and nonferrous foundries released and transferred a total of approximately 109 million pounds of pollutants during calendar year 1995. These releases and transfers are dominated by large volumes of metallic wastes. Evidence of the diversity of processes at foundries reporting to TRI is found in the fact that the most frequently reported chemical (copper) is reported by only 45 percent of the facilities and over half of the TRI chemicals were reported by fewer than ten facilities. The variability in facilities' pollutant profiles may be attributable to the large number of different types of foundry processes and products. For example, foundries casting only ferrous parts will have different pollutant profiles than those foundries casting both ferrous and nonferrous products.

##### *Releases*

Releases to the air, water, and land accounted for 33 percent (36 million pounds) of foundries' total reportable chemicals. Of these releases, 70 percent go to onsite land disposal, and about 75 percent are fugitive or point source air emissions (See Table 7). Metallic wastes accounted for over 95 percent of the industry's releases. Manganese, zinc, chromium, and lead account for over 95 percent of the on-site land disposal. The industry's air releases are associated with volatilization, fume or aerosol formation in the furnaces and byproduct processing. Lighter weight organics, such as methanol, acids and metal contaminants found in scrap metal are the principal types of TRI chemicals released to the air. In addition to air releases of chemicals reported to TRI, foundries are often a source of particulates, carbon monoxide, nitrogen oxides and sulfur compounds due to sand handling

operations, curing of chemical binders, and combustion of fossil fuels. Methanol, trichloroethylene and other solvent releases account for most of the fugitive releases (approximately 61 percent).

### *Transfers*

Off-site transfers of TRI chemicals account for 69 percent of foundries' total TRI-reportable chemicals (74 million pounds). Almost 57 percent of the industry's total TRI wastes (42 million pounds) are metallic wastes that were transferred off-site for recycling, typically for recovery of the metal content. Metallic wastes account for approximately 95 percent of the industry's transfers. About 61 percent of off-site transfers reported by foundries are sent off-site for recycling. Copper, manganese, zinc, chromium, nickel, and lead are the six metals transferred in the greatest amounts and number of facilities (See Table 8). TRI chemicals sent off-site for disposal (primarily manganese, zinc, chromium, and copper) account for 31 percent of transfers. Less than three percent of the remaining transfers from foundries go to treatment off-site, discharge to POTWs, and energy recovery.

After metals, the next largest volume of chemicals transferred are acids including: sulfuric acid, nitric acid, phosphoric acid, and hydrochloric acid. Spent acids can be generated in wet scrubber systems. In addition, acids are often used to clean and finish the surfaces of the metal castings before plating or coating. The spent acids are often sent off-site for recycling or for treatment. Solvents and other light weight organic compounds are frequently reported but account for a relatively small amount of total transfers. Solvents are used frequently for cleaning equipment and cast parts. The primary solvents and light weight organics include: phenol, xylene, 1,2,4-trimethylbenzene, 1,1,1-trichloroethane, trichloroethylene, methanol, and toluene. Transferred solvents are mostly sent off-site for disposal or recycling. Phenols and phenoisocyanates are frequently reported but amount to less than one percent of the total TRI pounds transferred. Phenols are often found in chemical binding systems and may be present in waste sand containing chemical binders (AFS and CISA, 1992).

**Table 7: 1995 TRI Releases for Foundries, 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
COPPER	249	78577	100548	4554	0	349835	533514	2143
NICKEL	182	23309	31804	1471	0	122406	178990	983
CHROMIUM	182	47389	33191	1653	0	162923	245156	1347
MANGANESE	179	163447	84164	3258	0	4891621	5142490	28729
PHENOL	89	219560	421803	4490	0	53891	699744	51996
LEAD	76	9671	24366	230	0	352489	386756	5089
DIISOCYANATES	65	12035	13152	260	0	9022	34469	530
MANGANESE COMPOUNDS	50	37530	63037	3020	0	2496212	2599799	19846
CHROMIUM COMPOUNDS	45	41903	70489	1529	0	779154	893075	19846
COPPER COMPOUNDS	36	14953	9020	517	0	65500	89990	2500
ZINC (FUME OR DUST)	35	71228	144470	2104	0	1696554	1914356	54696
NICKEL COMPOUNDS	32	12241	7188	512	0	724	20665	646
METHANOL	32	1952231	451245	7	0	0	2403483	75109
ZINC COMPOUNDS	31	40379	121541	2956	0	12733217	12898093	416068
ALUMINUM (FUME OR DUST)	31	40491	186471	259	0	792270	1019491	32887
TRIETHYLAMINE	30	235144	1143297	5	0	5	1378451	45948
PHOSPHORIC ACID	26	157071	578	10	0	86093	243752	9375
XYLENE (MIXED ISOMERS)	24	568145	284447	4	0	0	852596	35255
COBALT	24	1450	1832	501	0	5	3788	158
NAPHTHALENE	22	201461	104137	263	0	9481	315342	14334
MOLYBDENUM TRIOXIDE	22	2260	1755	275	0	2547	6837	311
1,2,4-TRIMETHYLBENZENE	18	188854	54393	1	0	32850	276098	15339
LEAD COMPOUNDS	16	5638	13160	579	0	221774	241151	15072
FORMALDEHYDE	16	75414	78441	245	0	11436	165536	10346
TOLUENE	13	334212	179171	20	0	14	513417	39494
BARIUM	13	34486	3691	135	0	141150	179462	13805
ALUMINUM OXIDE (FIBROUS FORMS)	11	82060	18828	250	0	592750	693888	63081
CERTAIN GLYCOL ETHERS	10	119511	85824	0	0	0	205335	20534
SULFURIC ACID	10	25739	510	5	0	0	26254	2625
NITRIC ACID	10	2685	7640	0	0	0	10325	1033
ETHYLENE GLYCOL	9	48835	14045	3	0	68000	130883	14543
HYDROCHLORIC ACID	9	6	1604	0	0	0	1610	179
(1995 AND AFTER "ACID AEROSOLS" ONLY)	8	86624	3520	5	0	482	90631	11329
N-METHYL-2-PYRROLIDONE	8	92708	325575	3002	0	0	421285	52661
AMMONIA	7	182997	61382	0	0	0	244379	34911
1,1,1-TRICHLOROETHANE	6	23455	5	201	0	43465	67126	11188
BARIUM COMPOUNDS	6	23455	5	201	0	43465	67126	11188

**Table 7, cont.: 1995 TRI Releases for Foundries, by Number of Facilities Reporting  
(Releases reported in pounds/year)**

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	DISCHARGES	WATER UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. RELEASES PER FACILITY
CUMENE HYDROPEROXIDE	6	2000	1300	0	0	3400	6700	1117
HYDROGEN FLUORIDE	6	1250	1130	0	0	0	2380	397
BENZENE	5	3150	239000	7	0	36	242193	48439
CHLORINE	5	8	5	615	0	0	628	126
COBALT COMPOUNDS	4	15	505	0	0	0	520	130
N-BUTYL ALCOHOL	4	33272	250	0	0	0	33522	8381
4,4'-ISOPROPYLIDENEDIPHENOL	4	750	0	0	0	0	750	188
ANTIMONY	4	260	260	0	0	0	520	130
DICHLOROMETHANE	3	110912	0	0	0	0	110912	36971
METHYLETHYL KETONE	3	39851	7820	0	0	0	47671	15890
TRICHLOROETHYLENE	3	30426	46996	0	0	0	77422	25807
STYRENE	3	33421	75457	0	0	0	108878	36293
TETRACHLOROETHYLENE	3	34450	16000	0	0	0	50450	16817
CADMIUM	3	5	6	0	0	0	11	4
NITRATE COMPOUNDS	2	1700	0	23000	0	0	24700	12350
CUMENE	2	340	150	0	0	0	490	245
ETHYLBENZENE	2	4610	18439	0	0	0	23049	11525
METHYL ISOBUTYL KETONE	2	41284	6367	0	0	0	47651	23826
ARSENIC	2	250	250	0	0	0	500	250
PHOSPHORUS (YELLOW OR WHITE)	2	10	255	750	0	0	1015	508
ANTIMONY COMPOUNDS	1	5	5	0	0	0	10	10
BERYLLIUM COMPOUNDS	1	0	0	0	0	0	0	0
URETHANE	1	0	0	0	0	0	0	0
HEXACHLOROETHANE	1	5	250	0	0	0	255	255
DIETHANOLAMINE	1	0	0	0	0	0	0	0
PROPYLENE	1	0	0	0	0	0	0	0
CRESOL (MIXED ISOMERS)	1	0	44,000	20	0	0	44,020	44,020
POLYCHLORINATED BIPHENYLS	1	0	0	0	0	0	0	0
1,1-DICHLORO-1-FLUOROETHANE	1	49,416	0	0	0	0	49,416	49,416
SELENIUM	1	0	5	0	0	0	5	5
	654	5,621,089	4,604,774	56,716	0	25,719,306	36,001,885	55,048



