



TO-11A and TO-15 Sample Collection Systems and Select Elements Related to Field Installation and Operation





Sample Collection Systems

- What are they
 - Facilitate automated or manual collection of representative time-integrated samples.
 - Basic system approach designed in 1986 and has not changed very much in the interim.
- What are the differences between various makes, models, and technical approaches
- Sub-ambient vs. pressurized collections – advantages and disadvantages



Sample Collection Systems

Genesis !! The First Air Toxics Sampler

Designed, constructed, and validated in 1985

First used during the EPA 1986 Urban Air Toxics Monitoring Program

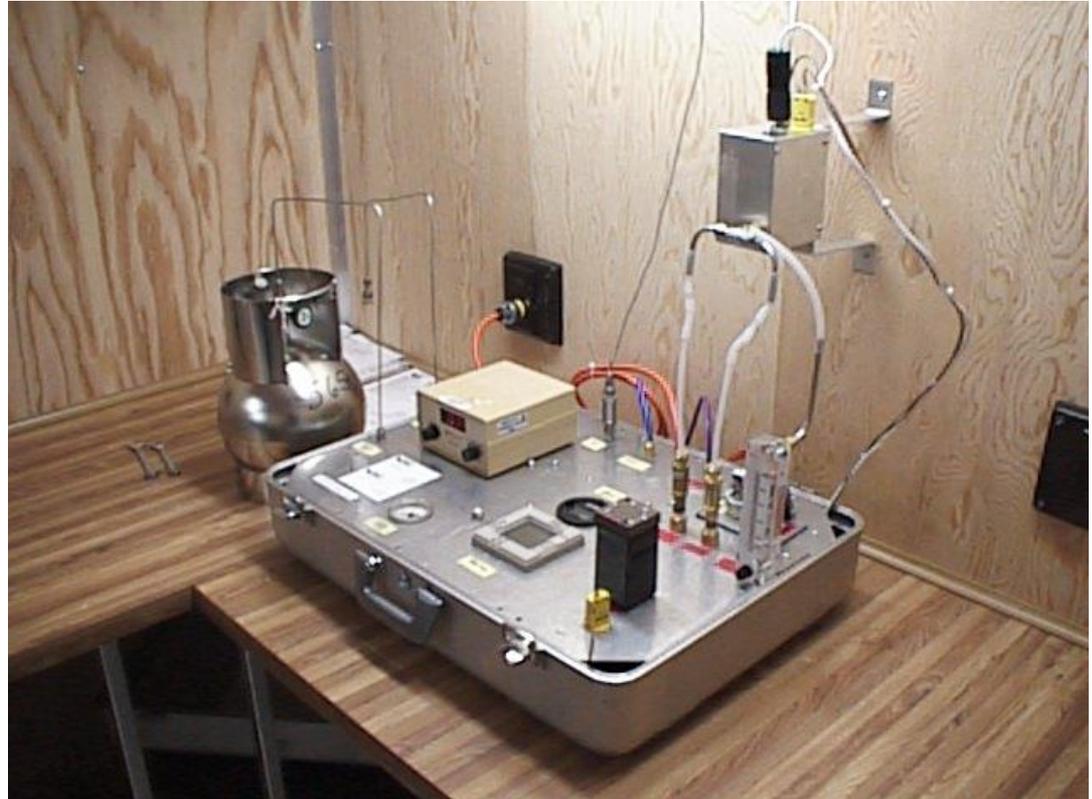
Offered automated operation

Provided Dual Channel TO-15 Air Toxics Canister Collections
(Negative Final Sample Pressure)
Sample flow control = mass flow controller(s)

Provided Dual Channel TO-11A Carbonyl Cartridge Collections
Sample flow control = fixed critical orifice(s)

Required sheltering

Provided Selectable pre-sampling purge duration



Sample Collection Systems

ATEC Model 2200

Automated operation

Dual Channel TO-15 Air Toxics Canister Collections

(Negative Final Sample Pressure)

Sample flow control = mass flow controller(s)

