REQUEST FOR QUOTATION

January 22, 2019

PROJECT: **Analysis of DNPH Aldehyde Cartridges**

QUOTES DUE BY: **5:00 PM on Tuesday, February 12, 2019**

OVERVIEW

The San Joaquin Valley Unified Air Pollution Control District (District) participates in the United States Environmental Protection Agency (USEPA) Enhanced Photochemical Assessment Monitoring Station (PAMS) monitoring program. It is the District's responsibility to collect the air samples, and to solicit laboratories that will analyze and upload data to EPA's Air Quality System (AQS). Part of this program involves sampling for aldehydes using dinitrophenylhydrazene (DNPH) loaded cartridges adhering to the 1998 USEPA PAMS Technical Assistance Document (TAD).

The District is issuing this Request for Quotation (RFQ) in order to retain a qualified contractor who will analyze cartridges collected in 2019. This contract is for the 2019 PAMS season only.

To be considered for this project, contractors must meet the minimum eligibility requirements, and submit cost-effective proposals that satisfy this RFQ's quotation requirements. The District will pay on a per cartridge basis. Payments will be made subsequent to proper verification of completed monthly data submission to EPA's AQS database and District evaluation of EPA Quality Control Reports, confirming that the work was completely and satisfactorily carried out.

Because District funding for the project may include federal funds:

- Contractor shall comply with all federal and state conflict of interest laws, statutes, and regulations, which apply to performance of this Agreement and shall be applicable to all parties and beneficiaries and any officer, agent, or employee of District under this Agreement

- The contractor shall comply with all federal and state conflict of interest laws, statutes, and regulations, which shall be applicable to all parties and beneficiaries under this Agreement and any officer, agent, or employee of District.

- The contractor must not be presently debarred, suspended, proposed for debarment, declared ineligible, voluntarily excluded from participation or otherwise excluded from or ineligible for participation under federal assistance programs. Contractor must ensure that all subcontractors employed for conduct of this project also certify compliance with this provision of law to the contractor.

- The contractor or any individual identified in the proposal that appears in the Excluded Parties List System (EPLS) is not eligible for award of a contract. The EPLS is a central registry that contains information regarding entities debarred, suspended, proposed for debarment, excluded, or otherwise declared ineligible from receiving Federal contracts. Access to the EPLS is available at www.epls.gov.

- The contractor certifies by signing the signature page of the original copy of the submitted proposal and any amendment signature page(s) that the proposer is not presently debarred, suspended, proposed for debarment, declared ineligible, voluntarily excluded from participation, or otherwise excluded from or ineligible for participation under federal assistance programs.

The contractor will provide certification that commercial general liability insurance coverage ($1,000,000 per occurrence) for bodily or personal injuries or for property damage as well as Workers Compensation Insurance as in accordance with the California Labor Code are obtained and are in full force.

The District reserves the right to reject any and all quotations, and to make no awards.

SUBMITTAL INSTRUCTIONS

A contractor who submits a quotation in response to this RFQ must adhere to the following instructions:

1. The deadline for submitting quotations is 5:00 PM on Tuesday, February 12, 2019. Quotations received after this time and date will not be accepted.

2. Quotations are to be mailed to the following address:

   San Joaquin Valley Unified Air Pollution Control District
   Attn: Stephen Shaw
   Senior Air Quality Specialist
   1990 E. Gettysburg Avenue
   Fresno, CA 93726-0244

3. The envelope should be marked with title “Quotation for Analysis of DNPH Aldehyde Cartridges.”

4. Include five (5) hard copies and one (1) electronic copy of the quotation.

MINIMUM ELIGIBILITY REQUIREMENTS

Contractors must meet the following minimum eligibility requirements:

1. Successful completion of PAMS analyses for a public agency within the last 5 years.

2. Possess demonstrated ability to create and upload AQS data files.

3. Completion of Attachment A (Itemized Cost List).

QUOTATION REQUIREMENTS

At a minimum, submitted quotations are to individually address the above 3 ‘Minimum Eligibility Requirements’ and numbers 2 through 11 of the below ‘Quotation Requirements:’

1. Not exceed 24 pages in length (including cover letter and reference material) and pages must be numbered.

2. Describe previous experience in the documentation and analysis of PAMS DNPH Aldehyde Cartridges (references are required).