**Table 8: 1995 TRI Transfers for Foundries, by Number and Facilities Reporting**  
(Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW TRANSFERS	DISPOSAL TRANSFERS	RECYCLING TRANSFERS	TREATMENT TRANSFERS	ENERGY RECOVERY		TOTAL TRANSFERS	AVG TRANSFER PER FACILITY
						TRANSFERS	TRANSFERS		
COPPER	249	3386	926053	12948705	49688	1	13927833	55935	
NICKEL	182	5811	752487	2925158	23193	1	3706650	20366	
CHROMIUM	182	3568	947383	2042419	14667	5	3008047	16528	
MANGANESE	179	2598	6528832	2834670	59838	0	9425938	52659	
PHENOL	89	2397	216754	5272	10282	2671	239976	2696	
LEAD	76	1566	78229	828352	22767	1	930915	12249	
DIISOCYANATES	65	5	110292	55	40449	2510	153561	2362	
MANGANESE COMPOUNDS	50	4553	5800216	6143043	152468	0	12100280	242006	
CHROMIUM COMPOUNDS	45	17857	4274721	5249563	1475	0	9543616	212080	
COPPER COMPOUNDS	36	1375	101566	1288917	31743	0	1423601	39544	
ZINC (FUME OR DUST)	35	861	592866	1420309	85916	0	2099952	59999	
NICKEL COMPOUNDS	32	2093	101546	1463377	8969	0	1575985	49250	
METHANOL	32	2	19260	0	608	2616	22486	703	
ZINC COMPOUNDS	31	7308	3479603	4339541	581458	0	8407910	271223	
ALUMINUM (FUME OR DUST)	31	7419	1347594	1205369	1500	0	2561882	82641	
TRITHYLAMINE	30	5	250	423423	228606	0	652284	21743	
PHOSPHORIC ACID	26	255	228515	49474	8576	0	286820	11032	
XYLENE (MIXED ISOMERS)	24	0	3391	12170	250	163869	179680	7487	
COBALT	24	1574	21956	618986	7719	0	650235	27093	
NAPHTHALENE	22	4	21270	6920	1490	8621	38305	1741	
MOLYBDENUM TRIOXIDE	22	0	13042	4965	1086	0	19093	868	
1,2,4-TRIMETHYLBENZENE	18	1	21671	6463	260	7922	36317	2018	
LEAD COMPOUNDS	16	86	351495	120552	29284	0	501417	31339	
FORMALDEHYDE	16	3845	44078	430	3530	0	51883	3243	
TOLUENE	13	2	1300	0	0	7906	9208	708	
BARIUM	13	294	121356	70525	6830	0	199255	15327	
ALUMINUM OXIDE (FIBROUS FORMS)	11	0	651926	17405	0	0	669331	60848	
CERTAIN GLYCOL ETHERS	10	0	6550	13000	255	0	19805	1981	
SULFURIC ACID	10	600	15162	0	12850	0	28612	2861	
NITRIC ACID	10	250	0	22772	35331	0	58353	5835	
ETHYLENE GLYCOL	9	38810	53800	17368	0	0	109978	12220	
HYDROCHLORIC ACID									
(1995 AND AFTER "ACID AEROSOLS" ONLY)	9	5	0	0	76000	0	76005	8445	
N-METHYL-2-PYRROLIDONE	8	2435	26470	13000	4902	1933	48740	6093	
AMMONIA	8	13195	0	40250	0	0	53445	6681	
1,1,1-TRICHLOROETHANE	7	0	0	600	250	250	1100	157	

**Table 8, cont.: 1995 TRI Transfers for Foundries, by Number and Facilities Reporting**  
**(Transfers reported in pounds/year)**

CHEMICAL NAME	# REPORTING CHEMICAL	POTW TRANSFERS	DISPOSAL TRANSFERS	RECYCLING TRANSFERS	TREATMENT TRANSFERS	ENERGY RECOVERY TRANSFERS	TOTAL TRANSFERS	AVG TRANSFER PER FACILITY
BARIUM COMPOUNDS	6	0	170228	245735	250	0	416213	69369
CUMENE HYDROPEROXIDE	6	0	4900	0	250	0	5150	858
HYDROGEN FLUORIDE	6	250	0	47746	79000	0	126996	21166
BENZENE	5	2	250	0	0	0	252	50
CHLORINE	5	0	0	0	0	0	0	0
COBALT COMPOUNDS	4	0	5869	394655	0	0	400524	100131
N-BUTYL ALCOHOL	4	0	0	0	0	0	0	0
4,4'-ISOPROPYLIDENEDIPHENOL	4	0	78170	0	0	0	78170	19543
ANTIMONY	4	255	0	758	250	0	1263	316
DICHLOROMETHANE	3	0	28	0	0	0	28	9
METHYL ETHYL KETONE	3	0	0	6458	250	10822	17530	5843
TRICHLOROETHYLENE	3	0	0	1350	0	2000	3350	1117
STYRENE	3	0	0	0	0	355	355	118
TETRACHLOROETHYLENE	3	0	0	250	0	0	250	83
CADMIUM	3	0	0	0	10	0	10	3
NITRATE COMPOUNDS	2	3700	0	0	0	0	3700	1850
CUMENE	2	0	400	0	250	0	650	325
ETHYLBENZENE	2	0	0	0	0	750	750	375
METHYL ISOBUTYL KETONE	2	0	0	0	53	0	53	27
ARSENIC	2	0	0	250	0	0	250	125
PHOSPHORUS (YELLOW OR WHITE)	2	5	19532	15043	0	0	34580	17290
ANTIMONY COMPOUNDS	1	0	0	0	0	0	0	0
BERYLLIUM COMPOUNDS	1	0	400	0	0	0	400	400
URETHANE	1	0	3000	0	0	0	3000	3000
HEXACHLOROETHANE	1	0	0	0	0	0	0	0
DIETHANOLAMINE	1	1300	0	0	2400	0	3700	3700
PROPYLENE	1	0	0	0	0	0	0	0
CRESOL (MIXED ISOMERS)	1	6	0	0	0	0	6	6
POLYCHLORINATED BIPHENYLS	1	0	0	0	0	0	0	0
1,1-DICHLORO-1-FLUOROETHANE	1	0	0	0	0	0	0	0
SELENIUM	1	0	5	0	0	0	5	5
<b>TOTAL</b>	<b>554</b>	<b>127,678</b>	<b>27,142,416</b>	<b>44,845,298</b>	<b>1,584,953</b>	<b>212,233</b>	<b>73,915,683</b>	<b>113,021</b>

#### IV.A.2. Toxic Release Inventory for Die Casting Facilities

According to the 1995 TRI data, the reporting die casting facilities released and transferred a total of approximately 13 million pounds of TRI chemicals during calendar year 1995. As with foundries, the releases and transfers for die casters are dominated by large volumes of metallic wastes. Evidence of the diversity of processes at die casting facilities reporting to TRI is found in the fact that all but three of the TRI reported chemicals (copper, nickel, and aluminum) are reported by fewer than ten percent of the facilities. The variability in facilities' pollutant profiles may be attributed primarily to the different types of metals cast.

##### *Releases*

Releases make up only four percent of die casters' total TRI-reportable chemicals (518,000 pounds). Almost all of these releases (99 percent) are released to the air through point source and fugitive emissions (see Table 9). Metallic wastes (primarily aluminum, zinc, and copper) account for over 67 percent of the releases. The remainder of the industry's releases are primarily solvents and other volatile organic compounds including, trichloroethylene, tetrachloroethylene, glycol ethers, hexachloroethane, and toluene, which account for 32 percent of the releases. In addition to air releases of chemicals reported to TRI, die casting facilities can be a source of particulates, carbon monoxide, nitrogen oxides and sulfur compounds due to the combustion of fossil fuels for metal melting, from the molten metal itself, and from die cleaning and lubricating operations.

##### *Transfers*

Off-site transfers of TRI chemicals account for 96 percent of die casters' total TRI-reportable chemicals (13 million pounds). Almost all off-site transfers (97 percent) reported by die casting facilities are sent off-site for recycling. Copper, aluminum, zinc, and nickel make up 98 percent of all transfers and are reported by the largest number of facilities (see Table 10). Chemicals sent off-site for disposal (primarily aluminum and copper) account for less than three percent of transfers. After metals, the next class of chemicals transferred are solvents. These chemicals account for only about one percent of total transfers.

**Table 9: 1995 TRI Releases for Die Casting Facilities, by Number of Facilities Reporting**  
**(Releases reported in pounds/year)**

CHEMICAL NAME	# REPORTING CHEMICAL	FUGITIVE AIR	POINT AIR	DISCHARGES	WATER UNDERGROUND INJECTION	LAND DISPOSAL	TOTAL RELEASES	AVG. RELEASES PER FACILITY
COPPER	79	7,319	17,283	1,006	0	250	25,858	327
NICKEL	24	835	3,028	0	0	0	3,863	161
ALUMINUM (FUME OR DUST)	21	17,663	257,448	22	0	0	275,133	13,102
ZINC (FUME OR DUST)	10	6,747	19,842	0	0	0	26,589	2,659
LEAD	9	34	59	0	0	0	93	10
MANGANESE	9	552	824	0	0	0	1,376	153
ZINC COMPOUNDS	7	992	6,610	321	0	2,959	10,882	1,555
CHROMIUM	6	39	1,069	5	0	0	1,113	186
COPPER COMPOUNDS	3	84	1,853	0	0	0	1,937	646
MANGANESE COMPOUNDS	3	0	0	250	0	0	250	83
TRICHLOROETHYLENE	3	12,689	101,545	0	0	0	114,234	38,078
NITRIC ACID	3	250	1,000	0	0	0	1,250	417
CHLORINE	3	255	1,705	0	0	0	1,960	653
CERTAIN GLYCOL ETHERS	2	4,800	5,600	0	0	0	10,400	5,200
ETHYLENE GLYCOL	2	0	0	0	0	0	0	0
HYDROCHLORIC ACID								
(1995 AND AFTER "ACID AEROSOLS" ONLY)								
SULFURIC ACID	2	500	0	0	0	0	500	250
LEAD COMPOUNDS	2	250	750	0	0	0	1,000	500
NICKEL COMPOUNDS	1	0	111	0	0	0	111	111
HEXACHLOROETHANE	1	12	240	0	0	0	252	252
STYRENE	1	1,146	10,316	0	0	0	11,462	11,462
PROPYLENE	1	1,450	0	0	0	0	1,450	1,450
TRIETHYLAMINE	1	0	0	0	0	0	0	0
TETRACHLOROETHYLENE	1	250	5	0	0	0	255	255
BERYLLIUM	1	5,800	23,200	0	0	0	29,000	29,000
	1	0	0	0	0	5	5	5
	100	61,667	452,488	1,604	0	3,214	518,973	5,189

**Table 10: 1995 TRI Transfers for Die Casting Facilities, by Number and Facilities Reporting**  
(Transfers reported in pounds/year)

