



Casting Emission Reduction Program

Prepared by:

**TECHNIKON LLC**

5301 Price Avenue ▼ McClellan, CA, 95652 ▼ (916) 929-8001

[www.technikonllc.com](http://www.technikonllc.com)

## US Army Task N256 Emission Measurement Procedure 2

### Technikon # 3.1.1

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UNITED STATES COUNCIL FOR AUTOMOTIVE RESEARCH

DAIMLERCHRYSLER *Ford Motor Company* General Motors

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# **Emission Measurement Procedure 2**

## **3.1.1**

**14 May 2001**

**Contract N.256: HAPs and Other Toxics Without Validated Test  
Methods**

**WBS 3.2 Methodology Evaluation**

Approved and reported by  
C. R. Glowacki, Measurement Technologies

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## Method Verification

Accurate and precise sampling and analysis methods are essential in evaluating the impact of industrial processes on the environment. The Clean Air Act Amendments of 1990 require the measurement of 188 compounds that may be contained in airborne process emissions. Many of these listed chemicals do not have validated methods and none of the methods for compounds of interest to the metal casting industry have been validated in a foundry environment. Methods validated in the environment of interest are necessary if data of known quality is to be obtained.

The attached compilation of Clean Air Act Amendment Hazardous Air Pollutants (CAAA HAPs), Mobile Source Air Toxics (MSAT), and Urban Air Toxics (UAT) identifies materials with validated methods (V1 & V2), proposed methods (P), and without methods (N). Those materials of special interest to the metal casting industry are also indicated.

The following methods were selected for verification (under Subtask 3.1) and definition (under Subtask 3.2) based on the abundance of the material emitted during the casting process and the toxicity of the material. In other words, the most toxic materials emitted in the largest quantities were selected.

<b>Subtask</b>	<b>Material</b>	<b>Activity</b>
3.1	Benzene	Verification Method 1
3.1	Phenol	Verification Method 2
3.2	Aniline	Definition Method 1
3.2	Triethylamine	Definition Method 2

**Hazardous Air Pollutants (CAAA, MSAT, UAT)**

CAS #	Compound	CAAA	MSAT	UAT	Foundry	Method*
75-07-0	Acetaldehyde	X	X		X	V1
60-35-5	Acetamide	X				P
75-05-8	Acetonitrile	X				V1
98-86-2	Acetophenone	X				V1
53-96-3	2-Acetylaminofluorene	X				N
107-02-8	Acrolein	X	X		X	N
79-06-1	Acrylamide	X				N
79-10-7	Acrylic acid	X			X	N
107-13-1	Acrylonitrile	X	X			N
107-05-1	Allyl chloride	X				P
92-67-1	4-Aminobiphenyl	X				P
<b>62-53-3</b>	<b>Aniline</b>	<b>X</b>			<b>X</b>	<b>P</b>
90-04-0	o-Anisidine	X				P
1332-21-4	Asbestos	X				V1
<b>71-43-2</b>	<b>Benzene</b>	<b>X</b>	<b>X</b>		<b>X</b>	<b>V1</b>
92-87-5	Benzedrine	X				P
98-07-7	Benzotrichloride	X				V2
100-44-7	Benzyl chloride	X				V1
92-52-4	Biphenyl	X			X	V1
117-81-7	Bis (2-ethylhexyl) phthalate	X			X	V2
542-88-1	Bis (chloromethyl) ether	X				P
75-25-2	Bromoform	X				V1
106-99-0	1,3-Butadiene	X	X	X		N
156-62-7	Calcium cyan amide	X				N
133-06-2	Captan	X				N
63-25-2	Carbaryl	X				N
75-15-0	Carbon disulfide	X				N
56-23-5	Carbon tetrachloride	X	X			V1
463-58-1	Carbonyl sulfide	X			X	P
120-80-9	Catechol	X			X	P
133-90-4	Chloramben	X				P
57-74-9	Chlordane	X				V1
7782-50-5	Chlorine	X				V1
79-11-8	Chloroacetic acid	X				N
532-27-4	2-Chloroacetophenone	X				V1
108-90-7	Chlorobenzene	X				V1
510-15-6	Chlorobenzilate	X				V1
67-66-3	Chloroform	X	X			V1
107-30-2	Chloromethyl methyl ether	X				N
126-99-8	Chloroprene	X				P
1319-77-3	Cresols/Cresylic	X			X	V1
95-48-7	o-Cresol	X			X	V1
108-39-4	m-Cresol	X			X	V1