3. Provide qualifications of contractor staff who will be assigned to this project and describe the role of each assigned staff member to be used in the project.

4. Generally describe the process that the contractor will use in the analyses of the samples.

5. Describe previous experience with AQS, including uploading data into AQS, and including a report from AQS of data that was uploaded by your respondent.

6. Describe previous experience with the 1998 USEPA PAMS TAD for DNPH Aldehyde Cartridges.

7. Describe previous experience with PAMS for analysis of carbonyls listed in Attachment B, specifically acetaldehyde, acetone, and formaldehyde.

8. Include a price quote on Attachment A (Itemized Cost List) for the analysis of an Audit Sample or Performance Evaluation that the District may request.

9. Provide the cost on Attachment A (Itemized Cost List) for 4 new glass tube ozone scrubbers for Xontech Model 925 carbonyl samplers and their preparation and maintenance.

10. Include a price quote on Attachment A (Itemized Cost List) for each of the following items on a per cartridge basis:
    a. The preparation and certification of sample cartridges.
    b. The cost of analysis of the cartridges.
    c. The cost of the creation of the AQS transaction files and uploading the files.
    d. Documentation of invalid samples and missing sample runs.

GENERAL PROJECT GUIDELINES

The following is a description of the general project guidelines, requirements, and responsibilities that both the District and contractor will hold during the life of the project:

1. At any time the District may require that the contractor successfully complete an analysis of an Audit Sample or Performance Evaluation in order for the District to evaluate the performance of the lab.

2. The contractor will supply the cartridges necessary for any Audit Sample or Performance Evaluation.

3. In 2019, there will be approximately ***342*** samples sent to the contractor for analysis. This number may increase or decrease depending on the number of samples collected. PAMS sampling will be conducted during the months of June, July, and August of 2019.

4. The contractor shall perform DNPH aldehyde cartridge analyses using the 1998 USEPA PAMS TAD (the District will not allow for a different collection or sampling device other than what is currently in use).

5. There are three (3) required compounds to be analyzed as listed in Attachment B: acetaldehyde, acetone, and formaldehyde. No other compounds are requested or desired.

6. The contractor will supply new cartridges with DNPH loaded on a silica gel substrate. The contractor will ship all 342 cartridges to the District as soon as possible after the signing of the contract. The contractor will contact and coordinate with the District with regards to shipping locations and addresses (Fresno and Bakersfield). The contractor is responsible for all record keeping and

costs regarding shipping the cartridges to the two locations, recording the number of cartridges sent, the manufacturer's cartridge lot number being sent to each location, and the shipment's date. The contractor is responsible for all record keeping and shipping and handling costs of other materials being sent to the District and/or the audit laboratory for this project.

7. If warranted, the contractor shall provide to the District specific instructions detailing the specific procedures for handling the cartridges. If the contractor prefers that the collected samples be returned to them using a specific kind of container and/or cooling material, other than what the District proposes to use, then the contractor must supply these materials to the District as part of the contract. The containers/shipping materials must meet all Department of Transportation and Federal Aviation Administration requirements for safe handling and transport provided by shipping companies like UPS or FedEx. If the contractor desires the District to use a particular written form for tracking the exposed sample (i.e. a chain of custody (COC) form other than the form the District provides), the contractor will supply a sufficient quantity of these forms for use by District staff.

8. The contractor is responsible for all record keeping and shipping and handling costs of the cartridges and other materials being sent to the District and/or the audit laboratory for this project. The District is responsible for recording keeping and shipping costs to return exposed cartridges to the contractor.