CHEMICAL NAME	# REPORTING CHEMICAL	POTW TRANSFERS	DISPOSAL TRANSFERS	RECYCLING TRANSFERS	TREATMENT TRANSFERS	ENERGY RECOVERY		TOTAL TRANSFERS	AVG TRANSFER PER FACILITY
						TRANSFERS	TRANSFERS		
COPPER	79	363	34,284	4,683,629	851	.	.	4,719,127	59,730
NICKEL	24	45	2,623	166,911	35	.	.	169,614	7,067
ALUMINUM (FUME OR DUST)	21	265	233,319	4,852,664	5	.	.	5,086,253	242,203
ZINC (FUME OR DUST)	10	11	20,810	258,685	5	.	.	279,511	27,951
LEAD	9	20	515	10,443	10	.	.	10,988	1,221
MANGANESE	9	10	776	5,997	.	.	.	6,783	754
ZINC COMPOUNDS	7	303	5,259	488,477	6,955	.	.	500,994	71,571
CHROMIUM	6	15	760	750	15	.	.	1,540	257
COPPER COMPOUNDS	3	1	502	64,928	.	.	.	65,431	21,810
MANGANESE COMPOUNDS	3	5	16,400	.	4,752	.	.	21,157	7,052
TRICHLOROETHYLENE	3	0	1,836	66,330	800	.	.	68,966	22,989
NITRIC ACID	3	98	.	.	24,324	.	.	24,422	8,141
CHLORINE	3	0	.	.	.	.	.	0	0
CERTAIN GLYCOL ETHERS	2	0	.	50,000	.	.	.	50,000	25,000
ETHYLENE GLYCOL	2	4	70	.	.	.	.	74	37
HYDROCHLORIC ACID									
(1995 AND AFTER "ACID AEROSOLS" ONLY)									
SULFURIC ACID	2	0	.	.	.	.	.	0	0
LEAD COMPOUNDS	2	0	.	.	.	.	.	0	0
NICKEL COMPOUNDS	1	0	360	1,500,000	.	.	.	1,500,360	1,500,360
HEXACHLOROETHANE	1	0	54	7,767	.	.	.	7,821	7,821
STYRENE	1	0	.	.	.	.	.	0	0
PROPYLENE	1	0	.	.	.	.	.	0	0
TRIETHYLAMINE	1	0	.	.	.	.	.	0	0
TETRACHLOROETHYLENE	1	.	.	2,009	.	.	.	2,009	2,009
BERYLLIUM	1	0	.	750	.	.	.	750	750
	100	1,140	317,568	12,159,340	37,752	0	0	12,515,800	125,158

The TRI database contains a detailed compilation of self-reported, facility-specific chemical releases. The top reporting facilities for the metal casting industry are listed below in Tables 11 and 12. Facilities that have reported only the primary SIC codes covered under this notebook appear on Table 11. Table 12 contains additional facilities that have reported the SIC codes covered within this notebook, or SIC codes covered within this notebook report and one or more SIC codes that are not within the scope of this notebook. Therefore, the second list may include facilities that conduct multiple operations -- some that are under the scope of this notebook, and some that are not. Currently, the facility-level data do not allow pollutant releases to be broken apart by industrial process.

Rank	Foundries (SIC 332, 3365, 3366, 3369)		Die Casters (SIC 3363, 3364)	
	Facility	Total TRI Releases in Pounds	Facility	Total TRI Releases in Pounds
1	GM Powertrain Defiance - Defiance, OH	14,730,020	Water Gremlin Co. - White Bear Lake, MN	97,111
2	GMC Powertrain - Saginaw, MI	2,709,764	BTR Precision Die Casting - Russelville, KY	93,903
3	American Steel Foundries - Granite City, IL	1,245,343	QX Inc. - Hamel, MN	67,772
4	Griffin Wheel Co. - Keokuk, IA	1,065,104	AAP St. Marys Corp. - Saint Marys, OH	55,582
5	Griffin Wheel Co. - Groveport, OH	1,042,040	Impact Industries Inc. - Sandwich, IL	45,175
6	Griffin Wheel Co. - Bessemer, AL	742,135	Tool-Die Eng. Co. - Solon, OH	29,005
7	U.S. Pipe & Foundry Co. - Birmingham, AL	738,200	Chrysler Corp. - Kokomo, IN	20,652
8	American Steel Foundries - East Chicago, IN	625,191	Metalloy Corp. - Fremont, IN	13,350
9	Griffin Wheel Co. - Kansas City, KS	607,266	Tool Products. Inc. - New Hope, MN	12,194
10	CMI - Cast Parts, Inc. - Cadillac, MI	604,100	Travis Pattern & Foundry, Inc. - Spokane, WA	11,614

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

<sup>1</sup> Being included on this list does not mean that the release is associated with non-compliance with environmental laws.

Rank	Foundries (SIC 332, 3365, 3366, 3369)			Die Casters (SIC 3363, 3364)		
	Facility	SIC Codes Reported in TRI	Total TRI Releases in Pounds	Facility	SIC Codes Reported in TRI	Total TRI Releases in Pounds
1	GM Powertrain Defiance - Defiance, OH	3321	14,730,020	Water Gremlin Co. - White Bear Lake, MN	3364, 3949	97,111
2	GMC Powertrain - Saginaw, MI	3321, 3365	2,709,764	BTR Precision Die Casting - Russelville, KY	3363	93,903
3	Heatcraft Inc. - Grenada, MS	3585, 3351, 3366	1,369,306	Honeywell Inc. Home & Building - Golden Valley, MN	3822, 3363, 3900	87,937
4	American Steel Foundries - Granite City, IL	3325	1,245,343	QX Inc. - Hamel, MN	3363	67,772
5	Griffin Wheel Co. - Keokuk, IA	3325	1,065,104	AAP St. Marys Corp. - Saint Marys, OH	3363	55,582
6	Griffin Wheel Co. - Groveport, OH	3325	1,042,040	Impact Industries Inc. - Sandwich, IL	3363	45,175
7	Geneva Steel - Vineyard, UT	3312, 3317, 3325	901,778	Tool-Die Eng. Co. - Solon, OH	3363	29,005
8	Griffin Wheel Co. - Bessemer, AL	3325	742,135	TAC Manufacturing - Jackson, MI	3086, 3363, 3714	25,684
9	U.S. Pipe & Foundry Co. - Birmingham, AL	3321	738,200	Superior Ind. Intl., Inc. - Johnson City, TN	3714, 3363, 3398	25,250
10	American Steel Foundries - East Chicago, IN	3325	625,191	General Electric Co. - Hendersonville, NC	3646, 3363	20,780

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

<sup>2</sup> 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<sup>3</sup>, contact the TOXNET help line at 1-800-231-3766.

##### Manganese and Manganese Compounds (CAS: 7439-96-5; 20-12-2)

**Sources.** Manganese is found in iron charge materials and is used as an addition agent for alloy steel to obtain desired properties in the final product. In carbon steel, manganese is used to combine with sulfur to improve the ductility of the steel. An alloy steel with manganese is used for applications

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<sup>3</sup> 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.



involving small sections which are subject to severe service conditions, or in larger sections where the weight saving derived from the higher strength of the alloy steels is needed (U.S. EPA, 1995).

**Toxicity.** There is currently no evidence that human exposure to manganese at levels commonly observed in ambient atmosphere results in adverse health effects.

Chronic manganese poisoning, however, bears some similarity to chronic lead poisoning. Occurring via inhalation of manganese dust or fumes, it primarily involves the central nervous system. Early symptoms include languor, speech disturbances, sleepiness, and cramping and weakness in legs. A stolid mask-like appearance of face, emotional disturbances such as absolute detachment broken by uncontrollable laughter, euphoria, and a spastic gait with a tendency to fall while walking are seen in more advanced cases. Chronic manganese poisoning is reversible if treated early and exposure stopped. Populations at greatest risk of manganese toxicity are the very young and those with iron deficiencies.

Ecologically, although manganese is an essential nutrient for both plants and animals, in excessive concentrations manganese inhibits plant growth.

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

**Environmental Fate.** Manganese is an essential nutrient for plants and animals. As such, manganese accumulates in the top layers of soil or surface water sediments and cycles between the soil and living organisms. It occurs mainly as a solid under environmental conditions, though may also be transported in the atmosphere as a vapor or dust.

#### Zinc and Zinc Compounds (CAS: 7440-66-6; 20-19-9)

**Sources.** To protect metal from oxidizing, it is often coated with a material that will protect it from moisture and air. In the galvanizing process, steel is coated with zinc. Galvanized iron and steel is often found in furnace charge materials (USITC, 1984).

**Toxicity.** Zinc is a trace element; toxicity from ingestion is low. Severe exposure to zinc might give rise to gastritis with vomiting due to swallowing of zinc dusts. Short-term exposure to very high levels of zinc is linked to lethargy, dizziness, nausea, fever, diarrhea, and reversible pancreatic and neurological damage. Long-term zinc poisoning causes irritability, muscular stiffness and pain, loss of appetite, and nausea.

Zinc chloride fumes cause injury to mucous membranes and to the skin. Ingestion of soluble zinc salts may cause nausea, vomiting, and purging.

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

**Environmental Fate.** Significant zinc contamination of soil is only seen in the vicinity of industrial point sources. Zinc is a stable soft metal, though it burns in air. Zinc bioconcentrates in aquatic organisms.

Methanol (CAS: 67-56-1)

**Sources.** Methanol is used as a cleaning solvent and can be emitted during the production of cores using the hot box and no-bake systems.

**Toxicity.** Methanol is readily absorbed from the gastrointestinal tract and the respiratory tract, and is toxic to humans in moderate to high doses. In the body, methanol is converted into formaldehyde and formic acid. Methanol is excreted as formic acid. Observed toxic effects at high dose levels generally include central nervous system damage and blindness. Long-term exposure to high levels of methanol via inhalation cause liver and blood damage in animals.

Ecologically, methanol is expected to have low toxicity to aquatic organisms. Concentrations lethal to half the organisms of a test population are expected to exceed one mg methanol per liter water. Methanol is not likely to persist in water or to bioaccumulate in aquatic organisms.

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

**Environmental Fate.** Methanol is highly volatile and flammable. Liquid methanol is likely to evaporate when left exposed. Methanol reacts in air to produce formaldehyde which contributes to the formation of air pollutants. In the atmosphere it can react with other atmospheric chemicals or be washed out by rain. Methanol is readily degraded by microorganisms in soils and surface waters.

*Trichloroethylene* (CAS:79-01-6)

**Sources.** Trichloroethylene is used extensively as a cleaning 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-term trichloroethylene poisoning include liver and kidney lesions, reversible nerve degeneration, and psychic disturbances. Long-term exposure can produce headache, dizziness, weight loss, nerve damage, heart damage, nausea, fatigue, insomnia, visual impairment, mood perturbation, sexual problems, dermatitis, and rarely jaundice. Degradation products of trichloroethylene (particularly phosgene) may cause rapid death due to respiratory collapse.

**Carcinogenicity.** Trichloroethylene is 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.

*Xylenes (Mixed Isomers)* (CAS: 1330-20-7)

**Sources.** Xylenes are used extensively as cleaning solvents and paint solvents and may be formed as a decomposition product of binders.