Dual Channel TO-11A Carbonyl Cartridge Collections

Sample flow control = mass flow controller(s)

Requires sheltering

Selectable pre-sampling purge duration



Sample Collection Systems

Tisch Model TE-323

Automated operation

Three Sample Channels for TO-15 Air
Toxics Canister Collections

(Positive Final Sample Pressure)

Sample flow control = micrometering
valve

Requires sheltering

Fixed 40 minute pre-sampling purge
duration



Sample Collection Systems

Xontech Model 924

Automated operation

Dual Channel TO-15 Air Toxics Canister
Collections

(Negative Final Sample Pressure)

Sample flow control = mass flow controller(s)

Dual Channel TO-11A Carbonyl Cartridge
Collections

Sample flow control = mass flow controller(s)

Does not require sheltering

Selectable pre-sampling purge duration



Model 924

Sample Collection Systems

ERG Model AT/C-C

Automated operation

Dual Channel TO-15 Air Toxics
Canister Collections
(Negative Final Sample Pressure)
Sample flow control = mass flow
controller

Dual Channel TO-11A Carbonyl
Cartridge Collections
Sample flow control = fixed critical
orifice(s)

Requires sheltering

24-hour pre-sampling purge
duration



Sample Collection Systems

EPA/ERG Air Toxics Sampler

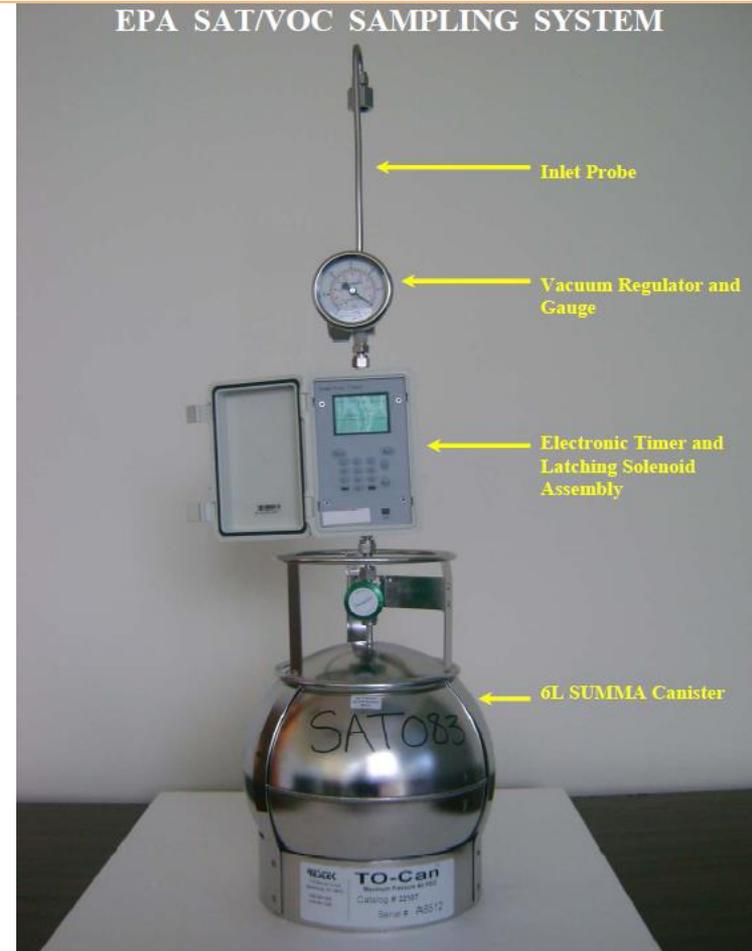
Vacuum Regulator Based System

Automated operation

Single Channel TO-15 Air Toxics
Canister Collections
(Negative Final Sample Pressure)

Does not require sheltering

No pre-sampling purge capability



Sample Collection Systems

ERG Air Toxics Sampler

Flow Capillary Based System

Manual operation

Single Channel TO-15 Air Toxics
Canister Collections
(Negative Final Sample Pressure)