9. Payment schedule:

    a. Since this is a short term contract, the District prefers invoicing when all the work is completed to the satisfaction of the District. Upon receiving the invoice, the District will compare what was uploaded to AQS with the documentation provided by the contractor and ensure that all of the contract requirements are met. Once everything is verified, the contractor will send a single invoice to the District and payment will be made.

    b. The District recognizes that some respondents require monthly invoices and that is also acceptable to the District. Once the District has concluded that the monthly deliverables are acceptable (verification of completed monthly data submission to EPA AQS and District evaluation of EPA Quality Control Reports – confirming that the work was completely and satisfactorily carried out) the contractor may submit a monthly billing statement based upon the site, sample collection date, and time of sample collection and the number of samples for that month (June, July, and August). The billing will not be based on the date of the 'Chain of Custody' form, the date the canisters were received at the laboratory, or the date of the laboratory's internal tracking system. Each monthly billing will list the gross amount but will invoice at 90% as 10% will be retained until all three month's billings and all services (analyses, reports, audits,

performance evaluations, etc.) are successfully completed and rendered to the satisfaction of the District. The 10% retained is the District's guarantee for satisfactory completion. When all of the above prerequisites have been completed and deemed satisfactory, the District will accept an invoice for the retained amount and the final payment will be dispensed.

10. The contractor shall retain and archive a copy of all paper and electronic records of this project for a minimum of three (3) years. The archived records will include any documentation pertaining to the analysis and reduction of raw and processed data, including calibrations, samples, and run sequences. In the case where there is a need of clarification or investigation of the reported data, the contractor will provide any and all necessary information as requested so that the entire analysis can be reconstructed.

11. The contractor will be available by phone to discuss issues related to this project on the same business day that the District places the call with the contractor. The contractor shall notify the District immediately upon the discovery of any irregularities during the course of the project.

12. It is understood by the Contractor that time is of the essence in the performance of this project.

13. Since this Agreement will exceed Ten Thousand Dollars ($10,000), the contractor will be subject to examination and audit of the auditor general for a period of three (3) years after final payment under contract.

QUALITY CONTROL REQUIREMENTS

The following procedures will be employed to ensure the quality of the project and the resulting data:

1. The contractor will ensure that upon receipt of the cartridges for analysis, they will be immediately placed in a refrigerated and isolated environment of 4 degrees Celsius or less to prevent degradation of the samples with the time between sampling and extraction not exceeding two (2) weeks. The contractor will also ensure the samples will be promptly analyzed for the same reason.

2. The contractor shall provide the District with "gold ring" cartridges **only**. The District will reject any cartridge not of this kind.

3. Only new Waters-brand cartridges (Sep-Pak DNPH-Silica Short Body Cartridges, part number WAT037500) are to be supplied by the contractor, and proof of the shelf life must be submitted to the District with the shipment (all cartridges must be of no more than one (1) month old at the time of purchase, and less than three (3) months old for sample collection. All cartridge expiration dates must be

after September 30th 2019. The District will not accept used or reconditioned cartridges. Cartridges must be in their sealed pouches, kept unexposed to sunlight, and be maintained under a monitored temperature of four (4) degrees Celsius or less. Shipped cartridges must be provided with enough ice for the shipment to arrive at the District with the cartridges still under the cover of ice. The District will not accept cartridge shipments that do not arrive under iced conditions. Left over cartridges will be returned.

4. For each manufacturer's lot of cartridges, at least one (1) cartridge per lot is to be analyzed for purity by the contractor prior to shipment. A copy of this analysis is to be forwarded to the District by including the report with the shipment of cartridges.

5. The contractor will supply the District with five (5) denuder ozone scrubbers for Xontech Model 925 carbonyl samplers. It will be the contractor's responsibility to purchase, service, and coat the interior of the denuder ozone scrubbers. The denuder ozone scrubbers are required to arrive at the District intact and unbroken. Should the denuder ozone scrubber arrive broken, it is the responsibility of the contractor to replace it at their expense. Denuder ozone scrubbers must adhere to the 1998 USEPA PAMS TAD. The denuder ozone scrubber construction material must be glass or copper tubing, and be treated as required in the 1998 USEPA PAMS TAD.

6. The contractor will provide written documentation indicating the methodology used for analytical instrument calibration, analysis, and quality control/assurance. Copies of all related paperwork used to conduct data analysis such as chromatograms; instrument calibrations, etc. shall be supplied to the District in an electronic file format (DVD, Flash Drive, Compact Disc, etc.)

7. At no additional cost, the contractor will analyze for quality control purposes any audit cartridge(s) sent to the contractor by a CARB, USEPA and/or EPA approved National Air Toxics Trend Stations (NATTS) Laboratory designated by the District. Contractor shall provide copies of these audit results to the District. The results shall include all pertinent information regarding calibration reports and standard certificates.

