

**Title: Standard Operating Procedure for Thermo-Miran SapphIRE portable gas analyzer**

Procedure No: SOP-039

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**1. INTRODUCTION AND SCOPE**

This document will outline specifics with regards to portable sampling analysis utilizing and operating the Thermo-Miran SapphIRE. The intent is to provide operating procedures for capture and analysis of air samples that can be quantified and recorded. This sampler is not used in conjunction with normal operations of CASA, NAPS, or AENV networks, but rather a tool for specific events under the direction of a competent technician. Monitoring for these events is usually conducted from a mobile platform such as the Mobile Air Monitoring Lab (MAML)

The operating manual supplied by the instrument manufacturer (Miran 205B Series SapphIRE Part # BK3538) provides detailed installation and operating procedures. Those procedures are part of this operating method.

**2. PRINCIPLE OF THE METHOD**

The analyzer utilizes the method of recording absorbances of infrared light through a single beam spectrophotometer. The method is controlled through a microcontroller that controls the analysis and records the measurement signal, which is then processed through a digital database to assimilate the absorbance curve and determine the composition. The operation can be setup through a long or short path length which can be altered for differing analysis.

Internal battery packs allow remote operation of this analyzer for a period before recharging. Ensure that the power pack has been charged prior to sampling requirements. The backup power can allow up to 4 hours of remote use before discharge. An A/C connection will recharge the analyzer and permit continued usage.

Chemical substances absorb IR radiation selectively at specific frequencies characteristic of the natural vibration of the bonds and the molecular groups comprising the substance. IR radiation at other frequencies is not absorbed. Each compound's pattern of absorption frequencies, its IR spectrum, is unique. Like fingerprints, no two are alike, and thus can be used to identify the molecules in an unknown sample. By knowing at what wavelengths energy is absorbed, the types of molecules in a compound can be identified.

Selecting a good fingerprint for a compound involves finding an intense absorption peak in its IR spectrum at a wavelength where:

- a. it can easily be identified from among other similar compounds, and
- b. interference from water and carbon dioxide is minimal.

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These practical considerations often mean selecting an alternate analytical wavelength for identifying and measuring the target compound.

The amount of the chemical compound present can also be determined using quantitative techniques based on Beer's Law. When a certain quantity of IR energy is beamed through the sample cell containing molecules of a chemical compound, the molecules absorb a certain percentage of that energy. The amount of energy absorbed can be expressed in percent Transmittance or in Absorbance Units. By knowing how much IR energy is absorbed, we can figure out how many molecules are in the chamber. Very low concentration levels of gases can thus be measured and expressed in parts per million (ppm).

### 3. MEASUREMENT RANGE AND SENSITIVITY

Analysis results can be processed in parts per billion (ppb), parts per million (ppm), percent (%), or absorbance units (AU). All detectable lower levels and ranges vary for different gas parameters. Please refer to Appendix H of the SapphIRE manual for varying ranges and accuracies of individual parameters.

### 4. EQUIPMENT AND APPARATUS

The following models are used in this method.

- Thermo-Miran SapphIRE XL

### 5. INTERFERENCES

Properly zeroing the analyzer will have influence on the readings if not done properly. The SapphIRE should be zeroed in the area sampling is to be initiated to account for RH values and temperature in this area. RH will influence the infrared wavelengths if the measurement area contains different levels of humidity from the zeroing point. To compensate for this the analyzer singles out an analysis wavelength responsive to water vapour. The humidity compensation mode should be enabled to ensure this correction is occurring during the sample period.

The SapphIRE is also susceptible to pressure and temperature variations. The menu does include user controlled states to compensate for these factors.

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In addition, if chemicals such as Butane, Carbon Dioxide, Carbon Monoxide, Ethane, Methane, Nitrous Oxide, and Propane are to be quantified, the zeroing of the unit must be performed in an area away from these chemicals as the internal scrubber for zero does not remove these chemicals.

### *System Leaks*

Air leaks in the sample system can affect the measured concentrations. Ensure the sample wand is properly assembled and properly connected.