**Toxicity.** Xylenes are rapidly absorbed into the body after inhalation, ingestion, or skin contact. Short-term exposure of humans to high levels of xylene can cause irritation of the skin, eyes, nose, and throat, difficulty in breathing, impaired lung function, impaired memory, and possible changes in the liver and kidneys. Both short- and long-term exposure to high concentrations can cause effects such as headaches, dizziness, confusion, and

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

**Carcinogenicity.** There is currently no evidence to suggest that xylenes are carcinogenic.

**Environmental Fate.** A portion of releases to land and water will quickly evaporate, although some degradation by microorganisms will occur. Xylenes are moderately mobile in soils and may leach into groundwater, where they may persist for several years. Xylenes are volatile organic chemicals. As such, xylene in the lower atmosphere will react with other atmospheric components, contributing to the formation of ground-level ozone and other air pollutants.

*Chromium and Chromium Compounds* (CAS: 7440-47-3; 20-06-4)

**Sources.** Chromium is used as a plating element for metal to prevent corrosion and is sometimes found on charge materials. Chromium is also a constituent of stainless steel.

**Toxicity.** Although the naturally-occurring form of chromium metal has very low toxicity, chromium from industrial emissions is highly toxic due to strong oxidation characteristics and cell membrane permeability. The majority of the effects detailed below are based on Chromium VI (an isomer that is more toxic than Cr III). Exposure to chromium metal and insoluble chromium salts affects the respiratory system. Inhalation exposure to chromium and chromium salts may cause severe irritation of the upper respiratory tract and scarring of lung tissue. Dermal exposure to chromium and chromium salts can also cause sensitive dermatitis and skin ulcers.

Ecologically, although chromium is present in small quantities in all soils and plants, it is toxic to plants at higher soil concentrations (i.e., 0.2 to 0.4 percent in soil).

**Carcinogenicity.** Different sources disagree on the carcinogenicity of chromium. Although an increased incidence in lung cancer among workers in the chromate-producing industry has been reported, data are inadequate to confirm that chromium is a human carcinogen. Other sources consider chromium VI to be a known human carcinogen based on inhalation exposure.

**Environmental Fate.** Chromium is a non-volatile metal with very low solubility in water. If applied to land, most chromium remains in the upper five centimeters of soil. Most chromium in surface waters is present in particulate form as sediment. Airborne chromium particles are relatively unreactive and are removed from the air through wet and dry deposition. The precipitated chromium from the air enters surface water or soil. Chromium bioaccumulates in plants and animals, with an observed bioaccumulation factor of 1,000,000 in snails.

**IV.C. Other Data Sources**

The toxic chemical release data obtained from TRI captures only about one quarter of the facilities in the metal casting industry. However, it allows for a comparison across years and industry sectors. Reported chemicals are limited to the approximately 600 TRI chemicals. A large portion of the emissions from metal casting 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, SO<sub>x</sub>, NO<sub>x</sub>, CO, particulates, etc.) from many metal casting 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 13 summarizes annual releases (from the industries for which a Sector Notebook Profile was prepared) of carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), particulate matter of 10 microns or less (PM<sub>10</sub>), sulfur dioxide (SO<sub>2</sub>), and volatile organic compounds (VOCs).

<b>Table 13: Air Pollutant Releases by Industry Sector (tons/year)</b>						
<b>Industry Sector</b>	<b>CO</b>	<b>NO<sub>2</sub></b>	<b>PM<sub>10</sub></b>	<b>PT</b>	<b>SO<sub>2</sub></b>	<b>VOC</b>
Metal Mining	4,670	39,849	63,541	173,566	17,690	915
Nonmetal Mining	25,922	22,881	40,199	128,661	18,000	4,002
Lumber and Wood Production	122,061	38,042	20,456	64,650	9,401	55,983
Furniture and Fixtures	2,754	1,872	2,502	4,827	1,538	67,604
Pulp and Paper	566,883	358,675	35,030	111,210	493,313	127,809
Printing	8,755	3,542	405	1,198	1,684	103,018
Inorganic Chemicals	153,294	106,522	6,703	34,664	194,153	65,427
Organic Chemicals	112,410	187,400	14,596	16,053	176,115	180,350
Petroleum Refining	734,630	355,852	27,497	36,141	619,775	313,982
Rubber and Misc. Plastics	2,200	9,955	2,618	5,182	21,720	132,945
Stone, Clay and Concrete	105,059	340,639	192,962	662,233	308,534	34,337
Iron and Steel	1,386,461	153,607	83,938	87,939	232,347	83,882
Nonferrous Metals	214,243	31,136	10,403	24,654	253,538	11,058
Fabricated Metals	4,925	11,104	1,019	2,790	3,169	86,472
Electronics and Computers	356	1,501	224	385	741	4,866
Motor Vehicles, Bodies, Parts and Accessories	15,109	27,355	1,048	3,699	20,378	96,338
Dry Cleaning	102	184	3	27	155	7,441
Ground Transportation	128,625	550,551	2,569	5,489	8,417	104,824
<b>Metal Casting</b>	<b>116,538</b>	<b>11,911</b>	<b>10,995</b>	<b>20,973</b>	<b>6,513</b>	<b>19,031</b>
Pharmaceuticals	6,586	19,088	1,576	4,425	21,311	37,214
Plastic Resins and Manmade Fibers	16,388	41,771	2,218	7,546	67,546	74,138
Textiles	8,177	34,523	2,028	9,479	43,050	27,768
Power Generation	366,208	5,986,757	140,760	464,542	13,827,511	57,384
Shipbuilding and Repair	105	862	638	943	3,051	3,967

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

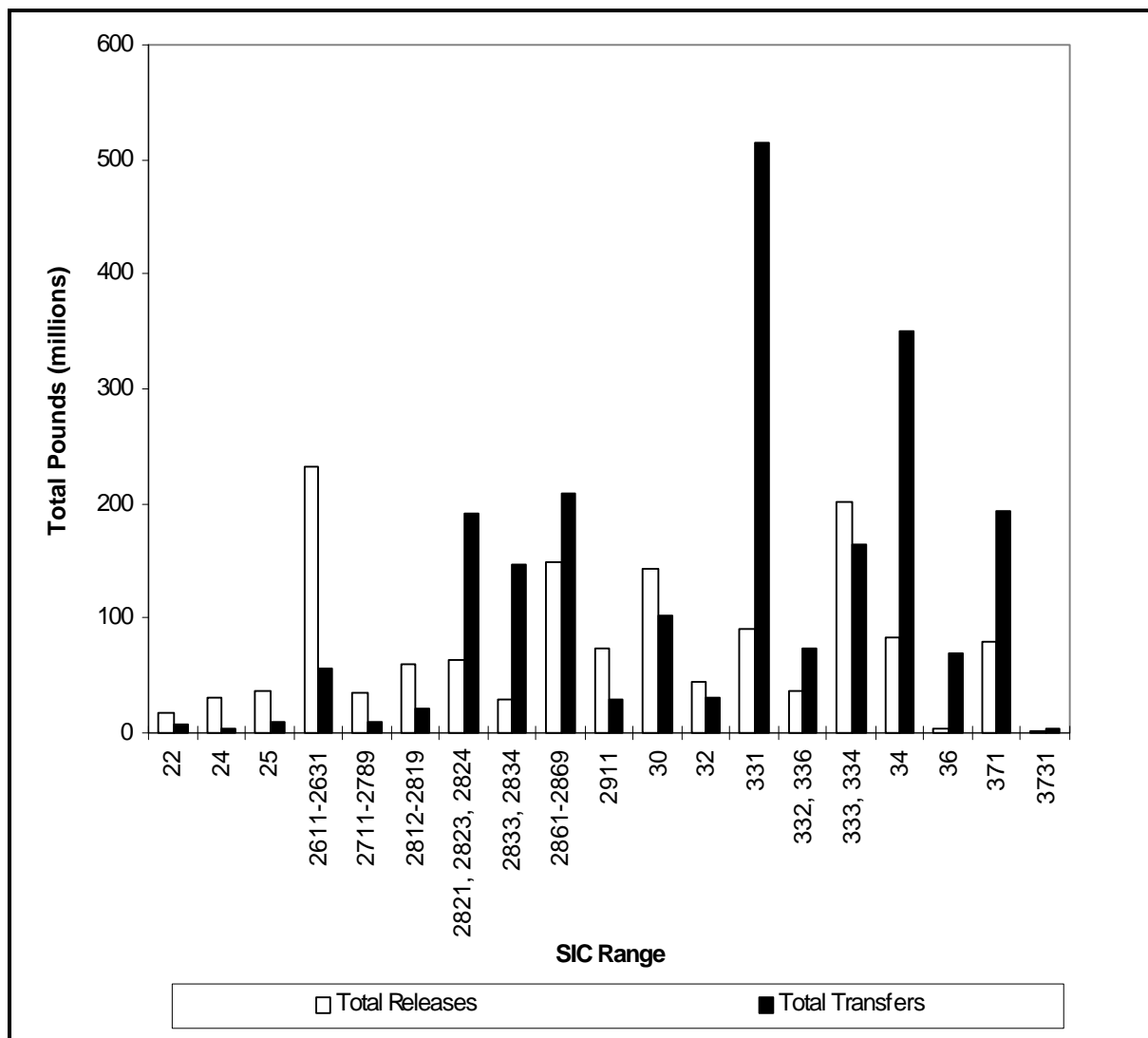
#### IV.D. Comparison of Toxic Release Inventory Between Selected Industries

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 figure and table 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 10 is a graphical representation of a summary of the 1995 TRI data for the metal casting industry and the other sectors profiled in separate notebooks. The bar graph presents the total TRI releases and total transfers on the vertical axis. The graph is based on the data shown in Table 14 and is meant to facilitate comparisons between the relative amounts of releases, transfers, and releases per facility both within and between these sectors. The reader should note, however, that differences in the proportion of facilities captured by TRI exist between industry sectors. This can be a factor of poor SIC matching and relative differences in the number of facilities reporting to TRI from the various sectors. In the case of the metal casting industry, the 1995 TRI data presented here covers 654 facilities. These facilities listed SIC 332 (Iron and Steel Foundries) and 336 (Nonferrous Foundries) as primary SIC codes.



Figure 10: Summary of TRI Releases and Transfers by Industry



Source: US EPA 1995 Toxics Release Inventory Database.