8. It is at the District's discretion to send duplicate samples for audit purposes.

9. The contractor will analyze contents of only the valid samples as identified in District chain of custody (COC) forms. The contractor will not analyze contents of invalid samples. The contractor will appropriately document missing samples.

DATA REQUIREMENTS

The following is a list of requirements for the collection and reporting of the data involved in this project:

1. The contractor will only report data for acetaldehyde, acetone, and formaldehyde that are required to be analyzed as listed in the North American Research Strategy for Tropospheric Ozone (NARSTO) Measurement Methods Compendium (Attachment B). No other compounds are requested or desired.

2. The laboratory will upload the results of the analysis to AQS as 'Reported Data.'

3. Laboratory equipment must be capable of detecting and measuring levels of VOCs as low as one (1) parts per billion carbon (PPBc) but reporting all detection levels.

4. Reported data is to meet Level IV criteria according to EPA guidelines for PAMS documentation (Laboratory Documentation Requirements For Data Validation, Document Control Number 9QA-07-89, January 1990).

5. Data is to be reported to the District in both parts per billion carbon (PPBc) and parts per billion volume (PPBv).

6. The data formatted and uploaded to the AQS database is to utilize PPBc.

7. All measured values are to be reported. Any data below the Practical Quantification Limit (PQL) will be reported and flagged with "LJ". All non-detectable data will be reported as zero and flagged with "ND". Other Qualifier Codes can be used if necessary.

8. The contractor will submit monthly e-mails summarizing the analyzed data during the course of the project.

9. The contractor's monthly data files and reports will provide the resulting data on a single CD, DVD, or flash drive :

    a. The CD, DVD, or flash drive shall have a subdirectory dedicated to each site's files labeled with the site's name and AIRSCODE. Each site will have monthly subdirectories containing all of the relevant files for that month as described elsewhere in this RFQ.

    b. EPA Quality Control Reports: 'Load Report', 'Statistical Evaluation and Critical Review Report' and the 'Raw Data Inventory Report' shall be also recorded on the same CD, DVD, or flash drive used above.

    c. This CD, DVD, or flash drive will be sent to the District after all the data is uploaded into AQS.

10. All laboratory activities and completed data file uploaded reports (to include passage of EPA Quality Control Reports) are to be submitted to the District and AQS by **no later than November 30, 2019.**

EVALUATION OF RESPONSES TO THIS RFQ

Each response to this RFQ will be evaluated with particular emphasis on how well the respondent complies with the information requested in this RFQ, experience in PAMS-type analysis, experience in uploading to EPA's AQS system, cost of postage, and cost for services as shown on Attachment A. Not providing all of the information requested in this RFQ will lower the overall score and may be grounds to disqualify the response from further review.

INQUIRIES

Technical and administrative questions concerning this RFQ should be directed to Stephen Shaw, Senior Air Quality Specialist, San Joaquin Valley Unified Air Pollution Control District at steve.shaw@valleyair.org or (559) 230-6000. An editable copy of Attachment A (Itemized Cost List) is available on request.

Attachment A

Itemized Cost List

Itemized Cost List for 2019 PAMS DNPH

Show all costs on the following table.

Cost per Cartridge	**Costs**
Cost to prepare and certify cartridges	
Cost per analysis of each valid sample	
Cost of audit sample or performance evaluation	
AIRS Upload Costs	
Cost per cartridge for file creation and uploading data into AQS	
Cost of reporting and uploading one (1) missing or invalid sample into AQS	
Cost of Denuder Tubes	
Cost of five (5) prepared denuder tubes for the Xontech Model 925 carbonyl sampler	
Other costs not included in the above	
1.	
2.	
3.	
Sub-Totals	
Cost to prepare and certify 342 cartridges	
Cost of shipping of 342 cartridges to the District's Fresno office	
Cost of one (1) audit sample or performance evaluation	
Cost per analysis of 342 valid samples	
Cost of reporting and uploading 342 valid samples into AQS	
Cost of five (5) denuder tubes	
Cost of shipping of five (5) denuder tubes	
Cost of shipping 15 empty coolers with icepacks to the Fresno Office	
Total cost for 'Other Costs'	
Grand Total for Project (Sum of the Sub-Totals)	