Does not require sheltering

No pre-sampling purge capability



Sample Collection Systems

EPA/ERG Carbonyl Compounds System

Automated operation

Single Channel TO-11A Carbonyl
Cartridge Collection

KI Ozone scrubber

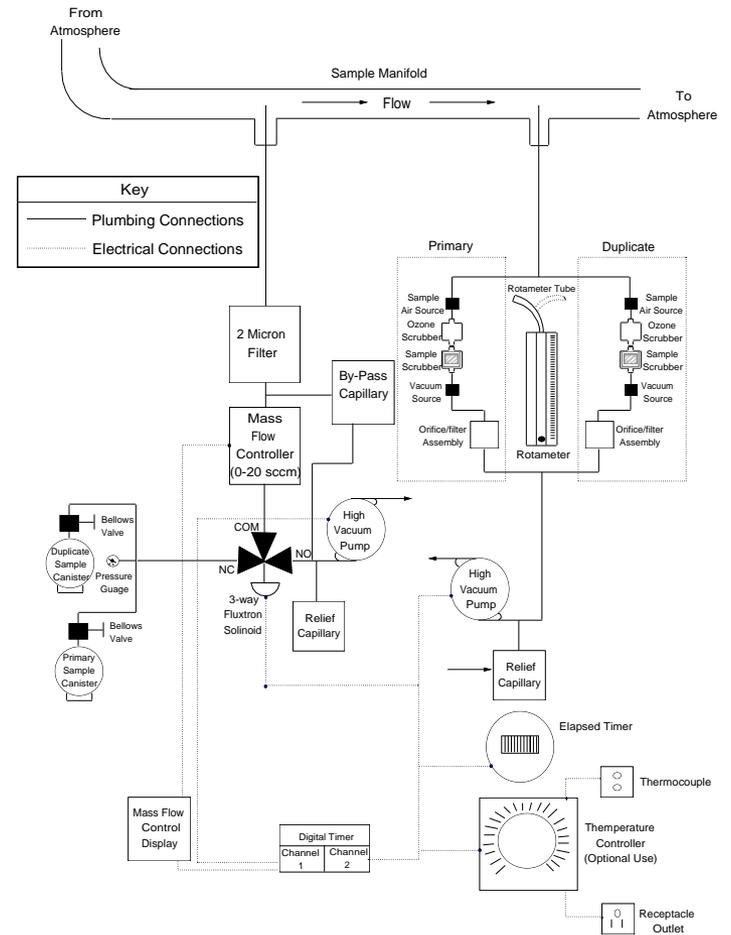
Does not require sheltering

No pre-sampling purge capability



Sample Collection Systems

Principle of operation for combination Air Toxics and Carbonyl Compounds collection systems





Pre-Deployment Certification

- What is TO-15 sampler certification and why is it done
 - Canister sampling systems must exhibit nonbiasing characteristics before being used to collect samples.
 - These sampling systems must be subjected to laboratory certification to quantify any additive or subtractive biases that may be attributed directly to the sampling system.
 - Under TO-15 canister samplers are challenged with a certified standard blend of VOCs that span the analytical chromatographic range at a known concentration in clean, humidified zero air or nitrogen (Certification Challenge Sample).
 - Samplers are also challenged with humidified zero air or nitrogen only (Certification Zero Sample).



Pre-Deployment Certification

- What is TO-11A sampler certification and why is it done
 - Carbonyl Compound sampling systems must exhibit nonbiasing characteristics before being used to collect samples.
 - These sampling systems must be subjected to laboratory certification to quantify any additive or subtractive biases that may be attributed directly to the sampling system.
 - Under TO-11A carbonyl compound samplers are challenged with clean, humidified zero air or nitrogen only (Certification Zero Sample).

Pre-Deployment Certification

ERG's Certification System with ERG and Commercial Sampling Systems Attached.

Capable of certifying four sampling systems simultaneously.

Capable of blending VOCs from two separate cylinders into humidified zero grade nitrogen.