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	3731	Shipbuilding
2812-2819	Inorganic Chemical Manufacturing	331	Iron and Steel		
2821, 2823, 2824	Plastic Resins and Manmade Fibers	332, 336	<b>Metal Casting</b>		

Table 14: 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 (pounds)
			Total Releases (million lbs.)	Ave. Releases per Facility (pounds)	Total Transfers (million lbs.)	Ave. Trans. per Facility (pounds)		
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
Plastic Resins and Manmade Fibers	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
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
<b>Metal Casting</b>	<b>332, 336</b>	<b>654</b>	<b>36.0</b>	<b>55,000</b>	<b>73.9</b>	<b>113,000</b>	<b>109.9</b>	<b>168,000</b>
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
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 metal casting 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.

Most of the pollution prevention activities in the metal casting industry have concentrated on reducing waste sand, waste electric arc furnace (EAF) dust and desulfurization slag, and increasing the overall energy efficiency of the processes. This section describes some of the pollution prevention opportunities for foundries within each of these areas.

**V.A. Waste Sand and Chemical Binder Reduction and Reuse**

Disposal of waste foundry sand in off-site landfills has become less appealing to foundry operators in recent years. Landfill disposal fees have increased considerably, especially in areas that suffer from shortages of landfill capacity.

Landfill disposal can be a long-term CERCLA liability as well (see Section VI.A. for a discussion of CERCLA). Currently, about 2 percent of foundry waste sands generated is considered hazardous waste under RCRA requiring expensive special treatment, handling and disposal in hazardous waste landfills. Therefore, there are strong financial incentives for applying pollution prevention techniques that reduce waste foundry sand generation. In fact, for years many foundries have been implementing programs to reduce the amounts of waste sand they generate. Also, the industry is conducting a significant amount of research in this area (AFS, 1996).

### V.A.1. Casting Techniques Reducing Waste Foundry Sand Generation

The preferable approach to reducing disposal of waste sands is through source reduction rather than waste management and pollution control or treatment techniques. Foundry operators aiming to reduce waste sand may want to examine the feasibility and economic incentives of new casting methods for all or part of their production. A number of the casting techniques described in Section III.A such as investment casting, permanent mold casting, die casting, and lost foam casting generate less sand waste than other techniques.

Adopting different casting methods, however, may not always be feasible depending on the physical characteristics of the parts to be cast (e.g., type of metal, casting size and configuration, tolerances and surface finish required, etc.), the capabilities of the alternative methods, and the economic feasibility. When considering the economic feasibility of implementing these alternative methods, the savings in waste sand handling and disposal and raw material costs should be examined.

In addition to the more common methods listed above and described in Section III.A, there are a number of lesser known and/or new casting methods that also have the potential to reduce the volume of foundry waste sand generated. One promising method, vacuum molding, is described below. For additional information on new, alternative casting techniques, see the references in Section IX.

#### *Vacuum Molding*

Vacuum molding, or the V-Process, uses a strong vacuum applied to free-flowing, dry, unbonded sand around patterns in air tight flasks. The vacuum inside the mold results in a net pressure outside pushing in, holding the sand rigidly in the shape of the pattern even after the pattern is removed. The process uses a specially designed plastic film to seal the open ends of the sand mold and the mold cavity. After the pattern is removed, the mold halves are placed together and the metal is poured. The plastic film inside the mold cavity melts and diffuses into the sand as it contacts the molten metal. When

the metal has cooled, the vacuum is removed, allowing the sand to fall away from the casting. Shakeout equipment is not needed and virtually no waste sand is generated. The V-Process can be used on almost all metal types, for all sizes and shapes. Although the process has not gained widespread use, it can be economical, uses very little energy and can produce castings with high dimensional accuracy and consistency (La Rue, 1989).

#### V.A.2. Reclamation and Reuse of Waste Foundry Sand and Metal

Although less preferable than source reduction, the more immediate shift in industry practices is towards waste reclamation and reuse. A number of techniques are being used to reclaim waste sand and return it to the mold and core making processes. In addition, markets for off-site reuse of waste foundry sand have also been found. (Unless otherwise noted, this section is based on the 1992 EPA Office of Research and Development report, *Guides to Pollution Prevention, The Metal Casting and Heat Treating Industry.*)

##### *Waste Segregation*

A substantial amount of sand contamination comes from mixing the various foundry waste streams with waste sand. The overall amount of sand being discarded can be reduced by implementing the following waste segregation steps:

- Replumbing the dust collector ducting on the casting metal gate cutoff saws to collect metal chips for easier recycling
- Installing a new baghouse on the sand system to separate the sand system dust from the furnace dust
- Installing a new screening system or magnetic separator on the main molding sand system surge hopper to continuously clean metal from the sand system
- Separate nonferrous foundry shot blast dust (often a hazardous waste stream) from other nonhazardous foundry and sand waste streams.
- Installing a magnetic separation system on the shotblast system to allow the metal dust to be recycled
- Changing the core sand knockout procedure to keep this sand from being mixed in with system sand prior to disposal

*Screen and Separate Metal from Sand*

Most foundries screen used sand before reusing it. Some employ several different screen types and vibrating mechanisms to break down large masses of sand mixed with metal chips. Coarse screens are used to remove large chunks of metal and core butts. The larger metal pieces collected in the screen are usually remelted in the furnace or sold to a secondary smelter. Increasingly fine screens remove additional metal particles and help classify the sand by size before it is molded. Some foundries remelt these smaller metal particles; other foundries sell this portion to metal reclaimers. The metal recovered during the screening process is often mixed with coarser sand components or has sand adhering to it. Therefore, remelting these pieces in the furnace generates large amounts of slag, especially when the smaller particles are remelted.

*Reclaim Sand by Dry Scrubbing/Attrition*

Reclaiming sand by dry scrubbing is widely used, and a large variety of equipment is available with capacities adaptable to most binder systems and foundry operations. Dry scrubbing may be divided into pneumatic or mechanical systems.

In pneumatic scrubbing, grains of sand are agitated in streams of air normally confined in vertical steel tubes called cells. The grains of sand are propelled upward; they impact each other and/or are thrust against a steel target to remove some of the binder. In some systems, grains are impacted against a steel target. Banks of tubes may be used depending on the capacity and degree of cleanliness desired. Retention time can be regulated, and fines are removed through dust collectors. In mechanical scrubbing, a variety of available equipment offers foundries a number of options. An impeller may be used to accelerate the sand grains at a controlled velocity in a horizontal or vertical plane against a metal plate. The sand grains impact each other and metal targets, thereby removing some of the binder. The speed of rotation has some control over impact energy. The binder and fines are removed by exhaust systems, and screen analysis is controlled by air gates or air wash separators. Additional equipment options include:

- A variety of drum types with internal baffles, impactors, and disintegrators that reduce lumps to grains and remove binder
- Vibrating screens with a series of decks for reducing lumps to grains, with recirculating features and removal of dust and fines

- Shot-blast cleaning equipment that may be incorporated into other specially designed units to form a complete casting cleaning/sand reclamation unit
- Vibro-energy systems that use synchronous and diametric vibration, where frictional and compressive forces separate binder from sand grains.

Southern Aluminum is a high-production automotive foundry in Bay Minette, Alabama. The company recently installed a rotating drum attrition/scrubber sand reclaimer unit to remove lumps and tramp aluminum from its spent green sand and core butts so that it could be used by an asphalt company. Spent sand is fed into one end of the rotating drum where the lumps are reduced and binder is scrubbed off the grains. The sand then enters a screening and classifying section, binder and fines are removed by a dust collector, and clean tramp metal is removed. The company is removing far more aluminum from the sand than expected (about 6,000 pounds per day) resulting in substantial cost savings. The equipment paid for itself before it finished treating three-months worth of spent sand stockpiled at the facility (Philbin, 1996).

#### *Reclaim Sand with Thermal Systems*

Most foundries recycle core and mold sands; however, these materials eventually lose their basic characteristics, and the portions no longer suitable for use are disposed of in a landfill. In the reclamation of chemically bonded sands, the system employed must be able to break the bond between the resin and sand and remove the fines that are generated. The systems employed most commonly are scrubbing/attrition and thermal (rotary reclamation) systems for resin-bonded sands.

Reclamation of green sand for reuse in a green sand system is practiced on a limited basis in the United States. However, reclamation of core sand and chemically bonded molding sand is widespread. Wet reclamation systems employed in the 1950s for handling green sands are no longer used. Specific thermal reclamation case studies are summarized in AFS (1989) and Modern Casting August (1996). A typical system to reclaim chemically bonded sand for reuse in core room and molding operations consists of a lump reduction and metal removal system, a particle classifier, a sand cooler, a dust collection system, and a thermal scrubber (two-bed reactor). A number of thermal sand reclamation techniques are described below. Note that EPA may classify some types of thermal sand reclamation as incineration. As of June 1996, EPA was taking comments on the regulatory status of thermal recovery units. Contact Mary Cunningham at (703) 308-8453.

*Thermal Calcining/Thermal Dry Scrubbing.* These systems are useful for reclamation of organic and clay-bonded systems. Sand grain surfaces are not smooth; they have numerous crevices and indentations. The application of heat with sufficient oxygen calcines the binders or burns off organic binders. Separate mechanical attrition units may be required to remove calcined inorganic binders. Heat offers a simple method of reducing the encrusted grains of molding sand to pure grains. Both horizontal and vertical rotary kiln and fluidized bed systems are available. Foundries should examine the regulatory requirements of using thermal systems to treat waste sand. The use of these systems may need to be permitted as waste incineration.

Carondelet Foundry Company in Pevely, Missouri installed a fluidized bed thermal sand reclamation unit and a mechanical reclaimer in 1994 to treat its phenolic urethane no-bake and phenolic urethane Isocure sand. The steel jobbing shop was sending on average 150 tons per day of waste sand off-site for landfill disposal at a cost of about \$29 per cubic yard. In addition, new sand was costing approximately \$22 per ton. The thermal system processes 125 tons per day and the mechanical system processes the remaining 25 tons. Only 5 percent of the foundry's sand is not reclaimed. The reclamations system is estimated to save the foundry over \$1 million per year and payed for itself in under a year. In addition, the foundry feels that the reclaimed sand is better than new sand and results in better castings (Philbin, 1996).

*Rotary Drum.* This system has been used since the 1950s for reclaiming shell and chemically bonded sands. The direct-fired rotary drum is a refractory-lined steel drum that is mounted on casters. The feed end is elevated to allow the sand to flow freely through the unit. The burners can be at either end of the unit with direct flame impingement on the cascading sand; flow can be either with the flow of solids or counter to it.