Attachment B

PAMS Compounds

Sampling and Analysis Summary Information for PAMS VOC Target Species

See Methods for VOCs on Next Page

Number of VOC Compounds = 60

	Compound Name	IUPAC Name (if different)	Group Designation (note 1)	AIRS Parameter Number (note 1)	Boiling Point (degrees C) (note 2)	Volatility	CAS Number (note 2)	Sampling Method Alternatives (note 3)	Separator (note 4)	Detector (note 5)	EPA Ref. Desig. For Current Method (note 6)	Detection Limit (ppbv) (note 6)	Alternative Methods (possibly lower cost) (note 6)
1	Ethane		paraffin	43202	-88.5	Very vol.	74-84-0	Multi-adsorbent	GC	MS	TO-17	0.2-25	No alternative
2	Propane		paraffin	43204	-42	Very vol.	74-98-6	Multi-adsorbent	GC	MS	TO-17	0.2-25	No alternative
3	Isobutane	2-Methylpropane	paraffin	43214	-12	Very vol.	75-28-5	Can+ads or Can	GC	MS/FID	TO-15	0.2-25	TO-14A
4	n-Butane		paraffin	43212	0	Very vol.	106-97-8	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
5	Isopentane	2-Methylbutane	paraffin	43221	28	Very vol.	78-78-4	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
6	n-Pentane		paraffin	43220	36	Very vol.	109-66-0	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
7	Cyclopentane		paraffin	43242	49	Very vol.	287-92-3	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
8	2,2-Dimethylbutane		paraffin	43244	50	Med. vol.	75-83-2	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
9	2,3-Dimethylbutane		paraffin	43284	58	Med. vol.	79-29-8	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
10	2-Methylpentane		paraffin	43285	60	Med. vol.	107-83-5	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
11	3-Methylpentane		paraffin	43230	63	Med. vol.	96-14-0	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
12	n-Hexane		paraffin	43231	69	Med. vol.	110-54-3	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
13	Methylcyclopentane		paraffin	43262	72	Med. vol.	96-37-7	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
14	Cyclohexane		paraffin	43248	81	Med. vol.	110-82-7	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
15	2,4-Dimethylpentane		paraffin	43247	81	Med. vol.	108-08-7	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
16	2-Methyl hexane		paraffin	43263	90	Med. vol.	591-76-4	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
17	2,3-Dimethylpentane		paraffin	43291	90	Med. vol.	565-59-3	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
18	3-Methylhexane		paraffin	43249	92	Med. vol.	6131-24-4	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
19	2,2,4-Trimethylpentane		paraffin	43250	99	Med. vol.	540-84-1	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
20	n-Heptane		paraffin	43232	99	Med. vol.	142-82-5	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
21	Methylcyclohexane		paraffin	43261	101	Med. vol.	108-87-2	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
22	2,3,4-Trimethylpentane		paraffin	43252	114	Med. vol.	565-75-3	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
23	2-Methylheptane		paraffin	43960	118	Med. vol.	592-27-8	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
24	3-Methylheptane		paraffin	43253	119	Med. vol.	6131-25-5	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
25	n-Octane		paraffin	43233	126	Less vol.	111-65-9	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
26	n-Nonane		paraffin	43235	151	Less vol.	111-84-2	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
27	n-Decane		paraffin	43238	174	Less vol.	124-18-5	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
28	n-Undecane		paraffin	43954	196	Less vol.	1120-21-4	Can+ads/can	GC	MS/FID	TO-15	0.2-25	TO-14A
29	n-Dodecane		paraffin	43141	217	Less vol.	112-40-3	Can+ads	GC	MS	TO-15	0.2-25	No alternative
