Appendix C - Michigan Toxic Emissions Inventory

BACKGROUND

The State of Michigan conducted its 1999 portion of the Great Lakes Region air toxic emissions inventory by collecting new point and area source, throughput and emissions data for the 1999 inventory year.

The 1999 inventory covers all measured point sources from the 1999 Michigan Air Emissions Reporting System (MAERS) and fourteen area source categories. Namely, agricultural pesticides, architectural surface coatings, autobody refinishing, consumer commercial solvents, dry cleaning, gasoline marketing, graphic arts, halogenated solvent degreasing, human cremation, industrial surface coatings, lamp breakage, lamp recycling, residential wood burning, and structure fires. Landfills were included in the point source inventory.

The 1999 point source inventory is a new, bottom up, emissions estimate for all of Michigan's eighty-three counties. The area source emissions are also generated from new bottom up, throughput and census data except for one category. Structure fire emissions were first estimated in 1998, and those data have been carried forward. Emphasis was placed on both point source and area source MERCURY emissions with this inventory. This led to adding MERCURY emission factors to 19 new SCC codes. Mobile source emissions are not reported because 1999 criteria emissions data for the new on-road and off-road models (Mobile 6 and The Nonroad Emissions Model), necessary for calculating the toxic air pollutants, have not been released by the Environmental Protection Agency (EPA) as of this reporting date.

Michigan followed the *Air Toxic Emissions Inventory Protocol for the Great Lakes Commission* in developing its inventory. The Factor Information Retrieval System (FIRE), reference tables from the Regional Air Pollutant Inventory Development System (RAPIDS), emission factors specific to the State of Michigan, and individual stack tests were used as sources of emission factors and constants. MAERS and RAPIDS software along with some spreadsheets were used to estimate emissions.

DATA SOURCES

Point Emissions Data Sources

Data for point source emissions were collected by the Michigan Department of Environmental Quality (DEQ), Air Quality Division (AQD) as part of its annual air emissions inventory process. A facility air emissions report is required under the administrative rules of the Michigan Department of Environmental Quality, under authority of Act 348, P.A. 1965, and by Section 182 (a) (3) (B) of the Clean Air Act. Data was collected from 1898 facilities under these reporting requirements. This data is deemed to be of high accuracy as it has been quality assured and used for criteria pollutant fee billings. A shortcoming is that the data collected contains little

reported toxic pollutant emission information. Michigan does not have a strong toxic emissions reporting requirement.

Operator supplied criteria pollutant data was used in MAERS to estimate toxic emissions for the processes within each facility. The FIRE tables contain emission factors for both criteria and toxic air pollutants specific to the SCC code representing the process used by the facility. When the throughput for a specific processed material is multiplied times the pollutant specific emission factor an estimate of the air emissions for that pollutant are produced. When adjusted for reductions due to process control equipment or any other process variable, the net emissions of that pollutant are produced. When annualized, the contributions from that specific process are added to all of the other like emissions and the inventory grows. This same procedure is used for all of the processes for all of the sources in the entire state to build the annual state inventory.

There is however a problem soon encountered when building a toxic pollutant inventory in this manner. Not all of the needed toxic pollutant emission factors are present in all of the SCC code related factor tables. The most common problem is that of gaseous toxic pollutants such as formaldehyde or ethylbenzene for example. It is common in emission factor tables to lump all of the gaseous pollutants together as a single pollutant called VOC (volatile organic compounds). This works fine for describing criteria pollutant data where groups of similar pollutant types are all that is required. It does not work well at all for estimating toxic air pollutants where the emphasis is on individual compounds and not groups. The EPA has a set of emission factors known as the Speciate Tables. These tables represent the average composition of VOC for a specific SCC code such as open top degreasers. There are eight or ten common degreasing agents used in open top degreasers. If all of the VOC's from 1000 degreasers are grouped together and the composite VOC analyzed, the result will be a fair representation of the relative contribution of each agent. These factors could then be applied to a composite of 2500 degreasers and would result in a worthwhile estimate of each component. If the Speciate factors are applied to the VOC generated from a single degreaser, the results would be meaningless. A single degreaser would probably only use one or two degreasing agents but would be charged with using all of them. For this reason, Speciate Factors are not used in developing the Michigan point source toxic air pollutant inventory.