In indirect-fired units, the drum is mounted on casters in the horizontal position and is surrounded by refractory insulation. Burners line the side of the drum, with the flames in direct contact with the metal drum. The feed end is elevated to allow the sand to flow freely through the unit, and in some cases flights (paddles connected by chains) are welded to the inside to assist material flow.

*Multiple-Hearth Vertical Shaft Furnace.* This furnace consists of circular refractory hearths placed one above the other and enclosed in a refractory-lined steel shell. A vertical rotating shaft through the center of the furnace is equipped with air-cooled alloy arms containing rabble blades (plows) that stir the sand and move it in a spiral path across each hearth.



Sand is repeatedly moved outward from the center of a given hearth to the periphery, where it drops through holes to the next hearth. This action gives excellent contact between sand grains and the heated gases. Material is fed into the top of the furnace. It makes its way to the bottom in a zigzag fashion, while the hot gases rise counter-currently, burning the organic material and calcining clay, if one or both are present. Discharge of reclaimed sand can be directly from the bottom hearth into a tube cooler, or other cooling methods may be used. The units are best suited to large tonnages (five tons or more).

New approaches and equipment designed for sand reclamation units are continuing to evolve, and foundries must evaluate each system carefully with regard to the suitability for a particular foundry operation.

In 1988, R.H. Sheppard Company, Inc. in Hanover, Pennsylvania installed a thermal sand reclamation system to recover its 2,200 tons per year of waste green sand. Between the sand purchase price and disposal costs, the foundry was spending over \$180,000 per year. Even considering the \$428,500 capital investment and regular operation and maintenance costs, over the 20 year useful life of the equipment, the company estimates it will save about \$2 million. This does not include the intangible savings of reduced liability of waste sand disposal (Pennsylvania DEP, 1996).

#### *Use Sand as a Construction Material*

Depending on its physical and chemical characteristics, non-hazardous waste foundry sand can be used as construction material assuming a market can be found and federal, state, and local regulations relating to handling, storage, and disposal allow it. Many foundries currently recycle foundry waste sand for construction purposes. Industry research, however, indicates that only a small portion of the potential market for waste sand is being utilized. Some potential construction uses for waste sand include: feed stock for portland cement production; fine aggregate for concrete; fine construction aggregate for fill; and bituminous concrete (asphalt) fine aggregate.

Since late 1993, Viking Pump, Inc., of Cedar Falls, Iowa has been shipping spent sand to a portland cement manufacturer for use as a raw material. This reuse reduces the costs for the cement company because the need for mining virgin sand is reduced. Landfill costs for the foundry have been reduced creating a win-win situation for both companies. When Viking began testing foundry sand for use in cement manufacturing, the sand was loaded with an endloader into grain trucks for hauling to the cement plant. Completing a loading took almost an hour. Once the cement company decided that the waste sand was compatible with its process, Viking invested in a sand silo for storage. The sand is now conveyed to the silo and gravity fed into trucks for transportation, significantly reducing handling time to six minutes. Viking expects to send at least half of the spent foundry sand to the portland cement manufacturer and is continuing to look for alternative uses to achieve its pollution prevention goals (U.S. EPA Enviro\$en\$e Website, 1996).

Not all foundry sand will be ideal for all construction uses. For example, although many foundry sands actually increase compression strengths of concrete when used as a fine aggregate, green molding sands have been shown to decrease compression strengths. In addition, foundries will probably not be able to find markets for their waste sand in its “as-generated” condition. Some processing is typically required in order to match the customers’ product specifications. Waste sand may first need to be dried, crushed, screened and separated from metals.

Waste sand streams from certain foundry processes could render a foundry’s entire waste sand stream worthless if mixed together. A material flow diagram detailing the flow of sand and its characteristics (particle size distribution, mineralogical composition, moisture content, and chemical and contaminant concentration) through the production processes will help foundry operators identify those spent sand generation points that must be separated out for either processing and sale to a customer or for disposal in a landfill.

## V.B. Metal Melting Furnaces

The metal casting industry is highly energy intensive and therefore has opportunities to prevent pollution through increasing energy efficiency. The majority of the energy is consumed by the furnaces used to melt metal; however, energy used in heat curing of sand molds can also be significant depending on the process used (DOE, 1996). Increases in energy efficiency in metal casting operations may have the dual pollution prevention effect of reducing fossil fuel consumption (and the associated environmental impacts) and reducing the amounts of wastes generated from furnaces and curing ovens (e.g., hazardous desulfurization slag, dust, VOCs, etc.). Since energy costs can be a large portion of a metal caster’s overall operating costs, increases in energy efficiency can also result in significant cost savings.

*Improve Furnace Efficiency*

Currently, many foundry furnaces are less than 35 percent energy efficient. Facilities using reverberatory or crucible furnaces may have opportunities to improve their furnace efficiency and stack emissions by upgrading their combustion system (DOE, 1996). New oxygen burners and computerized gas flow metering systems have helped a number of facilities to comply with Clean Air Act regulations for NO<sub>x</sub> and CO emissions while reducing energy costs. Some foundries are utilizing regenerative ceramic burner systems. The systems are comprised of two burners which function alternately as a burner and an exhaust port. When one burner fires, the other collects the exhaust gases, recouping the heat from the waste gases. In the next cycle, this burner then fires, recombusting the gases. The recombustion of the waste gases ensures complete combustion and has been shown to reduce NO<sub>x</sub> formation. One firm implementing this system reported a 33 percent reduction in energy use and a better melting rate, improving production capacity (Binczewski, 1993).

*Install Induction Furnaces*

Induction furnaces may offer advantages over electric arc or cupola furnaces for some applications. Induction furnaces are about 75 to 80 percent energy efficient and emit about 75 percent less dust and fumes because of the absence of combustion gases or excessive metal temperatures. When clean scrap material is used, the need for emission control equipment may be minimized. Of course, production operations and process economics must be considered carefully when planning new or retrofit melting equipment (U.S. EPA, 1992).

*Minimize Metal Melting*

Depending on the casting, between reject castings and gating systems, over half of the metal poured into molds may not become a useful part of the casting. This metal needs to be separated from the castings and remelted, usually at a significant cost. Any increases in yield (reductions in the amount of scrap) will result in energy cost savings from eliminating the need for melting the excess metal. In addition, costs of separating scrap from the castings and waste sand, and the time and expense in machining of gating systems may be reduced. Gating system design that increases yield and reduces the need for machining can reduce a foundry's costs. Optimally designed systems will not use any more metal than is necessary while ensuring that the metal flows into the mold cavity properly to minimize casting defects. A number of computer software products are available to optimize casting design. These products simulate mold filling and casting solidification for various designs and can reduce costs by improving quality and reducing scrap.

A number of casting methods use a central sprue gated to a number of individual casting patterns. Such assemblies termed “trees” or pattern clusters, can generate less excess metal than single pattern mold designs. This technique is most commonly used in the investment and lost foam casting methods. A variation of the investment casting method termed, hollow sprue casting, or counter gravity casting, employs a vacuum to fill the mold with molten metal. A mold or mold cluster assembly fabricated using the investment casting technique is placed in a closed mold chamber with only the open end protruding from the bottom. The mold and mold chamber are lowered to the surface of a ladle or crucible of molten metal until the mold opening is below the surface. A vacuum is then applied to the mold chamber and mold, forcing the molten metal to rise and fill the mold and gating system. The vacuum is maintained until the casting and gates have solidified and is released before the sprue has solidified. The sprue metal then drains back into the molten metal for reuse. If the gating system is designed properly, over 90 percent of the metal becomes part of the useful casting.

#### *Use Alternative Fuels for Melting*

Some melt furnaces can utilize natural gas or fuel-oil as a fuel source. Particulate emissions from fuel oils tend to be much greater than emissions from natural gas combustion. If fuel oil must be used, particulate emissions can be reduced by using a lower grade of fuel oil. Petroleum distillates (Numbers 1 and 2 fuel oil) will result in lower particulate emissions than heavier grade fuels (Nos. 4,5,6). Sulfur dioxide emissions can be reduced by choosing a fuel with a low sulfur content. Emissions of nitrogen oxides result from the oxidation of nitrogen bound in the fuel. Selection of a low nitrogen fuel oil will reduce NO<sub>x</sub> emissions (NADCA, 1996).

Air emissions from the operation of furnaces can be further reduced by using natural gas as a fuel source. Natural gas is considered a clean fuel which, when combusted, emits relatively small amounts of SO<sub>x</sub> and particulate matter. The primary emission resulting from the combustion of natural gas is nitrogen oxides. NO<sub>x</sub> emissions can be reduced by applying alternative firing techniques, including the recirculation of flue-gas, staged combustion, and the installation of low NO<sub>x</sub> burners (NADCA, 1996).

Proper maintenance of furnaces will also help to reduce air emissions. Inefficient fuel/air mixing may generate excess particulate emissions.

### V.C. Furnace Dust Management

Dust generation, especially in the Electric Arc Furnace (EAF), and its disposal, has been recognized as a serious problem, but one with potential for pollution prevention through material recovery and source reduction. EAF dust can have high concentrations of lead and cadmium. Some EAF dust can be shipped off-site for zinc reclamation. Most of the EAF dust recovery options are only economically viable for dust with a zinc content of at least 15 - 20 percent (U.S. EPA, 1995).

In-process recycling of EAF dust may involve pelletizing and then reusing the pellets in the furnace, however, recycling of EAF dust on-site has not proven to be technically or economically competitive for all foundries. Improvements in technologies have made off-site recovery a cost effective alternative to thermal treatment or secure landfill disposal.

#### *Maintain Optimal Operating Parameters*

Dust emissions from furnaces can often be minimized through a number of good operating practices. Such practices include: avoiding excessive superheating of the metal; maintaining a sufficient flux or slag cover over the metal to keep the molten metal separated from the atmosphere; preheating the metal charged; avoiding the addition of metals at maximum furnace temperatures; and avoiding the heating of the metal too fast.

#### *Recycle EAF Dust to the Original Process*

EAFs generate 1 to 2 percent of their charge into dust or fumes. If the zinc and lead levels of the metal dust are low, return of the dust to the furnace for recovery of base metals (iron, chromium, or nickel) may be feasible. This method may be employed with dusts generated by the production of stainless or alloy steels. However, this method is usually impractical for handling dust associated with carbon steel production because galvanized metal scrap is often used and the recovered dust tends to be high in zinc (U.S. EPA, 1992).