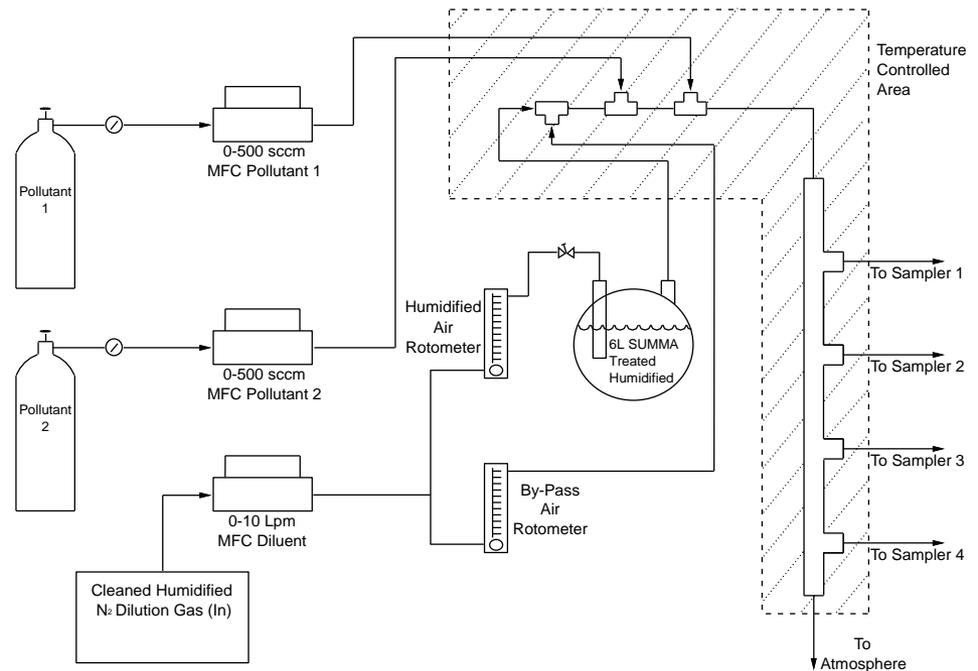
Pre-Deployment Certification

Procedure for conducting TO-15 Certification Challenge and Zero sample collections.

Associated TO-15 performance specifications.

Procedure for conducting TO-11A Certification Zero sample collections.

Associated TO-11A performance specifications.





Through the Probe Performance Evaluation

- For TO-15 and TO-11A “through the probe performance evaluations” have proven to not be practical to conduct.
- Generating 1-2 ppbV known concentration humidified gas streams for 24 hours continuously, at an overall flow rate needed to support performance evaluation sample collection, has not been readily accomplished. This is particularly true if a laminar flow glass manifold assembly is in use.



Site Installation

- A sample inlet and manifold assembly should be used to provide a representative air sample for collection and subsequent analysis.
 - Glass sample inlet and manifold assemblies are commercially available and may be used.
 - Custom-made inlet line assemblies constructed of chromatographic-grade stainless steel may also be used.