There is one more emission factor type that was used in the Michigan inventory. That is the State Specific emission factor. These factors are derived in order to supplement the FIRE emission factors. They are used in exactly the same way as the FIRE factors but are Michigan derived instead of EPA derived. They come from many different data sources, but typically, are from certified stack tests, surrogates used from similar processes, engineering judgment, controlled factors substituted to become uncontrolled factors, developed because Michigan uses a different throughput MATERIAL than may be used with the FIRE factors, negotiated with industrial associations, different factor needed because Michigan uses a different calculation algorithm than the EPA, etc. In every case these emission factors are chosen over any EPA factor.

The MAERS database includes facility SIC codes to identify industry type, and SCC codes to identify process type, control equipment and control efficiencies for each process, fuel and material throughputs for each process within the facility. SCC codes from all sources were

matched against available emission factors from FIRE Versions 6.1, 6.22, or 6.23. Facility specific emission factors were used preferentially when available. State specific emission factors were selected over FIRE factors. Sources with no FIRE or State specific emission factors were assumed to be included in the area source emission calculations.

Point Source Emissions

The 1999 Michigan point source data was collected from each facility, quality audits were performed, and the data was imported into the Michigan Air Emissions Reporting System (MAERS). MAERS was then used to make emission estimates for the toxic air pollutants of interest to the Regional Inventory. A calculation was made for every SCC code identified process which had state specific or generic toxic pollutant emission factors, a proper corresponding throughput material, and a throughput amount. These calculations produced annual emission estimates for 117 different point source toxic air pollutants. The calculated results were exported in National Emissions Inventory (NEI) format for analysis. A second quality assurance audit was performed which found several data manipulation errors and some emission factor discrepancies. Once these errors were corrected the inventory was compared to the Michigan 1998 point source inventory with the following results.

BENZ(A)ANTHR & BENZ(GHI)PE, emissions seemed a little high – Emission Factors matched FIRE6.23, no further action planned; CHROMIUM emissions increased 70,000 pounds from 1998 – emission factors were added after the 1998 inventory; FORMALDEHYDE increased 2,400,000 pounds from last year – new emission factors were added for the 1999 inventory and more will appear in the 2001 inventory, most of the increase from one source which has a material throughput of 3,250,000 tons; MANGANESE increased 80,000 pounds from last year – emission factors added; PHENOL increased 123,000 pounds from last year – emission factors added; STYRENE increased 720,000 pounds and XYLENES ISO decreased 1,100,000 pounds from last year – more accurate reporting of these pollutants; 10x00201 ANTIMONY & SELENIUM missing emissions – fixed for future inventories; 10x00202 CHLOROETHANE missing emissions – fixed for future inventories; 10x00226 BERYLLIUM & CHRYSENE missing emissions – fixed for future inventories; 30500201 missing many pollutants – 21 pollutants added and will appear in the 2001 inventory.

Area Source Emissions

Agricultural Pesticides

The Regional Protocol was followed. State specific emission factors for ATRAZINE and TRIFLURALIN were obtained from Michigan State University.

Architectural Surface Coating

This category was estimated consistent with the Regional Protocol.

Auto Body Refinishing

The regional protocol, alternate method two, was followed. National emissions for the category were allocated to the county level based on census estimates.

Consumer and Commercial Solvent Use

Michigan used the preferred method from the EIIP guidance.

Dry Cleaning

Michigan followed the Regional Protocol recommended EIIP guidance, alternative method two. Employment data for dry cleaning was only available for 13 counties. An emission factor was derived from the average per capita emissions of those 13 counties. This Michigan specific per capita emission factor was then applied to the remaining 70 counties**.**

Fluorescent Lamp Breakage

To estimate emissions of MERCURY from fluorescent lamp breakage, Michigan utilized the methodology from the *1999 Base Year Nonpoint Source National Emission Inventory for Hazardous Air Pollutants,* Appendix A, A-52.

Fluorescent Lamp Recycling

To estimate emissions of MERCURY from fluorescent lamp recycling, Michigan utilized the methodology set forth in the *1999 Base Year Nonpoint Source National Emission Inventory for Hazardous Air Pollutants,* Appendix A, A-30.

