REQUEST FOR PROPOSAL

January 12, 2026

PROJECT: **Analysis of DNPH Aldehyde Cartridges and Non-Methane Organic Compounds**

PROPOSALS DUE BY: **5:00 PM on Friday, February 13, 2026**

OVERVIEW

The San Joaquin Valley Unified Air Pollution Control District (District) collects ambient air samples that can be analyzed for specific aldehyde compounds and specific Non-Methane Organic Compounds (NMOC). Air samples are collected during the period of June-August 2026, and sent a laboratory that will analyze and upload to EPA's Air Quality System (AQS) using AIRS parameter codes.

The District is issuing this Request for Proposal (RFP) to solicit laboratories for analyzing air samples for acetaldehyde, acetone, and formaldehyde using dinitrophenylhydrazene (DNPH) loaded cartridges as well as EPA's list of PAMS Compounds (Attachment C) as the targeted species for analysis of NMOC's. For appropriate DNPH samples laboratories must operate using test method TO-11 or TO-15. Additionally, all analyses for NMOC's be performed in adherence to the 1998 EPA PAMS Technical Assistance Document (TAD), EPA method TO-15, or other methods as appropriate for PAMS analysis in accordance with US EPA's AQS database requirements.

To be considered for this project, contractors must meet the minimum eligibility requirements and submit a cost-effective proposal that satisfies the Proposal Requirements in this RFP. For the analysis of DNPH cartridges, the District will pay on a per cartridge basis. For NMOC analysis, the District will pay on a per canister 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:

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

- 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 this project also certify compliance with this provision 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 maintained by the System for Award Management (SAM) site of the federal government. 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.sam.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 proposals, and to make no awards.

SUBMITTAL INSTRUCTIONS

A contractor who submits a proposal in response to this RFP must adhere to the following instructions:

- The deadline for submitting proposals is 5:00 PM on Friday, February 13, 2026. Proposals received after this time and date may not be accepted.

- E-mail the proposal to Madison Jordan-Perkins at airqualityplanning@valleyair.org then call (559) 230-5826 to confirm receipt.

- The subject line of the email should read “Proposal for Analysis of DNPH Aldehyde Cartridges and Non-Methane Organic Compounds.”

DESIRED QUALIFICATIONS

Preferred qualifications for contractors include:

- Successful completion of PAMS or comparable analyses for a public agency within the last three years.
- Successful completion of TO-11 or TO-15 analyses for a public agency within the last three years for acetaldehyde, acetone, and formaldehyde.
- Possess demonstrated ability to create, upload, and post AQS data files within the last three years. Provide copies of appropriate AQS load reports.
- Completion of Attachment A and Attachment B (Itemized Cost Lists).

PROPOSAL REQUIREMENTS

At a minimum, submitted proposals are to individually address the above four 'Desired Qualifications' and numbers 1 through 10 of the below 'Proposal Requirements:'

1. Not exceed 30 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 NMOC canisters.
3. Describe previous experience in the documentation and analysis of DNPH Aldehyde Cartridges using TO-11 or TO-15 specifically for acetaldehyde, acetone, and formaldehyde.
4. 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.
5. Generally describe the process that the contractor will use in the analyses of the samples.
6. Describe the laboratory's compatability with the District's NMOC canister quick-connect configuration, including confirmation that the sample extraction can be performed using the District's standard quick connect fittings without removal of the canister stem, or a description of any proposed alternative approach.
7. Describe previous experience with AQS, including uploading and posting the data into AQS, and including a report from AQS of data that was uploaded by your respondent from the last three years.

8. Include a price quote on Attachment A (PAMS DNPH Itemized Cost List) for each of the following items:
    a. The preparation and certification of sample cartridges.
    b. The cost of analysis of the cartridges.
    c. The cost of audit sample or performance evaluation.
    d. The cost of the creation of the AQS transaction files, uploading, and posting the files.
    e. The cost of five new glass denuder tube ozone scrubbers for Xontech Model 925 carbonyl samplers and their preparation and maintenance
    f. Documentation of invalid samples and missing sample runs.
    g. The individualized shipping cost of Cooler/Blue Ice, 350 cartridges, and five denuder tubes from the laboratory to the District.

