

SAMPLING AND ANALYSIS
FOR HAZARDOUS AIR POLLUTANTS (HAPs)
UNDER TITLE III OF
THE CLEAN AIR ACT AMENDMENTS
OF 1990
(STACK TEST METHODOLOGY)

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I. INTRODUCTION

Over the last several years, public awareness of air pollution and its sources has increased steadily. Specifically, since the passage of the Clean Air Act Amendments of 1990 (the Act), more emphasis has been placed on local, State, and Federal agencies to keep the public informed on health effects of various air toxics and levels of exposure. This awareness has required industry to become accountable for air toxics emission as part of a source's compliance strategy.

Title III of the Act, Hazardous Air Pollutants (HAPs), mandates that EPA address emissions of HAPs from both area and point sources. Provisions within Title III require EPA to categorize sources, regulate emissions of 189 hazardous air pollutants, determine applicability of maximum achievable control technology (NIACT), evaluate residual risk after MACT, and address sudden accidental releases.

The timetable to meet the above provisions has begun for EPA. In addition, States will soon impose entirely new operating permit requirements. The Amendments require that State programs include a standard application form and monitoring and reporting requirements, along with annual fees. Permits will be valid for no more than 5 years, each with specific emission limits and a source specific compliance schedule.

In this new era of environmental awareness, industry must be prepared to know exactly what is being emitted from its facilities. The availability of quantitative source specific emission data long with risk information enables an industry to respond correctly to federal and State regulatory initiatives.

This article will discuss standardized sampling and analytical methodology used by EPA for quantifying HAPs emissions from point sources. The use of standardized test procedures will ensure compatibility of the data collected with its ultimate use as part of an industry emission monitoring program.

II. CLEAN AIR ACT AMENDMENTS OF 1990

Under Title III of the Act, EPA has now listed 188 hazardous air pollutants. In general, sources that emit more than 10 tons per year of any listed substance or 25 tons per year of any combination of listed substances must limit the emissions of these HAPs and comply with the provisions. Approximately 250 source categories will be affected.

The standards for listed source categories will require maximum achievable control technology (MACT) as a means of reduction in emissions. For existing sources, the applicable standard must at least achieve control levels to within 12% of the most tightly controlled existing sources. Existing sources must comply within three years of established MACT standards. For new sources, the standards must be more stringent than for existing sources. For both new and existing sources, technology feasibility and cost are factors which EPA must consider in determining maximum achievable controls.

Under some circumstances, MACT may not be sufficient to assure public health protection or may produce other significant environmental impacts. If any significant residual risk remains, EPA must tighten the emission reductions. The residual risk standards must be applied to assure an "ample margin of safety" to protect human health and protect the environment. These standards must be set by EPA for pollutants which may cause cancer whenever the risk is greater than 1-in-1,000,000 to the MEI (maximum exposed individual).

The sudden accidental release section of the Act requires the owner/operator of a facility which handles extremely hazardous substances to operate safely. It also requires an engineering analysis of the facility to identify potential hazards to public health. The Act establishes a Chemical Safety Board to investigate accidents and requires EPA to promulgate accident prevention regulations.

All of the above regulatory initiatives will require sources to quantitate their emissions in order to demonstrate compliance. Similar to ambient methodology, EPA has published numerous sampling and analytical methods for quantifying HAPs from industrial sources. Within the EPA, different programs have required the development of standardized methods involving different matrices to meet program objectives. The development of standardized methods has been initiated in most cases by regulatory mandates to support specific programs. Methods may therefore be found within the legislative announcement (i.e., Federal Reference Methods) or referenced to a particular compilation (i.e., Compendium of Methods, Statement-of-Works (SOWs), SW-846 etc.) of analytical methodology. Table 1 identifies specific Acts which required the subsequent development of standardized analytical methodologies.

III. FEDERAL REFERENCE METHODS (FRMs)

Regulatory authority associated with the enforcement of air quality standards has its basis in the Clean Air Act and its amendments. The Clean Air Act Amendments of 1970 established the Environmental Protection Agency, which was given the mandate to set and enforce the regulations. It became the responsibility of EPA to *"protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population..."* It is within this timeframe that Federal Reference Methods (FRMs) were established to be used as regulatory methodology in determining compliance by both the Agency and the affected facility. In 1971, the original eight FRMs were promulgated (36 FR 24877) dealing with stack gas monitoring. Since that time, FRMs have been developed to support major EPA programs dealing with New Source Performance Standards (NSPS), Prevention of Significant Deterioration (PSD) and National Emission Standards for Hazardous Air Pollutants (NESHAPs), to name only a few. FRMs are methods developed in some cases for a specific source category to demonstrate compliance with an applicable standard, as illustrated in Figure 1.

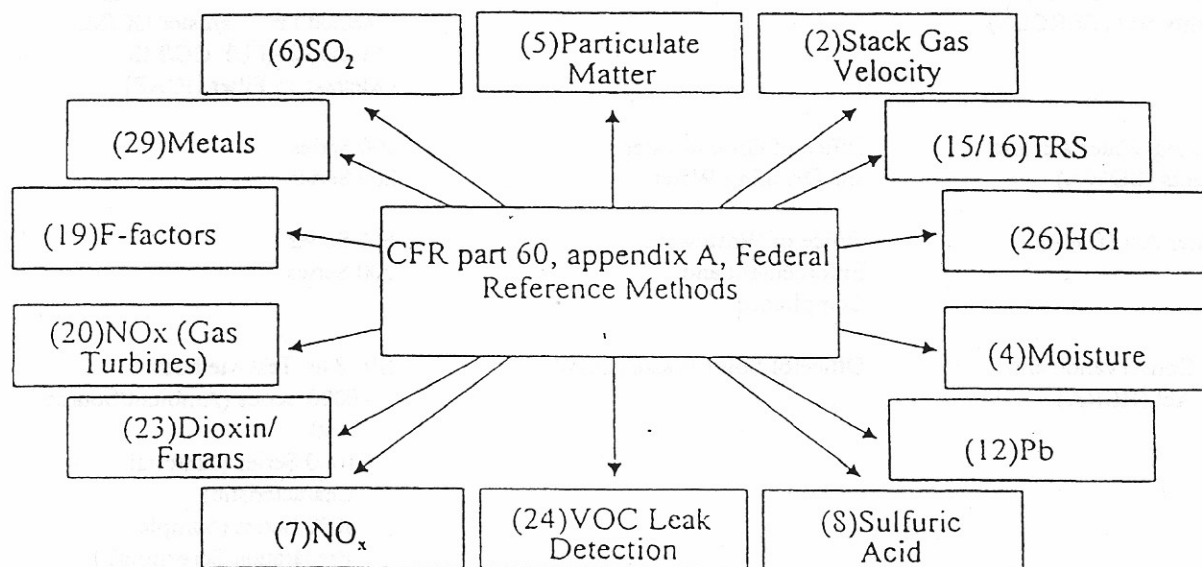


Figure 1. Federal Register Methods

As an example, FRM 16 is identified as one of the compliance methods for Subpart BB, Kraft Pulp Mills, but has also been used for monitoring total reduce sulfur (TRS) emissions from refineries, hazardous incinerators and other sources not originally intended when proposed in the regulations. Consequently, FRMs were designed with a specific need in mind for determining compliance with a pollutant emission limit. With the passage of the Act, Title III forced the Agency to look for test methodology which could quantitate many constituents at a time, thus reducing cost in testing associated with an industrial source compliance program.

**TABLE 1. REGULATORY ACTS REQUIRING DEVELOPMENT OF
STANDARDIZED METHODOLOGY**

Regulatory Acts	EPA Office	Analytical Methodology
Clean Air Act and Amendments	Office of Air Quality Planning and Standards	Compendium of Methods <ul style="list-style-type: none"> - Organic (TO Series) - Inorganic (IO Series) - Indoor (IP Series)
	Office of Research and Development	Federal Reference Methods (FPMs) <ul style="list-style-type: none"> - 40 CFR Part 50 (Appendix) - 40 CFR Part 51 (200 Series) - 40 CFR Part 60 (Methods 1, etc.) - 40 CFR Part 61 (100 Series) - 40 CFR Part 63 (300 Series)
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	Office of Emergency and Remedial Response	Statement of Work (SOW) <ul style="list-style-type: none"> - Method 1A - Tenax GC/MS - Method 1B - Canister GC/MS - Method 2 - PUF GC/MS - Method 3 - Filter [ICAP]
Safe Drinking Water Act and Amendments (SDWA)	Office of Groundwater and Drinking Water	500 Series 200 Series
Clean Water Act (CWA)	Office of Wastewater Enforcement and Compliance	600 Series 200 Series
Resource Conservation and Recovery Act (RCRA)	Office of Solid Waste (OSW)	SW-846: Test Methods <ul style="list-style-type: none"> - 0000 Series (Ambient/Source Test) - 1000 Series (Material Characteristic) - 3000 Series (Sample Preparation/Screening) - 5000 Series (Purge/Trap and Thermal Desorption) - 6000 Series (ICAP) - 7000 Series (AA) - 8000 Series (GC, GC/MS, HPLC) - 9000 Series (Material Properties)

IV. SW-846: TEST METHODS FOR EVALUATING SOLID WASTE; PHYSICAL/CHEMICAL METHODS

The U. S. EPA's Office of Solid Waste (OSW), under the authority of the Resource Conservation and Recovery Act (RCRA), has developed a Compendium of test and analytical methods for use in determining regulatory compliance under RCRA. The title of the Compendium is *"Test Methods for Evaluating Solid Waste (SW-846)."* Figure 2 illustrated the source test methods in SW-846. Except where mandated, SW-846 serves as a guidance document outlining criteria of acceptance in response to RCRA regulatory initiatives.