Gasoline Marketing (Stage I and II)

The Regional Protocol recommendation to utilize the EIIP guidance was followed. All gasoline marketing (stage I and stage II) emissions are included in this inventory.

Graphic Arts

The Regional Protocol recommending the use of the EIIP guidance was followed. Alternative method two, the per capita emission factor, was the method selected.

Halogenated Solvent Degreasing

Michigan selected the EIIP Alternative Method per the *Recommended Method for Solvent Cleaning Equipment* detailed in the protocol document as updated by Minnesota.

Human Cremation

Michigan followed the recommendations of the Regional Protocol. The human cremations per county for 1999 were obtained from the Michigan Department of Community Health. Emission factors from the NEI were then applied.

Industrial Surface Coating

In accordance with the Regional Protocol, Michigan used alternative method one of the EIIP guidance.

Residential Wood Burning

Michigan followed the methodology in the Regional Protocol using state energy data reports. However, to convert wood use from cords to tons, Michigan used the method proposed in the Emission Inventory Improvement Program (EIIP) guidance.

Structure Fires

Guidance from EIIP Volume III, Chapter 18: *Structure Fires,* was followed. The first alternative method for estimating emissions was used. Due to time constraints 1998 structure fire data was carried forward.

Landfills

This area source category was covered as a point source in Michigan's inventory.

Area Source Emissions

Once the area source emissions were estimated at the county level, the results were aggregated by pollutant for the entire state and added to the 1999 Michigan Air Toxic Pollutant Inventory at the end of this report. Inspection of the data led to the following observations.

An error was found in the 1996 area source emission totals which led to double counting of, METHYLENE CL, PERC, TCE,111, TOLUENE, TRICHLOROETHY, and XYLENES ISO. This led to an over reporting of an aggregate total of 41,000,000 lbs of toxic emissions. These emissions have been removed from the 1999 inventory. 1996 DIBUTYL PHTH emissions were from autobody refinishing. The recommended 1999 autobody refinishing methodology has no emission factor for DIBUTYL PHTH. DICLBENZ,14 emissions seemed high. A review of the recommended methodology for consumer and commercial solvent use showed that the emission factor had been applied correctly.

MERCURY EMISSIONS

The Michigan 1999 NEI data export was queried to identify point source and area source mercury emissions. The data was reviewed by the MDEQ, AQD, Emissions Reporting and Assessment Unit (ERAU) staff to identify instances of unexpected mercury emissions levels.

Noted discrepancies were corrected and the new values entered into the database. In addition 19 SCC codes were found with no mercury emission factors where similar processes did contain factors. New mercury emission factors were added for these SCC codes. Also three area source categories were found with mercury emissions estimating methods which were not a part of the Michigan inventory. These were fluorescent lamp breakage, fluorescent lamp recycling, and human cremation. These have been added to the area source inventory.

Michigan was able to inventory mercury for 67 different SCC code identified processes and 10 different AMS code categories. A table of mercury emissions by SCC or AMS code is at the end of this Appendix.

Table C-1: 1999 Mercury Emissions by Category (lb/yr)

Category		1999
10100201	7439976	1.06634562
10100202	7439976	220.5945354
10100212	7439976	327.1008689
10100218	7439976	2.253284
10100222	7439976	1894.202321
10100226	7439976	166.6443186
10100401	7439976	1.52379998
10100501	7439976	59.29188569
10100601	7439976	5.16837891
10100602	7439976	0.58969558
10100604	7439976	0.45924578
10100902	7439976	3.51397375
10100903	7439976	0.0694735
10200202	7439976	35.3376638
10200212	7439976	28.62086664
10200501	7439976	13.90543979
10200601	7439976	10.71540721
10200602	7439976	37.32936014
10200901	7439976	0.22820165
10200902	7439976	3.73826473
10200904	7439976	0.11006065
10200905	7439976	0.12477476
10200906	7439976	0.03326379
10300206	7439976	64.2766319
10300218	7439976	4.83004396
10300401	7439976	0.044427
10300501	7439976	0.1461222
10300601	7439976	1.612962
10300602	7439976	1.70856133