CAS #	Compound	CAAA	MSAT	UAT	Foundry	Method*
106-44-5	p-Cresol	X			X	V1
98-82-8	Cumene	X			X	V1
N/A	2,4-D (2,4-Dichlorophenoxyacetic Acid) salts and Esters	X				P
72-55-9	DDE (1,1-dichloro-2,2-bis (p-chlorophenyl) ethylene)	X				V1
334-88-3	Diazomethane	X				N
132-64-9	Dibenzofuran	X		X	X	V1
96-12-8	1,2-Dibromo-3-chloropropane	X				V1
84-74-2	Dibutyl phthalate	X			X	V1
106-46-7	1,4-Dichlorobenzene	X				V1
91-94-1	3,3'-Dichlorobenzidine	X				P
111-44-4	Bis [2-chloroethyl] ether	X				V1
542-75-6	1,3-Dichloropropene	X				P
62-73-7	Dichlorvos	X				V1
111-42-2	Diethanolamine	X				N
64-67-5	Diethyl sulfate	X				N
119-90-4	3,3'-Dimethoxybenzidine	X				P
60-11-7	4-Dimethylaminoazobenzene	X				P
121-69-7	N, N-Dimethylaniline	X			X	V2
119-93-7	3,3'-Dimethylbenzidine	X				V1
79-44-7	Dimethylcarbamoyl chloride	X				P
68-12-2	N,N-Dimethylformamide	X				P
57-14-7	1,1-Dimethylhydrazine	X				N
131-11-3	Dimethyl phthalate	X			X	V1
77-78-1	Dimethyl sulfate	X				P
N/A	4,6-Dinitro-o-cresol (including salts)	X				P
51-28-5	2,4-Dinitrophenol	X				P
121-14-2	2,4-Dinitrotoluene	X				N
123-91-1	1,4-Dioxane	X				V1
122-66-7	1,2-Diphenylhydrazine	X				P
106-89-8	1-Chloro-2,3-epoxypropane	X				N
106-88-7	1,2-Epoxybutane	X				P
140-88-5	Ethyl acrylate	X			X	P
100-41-4	Ethylbenzene	X			X	V1
51-79-6	Ethyl carbonate	X				P
75-00-3	Chloromethane)	X				P
106-93-4	Dibromoethane	X				V1
540-49-8	1,2 Dibromoethene		X			P
107-06-2	1,2-Dichloroethane	X				V1
540-59-0	1,2 Dichloroethene		X			P
563-54-2	1,2 Dichloropropene		X			P
542-75-6	1,3 Dichloropropene		X			P
107-21-1	Ethylene glycol	X				P
151-56-4	Ethyleneimine (Aziridine)	X				N
75-21-8	Ethylene oxide	X	X			P
96-45-7	Ethylene thiourea	X				P

CAS #	Compound	CAAA	MSAT	UAT	Foundry	Method*
75-34-3	1,1-Dichloroethane	X				V1
50-00-0	Formaldehyde	X	X		X	Y/P
76-44-8	Heptachlor	X				V1
118-74-1	Hexachlorobenzene	X	X			P
87-68-3	Hexachlorobutadiene	X				V1
608-73-1	1,2,3,4,5,6-Hexachlorocyclohexane	X				P
77-47-4	Hexachlorocyclopentadiene	X				V2
67-72-1	Hexachloroethane	X				V1
822-06-0	Hexamethylene diisocyanate	X				V1
680-31-9	Hexamethylphosphoramide	X				P
110-54-3	Hexane	X		X	X	V1
302-01-2	Hydrazine	X	X			N
7647-01-0	Hydrogen Chloride	X			X	V1
7664-39-3	Hydrogen fluoride	X			X	P
123-31-9	Hydroquinone	X				P
78-59-1	Isophorone	X			X	V1
108-31-6	Maleic anhydride	X				P
67-56-1	Methanol	X			X	V1
72-43-5	Methoxychlor	X				V2
74-83-9	Bromomethane	X				P
74-87-3	Chloromethane	X				V1
71-55-6	1,1,1-Trichloroethane	X				V1
78-93-3	2-Butanone	X			X	P
60-34-4	Methylhydrazine	X				N
74-88-4	Iodomethane	X				V1
108-10-1	Methyl isobutyl ketone	X			X	V1
624-83-9	Methyl isocyanate	X			X	V1
80-62-6	Methyl methacrylate	X				P
1634-04-4	Methyl tert-butyl ether	X				P
101-14-4	4,4'-Methylenebis(2-chloroaniline)	X				P
75-09-2	Dichloromethane	X	X			V1
101-68-8	4,4'-Methylenediphenyl diisocyanate	X			X	P
101-77-9	4,4'-Methylenedianiline	X			X	P
91-20-3	Naphthalene	X			X	V1
98-95-3	Nitrobenzene	X				V1
92-93-3	4-Nitrobiphenyl	X				V1
100-02-7	4-Nitrophenol	X				P
79-46-9	2-Nitropropane	X				P
684-93-5	N-Nitroso-N-methylurea	X				N
62-75-9	N-Nitrosodimethylamine	X				V1
59-89-2	N-Nitrosomorpholine	X				V1
56-38-2	Parathion	X				V1
82-68-8	Pentachloronitrobenzene	X				V1
87-86-5	Pentachlorophenol	X				V1
<b>108-95-2</b>	<b>Phenol</b>	<b>X</b>			<b>X</b>	<b>V1</b>
106-50-3	p-Phenylenediamine	X			X	P