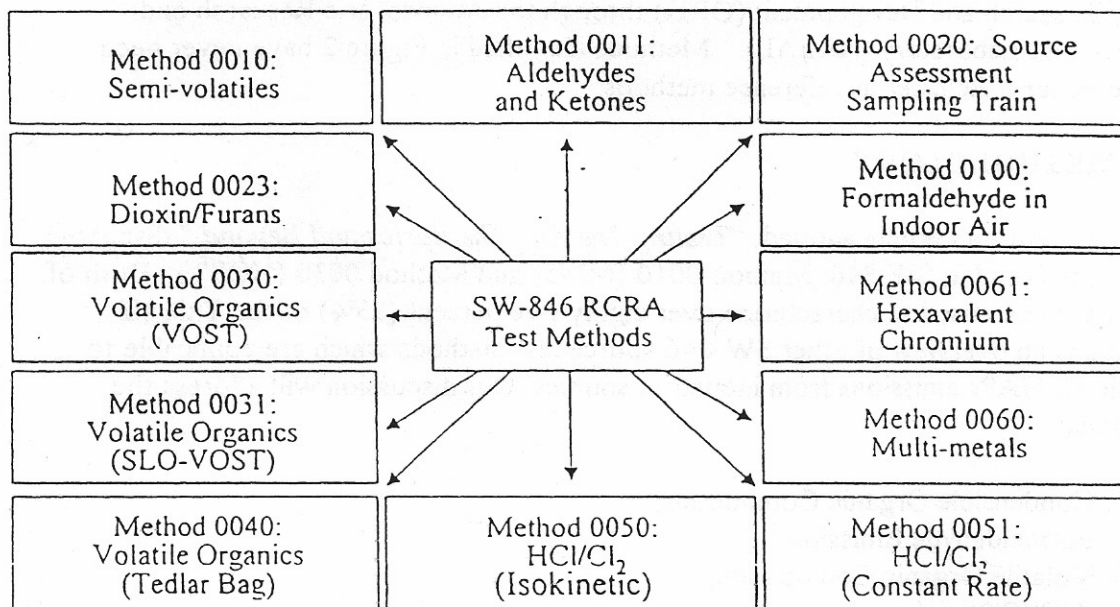


Figure 2. SW-846 Source Test Sampling Methods

While the original intent of SW-846 was to address solid waste, it has been expanded to now include sampling and analytical methods associated with both ambient and source monitoring, as illustrated in Figure 2. This is due, in part, to the public outcry for EPA to monitor not only the water and soil pathways at hazardous waste sites, but also to monitor the air pathway in order to demonstrate compliance with national, state and local standards.

SW-846 was conceived around 1980. Since that time, there have been two updates. The present regulatory status of the Compendium requires the use of the Second Edition methods (including Updates). Later this year, the third addition of SW-846 (including Update 1) is expected to be promulgated (thus replacing second addition).

The basic question asked associated with SW-846 methods is: *"Are they EPA approved?"* M: Lesnik answered that questions in his article entitled: *"Additional Perspective on SW-846.- How and When Can Draft Methods Be Used?"* In that article, he states: *"U. S. EPA approved means that a method has been incorporated by reference in a Final Rule that has been published"*

as a Federal Register Notice (FRN) either into SW-846 or directly into the RCRA regulations. In short, U. S. EPA-approved methods are promulgated methods that can be used without special permission for RCRA applications for which the use of SW-846 methods is mandatory. Therefore, until a method is promulgated by an frn, it is not an approved method for these mandatory applications, no matter where it may be in the regulatory process."

SW-846 methods are not published in the *Federal Register*, but are incorporated by reference in the appropriate RCRA regulations.

The present source test methods found in SW-846 were actually funded and developed by EPA's Office of Research and Development (ORD) through the Atmospheric Research and Exposure Assessment Laboratory (AREAL). Methods identified in Figure 2 have never been published in the *Federal Register* as reference methods.

V. SOURCE METHODOLOGY

Dr. Larry Johnson's article entitled: "*Testing The Air: The Basics and Beyond*," discussed two of the methods found in SW-846: Method 0010 (MM5) and Method 0030 (VOST). Both of these methods have been used to characterize over eighty-five percent (85%) of the Title III HAPs. Following is an overview of other SW-846 source test methods which are applicable to quantifying Title III HAPs emissions from industrial sources. Our discussion will address the following methods:

- Method 0010: Condensible Organic Compounds;
- Method 0011: Formaldehyde Emissions;
- Method 0030: Volatile Organic Compounds;
- Method 0050: HCl/Cl₂; and
- Method 0060: Multiple Metals Train.

Condensible Organic Compounds (Method 0010)

Condensible organic compounds are determined utilizing Modified Method 5 (MM5) sampling train. The MM5 protocol is outlined as Method 0010 in SW-846, "Test Methods for Evaluating Solid Waste," Third Edition, November 1986. The sampling train consists of a heated probe, heated filter, sorbent module, pumping and metering unit, as illustrated in Figure 3.

A gooseneck nozzle of an appropriate diameter to allow isokinetic sample collection is attached to the probe. An S-type pitot tube is used to monitor the velocity pressure and an orifice meter is used to determine the isokinetic sampling rate. From the heated filter, sample gas enters the sorbent module. The sorbent module consists of a water-cooled condenser followed by an XAD-2 resin trap. Following the resin trap is a dry, modified Greenburg-Smith impinger which collects the aqueous condensate. The stem of this impinger is short to reduce carryover of collected aqueous condensate. Following the condensate trap are two dry impingers to collect any mist carryover from the condensate trap and a final impinger containing silica gel to dry the sample gas before metering. A pump and dry gas meter are used to control and monitor the sample flow rate.

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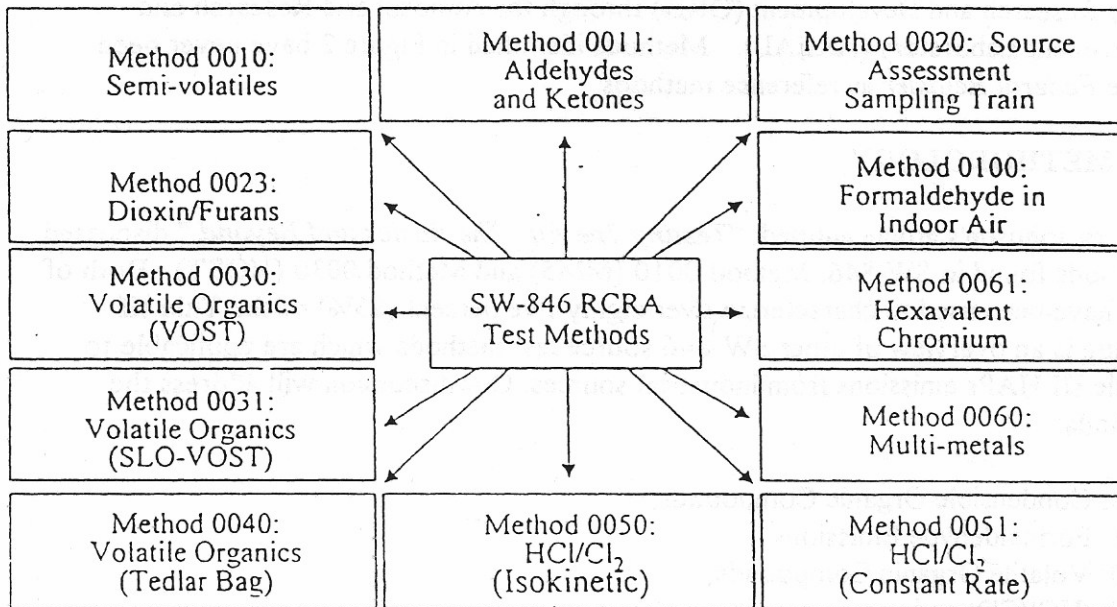