1	Acetylene	Ethyne	alkyne	43206	-85	Very vol.	74-86-2	Multi-adsorbent	GC	MS	TO-17	0.2-25	No alternative
1	Ethylene	Ethene	olefin	43203	-104	Very vol.	74-85-1	Multi-adsorbent	GC	MS	TO-17	0.2-25	No alternative
2	Propylene	1-Propene	olefin	43205	-48	Very vol.	115-07-1	Multi-adsorbent	GC	MS	TO-17	0.2-25	No alternative
3	1-Butene		olefin	43280	-6	Very vol.	106-98-9	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
4	trans-2-Butene		olefin	43216	1	Very vol.	624-64-6	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
5	cis-2-Butene		olefin	43217	4	Very vol.	590-18-1	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
6	1-Pentene		olefin	43224	30	Very vol.	109-67-1	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
7	Isoprene	2-Methyl-1,3-butadiene	olefin	43243	34	Very vol.	78-79-5	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
8	trans-2-Pentene		olefin	43226	36	Very vol.	646-04-8	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
9	cis-2-Pentene		olefin	43227	37	Very vol.	627-20-3	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
10	1-Hexene		olefin	43245	63	Med vol.	592-41-6	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
1	Benzene		aromatic	45201	80	Med. vol.	71-43-2	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
2	Toluene	Methyl-benzene	aromatic	45202	111	Med. vol.	108-88-3	Can+ads/can/CMS	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-2
3	Ethylbenzene		aromatic	45203	136	Less vol.	100-41-4	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
4	meta-Xylene	1,3-Methyl-benzene	aromatic	45109	139	Less vol.	108-38-3	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
5	para-Xylene	1,4-Methyl-benzene	aromatic	45109	138	Less vol.	106-42-3	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
6	Styrene	Ethenyl-benzene	aromatic	45220	145	Less vol.	100-42-5	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
7	ortho-Xylene	1,2-Methyl-benzene	aromatic	45204	145	Less vol.	95-47-6	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
8	Isopropylbenzene (cumene)	1-Methyl-ethyl-benzene	aromatic	45210	152	Less vol.	98-82-8	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
9	n-propylbenzene	Propyl-benzene	aromatic	45209	159	Less vol.	103-65-1	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
10	m-Ethyltoluene	1-Ethyl-3-methyl-benzene	aromatic	45212	161	Less vol.	620-14-4	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
11	p-Ethyltoluene	1-Ethyl-4-methyl-benzene	aromatic	45213	162	Less vol.	622-96-8	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
12	1,3,5-Trimethylbenzene		aromatic	45207	165	Less vol.	108-67-8	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
13	o-Ethyltoluene	1-Ethyl-2-methyl-benzene	aromatic	45211	165	Less vol.	611-14-3	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
14	1,2,4-Trimethylbenzene		aromatic	45208	169	Less vol.	95-63-6	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
15	1,2,3-Trimethylbenzene		aromatic	45225	176	Less vol.	526-73-8	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
16	m-Diethylbenzene	1,3-Diethyl-benzene	aromatic	45218	181	Less vol.	141-93-5	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
17	p-Diethylbenzene	1,2-Diethyl-benzene	aromatic	45219	184	Less vol.	105-05-5	Can+ads/can/cryog.	GC	MS/FID	TO-15	0.2-25	TO-14A/TO-3
1	Acetaldehyde	Ethanal	oxidized alcohols	43503	20	Very vol.	75-07-0	Cartridge/Liquid Impinger	HPLC	UV	TO-11A	0.5-100	TO-5
2	Acetone	2-Propanone	oxidized alcohols	43551	56	Med. vol.	67-64-1	Cartridge/Liquid Impinger	HPLC	UV	TO-11A	0.5-100	TO-5
3	Formaldehyde	Methanal	oxidized alcohols	43502	-20	Very vol.	50-00-0	Cartridge/Liquid Impinger	HPLC	UV	TO-11A	0.5-100	TO-5