9. Include a price quote on Attachment B (PAMS NMOC Itemized Cost List) for each of the following items:
    a. The cost per analysis of each valid sample.
    b. The cost per canister for evacuation, cleaning, and certification.
    c. The cost of audit sample or performance evaluation.
    d. The cost of the creation of the AQS transaction files, uploading, and posting the files.
    e. The cost of reporting one missing or invalid sample.
    f. Shipping cost of 1 canister from the laboratory to the District.
    g. Repair Cost for a valve with OEM kit, replace valve or gauge, and hourly labor rate for repairs.

A contractor who submits a proposal in response to this RFP is encouraged to demonstrate support for the District's *Green Procurement and Sustainable Practices Policy* through the following:

1. Provide verification of environmentally friendly business practices through green certification programs or equivalent means

2. Participate in eco-friendly programs such as HAL Partners. More information can be found here: http://healthyairliving.com/

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:

DNPH Analysis:

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 2026, there will be approximately ***350*** samples sent to the contractor for analysis. This number may increase or decrease depending on the number of samples collected. Sampling is scheduled for June, July and August of 2026.

4. The contractor shall perform DNPH aldehyde cartridge analyses using TO-11 or TO-15.

5. The three compounds to be analyzed are acetaldehyde, acetone, and formaldehyde.

6. The contractor will supply new cartridges with DNPH loaded on a silica gel substrate. The contractor will ship 350 cartridges to the District as soon as possible after 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 and handling costs of the cartridges, and other materials being sent to the two locations and/or the audit laboratory for this project; recording the number of cartridges sent, the manufacturer's cartridge lot number being sent to each location, and the shipment's date.

7. The District is responsible for recordkeeping and shipping costs to return exposed cartridges to the contractor.

8. 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.

NMOC Analysis:

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. In 2026, there will be approximately ***560*** samples sent to the contractor for analysis. Sampling will be conducted during the months of June, July and August of 2026.

3. The contractor shall perform NMOC analysis using the 1998 USEPA PAMS Technical Assistance Document (TAD), EPA method TO-15, or other methods as appropriate for PAMS analysis in accordance with EPA's AQS database requirements, for the list of chemicals found in Attachment B (except for acetaldehyde, acetone, and formaldehyde).

4. The District will supply the Entech two liter (2L) inert ceramic-coated (Silonite™) stainless steel canisters.

5. The District utilizes standardized quick-connect hardware for NMOC canister sampling and laboratory analysis to minimize handling, reduce wear on canister components, and maintain consistency across field and laboratory operations. District-supplied canisters are equipped with the following configuration:

    - Canister valve: 29-TS-01
    - Canister stem: MQT-ST400S (stem is not to be removed)
    - Quick-connect fitting: FQT-400, used for connection to the canister and for sample extraction on the laboratory test bench.

6. Proposals shall include a description of the laboratory's ability to utilize this configuration without removal or modification of the canister stem. If alternative connection methods or adapters are proposed, the proposal must clearly describe the approach and demonstrate that it provides equivalent protection against leakage, contamination, and premature component wear. Additional details can be provided upon request.

7. The District will supply the shipping containers. The contractor will supply the Chain of Custody Forms (COC). The District can provide a COC form at the request of the contractor.

8. Analyzed, cleaned and certified canisters shall be in the District's possession within 11 days of the contractor receiving them. All canisters are to be shipped via UPS ground shipping. If canister shipments need to be expedited, then the contractor is responsible for any additional cost. 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 regarding the shipping of canisters to the individual District locations, recording the

number of canisters being sent to each location, and the shipment's date. The District is responsible for all shipping costs of canisters (including audit samples) sent to the District and/or returned to the contractor for this job. The contractor shall be responsible for the shipping cost of canisters that are returned to the District with unacceptable conditions, canister pressure such as greater than 1 psia, missing parts, etc. The certification tag shall include a check list for these items.

9. The District may ask the contractor make repairs.

10. The contractor is responsible for all recordkeeping and shipping costs of canisters and other materials being sent to the District and/or the audit laboratory for this project. The District is responsible for recordkeeping and shipping costs to return the above mentioned materials (other than canisters) to the contractor.

DNPH Analysis and NMOC Analysis:

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

2. The contractor shall retain and archive a copy of all paper and electronic records of this project for a minimum of three 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.

3. 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.