Many methods have been proposed for flue-dust recycling, including direct zinc recovery. Zinc content can be increased to the required 15 to 20 percent by returning the dust to the furnace from which it is generated. If the dust is injected into the furnace after the charge of scrap metal is melted, temperatures are high enough for most of the heavy metals to fume off. This technique results in an increased zinc concentration in the dust collected by the scrubbers, electrostatic precipitation systems, or baghouses (U.S. EPA, 1992).

*Recycle Dust Outside the Original Process*

Silica-based baghouse dust from sand systems and cupola furnaces may be used as a raw material by cement companies. The dust is preblended with other components and transferred to a kiln operation. It is envisioned that baghouse dusts may constitute 5 to 10 percent of the raw material used by cement manufacturers in the future. The use of higher levels may be limited by adverse effects of the baghouse dust on the setting characteristics of the cement (U.S. EPA, 1992).

Waste EAF dust can be reused outside the original process by reclaiming the zinc, lead, and cadmium concentrated in emission control residuals. The feasibility of such reclamation depends on the cost of dust treatment and disposal, the concentration of metals within the residual, the cost of recovering the metals, and the market price for the metals. While this approach is useful in the nonferrous foundry industry (i.e., brass foundries), its application within gray iron foundries is extremely limited. Some foundries market furnace dust as input to brick manufacturing and other consumer product applications, but product liability limits this option. Recovery methods include: pyrometallurgical, rotary kiln, electrothermic shaft furnace, and zinc oxide enrichment (U.S. EPA, 1992).

Pyrometallurgical methods for metals recovery are based on the reduction and volatilization of zinc, lead, cadmium, and other components of EAF dust. Lead is removed preferentially through roasting in an oxidizing environment, while zinc, cadmium and other metals are removed through roasting under reducing conditions. The rotary (or Waelz) kiln method can simultaneously reduce ferrous iron oxide to solid iron and lead and zinc oxide to their metallic forms, using a reducing atmosphere such as carbon monoxide and hydrogen. However, rotary kilns must be fairly large and must process large volumes of dust to be economically and thermally efficient. The electrothermic shaft furnace can extract metallic zinc from a feed containing at least 40 percent of the metal. Typically, agglomerated EAF dust is mixed with other feed to attain this percentage. To recycle dust by direct reduction of oxides, iron oxide is reduced to iron and water using pure hydrogen at a temperature range of 1000 to 1100°C. The reduction of zinc oxide produces zinc vapors and steam at 1000 to 1100°C that are removed from the furnace and subjected to an oxidation step. The zinc reacts with water to produce zinc oxide, and hydrogen is removed and recycled. The zinc oxide produced is separated in a baghouse. The hydrogen containing the steam is further treated for steam condensation, and then the hydrogen is ready for recycling into the furnace (U.S. EPA, 1992).

*Alter Raw Materials*

The predominant source of lead, zinc, and cadmium in ferrous foundry baghouse dust or scrubber sludge is galvanized scrap metal used as a charge material. To reduce the level of these contaminants, their source must be identified and charge material containing lower concentrations of the contaminants must be acquired. A charge modification program at a large foundry can successfully reduce the lead and cadmium levels in dust collector waste to below EP-toxicity values. Foundries need to work closely with steel scrap suppliers to develop reliable sources of high-grade scrap.

**V.D. Slag and Dross Management***Minimize Hazardous Desulfurizing Slag*

In the production of ductile iron, it is often necessary to add a desulfurizing agent in the melt to produce the desired casting microstructure. One desulfurization agent used commonly is solid calcium carbide ( $\text{CaC}_2$ ). Calcium carbide is thought to decompose to calcium and graphite. The calcium carbide desulfurization slag is generally removed from the molten iron in the ladle and placed into a hopper. For adequate sulfur removal,  $\text{CaC}_2$  must be added in slight excess. Since an excess of  $\text{CaC}_2$  is employed to ensure removal of the sulfur, the resulting slag contains both  $\text{CaS}$  and  $\text{CaC}_2$  and must be handled as a reactive waste. The slag might also be hazardous due to high concentrations of heavy metals (U.S. EPA, 1992).

Treatment of this material consists normally of converting the carbide to acetylene and calcium hydroxide by reacting with water. Problems with this method include handling a potentially explosive waste material; generating a waste stream that contains sulfides (due to calcium sulfide in the slag) and many other toxic compounds; and liberating arsine, phosphine, and other toxic materials in the off gas (U.S. EPA, 1992).

One way to reduce the need for calcium carbide is to reduce the amount of high sulfur scrap used as furnace charge materials. While this method is effective, the ability to obtain a steady supply of high-grade scrap varies considerably and may be uneconomical (U.S. EPA, 1992).

To eliminate entirely the use of calcium carbide, several major foundries have investigated the use of alternative desulfurization agents. One proprietary process employs calcium oxide, calcium fluoride, and two other materials. The process can be more economical than carbide desulfurization and results in a satisfactory iron quality (U.S. EPA, 1992).

Often, the amount of sulfur removal for a product is based not on the requirements of that product but on what is achievable in practice. When total sulfur removal is required, it is not uncommon that 20 to 30 percent excess carbide is employed resulting in the generation of larger amounts of slag. If the iron were desulfurized only to the extent actually needed, much of this waste could be reduced or eliminated (U.S. EPA, 1992).

#### *Recycle Hazardous Desulfurizing Slag*

Because calcium carbide slag is often removed from the metal by skimming, it is not uncommon to find large amounts of iron mixed in with the slag. Depending on the means of removal, this metal will either be in the form of large blocks or small granules. To reduce metal losses, some foundries crush the slag and remove pieces of metal by hand or with a magnet for remelting. Other foundries have investigated recharging the entire mass to the remelting furnace. Inside the furnace, calcium hydroxide forms in the slag as the recycled calcium carbide either removes additional sulfur or is oxidized directly. While this method has been successful, more research is necessary. For example, it is not known to what extent the calcium sulfide stays with the slag or how much sulfur is carried in the flue gas and the scrubber system. Initial tests indicate that the sulfur does not concentrate in the metal, so that product quality is not affected (U.S. EPA, 1992).

Slag from stainless steel melting operations (where Ni, Mo, and Cr metals are used as alloy additions) is hazardous as a result of high chromium concentrations. Such slag can be recycled as a feed to cupola furnaces (gray iron production line). The cupola furnace slag scavenges trace metals from the induction furnace slag. The resulting cupola slag may be rendered a nonhazardous waste (U.S. EPA, 1992).

#### *Minimize Air Emissions During Dross and Slag Removal*

Emissions resulting from the removal of dross and slag can be reduced by decreasing the time in which the dross is exposed to the air. This is true for dross and slag removal processes throughout the facility (e.g., melting, laundering, die casting). Dross and slag pots should be covered as soon as possible to eliminate emissions to the atmosphere. Alternative dross and slag handling techniques can also be practical to reduce emissions. Dross and slag pots can be positioned under or near exhaust hoods in order to divert the emissions to a filter or other emission control device (NADCA, 1996).



**V.E. Wastewater***Reduce Phenols in Die Casting Wastewater Streams*

The major pollutants in the wastewater streams from die casting operations are oils and phenols, with the phenols being the regulated pollutant in most wastewater discharge situations. Common sources of phenols in die casting are the various oils used in the process, such as phosphate ester-based hydraulic oil, die lube, way lube, die cast coolant, etc. Cast salts, degreasers, and heat transfer oils may also contain phenols as an impurity (NADCA, 1996).

An effective method for source control of phenols would be to check each individual raw material used in die casting for phenols, and use or substitute with materials which have little or no phenols. For example, petroleum oils which often contain phenols as contaminants may be substituted with synthetic oils or water-based materials that contain no phenols. Although the alternative materials can be more costly than petroleum-based oils, the annual incremental cost increase may not be significant depending on the volume of material used. In addition, anticipated reductions in environmental control costs may outweigh potential raw material cost increases (NADCA, 1996).

Another effective method of reducing or eliminating phenols in wastewater consists of segregating the various waste streams at the point of generation by collecting the materials in catch pans and handling them separately. For example, die lube overspray can be collected in a metal pan installed below the die, screened to remove debris, filtered (if necessary) to remove fine particulate matter, treated (if necessary) for bacteria contamination, and recycled for reuse in the plant. Plunger lubricants and other drippings may also be collected in pans and recycled off-site as used oil (NADCA, 1996).

*Reduce Wastewater and Sludge Generation*

Water used to cool parts can be reduced by implementing cooling water recycling systems. Further wastewater reductions may be accomplished by optimizing deburring operations to minimize the total suspended solids in wastewater. This, in turn, will reduce the sludge generation from subsequent treatment. Sludge dewatering can also be optimized through the use of pH controls and filter aids (such as diatomaceous earth) to produce a drier filter cake prior to land disposal.

R.H. Sheppard Company, Inc. in Hanover, Pennsylvania used large quantities of fresh water for cooling metal parts as they were ground to fine tolerances. The company installed a 16,000 gallon closed loop cooling system with temperature and bacteria controls which improved the grinding process and saves 3.4 million gallons of water per year. From its reduced coolant disposal costs and savings in water costs, R.H. Sheppard Company expects a two- to three-year payback period on its \$540,000 investment (Pennsylvania DEP, 1996).

#### *Reduce VOC Emissions from Cooling and Quench Water*

The primary cause of air emissions from non-contact cooling water cooling towers and quench baths is the use of additives, such as biocides, which contain volatile organic compounds that are eventually emitted to the atmosphere. The best method for reducing air emissions from cooling towers and quench baths is to use fewer additives or to use additives containing no VOCs or Hazardous Air Pollutants (HAPs) (NADCA, 1996).

#### **V.F. Die Casting Lubrication**

The majority of emissions generated during the die casting process come from the application of die lubes. These emissions consist of VOC, particulate matter, and HAPs. VOC emissions from die lube application can be reduced by the use of water-based die lubricants or solid lubricants. Eliminating the volatile components of petroleum-based lubricants will also reduce VOC emissions when wet milling finishing techniques are used. However, it is important to note that lubricants which reduce VOC emissions may not necessarily reduce HAP emissions and, in some cases, HAP emissions may be greater from water-based die lubes. Apparently, some of the solvent replacement additives in water-based lubricants may result in increased HAP emissions. It is important to thoroughly evaluate the potential implications for air emissions before alternative lubricant products are used (NADCA, 1996).