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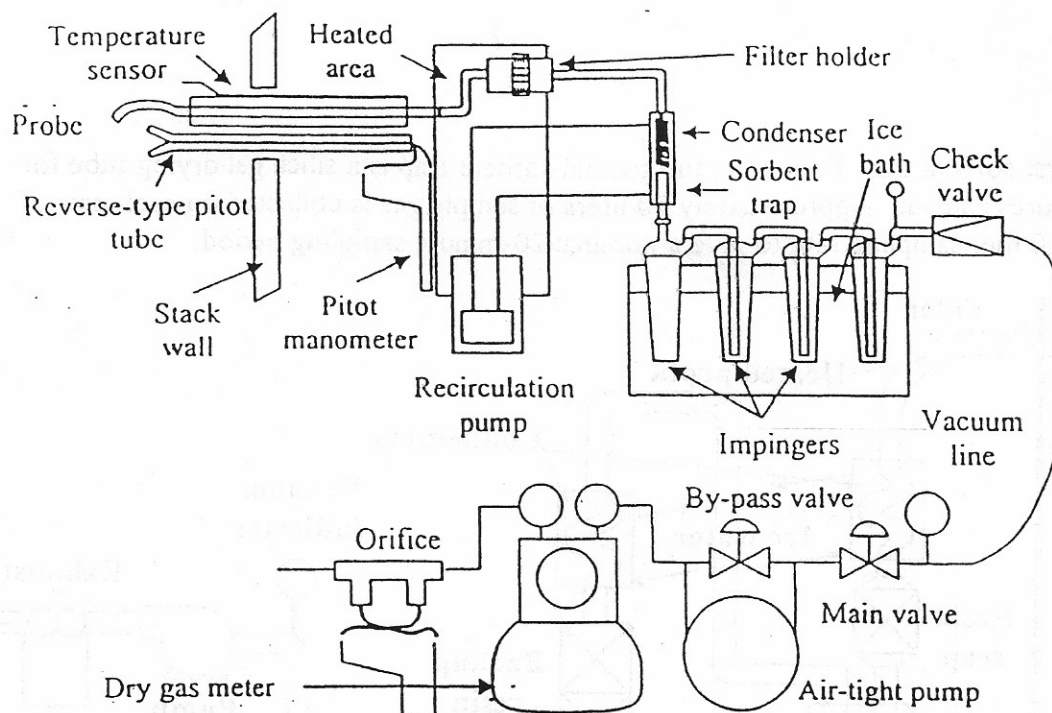


Figure 3. SW-846, Method 0030 Semi-volatile Sampling Train

Samples of industrial duct and stack gas collected using Method 0010 sampling procedure are analyzed for condensible organic compounds using Soxhlet extraction followed by low resolution capillary column GC/MS in, accordance with Method 8270 from SW-846. The method uses matrix specific extraction and analyte specific cleanup techniques for sample preparation. Stack gas samples collected by the Modified Method 5 sampling train are extracted with methylene chloride. The extracts are then acid-base washed, purified and concentrated for analysis by GC/MS. Calibration of the GC/MS is accomplished with internal standards and calibrating solution.

Volatile Organic Compounds (Method 0030)

Volatile organic compounds from industrial sources are determined utilizing the volatile organic sampling train (VOST). The VOST is described in Method 0030 in SW-846, "Test Methods for Evaluating Solid Waste," Third Edition, November 1986.

The VOST was designed to quantitatively determine volatile principle organic hydrocarbons (POHCs) and other hazardous substance list (HSL) volatile organics present in the flue gas of incinerators to be used in calculating destruction removal efficiency (DRE). The method utilizes Tenax and Tenax/Charcoal cartridges to adsorb the volatile organic compounds; each cartridge is preceded by a condensing module.

The train consists of a glass-lined probe with a glass wool plug to remove particulate, followed by an assembly of condensers and organic resin traps, as illustrated in Figure 4. The first condenser cools the gas stream and condenses the water vapor present. The flue gas and condensed moisture then pass through a sorbent bed, then into the first impinger. The organics are retained on the sobent following the first condenser. The second condenser maintains the stack gas stream at 68 F or below. The second sorbent bed traps out the organics that break

through the first sorbent trap. Following the second sorbent trap is a silica gel drying tube for residual moisture removal. Approximately 20 liters of sample gas is collected on each pair of traps with a 1.0 liter sampling rate to give a nominal 20-minute sampling period.

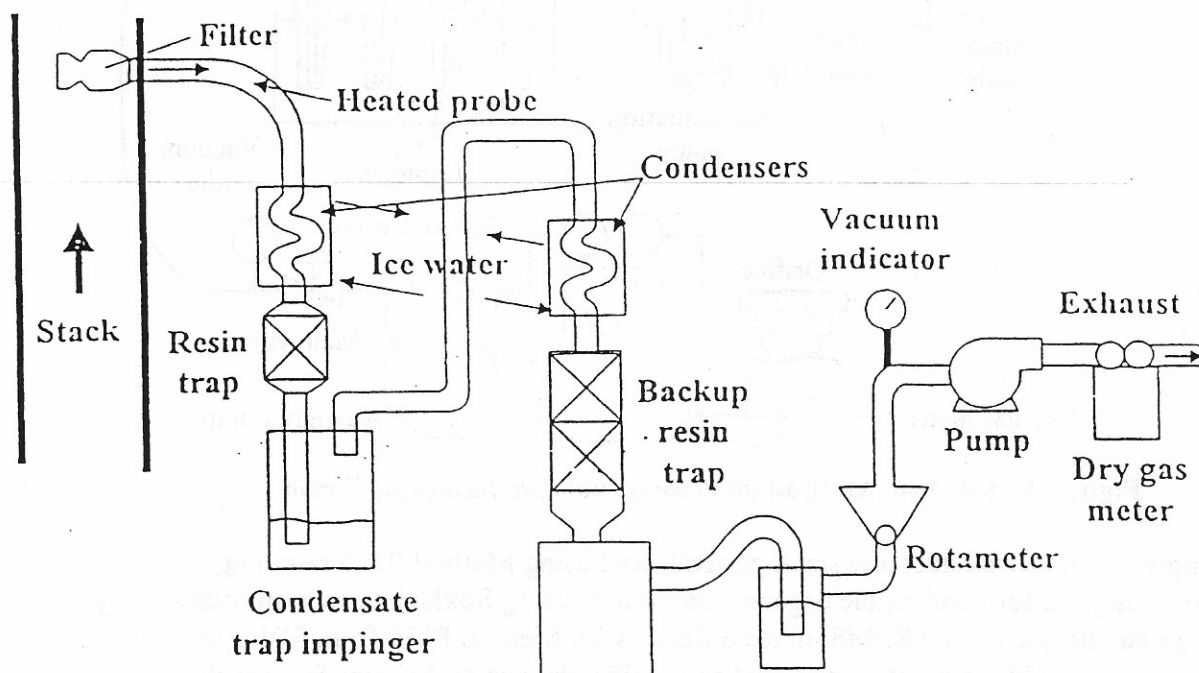


Figure 4. SW-846, Method 0030 Volatile Organic Sampling Train (VOST)

Analysis of the sorbent traps are performed by a "purge-and-trap" configuration, as specified in Method 5040.

Upon receipt at the laboratory, the content of the sorbent traps (Tenax and Tenax'/Charcoal) are spiked with an internal standard. The sorbents are then thermally desorbed for 10 minutes at 180°C with organic free nitrogen on helium gas (at 40 mL/min), bubbles through 4 mL of organic free water, and then trapped on a second (analytical) adsorbent trap.

The analytical adsorbent trap is rapidly heated to 180°C following the 10 minute desorption, and the carrier gas flow is reversed so that the effluent flow from the analytical trap is directed into a GC/MS. Volatile compounds are then separated by temperature programmed gas chromatography and detected by low-resolution mass spectroscopy as outlined in Method 8240 of SW-846.

Formaldehyde Emissions (Method 0011)

Formaldehyde and other aldehydes and ketones are determined using a Federal Reference Method 6 sampling train involving midjet impingers. The Method is described in Draft Method 0011 in SW-846, "Test Methods for Evaluating Solid Waste," Third Edition, November 1986.

EPA Draft Method 0011 is used to determine the Destruction and Removal Efficiency (DRE) of formaldehyde. Although this methodology has been applied specifically to formaldehyde, many laboratories have extended the application to other aldehydes; and ketones. Compounds derivatized with 2,4-dinitrophenylhydrazine (DNPH) can be detected in concentrations as low as 1.8 ppbv in 40 cu ft of stack gas sampled over a 1-hour period.

As illustrated in Figure 5, gaseous and particulate pollutants are withdrawn isokinetically from an emission source and are collected in aqueous acidic DNPH solution. Formaldehyde (and other aldehydes and ketones) present in the emissions reacts with DNPH to form the dinitrophenylhydrazone derivative. The dinitrophenylhydrazone derivative is extracted, solvent-exchanged, concentrated, and then analyzed by high performance liquid chromatography (HPLC).