10300603	7439976	0.89298816
10300902	7439976	0.9663582
10300903	7439976	0.00428109
20100101	7439976	0.064755
20200101	7439976	0.00002976
20200102	7439976	2.80574718
20200201	7439976	111.2487705
20200202	7439976	70.68624256
20200253	7439976	0.4132044
20200254	7439976	0.54523351
30300908	7439976	59.99998
30400301	7439976	236.7925735
30400304	7439976	21.220807
30500205	7439976	0.0685064
30500251	7439976	0
30500255	7439976	0.00284342
30500311	7439976	1.07346052
30500706	7439976	67.1999969
30600106	7439976	15.38311387
31000299	7439976	2.04969447
39999994	7439976	2.52999997
50100102	7439976	1295.2096
50200501	7439976	49.56000042
50200504	7439976	0
50200505	7439976	0.35543507
50300102	7439976	0.00034528
50300111	7439976	0.000952
50300506	7439976	162.056257
50300601	7439976	0
50400201	7439976	0
2810060100	7439976	9.8124
2861000000	7439976	68.84
31301200	7439976	0.0065143

RESULTS

The toxic emissions for Michigan are listed in the table following R*eferences.* The values are expressed in total pounds per year of pollutant by inventory type. As indicated in the text, point source emissions were calculated at the process level, but have been aggregated to and are only reported at the state level. An electronic database of toxic emissions, NEI format, for the state of Michigan, is available at the process level upon request. For additional information, contact the Michigan Department of Environmental Quality, Air Quality Division, Emissions Reporting and Assessment Unit.

Michigan was only able to estimate emissions for 146 of the 213 toxic air pollutants of concern. This was due to lack of emission factors, throughput data, production or handling data, products no longer manufactured, products no longer used, or a lack of resources. For example Michigan was not able to produce area source emissions for *Traffic Markings* as we received MSDS data from the paint supplier too late to be included in the inventory. *References* and a toxic emissions summary table follow.

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INFORMATION

For more information about Michigan's emissions inventory, please contact:

Michigan Department of Environmental Quality
Air Quality Division, Emissions Reporting and Assessment Unit.
Constitution Hall, Third Floor
P.O. Box 30260
Lansing, MI 48909

(P) 517-373-7023
(F) 517-373-1265

Table C-2: Michigan - Statewide Emissions (lb/yr)