Site Installation

Example of glass manifold installation

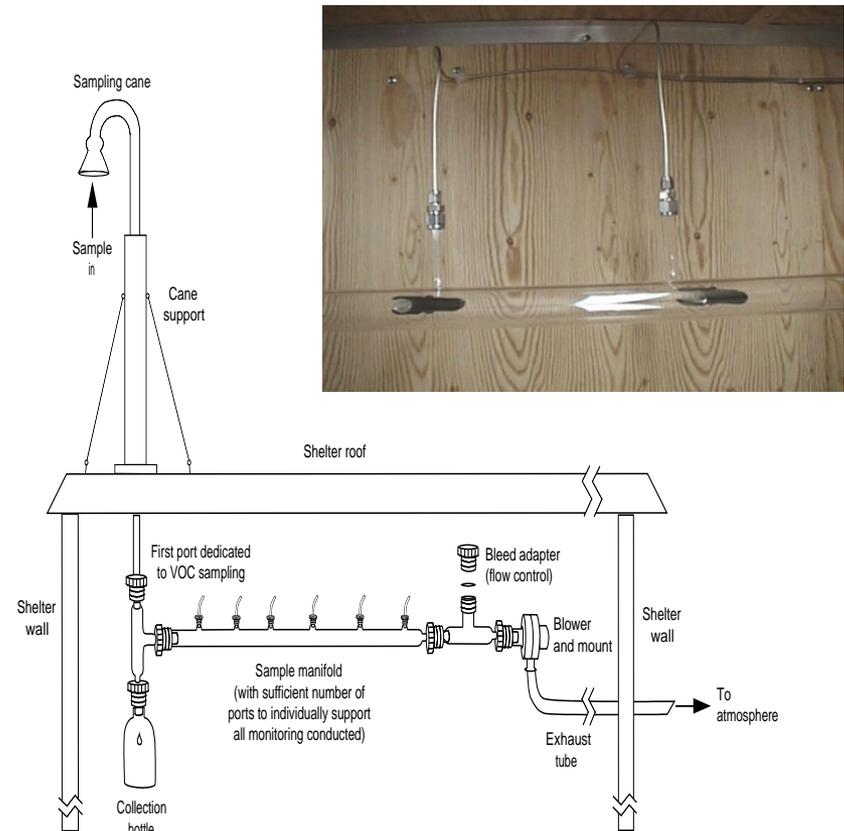
Inlet and manifold should be temperature controlled and insulated to insure condensation does not occur internally.

First port dedicated to VOC sampling.

Second port dedicated to Carbonyl Compounds sampling.

Manifold cleaning must be performed using deionized water only.

Separate dedicated insulated stainless steel lines are used to connect the sampling system to the manifold ports.



Site Installation

Example of direct sample line installation

Separate dedicated stainless steel inlet lines should be kept as short as possible to reduce residence time.

0.125" OD lines used for VOC sampling.

0.250" OD lines used for Carbonyl Compound sampling.

Each dedicated line has its own inlet funnel to prevent moisture from being pulled in during sampling.

Separate lines run directly to the associated sample inlet ports on the back of the air toxics sampler.



Site Installation

Sampler is positioned to allow for the shortest possible inlet line lengths.

Stainless steel lines are insulated to maintain sample gas temperature during sampling and prevent condensation from occurring within the lines.





Site Installation

- For glass inlet and manifold assemblies
 - Because of the large volume of gas and particulate pulled through the manifold during laminar flow ambient air extraction and because of the large internal surface area, cleaning of the manifold will be necessary.
 - Frequency of cleaning is determined by the site operator based on visual inspection of the internal surfaces of the glass components.
 - Cleaning is accomplished using distilled deionized water only. No chemical solvents of any kind should be used to clean the inside of the glass components.



Site Installation

- For stainless steel direct inlet line assemblies
 - Because the volume of gas pulled through the direct inlet lines is very low, cleaning is typically not a requirement.
 - If it is determined that the stainless steel direct inlet line assemblies have in some way become contaminated, they should be changed out with new stainless steel tubing.
 - However, contamination of these lines is atypical and usually not a concern.



Field QA Samples for Determination of Precision

- Precision refers to the agreement between independent measurements performed according to identical protocols and procedures.
- Collocated or duplicate samples are collected and used to determine method precision for both TO-15 and TO-11A.



Field QA Samples for Determination of Precision

- Duplicate Sample Collection
 - Duplicate samples are samples collected simultaneously using either 1 or 2 flow control devices, but through a common inlet probe so that they are sampling the exact same air parcel.
 - This approach provides a measure of “Intra-system” variability which does not include the variable of non-homogeneity of the target pollutants in the air parcel sampled as the common inlet is employed.



Field QA Samples for Determination of Precision

- Duplicate Sample Collection
 - Because the hardware design and principle of operation of the associated NATTS sample collection systems lend themselves to sampling through a common manifold, precision assessment samples for Method TO-11A (Carbonyls) and Method TO-15 (Air Toxics) should always be collected as duplicate.