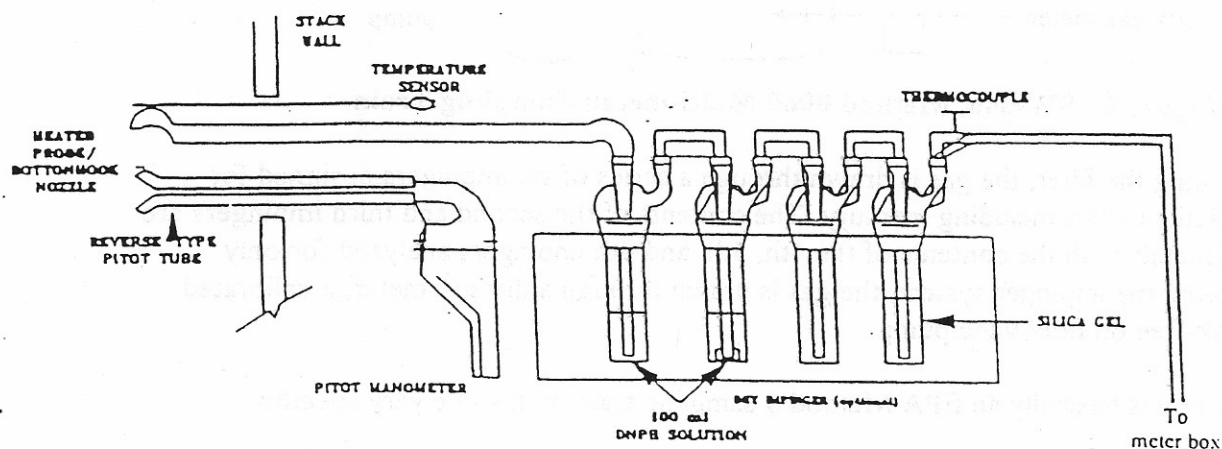


Figure 5. SW-846, Method 0011 Formaldehyde Sampling Train

Multiple Metals Train (Method 0060)

The determination of metal emissions from industrial sources involves a modification of the Method 5 train. The sampling train is operating as a Method 5 particulate train with modifications to the impinger configuration to enhance the collection of metals of interest. The train is described in Method 0060 in SW-846, "Test Methods for Evaluating Solid Wastes." The method has been utilized for the collection of the following metals: antimony, arsenic, barium, beryllium, cadmium, chromium (total), lead, mercury, silver and thallium.

As illustrated in Figure 6, the train consists of a glass button-hook nozzle attached to a heated glass-lined probe (250°F+25°F). A thermocouple and S-type pitot tube are attached to the probe for measurement of gas temperature and velocity. Sample gas is drawn through the nozzle and probe and then through a heated quartz fiber filter (250°F+25°F). Particulate collected on the filter and in the probe will be weighed and analyzed for the metals of interest.

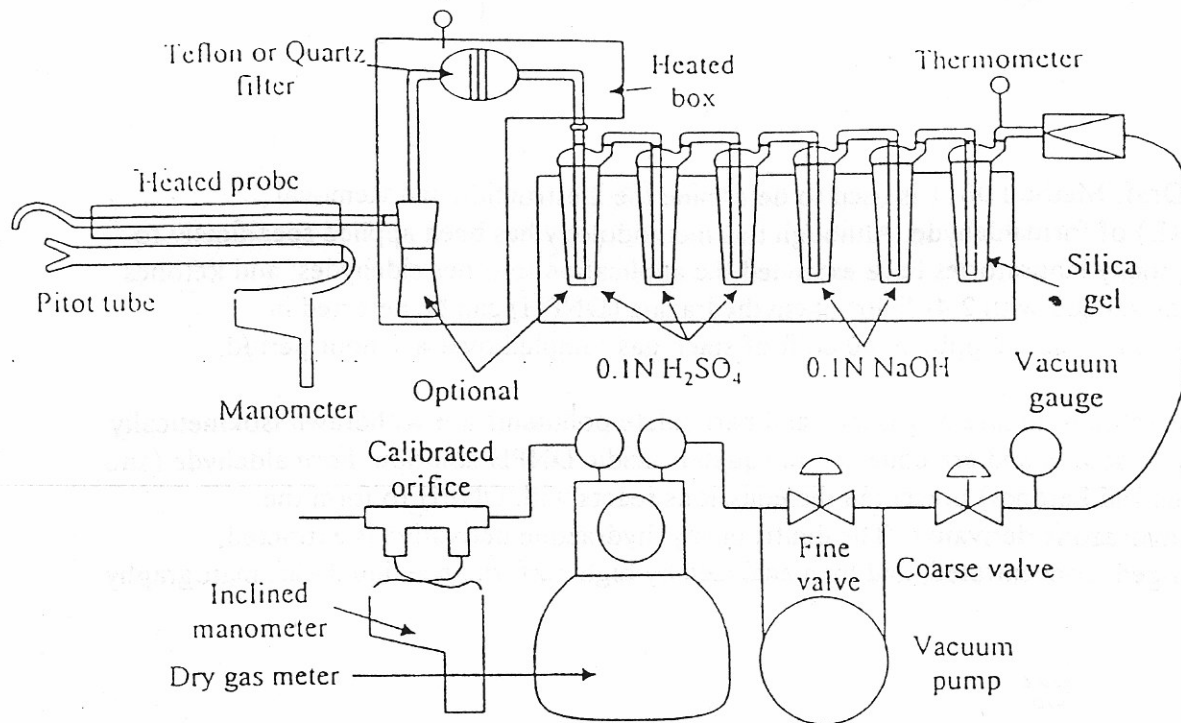


Figure 6. SW-846, Method 0060 Multi-metals Sampling Train

Upon exiting the filter, the gas is drawn through a series of six impingers designed for collection of volatile metals including mercury. The contents of the second and third impingers are analyzed for all metals with the contents of the 4th, 5th, and 6th impingers analyzed for only mercury. Following the impinger system, the gas is drawn through a dry gas meter, a calibrated orifice and a leak-free oil fiber vane pump.

This method is basically an EPA Method 5 sampling train with some very specific modifications:

The nozzle and probe liner is glass or quartz with all connections glass or Teflon. The filter is glass or quartz, with a fritted glass support. Impingers 2 and 3 contain a 5% nitric acid (HNO_3) and 10% hydrogen peroxide (H_2O_2) solution. Impinger 5 and 6 contains a 4% potassium permanganate (KMnO_4) and 10% sulfuric acid (H_2SO_4) solution. Impinger 7 containing silica gel desiccant. A non-metallic brush and 0.1 N nitric acid is used for the probe and nozzle rinse.

Impinger solutions and probe rinses are analyzed by inductively coupled argon plasma emission spectroscopy (ICP), atomic absorption spectroscopy (AAS), or graphite furnace AAS depending upon sensitivity required or the matrix effects on the specific analyte.

To sample chromium +6, a modification to the multiple metals train is used and is part of SW-846, Method 0061. As illustrated in Figure 7, the difference between the trains is the use of recirculating impinger fluid. This method can also be found in "Methods Manual for Compliance with the BEF Regulations," EPA 503-SW-91-101, December 1990.

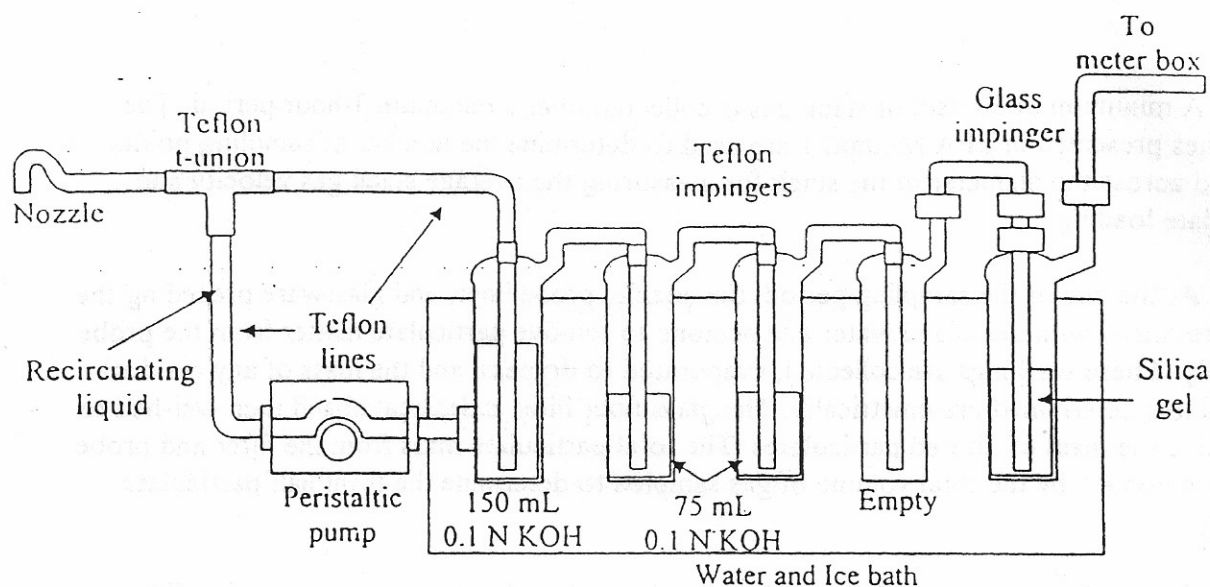


Figure 7. SW-846, Method 0061-Chromium +6 Sampling Train

HCl/Cl₂ (Method 0050)

Sampling for the HCl/Cl₂ and particles containing HCl/Cl₂ from industrial sources can be determined together utilizing Method 0050. The method is described in Method 0050 in SW-846, "Test Methods for Evaluating Solid Wastes," Third Edition, November 1986.