In the same manner as VOC emissions, alternative lubricants can be used to reduce particulate emissions from the application of die lubes. However, lubricant-specific evaluations should be performed to determine the particulate emission reduction potential of individual lubricant changes (NADCA, 1996).

#### **V.G. Miscellaneous Residual Wastes**

The generation of solid wastes from shipping and receiving processes can be minimized through the use of reusable packaging materials. Metal casters can seek suppliers that use these materials, and work with customers to initiate their use of reusable shipping materials. Many of the common packaging materials in use today, including shrink wrap, strapping materials, cardboard,

totes, and drums, can be recycled off-site using commercial recycling services. (NADCA, 1996)

Dross from melting operations is commonly sold to secondary smelters for recovery of the valuable metals. Die casting shot-tip turnings can be re-sized on-site and re-used in the original process (NADCA, 1996).

Leaking hydraulic fluid from die cast machines can be segregated from other die cast fluids using drip pans and/or containment curbing. Leaking and spent hydraulic fluids may be collected and recycled as used oil. Used oil recycling options include re-refining and burning the material for energy recovery in space heaters, boilers, or industrial furnaces (NADCA, 1996).

Refractory, coils, and servicing tools must be periodically replaced in the melting and conveyance operations due to wear. Although the generation of these materials cannot be eliminated, their generation rates can be minimized by raising the pollution prevention awareness of maintenance personnel and optimizing maintenance and servicing schedules (NADCA, 1996).

The generation of floor absorbent solid waste at die cast machines can be minimized through the use of drip pans and containment berming. Hydraulic fluids, die release agents, way lubricants, and other leaking fluids can be collected in this manner. If floor absorbents are to be used, launderable absorbents should be considered. These absorbents are becoming available increasingly from industrial suppliers and laundry services, and can be reused over and over. The use of launderable absorbents results in reduced landfill disposal for both the absorbents and the recovered fluids (NADCA, 1996).

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## 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), 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, 32 (except 323)-stone, clay, glass, and concrete, 33-primary metals, 3441-fabricated structural metal, and 373-ship and boat building and repairing.

**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, volatile organic compounds (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 may go into effect as early as late 1997.

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.

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 Clean Air 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 Clean Air Technology Center's website includes recent CAA rules, EPA guidance documents, and updates of EPA activities ([www.epa.gov/ttn](http://www.epa.gov/ttn) then select Directory and then CATC).*



**VI.B. Industry Specific Requirements***Resource Conservation and Recovery Act (RCRA)*

Under the authority of RCRA, EPA created a regulatory framework that addresses the management of hazardous waste. The regulations address the generation, transport, storage, treatment, and disposal of hazardous waste.

The metal casting industry generates waste during molding and core making, melting operations, casting operations, and finishing and cleaning operations. The wastes that are produced during these processes which meet the RCRA hazardous waste criteria must be handled accordingly.

Molding and core making operations produce large quantities of spent foundry sand. Although most of the spent sand is non-hazardous, sand that results from the production of brass or bronze may exhibit the toxicity characteristic for lead or cadmium. The hazardous sand may be reclaimed in a thermal treatment unit which may be subject to RCRA requirements for hazardous waste incinerators. EPA is currently taking public comment on the regulatory status of these units. Wastewaters that are produced during molding and core making may exhibit the corrosivity characteristic but are generally discharged to a POTW after being neutralized, in which case they are not subject to RCRA. Sludges resulting from mold and core making may also be corrosive hazardous wastes.

The wastes associated with metal casting melting operations include fugitive dust and slag. Lead and chromium contamination may cause the waste slag to be subject to RCRA as a hazardous waste. Additionally, calcium carbide desulfurization slag generated during metal melting could be a reactive hazardous waste. Spent solvents used in the cleaning and degreasing of scrap metal prior to melting may also be a hazardous waste. The inorganic acids and chlorinated solvents used in the cleaning operations could be subject to RCRA as well, if they are spilled or disposed of prior to use.

Casting facilities that use electric arc furnaces (EAF) for metal melting produce dust and sludge that may be characteristically hazardous. However, the emission control dust and sludge from foundry operations that use EAFs is not within the K061 hazardous waste listing. Also, this dust and sludge is not considered to be a solid waste under RCRA when reclaimed.

Finishing operations produce wastes similar to those resulting from the cleaning and degreasing of scrap metal prior to melting, including spent solvents and alkaline cleaners. Additionally, any sludge from spent pickle liquor recovery generated by metal casting facilities (SIC code 332) would be a listed hazardous waste (K062).

*Clean Air Act*

The CAA New Source Review (NSR) requirements apply to new facilities, expansions of existing facilities, or process modifications. New sources of the NAAQS "criteria" pollutants in excess of "major" levels defined by EPA are subject to NSR requirements (40 CFR §52.21(b)(1)(i)(a)-(b)). NSRs are typically conducted by the state agency under standards set by EPA and adopted by the state as part of its state implementation plan (SIP). There are two types of NSRs: Prevention of Significant Deterioration (PSD) reviews for those areas that are meeting the NAAQS; and nonattainment (NA) reviews for areas that are violating the NAAQS. Permits are required to construct or operate the new source for PSD and NA areas.

For NA areas, permits require the new source to meet lowest achievable emission rate (LAER) standards and the operator of the new source must procure reductions in emissions of the same pollutants from other sources in the NA area in equal or greater amounts to the new source. These emission offsets may be banked and traded through state agencies.

For PSD areas, permits require the best available control technology (BACT), and the operator or owner of the new source must conduct continuous on-site air quality monitoring for one year prior to the new source addition to determine the effects that the new emissions may have on air quality.

EPA has not established New Source Performance Standards (NSPSs) for the metal casting industrial category.

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 permits, for the most part, began to be due in late 1995. Due dates for filing complete applications vary 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 if it includes sources subject to the NSPS acid rain provisions or NESHAPS, or if it releases a certain amount of any one of the CAAA regulated pollutants ( $\text{SO}_x$ ,  $\text{NO}_x$ , CO, VOC,  $\text{PM}_{10}$ ), 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 and require emissions monitoring, recordkeeping, and reporting.

Many large and some medium-sized foundries are likely to be major sources and therefore must apply for a Title V permit. Selected small foundries may also be classified as major sources, depending on their location and operational factors.

#### *Clean Water Act*

Foundry and die casting facility wastewater released to surface waters is regulated under the CWA (40 CFR Part 464). National Pollutant Discharge Elimination System (NPDES) permits must be obtained to discharge wastewater into navigable waters (40 Part 122). Effluent limitation guidelines, new source performance standards, pretreatment standards for new sources, and pretreatment standards for existing sources for the Metal Molding and Casting Point Source Category apply to ferrous and non-ferrous foundries and die casters and are listed under 40 CFR Part 464 and are divided into subparts according to the metal cast:

Subpart A	Applies to aluminum casting operations
Subpart B	Applies to copper casting operations
Subpart C	Applies to ferrous casting operations
Subpart D	Applies to zinc casting operations

In addition to the effluent guidelines, 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 (Contact Pat Bradley, EPA Office of Water, 202-260-6963). As shown above, pretreatment standards applying specifically to the metal casting point source category are listed in the subparts of 40 CFR Part 464 (Contact: George Jett, EPA Office of Water, 202-260-7151).

Stormwater rules require that metal casting 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. The rules require that certain facilities with storm water discharge from from industrial activity apply for storm water permit applications (see Section VI.A).

*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). The metals and metal compounds used in metal casting, are often found in casting facilities’ air emissions, water discharges, or waste shipments for off-site disposal. These include chromium, manganese, aluminum, nickel, copper, zinc, and lead. Metals are frequently found at CERCLA's problem sites. In 1989, when Congress ordered EPA and the Public Health Service's Agency for Toxic Substances and Disease Registry (ATSDR) to list the hazardous substances found most commonly at problem sites and that pose the greatest threat to human health, lead, nickel, and aluminum all made the list (Breen and Campbell-Mohn, 1993). A number of sites containing foundry wastes are on the National Priorities (Superfund) List. Compliance with the requirements of RCRA lessens the chances that CERCLA compliance will be an issue in the future.

## VI.C. Pending and Proposed Regulatory Requirements

### *Resource Conservation and Recovery Act (RCRA)*

Currently, the practice of adding iron dust or filings to spent foundry sand as a form of stabilization is subject to case-specific interpretation by EPA regarding whether this activity effectively treats the waste. However, EPA has proposed to regulate this activity as impermissible dilution, which is strictly prohibited under the land disposal restrictions program, and intends to examine the issue further.

Thermal processing or reclamation units (TRUs) remove contaminants from spent foundry sand primarily by combusting the organic binder materials in the sand. These units are identified as foundry furnaces under the definition of industrial furnace and are subject to regulation under 40 CFR Part 266, Subpart H when they burn hazardous waste. However, EPA did not consider whether TRUs would be appropriately controlled under these standards. EPA has proposed two approaches to ensure controls for TRUs. The first option is a deferral from regulation under 40 CFR Part 266, Subpart H. This would allow development of the foundry maximum achievable control technology under the Clean Air Act and potentially the application of these controls to TRUs that process hazardous waste sand. The second option is to provide a variance from the RCRA definition of solid waste. Under the variance provisions, EPA may grant a variance from the definition of solid waste for materials that are reclaimed and used as a feedstock within the original production process if the reclamation process is an essential part of the production process. Under this option, TRUs would not be subject to RCRA regulation, but could be regulated under the Clean Air Act or state or local air pollution laws (EPA, RCRA Hotline, 1997).

### *Clean Air Act*

In addition to the CAA requirements discussed above, EPA is currently working on or will be working on additional regulations that will directly affect the metal casting industry. Under Title III, EPA is required to develop national standards for 189 hazardous air pollutants (HAPs) some of which are emitted from foundries. NESHAP standards may limit the air emissions from foundries through Maximum Achievable Control Technology (MACT) based on performance standards that will set limits based upon concentrations of HAPs in the waste stream. NESHAP standards for ferrous foundries are scheduled to be promulgated by EPA in November of 2000 (James Maysilles, U.S. EPA, Office of Air, (919) 541-3265). Non-ferrous foundries and die casting facilities will not be subject to NESHAP standards.

EPA is also developing the Compliance Assurance Monitoring Rule. The rule may require monitoring of certain emissions from certain facilities. Facilities are required to pay a fee for filing for a permit and are required to pay an annual fee based on the magnitude of the facility's potential emissions.