Field QA Samples for Determination of Precision

- Collocated Sample Collection
 - Collocated samples are samples collected simultaneously using two completely separate sampling systems with separate sample inlets positioned in close proximity to each other (i.e., not through a common inlet).
 - This approach provides a measure of “Inter-system” variability which includes the variable of non-homogeneity of the target pollutants in the air parcel sampled.



Field QA Samples for Determination of Precision

- Collocated Sample Collection
 - Because of physical limitations presented by the hardware design and principle of operation of the associated NATTS sample collection systems (i.e., they do not lend themselves to sampling through a common manifold), precision assessment samples for Method TO-13A (SVOC), Method IO-3.5 (Metals), and the Hexavalent Chromium method should always be collected as collocated.



Field Collection Documentation

- Chain of Custody Forms
 - Are used to document all parameters associated with an individual sample collection episode.
 - A copy of the Chain of Custody is retained at the collection site with the remaining copies sent with the sample as a traveler.
 - It is important that the data included on the Chain of Custody are accurate and complete as elements of the data are used to determine volumetric concentrations, or to explain any anomalies realized.

Field Collection Documentation



ERG Lab ID #

901 Keystone Park Drive, Suite 700, Morrisville, NC 27560

CARBONYL COMPOUNDS CHAIN OF CUSTODY

Lab Pre-Samp.	Site Code: _____	Collection Date: _____
	City/State: _____	Cartridge Lot #: _____
Field Setup	AQS Code: _____	Duplicate Event (Y/N): _____
	Relinquished by: _____	Date: _____
Field Recovery	Received by: _____	Date: _____
	Set-Up Date: _____	Operator: _____ Sys. #: _____
Lab Recovery	Pre-Sampling Rotameter Reading (cc/min): _____	Elapsed Timer Reset (Y/N): _____
	Recovery Date: _____	Sample Duration (3 or 24 hr): _____
PAMS	Operator: _____	Elapsed Time: _____
	Post Sampling Rotameter Reading (cc/min): _____	Status: VALID VOID (Circle one)
	Cartridges Capped (Y/N): _____	Relinquished by: _____
	Relinquished by: _____	Date: _____
Lab Recovery	Received by: _____	Date: _____
	Status: VALID VOID (Circle one)	Temperature: _____
	If void, why: _____	Sample Volume (total Liters): _____

Sample Date	Sample Time	Sample Duration	Sample Volume	Cartridge Lot #	Sample ID	Lab ID

Comments: _____

White: Sample Traveler
Canary: Lab Copy
Pink: Field Copy



ERG Lab ID #

901 Keystone Park Drive, Suite 700, Morrisville, NC 27560

TOXICS/SNMOC SAMPLE CHAIN OF CUSTODY

Lab Pre-Sampling	Site Code: _____	Canister Number: _____
	City/State: _____	Lab Initial Can. Press. ("Hg): _____
Field Setup	AQS Code: _____	Date Can. Cleaned: _____
	Collection Date: _____	Cleaning Batch #: _____
Field Recovery	Options	Duplicate Event (Y/N): _____
	SNMOC (Y/N): _____	Duplicate Can #: _____
Lab Recovery	TOXICS (Y/N): _____	Relinquished by: _____
	Relinquished by: _____	Date: _____
	Received by: _____	Date: _____
	Operator: _____	Sys. #: _____
Field Setup	MFC Setting: _____	Setup Date: _____
	Field Initial Can. Press. ("Hg): _____	Elapsed Timer Reset (Y/N): _____
Field Recovery	Canister Valve Opened (Y/N): _____	Recovery Date: _____
	Sample Duration (3 or 24 hr): _____	Operator: _____
Lab Recovery	Elapsed Time: _____	Field Final Can. Press. ("Hg): _____
	Canister Valve Closed (Y/N): _____	Status: VALID VOID (Circle one)
	Relinquished by: _____	Date: _____
Lab Recovery	Received by: _____	Date: _____
	Status: VALID VOID (Circle one)	Lab Final Can. Press. ("Hg): _____
Lab Recovery	If void, why: _____	