As illustrated in Figure 8, Method 0050 is an isokinetic method involving the Method 5 sampling train, where six (6) impingers are used, instead of the traditional four (4) impingers. The 1st impinger is a knock-out impinger, with the 2nd and 3rd impingers containing 0.1 N H₂ SO₄ solution and the 4th and 5th impingers containing 0.1 N NaOH solution for more effective collection of HCl and Cl₂. The 6th impinger contains silica gel.

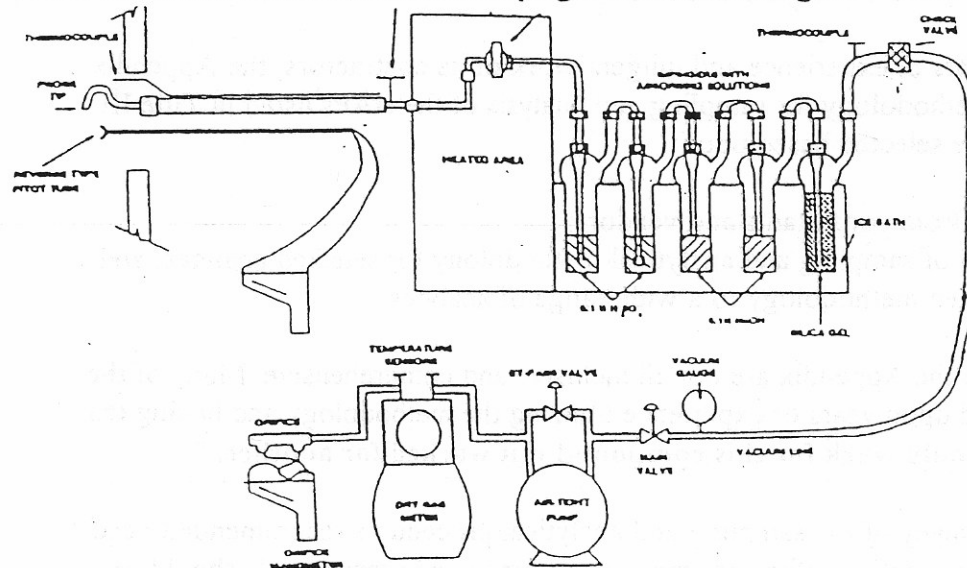


Figure 8. SW-846, Method 0050, HCl/Cl₂ Sampling Train.

A minimum of 30 dscf of stack gas is collected over a minimum 3-hour period. The guidelines presented in EPA Method 1 are used to determine the number of sampling points required across the diameter of the stack for measuring the average stack gas velocity and particulate loading.

At the end of the sampling period, the nozzle, probe liner, and glassware preceding the filter are rinsed with deionized water and acetone to remove particulate matter from the probe assembly. These washings are collected, evaporated to dryness, and the mass of any residual particulates determined gravimetrically. The glass fiber filter is desiccated and then weighed to determine the mass of filtered particulates. The total particulate mass from the filter and probe wash are divided by the total volume of gas sampled to determine the front half particulate loading.

The moisture content of the stack gas is determined by the total weight gain of the impingers used over each Method 0050 sampling period. HCl is determined by analysis of the first three impinger solutions combined, using ion chromatography. Cl₂ is determined by analysis of the 4th and 5th impinger solutions combined, using ion chromatography.

VI. SUMMARY

When a sampling and analytical methodology is selected for a given analyte or group of analytes, the first priority should be given to the use of existing *Federal Register* methods (40 CFR Parts 60 and 61) which have been validated specifically for the analytes of interest in stationary sources. These methods have documented precision and accuracy associated with them. Methods also found in EPA's SW-846, "Test Methods for Evaluating a Solid Waste" and "Methods Manual for Compliance with BEF Regulations" should be considered part of this level of highest accuracy and precision. It is the intent of EPA and its ultimate goal to have validated test methods for all listed 189 HAPS under Title III of the CAAA of 1990.

Based upon EPA's years of experience and diligent work of its contractors, the Appendix contains suggested source methodology for sampling and analysis of the HAPs listed in Title III of the Act. The methods were selected based upon:

1. Validation data available from consultants and vendors;
2. Availability and reliability of sampling and analytical methodology for selected analytes; and
3. Applicability of the selected methodology to a wide range of analytes.

Methods identified in the Appendix are not all inclusive and comprehensive. Many of the methods selected were based upon years of experience utilizing the methodology and having that feeling that "the method should work for this compound if it worked for another."

It is anticipated that many of the sampling and analytical procedures recommended need additional development and validation efforts to improve accuracy and precision. It should be stressed that a method which requires validation is not an inferior method; the method simply

requires additional experimentation to define precision and bias. The performance of the method for a given analyte and source may be entirely acceptable, but until validation data are available, the user cannot know that the performance of the method will be acceptable prior to use.

To validate a method for a given analyte, the following procedures must be performed:

1. A known concentration of an analyte must be introduced in the sampling procedure and carried through the entire sampling and analytical procedure to assess the bias of the proposed method;
2. Alternatively, the proposed test method may be compared against a previously validated test method in order to assess bias; and
3. Multiple or collocated simultaneous samples must be collected to determine the precision of the test method.

For those methods that do not have accuracy and precision data associated with them, EPA proposed Method 301. The purpose of Method 301 procedures is to determine bias (systematic error) and precision (random error) of a test method at a permissible emission concentration, e.g., emission standard, in the gas stream. The procedures in Method 301 involve (a) introducing known concentrations of an analyte or comparing the test method against a validated test method to determine the method's bias and (b) collecting multiple or collocated simultaneous samples to determine the method's precision.

The timetable to meet the CAAA of 1990 monitoring requirements has begun for both industry and EPA. In addition, states will soon impose entirely new operating permit requirements involving quantitation of emitted HAPs. The Act requires that state programs include a standard application form and monitoring and reporting requirements, along with annual fees. Permits will be valid for no more than five years, each with specific emission limits and a source specific compliance schedule. Consequently, industry must be prepared to know exactly what is being emitted from its facilities. The availability of quantitative source specific emission data along with risk information enables an industry to respond correctly to federal and state regulatory initiatives.

The objective of this paper has been to discuss and identify those sampling/analytical procedures for the Title III HAPs which have been field proven and can now become part of an agency or industry emission monitoring program. The use of standardized procedures will ensure compatibility of the data collected with its ultimate use as part of an agency or industrial monitoring management program. The use of field proven methodology for specific target analytes will ensure that "...if you collect data, you collect accurate data."

**SAMPLING AND ANALYSIS
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(STACK TEST METHODOLOGY)**

ATTACHMENT

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
75-07-0	Acetaldehyde	0011	f1	8315A	Simultaneous aldehydes possible. Refs. 23, 40
60-35-5	Acetamide	0010	m.sp	8032	May be reactive
75-05-8	Acetonitrile	XACN	f1	8015B 8033	See Refs. 24 & 26.
98-86-2	Acetophenone	0010 0011	f1 f1	3542 8270C 8315A	See References 23 & 40 for 0011.
53-96-3	2-Acetylaminofluorene	0010?	f2f411	3542 8270C	
107-02-8	Acrolein	0011? PFBHA	f2, kp 14	8315A GC/MSorECD	Stability problems, even in DNPH See references 45 & 50 for PFBHA approach.
79-06-1	Acrylamide	0010	m, sp	GC/MS or 8316	Polar, water soluble. Poor GC, needs work.
79-10-7	Acrylic Acid	0010 sorbent	m, sp 14	8316 GC/FID	Suspect polymerization may be problem Ref 50&54, prototype needs to be isokinetic.
107-13-1	Acrylonitrile	XACN 0030 0031	s s 18	8015B 8033 5041A 8260B	See Refs. 24 & 26. Purges poorly, needs special attention.
107-05-1	Allyl Chloride	0030 kp 0031 kp 0040	f4 11 f4 f1	5041A 8260B 5041A 8260B 8260B	0030 recoveries good in lab., 30% from field test (suspect reactivity)
92-67-1	4-Aminobiphenyl	0010 acid liquid	m, sp s	GC/MS HPLC/PDA	Ref 50&51.
62-53-3	Aniline	0010? kp acid liquid	f2f412 14	3542 8270C HPLC/PDA	Extraction and reactivity problems. Ref 50&51, prototype needs to be isokinetic.
90-04-0	o-Anisidine	0010 kp acid liquid	f4 12 s	3542 8270C HPLC/PDA	Ref 50&51, prototype needs to be isokinetic.
1332-21-4	Asbestos	-	-	microscopy	Separate S&A
71-43-2	Benzene	0030 0040	f1 f1	5041A 8260B 8260B	Make sure that the Tenax is clean.
92-87-5	Benzidine	0010? kp acid liquid	f2f413 s	3542 8270C HPLC/PDA	May react during sampling. Ref 50&51, prototype needs to be isokinetic.
98-07-7	Benzotrithloride	0010	f2	3542 8270C	
100-44-7	Benzyl Chloride	0010	f1 f2	3542 8270C	
92-52-4	Biphenyl	0010	f1	3542 8270C	
117-81-7	Bis(2-ethylhexyl)phthalate	0010	f2f411	3542 8270C	a.k.a. DEHP
542-88-1	Bis(chloromethyl)ether	n, kp 0010 kp 0030	f4 11 17	3542 8270C	Reacts quickly with water
75-25-2	Bromoform	0010	f1 f2	3542 8270C	
106-99-0	1,3-Butadiene	0040? kp	f4	8260B	Reactive, borderline results.
156-62-7	Calcium cyanamide	0010 MS	s	?	Should be able to collect salt as particulate. Analysis is problematic, low solubility without decomposition.
105-60-2	Caprolactam	0010?	f1f411	3542 8270C	Mixed results, suspect hydrolysis.
133-06-2	Captan	0010	m	3542 8270C HPLC	Can be reactive.
63-25-2	Carbaryl	0010?	f1f411	3542 8270C	Mixed results.