CAS #	Compound	CAAA	MSAT	UAT	Foundry	Method*
75-44-5	Phosgene	X				P
7803-51-2	Phosphine	X				P
7723-14-0	Phosphorus	X				P
85-44-9	Phthalic anhydride	X				P
1336-36-3	Polychlorinated biphenyls	X	X			P
1120-71-4	1,3-Propane sultone.	X				N
57-57-8	beta-Propiolactone	X				N
123-38-6	Propionaldehyde	X			X	V1/P
114-26-1	Propoxur	X				P
78-87-5	1,2-Dichloropropane	X				V1
75-56-9	Propylene oxide	X				P
75-55-8	1,2-Propylenimine	X				N
91-22-5	Quinoline	X	X			P
106-51-4	Quinone (p-Benzoquinone)	X				P
100-42-5	Styrene	X		X	X	P
96-09-3	Styrene oxide	X				P
1746-01-6	2,3,7,8-Tetrachlorodibenzo p-dioxin	X	X	X	X	V1
79-34-5	1,1,2,2-Tetrachloroethane	X	X			V1
127-18-4	Tetrachloroethylene	X	X			V1
7550-45-0	Titanium tetrachloride	X				P
108-88-3	Toluene	X		X	X	V1
95-80-7	Toluene-2, 4-diamine	X				P
584-84-9	2,4-Toluene diisocyanate	X				V1
95-53-4	o-Toluidine	X				P
8001-35-2	Toxaphene	X				P
120-82-1	1,2,4-Trichlorobenzene	X				V1
79-00-5	1,1,2-Trichloroethane	X				V1
79-01-6	Trichloroethylene	X	X			V1
95-95-4	2,4,5-Trichlorophenol	X				V1
88-06-2	2,4,6-Trichlorophenol	X				V1
<b>121-44-8</b>	<b>Triethylamine</b>	<b>X</b>			<b>X</b>	<b>N</b>
1582-09-8	Trifluralin	X				N
540-84-1	2,2,4-Trimethylpentane	X				V1
108-05-4	Vinyl acetate	X				P
593-60-2	Vinyl bromide	X				V1
75-01-4	Vinyl chloride	X	X			V1
75-35-4	1,1-Dichloroethylene	X				V1
1330-20-7	Xylenes	X		X	X	V1
95-47-6	o-Xylene	X			X	V1
108-38-3	m-Xylene	X			X	V1
106-42-3	p-Xylene	X			X	V1
	Antimony Compounds	X				V1
	Arsenic Compounds (inorganic including arsine)	X	X			V1
	Beryllium Compounds	X	X			V1
	Cadmium Compounds	X	X			V1
	Chromium Compounds	X	X	X		V1

CAS #	Compound	CAAA	MSAT	UAT	Foundry	Method*
	Cobalt Compounds	X				P
	Coke Oven Emissions	X	X			N
	Cyanide Compounds <sup>1</sup>	X				P
	Glycol ethers <sup>2</sup>	X				N
	Lead Compounds	X	X	X		V1
	Manganese Compounds	X	X	X		V1
	Mercury Compounds	X	X	X		V1
	Fine mineral fibers <sup>3</sup>	X				N
	Nickel Compounds	X	X			V1
	Polycyclic Organic Matter <sup>4</sup>	X	X		X	P
	Radionuclides (including radon) <sup>5</sup>	X				N
	Selenium Compounds	X				V1

\*N=without methods, P=proposed, V1=verified  $\pm 30\%$  Relative Standard Deviation (RSD),  
V2=verified  $\pm 50\%$  RSD

**Note:**

For all listings above which contain the word "compounds" and for glycol ethers, the following applies: Unless otherwise specified, these listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical's infrastructure.

1. X'CN where X = H' or any other group where a formal dissociation may occur. For example, KCN or Ca(CN)<sub>2</sub>.
2. On January 12, 1999 (64FR1780), the EPA proposed to modify the definition of glycol ethers to exclude surfactant alcohol ethoxylates and their derivatives (SAED). On August 2, 2000 (65FR47342), the EPA published the final action. This action deletes each individual compound in a group called the surfactant alcohol ethoxylates and their derivatives (SAED) from the glycol ethers category in the list of hazardous air pollutants (HAP) established by section 112(b)(1) of the Clean Air Act (CAA). EPA also made conforming changes in the definition of glycol ethers with respect to the designation of hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The following definition of the glycol ethers category of hazardous air pollutants applies instead of the definition set forth in 42 U.S.C. 7412(b)(1), footnote 2:

Glycol ethers include mono- and di-ethers of ethylene glycol, diethylene glycol, and triethylene glycol R- (OCH<sub>2</sub>CH<sub>2</sub>)<sub>n</sub>-OR'

Where:

n= 1, 2, or 3

R= alkyl C7 or less, or phenyl or alkyl substituted phenyl

R'= H, or alkyl C7 or less, or carboxylic acid ester, sulfate, phosphate, nitrate, or sulfonate.

3. (Under Review)
4. (Under Review)
5. A type of atom that spontaneously undergoes radioactive decay.