Pollutant	Point Sources	Area Sources	TOTAL
1,1,1-TRICHLOROETHANE	3018.087055	5799978.225	5802996.312
1,1,2,2-TETRACHLOROETHANE	1267.735829		1267.735829
1,1,2-TRICHLOROETHANE	5.97823198		5.97823198
1,1-DICHLOROETHANE	1536.203173		1536.203173
1,2,3,4,6,7,8- HEPTACHLORODIBENZODIOXIN	0.00001187		0.00001187
1,2,3,4,6,7,8-HEPTACHLORODIBENZOFURAN	0.00000274		0.00000274
1,2,3,4,7,8-HEXACHLORODIBENZODIOXIN	0.00002609		0.00002609
1,2,3,7,8- PENTACHLORODIBENZODIOXIN	0.00001316		0.00001316
1,2,3,7,8,9-HEXACHLORODIBENZODIOXIN	0.00000056		0.00000056
1,2,3,7,8,9-HEXACHLORODIBENZOFURAN	0.00004488		0.00004488
1,2-DIBROMOETHANE	59.16545769		59.16545769
1,2-DICHLOROETHANE	1322.162634	1981.903	3304.065634
1,3-BUTADIENE	689.0890528		689.0890528
1,3-DICHLOROPROPENE	18.14182924	1578204	1578222.142
1,4-DICHLOROBENZENE	26.35851327	768388.0269	768414.3854
1,4-DIOXANE	0.0438	98.6383	98.6821
2,2,4-TRIMETHYLPENTANE	295.8240166	246605.47	246901.294
2,3,7,8-TETRACHLORODIBENZODIOXIN	0.00035533		0.00035533
2,3,7,8-TETRACHLORODIBENZOFURAN	0.02975828		0.02975828
2,4-DINITROPHENOL	4.28312467		4.28312467
2,4-DINITROTOLUENE	6.70834719		6.70834719
2-CHLOROACETOPHENONE	80.61853163		80.61853163
3,3-DICHLOROBENZIDENE	1		1
4-NITROPHENOL	5.07387085		5.07387085
ACENAPHTHENE	47.59091955	5347.89	5395.48092
ACENAPHTHYLENE	137.3768767	113382.33	113519.7069
ACETALDEHYDE	75302.53577		75302.53577
ACETONITRILE	2321.314994		2321.314994
ACETOPHENONE	359.3757531	84.1379	443.5136531
ACROLEIN	11166.12649	66411.26	77577.38649
ACRYLONITRILE	3188.314894		3188.314894
ALLYL CHLORIDE	0		0
ANILINE	5.01000022		5.01000022
ANTHRACENE	30.57901594	7487.18	7517.759016
ANTIMONY	138.6036866		138.6036866
ARSENIC	6028.121417	0.7383	6028.859717
ASBESTOS	0		0
BENZ(A)ANTHRACENE	180796.6855	10696.16	191492.8455
BENZENE	161535.6432	1627423.305	1788958.949
BENZO(A)PYRENE	2527.737904	2138.92	4666.657904
BENZO(B)FLUORANTHENE	1.54653545	3208.57	3210.116535
BENZO(G,H,I)PERYLENE	747.3373063	2138.92	2886.257306
BENZO(K)FLUORANTHENE	3.18511559	1069.26	1072.445116
BENZYL CHLORIDE	16776.91457		16776.91457
BERYLLIUM	349.8970452	0.034	349.9310452
BIPHENYL	78.4520947		78.4520947
BROMOFORM	934.3769585		934.3769585
BROMOMETHANE	1842.8486	2189758.012	2191600.861
CADMIUM	9397.020139	16.1193	9413.139439
CARBON DIOXIDE	35201387542		35201387542
CARBON DISULFIDE	3380.744368		3380.744368
CARBON TETRACHLORIDE	83.01363493	1433.3008	1516.314435
CARBONYL SULFIDE	200		200
CHLORINE	47893.25131	694300.0628	742193.3141
CHLOROBENZENE	761.8279731	706395.2068	707157.0348
CHLOROETHANE	1103.430669	84962.60278	86066.03345
CHLOROFORM	1629.413407	17893.2684	19522.68181
CHLOROPRENE	0		0
CHROMIUM	72847.51629	1.4672	72848.98349
CHROMIUM (VI)	670.3951891		670.3951891
CHRYSENE	70.11375663	6417.52	6487.633757
COBALT	403.0531678		403.0531678
COKE OVEN EMISSIONS	4679.99984		4679.99984
COPPER	4125.628048		4125.628048
CUMENE	2880.519878	3023.71	5904.229878
CYANIDE	29161.32274		29161.32274