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
75-15-0	Carbon Disulfide	0030?	f2f4l2	5041A 8260B	Mixed results.
463-58-1	Carbon Tetrachloride	0030/0031	fl	5041A 8260B	
463-58-1	Carbonyl Sulfide	M15 0040	s	GC/FPD CG/FPD	
120-80-9	Catechol	0010	m	3542 8270C	Careful pH control during extraction mandatory. Recovery may be difficult.
133-90-4	Chloramben	acid liquid	l4	HPLC/PDA	Ref 50&51, prototype needs to be isokinetic
57-74-9	Chlordane	0010	fl	3542 8270C	
7782-50-5	Chlorine	M26/26A 0050 0051	fl	9056 9057	Halogens & halo-acids can be done simultaneously
79-11-8	Chloroacetic Acid	n, sp	n	HPLC	
532-27-4	2-Chloroacetophenone	0010	fl f2	3542 8270C	
108-90-7	Chlorobenzene	0010 0030? 0031?	fl f2 fl fl	3542 8270C 5041A 8260B 5041B 8260B	Above recommended bp limit for 0030/0031, and for 0040.
510-15-6	Chlorobenzilate	0010	flf3f4	3542 8270C	
67-66-3	Chloroform	0030 0031 0040	fl fl s	5041A 8260B 5041A 8260B 8260B	
107-30-2	Chloromethyl Methyl Ether	n kp <u>0030</u>	l7	<u>5041A 8260B</u>	May decompose during s&a
126-99-8	Chloroprene	0030? 0031	f2f4l1 fl	5041A 8260B 5041A 8260B	Recoveries good in lab., mixed in field. Suspect reactivity.
1319-77-3	Cresols/Cresylic Acid	-	-	-	Determine as individual cresols by methods following.
95-48-7	o-Cresol	0010 NaOH	fl f2 fl	3542 8270C HPLC	NaOH impinger collection for emissions in the 20-100 ppm range. Refs. 46, 64, & 65.
108-39-4	m-Cresol	0010 NaOH	f2 fl	3542 8270C HPLC	NaOH impinger collection for emissions in the 20-100 ppm range. Refs. 46, 64, & 65.
106-44-5	p-Cresol	0010 NaOH	f2 fl	3542 8270C HPLC	NaOH impinger collection for emissions in the 20-100 ppm range. Refs. 46, 64, & 65.
98-82-8	Cumene	0010	fl	3542 8270C	
94-75-7	2,4-d	0010	s	8151A, 8321A	
3547-04-4	DDE	0010	fl	3542 8270C	CAS #3547-04-4 is on CAAA. The large volume pesticide is 72-55-9. The two are similar (almost congeners) and should behave comparably.
334-88-3	Diazomethane	n, kp	-	-	Very reactive. Derivative method should be developed.
132-64-9	Dibenzofurans	0010	fl	3542 8270C	For PCDF, use Method 0023A or Method 23
84-74-2	1,2-Dibromo-3-Chloro-propane	0010	fl f4	3542 8270C	
84-74-2	Dibutylphthalate	0010	fl f4	3542 8270C	Common contaminant
106-46-7	1,4-Dichlorobenzene(p)	0010	fl f2	3542 8270C	

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
91-94-1	3,3-Dichlorobenzidene	0010 acid liquid	f4 f5 s	3542 8270C HPLC/PDA	Reactive, no good with 0010. Ref 50&51, prototype needs to be isokinetic.
111-44-4	Dichloroethyl Ether	0010	f1 f2	3542 8270C	Same as bis(2-chloroethyl)ether
542-75-6	1,3-Dichloropropene	0030/0031 0010	f1 f2 f1 f2	5041A 8260B 3542 8270C	Mixed results. May be source sensitive.
62-73-7	Dichlorvos	0010	f1 f2	3542 8270C	
111-42-2	Diethanolamine	n, kp acid liquid	- s	8270 HPLC should	The method of Ref. 50&51 should collect OK if made isokinetic. No benzene ring, so alternate detector may be needed
91-66-7	N,N-Diethyl aniline	0010 acid liquid	f1 f2 s	3542 8270C HPLC/PDA	Compound confused with Dimethylaniline on CAAA, wrong CAS number listed. Ref. 50&51, prototype needs to be isokinetic.
64-67-5	Diethyl Sulfate	n, kp	-	-	Probably special S&A. a.k.a. sulfuric acid, diethyl ester
119-90-4	3-3-Dimethoxybenzidine	kp 0010 acid liquid	f413 s	3542 8270C HPLC/PDA	Likely reactive. Ref 50&51, prototype needs to be isokinetic.
60-11-7	Dimethyl Aminoazobenzene	0010? acid liquid	f4 11 s	3542 8270C HPLC/PDA	Suspect reactivity. Ref 50&51, prototype needs to be isokinetic.
121-69-7	N,N-dimethylaniline	0010 acid liquid	f2 11 14	3542 8270C HPLC/PDA	Incorrectly called diethylaniline on CAAA Ref 50&51, prototype needs to be isokinetic
119-93-7	3,3-Dimethyl Benzidine	0010? kp acid liquid	f1f413 14	3542 8270C HPLC/PDA	Mixed results probably due to reactivity. Ref 50&51, prototype needs to be isokinetic
79-44-7	Dimethyl Carbamoyl Chloride	0010	m, sp	8321A	
68-12-2	Dimethyl Formamide	0010	m, sp	8260B, 8141A	
57-14-7	1,1-Dimethyl Hydrazine	0030?	kp 17		Stability problems. Probably needs derivatization method.
131-11-3	Dimethyl Phthalate	0010	f1	3542 8270C	Common contaminant
77-78-1	Dimethyl Sulfate	special	s	special	
534-52-1	4,6-Dinitro-o-Cresol. and salts	0010	f1f213	3542 8270C	Bad lab results are puzzling. This test was for the cresol only, not salts.
51-28-5	2,4-Dinitrophenol	0010?	f1f413	3542 8270C	Mixed results, very good to very bad.
121-14-2	2,4-Dinitrotoluene	0010	f1	3542 8270C	
123-39-11	1,4-Dioxane	0010 0030	f1 17	3542 8270C	a.k.a. 1,4-Diethyleneoxide. Easily lost during extraction and concentration. Labeled lab. recovery standard is mandatory.
122-66-7	1,2-Diphenylhydrazine	0010 acid liquid	m s	GC/MS HPLC/PDA	Reactive. Ref 50&51, prototype needs to be isokinetic.
106-89-8	Epichlorohydrin	0010 kp 0030 kp	f2f413 17	3542 8270C	Mostly poor with 0010, worse with 0030. New method needed.
106-88-7	1,2-Epoxybutane	0030	m,sp	5040.(GCMS)	Suspect reactivity problems
140-88-5	Ethyl Acrylate	kp 0030? 0010 sorbent	18 m,sp 14	GC/MS GC/FID	Polymerizes easily Ref 50&54.