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

5. Since this Agreement exceeds ten thousand dollars ($10,000), the contractor will be subject to examination and audit of the auditor general for a period of three 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:

DNPH Analysis:

1. The contractor is to provide their own certified TO-11 or TO-15 Reference Gas Cylinder for calibration standard purposes. The gas cylinder must include the compounds appropriate for TO-11 or TO-15. These gases must be traceable to a National Institute of Standards and Technology (NIST) standard.

2. 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 weeks. The contractor will also ensure the samples will be promptly analyzed for the same reason.

3. The contractor shall provide the District with “gold ring” cartridges. The District will reject any cartridge not of this kind.

4. 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 cartridge expiration dates must be after September 30, 2026. 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 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.

5. For each manufacturer’s lot of cartridges, at least one 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.

6. The contractor will supply the District with five 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 EPA PAMS TAD, TO-11, or TO-15. The denuder ozone scrubber construction material must be glass or copper tubing, and be treated as required in the 1998 EPA PAMS TAD, TO-11 or TO-15.

7. 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 (Flash Drive or District approved alternative).

8. At the District's discretion and at no additional cost, the contractor will analyze for quality control purposes any audit cartridge(s) sent to the contractor by a CARB, EPA 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.

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

10. 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.

<u>NMOC Analysis:</u>

1. The contractor is to provide their own certified Reference Gas Cylinder for calibration standard purposes. The gas cylinder must include the compounds appropriate for compounds listed in Attachment B. These gases must be traceable to a National Institute of Standards and Technology (NIST) standard.

2. Samples shall be promptly analyzed to prevent degradation of the hydrocarbon species, and to facilitate timely return of the canisters to the District. Analyzed, cleaned and certified canisters shall be returned and be in the District's possession within 11 days of the contractor receiving them. All canisters are to be shipped via UPS ground shipping. If canister shipments need to be expedited, then the contractor is responsible for any additional cost.

3. 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. For invalid samples, the contractor will prepare, clean, and certify canisters for subsequent sampling. The contractor will appropriately document missing samples.

4. Upon completion of analysis, the contractor will evacuate, clean, and certify each canister for future sampling and analysis before returning it to the District. Preparation shall include cleaning the canister, verification of 0 psia and leak testing. Canisters received with a pressure value between 0 psia and 1 psia will be considered acceptable and ready for use. Canisters received with greater than 1.01 PSI (truncated) may be returned to the contractor for cleaning and certifying if no leaks or other issues are found. If the canister has a leak the District will work with the contractor or the manufacture to repair the leak. In

some instances the District will repair the canister. In addition, any canisters (up to 200) not meeting minimum requirements for sampling will be sent to the lab for evacuation/cleaning prior to the start of the sampling season.

5. The contractor will analyze and include in the reports one clean and certified canister per day as a part of the quality control certification process. Another report is to include the number of canisters passed and failed with regards to the total number of canisters that went through the certification process.

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 form (Flash Drive or District approved alternative)

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

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 report DNPH analysis data for acetaldehyde, acetone, and formaldehyde. The contractor will also will also report NMOC analysis data for the compounds in Attachment C. Additional compounds that the District is interested in will be reported directly to the District and not uploaded to AQS. A summary report will need to be created for these compounds.

2. The laboratory will upload and post the results of the DNPH and NMOC analyses to AQS as ‘Reported Data.’

3. Laboratory equipment must be capable of detecting and measuring levels of VOCs as low as one 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, uploaded, and posted 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 files and reports will provide the resulting data on a flash drive or alternative approved by the District.

10. The submittal 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 RFP.

11. 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 flash drive used above.

12. The submittal will be sent to the District after all the data is uploaded and posted to AQS.

13. 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 October 31, 2026.**

EVALUATION OF RESPONSES TO THIS RFP

The selection of a qualified contractor will be based on the following weighted criteria.

Criterion	Weight	Description
Reliability and Timeliness	25%	Demonstrated ability to consistently perform activities and deliver results on time
Customer Service	25%	Proven track record of providing exceptional customer service and effective communication
Experience and Technical Capability	25%	Demonstrated experience, expertise, and technical ability in PAMS laboratory analysis
Cost Effectiveness	25%	Costs for services and postage as outlined in Attachment A and Attachment B.

Note: Failure to provide all requested information may result in disqualification, regardless of score.