Pollutant	Point Sources	Area Sources	TOTAL
DIBENZO(A,H)ANTHRACENE	5.79946934		5.79946934
DIBUTYL PHTHALATE	2020.03793		2020.03793
DICHLORODIBENZODIOXINS, ALL ISOMERS	0		0
DIETHANOLAMINE	40		40
DIETHYLHEXYL PHTHALATE	2080.381808		2080.381808
DIMETHYL PHTHALATE	0		0
DIMETHYL SULFATE	1150.002411		1150.002411
DIMETHYLFORMAMIDE, N,N-	99	96867.15105	96966.15105
ETHYLBENZENE	14314.85815	883578.4653	897893.3234
ETHYLENE GLYCOL	650.6599942	250822.0156	251472.6756
ETHYLENE OXIDE	1595.14994	148942.9998	150538.1497
FLUORANTHENE	270.9517316	10696.16	10967.11173
FLUORENE	12132.93988	12835.42	24968.35988
FORMALDEHYDE	2980721.429	517289.5781	3498011.007
GLYCOL ETHERS (MISC.)	123685.0771	369816.597	493501.6741
HEPTACHLORODIBENZODIOXIN, ALL ISOMERS	0.01841072		0.01841072
HEPTACHLORODIBENZOFURAN, ALL ISOMERS	0.13502959		0.13502959
HEXACHLORODIBENZODIOXINS, ALL ISOMERS	0.00424933		0.00424933
HEXACHLORODIBENZOFURANS, ALL ISOMERS	0.00947578		0.00947578
HEXACHLOROETHANE	660.00002		660.00002
HYDROCHLORIC ACID	32273513.65	231194.1481	32504707.8
HYDROFLUOROCARBONS	4999.99998		4999.99998
HYDROGEN FLUORIDE	3914899.529	127.0249	3915026.554
INDENO(1,2,3-C,D)PYRENE	6.06999257		6.06999257
ISOPHORONE	14253.7678	9340.9954	23594.7632
LEAD	85702.45448	17.3187	85719.77318
MANGANESE	173477.2889	109.1592	173586.4481
MERCURY	4986.371354	78.6589143	5065.030269
METHANE	5190077.099		5190077.099
METHANOL	428059.4771	6288812.344	6716871.821
METHOXYCHLOR	319.99998		319.99998
METHYL CHLORIDE	22363.05899	70802.16677	93165.22576
METHYL ETHYL KETONE	64969.31067	2493516.731	2558486.042
METHYL HYDRAZINE	1957.878626		1957.878626
METHYL IODIDE	13.31091053		13.31091053
METHYL ISOBUTYL KETONE	9712.469709	2314596.144	2324308.613
METHYL METHACRYLATE	743.267677		743.267677
METHYL TERT BUTYL ETHER	4069.543424	212.0711	4281.614524
METHYLENE CHLORIDE	255762.9677	1537048.97	1792811.937
METHYLENE(B)4-PHENYLISOCYANATE	1789.20826		1789.20826
M-XYLENE	3629.251353	27507.41	31136.66135
NAPHTHALENE	15239.28708	611836.8418	627076.1289
N-HEXANE	480902.2919	5285243.38	5766145.672
NICKEL	18204.52266	10.8938	18215.41646
NITROUS OXIDE	2048762.554		2048762.554
O-CRESOL	2.49999993		2.49999993
OCTACHLORDIBENZOFURANS, ALL ISOMERS	0.04272609		0.04272609
OCTACHLORODIBENZODIOXINS, ALL ISOMERS	0.04159267		0.04159267
O-TOLUIDINE	1.37		1.37
O-XYLENE	441.7482993	169561.1786	170002.9269
PENTACHLORDIBENZOFURANS, ALL ISOMERS	0.0550275		0.0550275
PENTACHLORODIBENZODIOXINS, ALL ISOMERS	0.00123781		0.00123781
PHENANTHRENE	444.0191589	41715.83	42159.84916
PHENOL	130493.3537		130493.3537
PHOSGENE	0		0
PHOSPHORUS (YELLOW OR WHITE)	18194.9732		18194.9732
POLYCHLORINATED BIPHENYLS (PCBS)	0		0
POLYCHLORINATED DIBENZODIOXINS, TOTAL	0.07272749		0.07272749
POLYCHLORINATED DIBENZOFURANS, TOTAL	0.24898203		0.24898203
PROPIONALDEHYDE	9114.461729		9114.461729
PROPYLENE DICHLORIDE	79.11382963		79.11382963
PROPYLENE OXIDE	92.99998		92.99998
P-XYLENE	266.8741226	27507.41	27774.28412
PYRENE	83.28389087	12835.42	12918.70389
QUINONE	136.5643998		136.5643998
SELENIUM	3074.704526		3074.704526
STODDARD	10900.00002		10900.00002
STYRENE	836084.0266	12336.4907	848420.5173
TETRACHLORODIBENZODIOXINS, ALL ISOMERS	0.0485029		0.0485029
TETRACHLOROETHYLENE	170512.7802	4667183.269	4837696.049

Pollutant	Point Sources	Area Sources	TOTAL
TETRCHLORODIBENZOFURANS, ALL ISOMERS	0.26634324		0.26634324
TOLUENE	3945789.278	8340921.108	12286710.39
TOLUENE-2,4-DIISOCYANATE	240.86		240.86
TRICHLOROETHYLENE	273671.0536	2135384.316	2409055.37
TRIETHYLAMINE	20159.81963	8275.7071	28435.52673
VINYL ACETATE	10560.18328	0.4468	10560.63008
VINYL CHLORIDE	3299.194693	25328.5449	28627.73959
VINYLIDENE CHLORIDE	62.56960002	1638.9058	1701.4754
XYLENES (MIXED ISOMERS)	977138.0791	5080514.703	6057652.783