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
100-41-4	Ethyl Benzene	0010	f1	3542 8270C	
51-79-6	Ethyl Carbamate	0010?	f1f412	3542 8270C	a.k.a. urethane
75-00-3	Ethyl Chloride (Chloroethane)	0030?kp 0031?kp	f2f411 f4	5041A 8260B 5041A 8260B	Low bp. 0031 should have done better.
106-93-4	Ethylene Dibromide	0010 0030? 0031?	f1 f2 f1f411 f1	3542 8270C 5041A 8260B 5041A 8260B	a.k.a. dibromoethane. Above recommended bp for 0030/0031.
107-06-2	Ethylene Dichloride	0030 0031	f1 f2 f1	5041A 8260B 5041A 8260B	a.k.a. 1,2 dichloroethane
107-21-1	Ethylene Glycol	0010	s	8015B, 8430	
151-56-4	Ethylene Imine (Aziridine)	n kp 0030	17		Water soluble & polymerizes
75-21-8	Ethylene Oxide	tedlar bag CARB 431	f3	GC/MS GC/FID	Reactivity can cause problems in some matrices
96-45-7	Ethylene Thiourea	0010	m	HPLC/UV 8325	Reactive and water soluble. See Ref. 56 & 57 for HPLC/UV.
75-34-3	1,1 dichloroethane (misnamed Ethylidene Dichloride on CAAA)	0030 0031 0040	f1 f2 f1 f1	5041A 8260B 5041A 8260B 8260B	75-34-3 is really 1,1 dichloroethane. Ethylidene dichloride is 75-35-4
50-00-0	Formaldehyde	0011	f1	8315A	Simultaneous aldehydes possible, ref. 23&40
76-44-8	Heptachlor	0010	f1f411	3542 8270C	
118-74-1	Hexachlorobenzene	0010	f1 f2 f4	3542 8270C	Recovery increased greatly with each field test. Last one was 82.6%
87-68-3	Hexachlorobutadiene	0010	f1 f2	3542 8270C	
77-47-4	Hexachlorocyclopentadiene	0010	f2 f4	3542 8270C	Good to mediocre field tests, poor in the lab.
67-72-1	Hexachloroethane	0010	f1	3542 8270C	
822-06-0	Hexamethylene-1,6- diisocyanate	M207-1	f1	M207-2	Reactive, a.k.a. 1,6 diisocyanatohexane a.k.a. HDI
680-31-9	Hexamethylphosphoramide	0010	f4 13	3542 8270C	Suspect reactivity
110-54-3	Hexane	0030 0040	f1 f1	5041A 8260B 8260B	
302-01-2	Hydrazine	0010	kp	GC/MS	Water soluble & unstable, probably requires special S&A
7647-01-0	Hydrochloric Acid	M26/26A 0050 0051	f1	9056 9057	Halogens & halo-acids can be done simultaneously
7664-39-3	Hydrogen Fluoride	M26/26A	14	9057	Methods 13A,13B,14 for total fluoride
123-31-9	Hydroquinone	0010	m.sp	GC/MS	Reactive, solubility problems.
78-59-1	Isophorone	0010 0011	f1 f1	3542 8270C 8315A	
58-89-9	Lindane (all isomers)	0010	f1	3542 8270C	a.k.a. hexachlorocyclohexane
108-31-6	Maleic Anhydride	0010	s,kp	HPLC	Reacts with water, must quantitate the acid & report as parent compound

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
67-56-1	Methanol	0030? M308 MST	m.sp f1 f1	5041A 8260B GC/FID GC/FID	Easily water soluble, may purge poorly See References 59, 60, & 61 for evaluation of M308 and MST.
72-43-5	Methoxychlor	0010	f2	3542 8270C	
74-83-9	Methyl Bromide	0030?kp 0031?kp 0040?kp	f2 f4 f4	5041A 8260B 5041A 8260B 8260B	a.k.a. bromomethane. 0030 barely met f2, 0031 should be better, but was worse. Low bp. 0040 results high.
74-87-3	Methyl Chloride (Chloromethane)	0030 kp 0031 kp 0040	f4 f4 f1	5041A 8260B 5041B 8260B 8260B	Artifact problems with Tenax.
71-55-6	Methyl Chloroform	0030/0031 0040	f1 f1	5041A 8260B 8260B	a.k.a. 1,1,1-trichloroethane
78-93-3	Methyl Ethyl Ketone (2-Butanone)	0011 0030? PFBHA	f4 18 14	8315A 5041A 8260B GC/MSorECD	Water solubility causes problems with 5041A purge. See References 45 & 50 for PFBHA approach.
60-34-4	Methyl Hydrazine	0030	kp	5040	Reactive, probably requires special S&A
74-88-4	Methyl iodide	0030/0031	f1	5041A 8260B	a.k.a. Iodomethane
108-10-1	Methyl Isobutyl Ketone (Hexone)	0010 0011 PFBHA kp 0030?	f1 f4 14 18	3542 8270C 8315A GC/MSorECD	See references 45 & 50 for PFBHA approach, 23 & 40 for DNPH (0011).
624-83-9	Methyl Isocyanate	M 207-1	f1	M207-2	a.k.a. isocyanic acid, methyl ester, a.k.a. MI. See Ref. 18.
80-61-6	Methyl Methacrylate	0010 kp 0030? sorbent	m.sp 18 14	5040,(GC/MS) GC/FID	May polymerize Ref 50&54.
1634-04-4	Methyl Tert Butyl Ether	kp 0030?	18		a.k.a. tert. butyl methyl ether
101-14-4	4,4-Methylene Bis(2-chloroaniline)	0010 acid liquid	m.sp s	GC/MS HPLC/PDA	Suspect reactivity problems during sampling. Ref 50&51, prototype needs to be isokinetic.
75-09-2	Methylene Chloride (dichloromethane)	0030/0031 0040	f1 f1	5041A 8260B 8260B	a.k.a. dichloromethane
101-68-8	Methylene Diphenyl Diisocyanate	M207-1	f1	M207-2	Reactive. See Ref. 18. a.k.a. MDI, a.k.a. 4,4'-Bis(carbonylamino)diphenylmethane.
101-77-9	4,4-Methylenedianiline	0010 acid liquid	m. sp s	GC/MS HPLC/PDA	Reactive? Ref 50&51, prototype needs to be isokinetic.
91-20-3	Naphthalene	0010	f1	3542 8270C	
98-95-3	Nitrobenzene	0010	f1	3542 8270C	
92-93-3	4-Nitrobiphenyl	0010	f1	3542 8270C	
100-02-7	4-Nitrophenol	0010	f1 f213	3542 8270C	Bad lab results are puzzling.
79-46-9	2-Nitropropane	0010,0030	s	GC/MS	
684-93-5	N-Nitroso-N-Methylurea	0010	m.sp	HPLC	Unstable
62-75-9	N-Nitrosodimethylamine	0010	f1	3542 8270C	
59-89-2	N-Nitrosomorpholine	0010	f1	3542 8270C	
56-38-2	Parathion	0010	f1 f2	3542 8270C	

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
82-68-8	Pentachloronitrobenzene	0010	f1 f3 f4	GC/MS	
87-86-5	Pentachlorophenol	0010	f1 f3 f4	3542 8270C	
108-95-2	Phenol	0010 NaOH	f1 f2 f1	3542 8270C HPLC	NaOH impinger collection for emissions in the 20-100 ppm range. Refs. 46, 64, & 65.
106-50-3	p-Phenylenediamine	0010 acid liquid	m,sp s	GC/MS HPLC/PDA	Reactive, polar, water soluble. Ref 50&51, prototype needs to be isokinetic.
75-44-5	Phosgene	XPHS	11	GC/MS	Reactive, must be derivatized as collected. See Refs. 52 & 53.
7803-51-2	Phosphine	M29 0060	s	6010 6020 7000	Yields total P value
7723-14-0	Phosphorus	M29 0060	s	6010 6020 7000	Yields total P value
85-44-9	Phthalic anhydride	0010 0010 kp	s f4 13	HPLC 3542 8270C	Reacts with water, must quantitate the acid & report as parent compound
1336-36-3	Polychlorinated Biphenyls (Aroclors)	0010 CARB 428	s	3542 GC/MS CARB 428	Combustion destroys Aroclor patterns. Determine isomer groups or individuals.
1120-71-4	1,3-Propane Sultone	0010	m	GC/MS	Polar and reactive.
57-57-8	Beta-Propiolactone	0010	m,sp	GC/MS	May be too reactive
123-38-6	Propionaldehyde	0011	f1	8315A	Simultaneous aldehydes possible. Ref.23&40
114-26-1	Propoxur	0010	f1 f2	3542 8270C	a.k.a. Baygon
78-87-5	Propylene Dichloride	0030 0031	f1 f2 f1	5041A 8260B 5041A 8260B	a.k.a. 1,2 dichloropropane
75-56-9	Propylene Oxide	kp 0030 0040	17 m, sp		Reactive, water soluble, a.k.a. 1,2 propylene oxide
75-55-8	1,2-Propylenimine	n kp 0030	17		May be reactive
91-25-5	Quinoline	0010 acid liquid	f1 14	3542 8270C HPLC/PDA	Ref 50&51, prototype needs to be isokinetic
106-51-4	Quinone	0010 0011?	f413kp f2.kp	3542 8270C 8315A	May be reactive, a.k.a. 1,4-benzoquinone, a.k.a. p-benzoquinone
100-42-5	Styrene	0010?	f1 f411	3542 8270C	Low f4 results puzzling. Reactivity?
96-09-3	Styrene Oxide	0010 kp	f4 13	3542 8270C	Reactive. a.k.a. 1,2 epoxyethylbenzene
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	M23 0023A	f1	M23 8290	Special care needed during recovery and analysis.
79-34-5	1,1,2,2-Tetrachloroethane	0010	f1	3542 8270C	
127-18-4	Tetrachloroethylene	0010 0030/0031	f2 f1 f2	3542 8270C 5041A 8260B	a.k.a. tetrachloroethene, a.k.a. perchloroethylene
7550-45-0	Titanium Tetrachloride	M29 0060	s	6010 6020 7000	For total titanium
108-88-3	Toluene	0010 0030 0040	f1 f2 f1 f1	3542 8270C 5041A 8260B 8260B	
95-80-7	2,4-Toluene Diamine	0010 acid liquid	m,sp 14	GC/MS HPLC/PDA	Reactive Ref 50&51, prototype needs to be isokinetic.