INQUIRIES

Technical and administrative questions concerning this RFP should be directed to Madison Jordan-Perkins, Air Quality Analysis and Research Supervisor, San Joaquin Valley Unified Air Pollution Control District at airqualityplanning@valleyair.org or (559) 230-5826. An editable copy of Attachment A and Attachment B (Itemized Cost Lists) are available on request.

Attachment A

Itemized Cost List for PAMS DNPH

Attachment A:
Itemized Cost List for 2026 PAMS DNPH

Show all costs on the following table.

Per Cartridge	**Costs**
Cost to prepare and certify a cartridge	
Cost per analysis of each valid sample	
Cost of audit sample or performance evaluation	
AQS Upload	
Cost per cartridge for file creation, uploading and posting data into AQS	
Cost of reporting and uploading one (1) missing or invalid sample into AQS	
Denuder Tubes	
Cost of five (5) prepared denuder tubes for the Xontech Model 925 carbonyl sampler	
Shipping	
Shipping cost of Cooler/Blue Ice from laboratory to the District	
Shipping cost of 350 cartridges from laboratory to the District	
Shipping cost of five denuder tubes from laboratory to the District	

Attachment B

Itemized Cost List for PAMS NMOC

Attachment B:
Itemized Cost List for 2026 PAMS NMOC

Show all costs on the following table.

Per Canister	**Costs**
Cost per analysis of each valid sample.	
Cost per canister for evacuation, cleaning, and certification.	
Cost of audit sample or performance evaluation.	
AQS Upload	
Cost per canister for file creation, uploading, and posting data into AQS.	
Cost of reporting one (1) missing or invalid sample (canisters not eligible for analysis).	
Shipping	
Shipping Cost of 1 Canister from the laboratory to the District	
Repairs	
Repair a valve with OEM kit	
Replace a valve (if not repairable)	
Replace a gauge	
Hourly labor rate for repairs	

Attachment C

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 matches (note 2) and Measurement	Collector	Analyzer	Detector	Volatility category that method best	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,
TO-1 cartridge and xylene as part of this method.	Tenax	GC	MS	Less volatile	80 to 200 hydrocarbons,	aromatic benzene, toluene,	0.01 to 100 no cannister required	2: MS is costly, but ambient air through	1. Collect sample by drawing 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
TO-2 molecular sieve cartridge into GC.	Carbon	GC FID	MS	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. preferable for this method.	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	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
TO-3 cannister but FID cheaper than MS	Cryogenic	GC	FID	Medium volatile	-10 to 200	many VOCS	0.1 to 200	2: Cryog. cannister system raises cost,	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 impinger 10 ml DNPH reagent	DNPH liquid	HPLC	UV	Very volatile	-20 to 56	aldehydes and ketones	1 to 50	2: Uses HPLC	1. Draw ambient air into midget impinger containing	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 Cartridge might be more costly and seal.	DNPH Place cartridge in glass vial	HPLC	UV	Very volatile	-20 to 56	aldehydes and ketones	0.5 to 100	2: Similar to TO-5, but use of cartridge	1. Draw ambient air into DNPH coated cartridge.	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 cryog. trap VOCs) into GC.	Cannister /	GC or MS	FID/ECD (covers almost all	Medium volatile	-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 FID-PID).	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
TO-15 sorbent trap VOCs) helium.	Cannister /	GC	MS (covers almost all	Medium volatile	-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	3. Cryog. trap concentrator optional.	4. Separation in GC.	5. identify and measure compounds by MS
TO-16 open path spectrom. complex field equip.	none (covers med. also)	FTIR,	Infra-red	Less volatile	25 to 500 VOCs	polar/non-polar system req., but		2: No sampling system. All of the air in the	1. No specific sampling line of the FTIR is "sampled".	2. none	3. none	4. none compounds in open air by	6. Identify and measure FTIR.
TO-17 tube before analysis. sampling tube.	Adsorbent	GC	MS (covers med. also)	Very volatile	-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	3. Transfer VOCs to intermediate adsorbent trap or directly to GC, by heating	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 webpagee, 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
adsorbent cann/ads	SAMPLING: cannister	TO-14A(?) TO-17 TO-15 (?)	TO-14A TO-2 TO-15	none TO-3 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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