Comments: _____

White: Sample Traveler
Canary: Lab Copy
Pink: Field Copy



TO-15 Pre- and Post-Collection Pressure Checks

- Pre-Collection Pressure Check
 - Before canisters are shipped to the field, they are evacuated to a minimum of 29.5" Hg vacuum.
 - This measurement is made using a calibrated independent gauge or the gauge associated with the canister cleaning system.
 - The measured pre-collection pressure is documented on the Chain of Custody that travels with the sample canister to the site.
 - When the sample canister is received in the field, the pressure is measured again using a calibrated independent gauge or the gauge on the sampling system to ensure that it is comparable to the pressure measured at the laboratory.



TO-15 Pre- and Post-Collection Pressure Checks

- Post-Collection Pressure Check
 - After a collection episode is completed, the final sample pressure attained is measured using a calibrated independent gauge or the gauge build into the sample collection system.
 - The measured post-collection pressure is documented on the Chain of Custody that travels with the sample canister to the laboratory.
 - When the sample canister is received at the laboratory, the pressure is measured again using a calibrated independent gauge to ensure that it is comparable to the pressure measured in the field.



TO-15 Pre- and Post-Collection Pressure Checks

- Considerations

- The acceptable difference between laboratory to field measured pressures and field to laboratory measured pressures must be established based on the equipment used at both locations. Typically the laboratory measurements are made using more precise equipment than is used in the field. Accordingly, a 2" Hg vacuum difference can be realized even though no change in pressure occurred.
- Also, differences in altitude at which the measurements are made can manifest differences in measured pressure.



TO-11A Information

- Ozone Scrubber
 - 0.250" OD copper tube coated internally with a saturated solution of potassium iodide (KI)
 - Temperature controlled (160 – 200 °F) – however, temperatures above 200 °F can be utilized if required to control moisture
 - Unheated cartridge version available but not recommended
- How often should ozone scrubbers be recharged
 - Dependent on multiple factors
- Approved modifications to ozone scrubbers
 - Units longer than specified in TO-11A



TO-11A Information

- **Field Blanks**
 - Field blanks are blank cartridges which are sent to the field, connected to the sampling system and treated identically to the samples except that no air is drawn through the cartridge.
 - Field blanks are used to assess the background carbonyl levels for cartridges used during the ambient sample collection process.
 - Acceptance criteria is:
 - Formaldehyde: < 0.3 µg/cartridge
 - Acetaldehyde: < 0.4 µg/cartridge
 - Acetone: < 0.75 µg/cartridge
 - Sum of others: < 7.0 µg/cartridge



TO-11A Information

- **Field Blanks**
 - Method TO-11A does not specify a required frequency
 - Frequency required for the NATTS program is once every other month
 - For all Air Toxics work conducted by ERG, frequency used is once monthly
 - Not passing the criteria should be very infrequent (the exception, not the rule). For episodes where the criteria is not met, the corresponding primary sample data is flagged accordingly.
 - If criteria is not met, sample handling and operational procedures should be assessed to identify problems that could lead to contamination.



TO-11A Information

- Sample Breakthrough Potential
 - Method specifies a sample collection flow rate of 1 lpm.
 - How this came about and why it should not be used.
(3-hr collections, residence time too short)
 - Breakthrough testing involves sampling simultaneously through two cartridges in series.
 - Sample collection flow rate should not exceed 800 cc/min.



TO-11A Information

- **Sample Breakthrough Potential**
 - Tests have shown that a sample collection flow rate between 700 cc/min and 800 cc/min provides needed method sensitivity (MDL) without breakthrough occurring.
 - Tests have also shown that sampling at a collection flow rate of 1 L/min (as allowed in Method TO-11A) elevates the potential for breakthrough in typical urban atmospheres.
 - In typical urban atmospheres using a collection flow rate of 800 cc/min or less, the potential for breakthrough is not great.
 - New tests show better overall performance (% recovery, greater residence time) at a sample collection flow rate of 400 cc/min.