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
584-82-1	2,4-Toluene Diisocyanate	M207-1	fl	M207-2	Reacts with water, a.k.a. TDI
95-53-6	o-Toluidine	0010? acid liquid	f2/f411 14	3542 8270C HPLC/PDA	Mixed results, may be reactive. Ref 50&51, prototype needs to be isokinetic.
8001-35-2	Toxaphene (Chlorinated Camphene)	0010	s	GC/MS, 8250	
120-82-1	1,2,4-Trichlorobenzene	0010	fl f2	3542 8270C	
79-00-5	1,1,2-Trichloroethane	0010 0030/0031 0040	fl f2 fl fl	3542 8270C 5041A 8260B 8260B	
79-01-6	Trichloroethylene	0030/0031	fl	5041A 8260B	a.k.a. trichloroethene
95-95-4	2,4,5-Trichlorophenol	0010	fl	3542 8270C	
88-06-2	2,4,6-Trichlorophenol	0010	fl f2	3542 8270C	
121-44-8	Triethylamine	n kp 0030 acid liquid	17 s	HPLC should	a.k.a. N,N-diethylethanamine. Suspect reactivity. The method of Ref. 50&51 should collect OK. No benzene ring, so alternate detector may be needed
1582-09-8	Trifluralin	0010 acid liquid	f412kp m, kp	3542 8270C HPLC/PDA	Suspect reactivity, a.k.a. Treflan Ref 50&51, prototype needs to be isokinetic. Analysis method needs modification.
540-84-1	2,2,4-Trimethylpentane	0030 0040	f2 fl	5041A 8260B 8260B	a.k.a. isooctane
108-05-4	Vinyl Acetate	kp 0030? sorbent	18 14	GC/FID	Ref 50&54.
593-60-2	Vinyl Bromide	0030?kp 0031?kp 0040 M106	f2/f411 f4 fl	5041A 8260B 5041A 8260B 8260B GC/MS	
75-01-4	Vinyl Chloride	0030 kp 0031? kp 0040 M106	fl f411 f4 11 fl 15	5041A 8260B 5041A 8260B 8260B GC/MS	Mixed results, 0030 is questionable. Poor field results for 0031 are puzzling, may be due to reactivity.
75-35-4	Vinylidene Chloride	0030/0031 0040 M106	fl/fl fl 15	5041A 8260B 8260B GC/MS	a.k.a. 1,1 dichloroethene. a.k.a. 1,1 dichloroethylene
1330-20-7	Xylenes(mixture)	0010	fl	3542 8270C	Determine individual xylenes, not total.
95-47-6	o-Xylene	0010	fl	3542 8270C	
108-38-3	m-Xylene	0010	fl	3542 8270C	
106-42-3	p-Xylene	0010	fl	3542 8270C	
-	Antimony Compounds	M29 0060	fl	6010 6020 7000	
-	Arsenic Compounds	M29 0060	fl	6010 6020 7000	Also Method 108 & 108A
-	Beryllium Compounds	M29 0060	fl	6010 6020 7000	Also Method 103 & 104
-	Cadmium Compounds	M29 0060	fl	6010 6020 7000	

CAS No.	Chemical Name	Sampling Method	S. Code	Analysis Method	Comments
-	Chromium Compounds	M29 0060	fl	6010 6020 7000	M29 or 0060 for total chromium, 0061 for hexavalent Cr.
-	Cobalt Compounds	M29 0060	s	6010 6020 7000	
-	Coke Oven Emissions	Method 109	-	-	
-	Cyanide Compounds	XHCN	ll	XHCN	XHCN for HCN, CARB426 for total cyanide.
-	Glycol Ethers	n 0010	- s	- 8430, 8015B	Category too general, however a method is possible for individual compounds. Should be isokinetic, probably 0010.
-	Lead Compounds	M29 0060	fl	6010 6020 7000	Also Method 12
-	Manganese Compounds	M29 0060	fl	6010 6020 7000	
-	Mercury Compounds	M29 0060	fl	7470	Also Methods 101,101A,102. For speciation research see references 50 & 55.
-	Mineral Fibers				
-	Nickel Compounds	M29 0060	fl	6010 6020 7000	
-	Polycyclic Organic Matter	0010 CARB 429	f3	3542 8270C CARB 429	Individual compounds are determined, not total POM, more or less synonymous with pna, pah, pac.
-	Radionuclides (including radon)	M111 M114 M115			
-	Selenium Compounds	M29 0060	fl	6010 7000	

STATUS AND RECOVERY TABLE CODE DEFINITIONS

- R %Recovery of spiked standard.
- C Method 301 bias correction factor
- An underlined method is not recommended for the listed air toxic.
- ? Effectiveness of the method for the listed air toxic is questionable or showed mixed results.
- f1 Data are available from at least one Method 301 field test where $143\% \geq R \geq 76.9\%$ (equivalent to $0.70 \leq C \leq 1.30$) and the RSD of R was $\leq 50\%$.
- f2 Data are available from at least one Method 301 field test where $150\% \geq R \geq 50\%$ (equivalent to $0.67 \leq C \leq 2.00$) and the RSD of R was $\leq 50\%$.
- f3 Data are available from at least one field test not fully qualifying as Method 301 where $150\% \geq R \geq 50\%$ (equivalent to $0.67 \leq C \leq 2.00$) and the RSD of R was $\leq 50\%$. Some of the recovery data may be better than the minimum shown, and the test may only have failed to meet minimum replicate criteria for full Method 301 statistical analysis.
- f4 Data are available from at least one Method 301 field test where $R \leq 50\%$ or $R \geq 150\%$ or the RSD of R was $\geq 50\%$.
- f5 Data are available from at least one field test not fully qualifying as Method 301 where $R \leq 50\%$ or $R \geq 150\%$ or the RSD of R was $\geq 50\%$.
- 11 Laboratory test data are available where full scale sampling equipment, dynamic spiking, and a stack simulator were utilized. The RSD of R was $\leq 50\%$, and $143\% \geq R \geq 76.9\%$ (equivalent to $0.70 \leq C \leq 1.30$). This is essentially a successful Method 301 test in the laboratory.
- 12 Laboratory test data are available where full scale sampling equipment, dynamic spiking, and a stack simulator were utilized. The RSD of R was $\leq 50\%$, and $150\% \geq R \geq 50\%$ (equivalent to $0.67 \leq C \leq 2.00$).
- 13 Laboratory test data are available where full scale sampling equipment, dynamic spiking, and a stack simulator were utilized. $R \leq 50\%$ or $R \geq 150\%$ or the RSD of R was $\geq 50\%$ or unknown.
- 14 Other laboratory test data are available, where $143\% \geq R \geq 76.9\%$ (equivalent to $0.70 \leq C \leq 1.30$) and the RSD of R $\leq 50\%$ or unknown. The data from tests in this category may be insufficient to yield a credible RSD.
- 15 Other laboratory test data are available, where $150\% \geq R \geq 50\%$ (equivalent to $0.67 \leq C \leq 2.00$) and the RSD of R $\leq 50\%$ or unknown. The data from tests in this

category may be insufficient to yield a credible RSD.

- 16 Other laboratory test data are available, where $R \leq 50\%$ or $R \geq 150\%$ or the RSD of R was $\geq 50\%$ or unknown. The data from tests in this category may be insufficient to yield a credible RSD.
- 17 Laboratory tests showed no response in VOST analytical system (5041A & 8260B). See References 5, 7, 11, and 16.
- 18 Laboratory tests showed weak response in VOST analytical system (5041A & 8260B). See References 5, 7, 11, and 16. Special attention or modification necessary for reliable operation.
- s Should work. For sampling methods, no confirmatory field or laboratory data has been identified, but the structure of the compound or its similarity to validated compounds makes the prognosis optimistic.
- m Might work. This designation usually implies that the technique given should work if the compound survives the sampling and analysis process, but that we have strong reservations about its ability to do so. This status is usually linked with reactivity/instability. Many compounds are stable enough to analyze, but will not tolerate prolonged exposure to water, NO_2 , or other materials during sampling.
- n No known adequate method. This always means we know of no reliable method for this pollutant. We usually have identified a number of unreliable methods for the pollutant. **If negative data are available, the sampling method will be underlined.**
- sp Suspected problems. The suspected problem is given in the comments, and is often related to reactivity.
- kp Known problems. This is similar to the suspected problem except that our fears have been confirmed by data. **If data indicate questionable or inconsistent performance, the sampling method will be followed by a question mark.**