note 1: See lists and discussion in " Technical Assistance Document for Sampling and Analysis of Ozone Precursors" EPA/600-R-98/161 (USEPA, Human Exposure and Atmospheric Sciences Division, Research Triangle Park, North Carolina. September, 1998, Section 2, pp. 5-7.

note 2: Boiling Points and CAS numbers are found in "CRC Handbook of Chemistry and Physics," 79th Edition, D. R. Lide, ed., Boca Raton, January, 1998, Section 3, pp. 3-1 ff.

note 3: At a simple level, sampling procedures fall into either cannister techniques or adsorbent techniques. But the five methods, TO2,3,14A,15 and 17, provide for alternatives within these two categories. In addition, adsorbents vary with respect to breakthrough limits and VOC volatilities. The abbreviations shown include: Can = cannister of any type, CMS = carbon molecular sieve adsorbent, Cry = cryogenic concentration technique (types vary), Ads = adsorbent of type other than CMS, including multisorbent tubes. Generally, it is assumed that most cannister sampling methods are more costly than most adsorbent methods. However, complex multi-adsorbent cartridges can be costly.

note 4: Gas chromatograph is the designated separation method for both mass spectrometer and flame ionization methods.

note 5: Although mass spectrometer is the method of detection given for the most recent EPA methods, flame ionization is shown as an alternative detector for Methods TO-14A and TO-2.

note 6: Detailed descriptions of methods TO-1 through TO-17 are shown at http://www.epa.gov/ttn/amtic/airtox.html.

METHODS FOR PAMS VOCs (note 1)

See VOC Species Information on Previous Page

Method Designation	Collector	Analyzer	Detector	Volatility category that method best matches (note 2)	Boiling pt. range (C) (note 1)	Most Appropriate Compounds	Detection limit (ppbv)	Cost comments and ratings: 1 = least costly (note 3)	Procedural Steps in Methods: 1. Sample Collection	2. Sample Treatment	3. Sample Transfer	4. Separation	5. Detection, Identification, and Measurement
TO-1	Tenax cartridge	GC	MS	Less volatile	80 to 200	aromatic hydrocarbons, benzene, toluene, and xylene	0.01 to 100	2: MS is costly, but no cannister required	1. Collect sample by drawing ambient air through Tenax cartridge.	2. Return to lab. Heat cartridge and purge with inert gas.	3. Transfer VOCs to cryog. trap, then heat trap for insertion of VOCs into GC.	4. Hold GC column at low temperature, then heat as VOCs are introduced.	5. Separate by GC and identify and measure by MS. ECD and FID are mentioned, but not identified as part of this method.
TO-2	Carbon molecular sieve cartridge	GC	MS FID	Medium volatile	-15 to 120	benzene, toluene	0.1 to 200	1: FID not as costly as MS, and no cannister req.	1. Collect sample by drawing ambient air through CMS cartridge.	2. Return to lab and purge water vapor from cartridge with dry air and heated helium.	3. Transfer VOCs to cryog. loop (trap), then heat trap for insertion of VOCs into GC.	4. Hold GC column at low temperature, then heat as VOCs are introduced.	5. Separate by GC and identify and measure by MS. FID is identified as a possibly preferable for this method.
TO-3	Cryogenic cannister	GC	FID	Medium volatile	-10 to 200	many VOCS	0.1 to 200	2: Cryog. cannister system raises cost, but FID cheaper than MS	1. Collect sample by drawing ambient air directly into cryog. trap (container), e.g., immersed in liquid argon.	2. May use Nafion or other dryer before air goes into cryog. container.	3. No intermediate transfer.	4. Cryog. cont. intake valve is switched to GC column injection, possibly on site. Cont. is heated to 150 deg C.	5. Identify and measure compounds by FID (provides det. limits of 1 to 5 ng for many compounds).
TO-5	DNPH liquid impinger	HPLC	UV	Very volatile	-20 to 56	aldehydes and ketones	1 to 50	2: Uses HPLC	1. Draw ambient air into midget impinger containing 10 ml DNPH reagent	2. Place solution in vial and return to lab. Remove isooctane layer, extract aq.	3. Evaporate organic layers and dissolve residue in methanol.	4. Inject into HPLC.	5. Determine derivatives using UV detector at 370 nm.
TO-11A	DNPH Cartridge	HPLC	UV	Very volatile	-20 to 56	aldehydes and ketones	0.5 to 100	2: Similar to TO-5, but use of cartridge might be more costly	1. Draw ambient air into DNPH coated cartridge. Place cartridge in glass vial and seal.	2. Return to lab. Remove cartridge and wash with acetonitrile.	3. No further processing needed.	4. Acetonitrile solution is diluted and injected into HPLC.	5. Determine derivative by UV detection at 350 nm.
TO-14A	Cannister / cryog. trap	GC	FID/ECD or MS	Medium volatile (covers almost all VOCs)	-29 to 213	non-polar VOCs	0.2 to 25	2: Cannister system req., FID optional	1. Draw ambient air into cannister (e.g. 6L) equipped with flow control device.	2. Return to lab. Dry with Nafion dryer or alternative.	3.Transfer VOCs to cryog loop (trap), then heat trap for insertion of VOCs into GC.	4. Separation in GC for transfer either to MS or to combination-detector system.	5. TO-14A describes either a two-way MS system (SCAN versus SIM) or a three-way FID-PID).
TO-15	Cannister / sorbent trap	GC	MS	Medium volatile (covers almost all VOCs)	-50 to 240	polar/non-polar VOCs	0.2 to 25	3: Cannister plus solid adsorbent with MS	1. Draw ambient air into cannister (e.g. 6L) equipped with flow control device.	2. Return to lab. Pass sample through multisorbent packed tube. Purge water vapor with helium.	3. Cryog. trap concentrator optional.	4. Separation in GC.	5. identify and measure compounds by MS
TO-16	none	FTIR, open path	Infra-red spectrom.	Less volatile (covers med. also)	25 to 500	polar/non-polar VOCs		2: No sampling system req., but complex field equip.	1. No specific sampling system. All of the air in the line of the FTIR is "sampled".	2. none	3. none	4. none	6. Identify and measure compounds in open air by FTIR.
TO-17	Adsorbent tube	GC	MS	Very volatile (covers med. also)	-60 to 200	polar/non-polar VOCs	0.2 to 25	3. Uses multisorbent cartridge and MS	1. Draw ambient air through a multisorbent packed tube.	2. Seal and pack tube. Return to lab. Tube may be stored before analysis.	3. Transfer VOCs to intermediate adsorbent trap or directly to GC, by heating sampling tube.	4. Separation in GC.	5. Identify and measure compounds by MS.

Note 1 Most of the information in this table is from the EPA " Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, 2nd Edition, EPA/625/R-96/010b, January 1999, available at the AMTIC webpage. AMTIC webpage, http://www.epa.gov/ttn/amtic/airtox.html, or from descriptions of the individual Methods, available at the same webpage.

Note 2 Temperature ranges for the methods are found in the Compendium referenced above, Table 2, pages 5-10, or in the descriptions of the Methods, where the temperature range for the Method is inferred from tests for detection of VOCs Boiling Points and CAS numbers are found in "CRC Handbook of Chemistry and Physics," 76th Edition, D. R. Lide, ed., Boca Raton, January 1995, Section 3, pp.3-1ff.

Effective temperature ranges for adsorbents are found in the description for TO-17, Table 1, pp. 17-33 to 17-44

FOR VERY VOLATILE VOCs: (BP < 50)	Choose an adsorbent (multisorbent) with capability of adsorbing in the required BP range. Then choose a TO Method with an adsorbent sampling procedure.
FOR MEDIUM VOLATILE VOCs: (50 < BP < 120)	Choose either a cannister or an adsorbent system which covers the BP range as precisely as possible, so as to avoid the cost of excess capability.
FOR LESS VOLATILE VOCs: (120 < BP)	Choose either a cannister or an adsorbent system of lowest possible cost.

		HIGHLY VOLATILE	MEDIUM VOLTILE	LESS VOLATILE
SAMPLING:	**cannister**	TO-14A(?)	TO-14A	none
	adsorbent	TO-17	TO-2	TO-3
	cann/ads	TO-15 (?)	TO-15	TO-1
DETECTION:	**mass spec**	TO-15, TO-17	TO-2, TO-14A	TO-1
	flame ion.	TO-14A (?)	TO-2, TO-14A	TO-3

(?) = not optimal match of ranges.

Note 3 The assumptions underlying the cost comments are, that in general, cannister sampling is more costly than adsorbent because of the equipment required for field air intake, and that MS is a more costly method than FID because of the higher equipment cost. However, there are always tradeoffs, for example, between equipment cost and personnel training costs. And some sorbent cartridges may well be as costly as the comparable cannister equipment.

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