## **6. PRECISION AND ACCURACY**

Accuracy and precision vary on operator familiarity and parameters measured (see below).

### 4.1 Accuracy

The lists of parameters indicated in range and sensitivity also indicate the accuracy tolerances. Accuracy for the SapphIRE is defined as +/- the average value displayed from five times the detection limit to the full scale reading

### 4.2 Precision

No listings for precision are referenced by the manufacturer.

## **7. SITE REQUIREMENTS**

The SapphIRE is typically utilized in various situations to detect various presences of gases. AENV technicians will only use the SapphIRE in routine ambient monitoring projects or emergency monitoring in the cold zone of an event where no PPE respirators or special clothing is required. The SapphIRE is intrinsically safe for hazardous environments; please refer to Appendix B – Intrinsic Safety for instructions.

For general sampling purposes, the inlet port should always be connected to the wand with a particulate filter to protect the optics of the analyzer. When the wand is not in use ensure the inlet and outlet caps are attached to the ports.

Ensure prior to sampling there is sufficient charge to the batteries prior to sampling (if no available charging supply is available or is intrinsically unsafe).

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**8. INSTALLATION REQUIREMENTS**

The analyte in interest should be pre-selected prior to sampling. Select 1 from the main menu to access the standard library and once accepted press 1 for *Analyze/Start*. The zero menu will come up post selection; ensure proper zeroing protocols are addressed according to Chapter 5 – *Analyze/Start* of the manual. Ensure that proper environmental conditions were followed to condition a proper zero. Once this is captured the SapphIRE will prompt the user to replace the chemical filter with the particulate filter. By pressing *Enter* once the sampling of the area in interest will begin. Allow sufficient time for the cell to analyze the sample; when completed, the display will change to the analysis menu. The active measurement will be displayed on the left with selection menu and the right. The results should then be recorded for future downloading.

**8.1 QUICK OPERATION GUIDE AND REFERENCE**

*All page references refer to the Miran 205B Series SapphIRe manual # MI 611-037 dated March 1999*

**A. General Description:**

The Miran SapphIRe analyzer is a lightweight portable ambient air monitor, which uses Infrared Spectrophotometry to measure gases in the Infrared Spectrum. See Infrared Spectroscopy Tutorial on page 101. Results are displayed in parts per billion (ppb), parts per million (ppm), percent (%), or absorbance units (AU). In most cases the analyzer will use ppb and ppm for display of results.

This analyzer is not meant to run continuously for longer than 24 hours.

**B. Start Up Procedure (page 4):**

1. Use the charger/power supply when operating in a fixed location.
2. Remove caps from inlet/outlet ports and stow in a safe location.
3. Press the *On/Off* key. The analyzer goes through a self-diagnostic test.
4. Allow the unit to warm up for 20-30 min., or if no compensations (page 57) are activated warm up for 10 min.
5. Note: The normal operating time for the internal Battery is 4 hours at 23°C. The colder the operating temperature the shorter the life of the battery. There is a spare battery for the analyzer and it is recommended that the spare always be charged for quick replacement. Press the Control key on the keypad to observe remaining battery life of the internal battery.
6. Assemble the wand and filter (page 3).



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***If the analyzer has been set up already then proceed to “Choosing your Site and Application” below***

**Setup Procedure (Section 8, page 47):**

1. From the main menu press 4 (config/setup)

Setup Menu (Quick Description)

<b>1=Calibration</b>	<b><i>Should only be performed by Alberta Environment</i></b>		
<b>2=Preferences</b>	Set 11 preferences in this menu (page 49)		
<b>3=Gas Unit</b>	Available gas units are ppb, ppm, percent, mg/m <sup>3</sup> (page 50)		
<b>4=Clock</b>	Enter current date and time (page 51)		
<b>5=Analysis</b>	There are 4 analysis setup menus as follows ( <b>Note:</b> This section may be password protected)		
	<b><i>Use arrow keys on the keypad to access the 4 modes listed below</i></b>		
	<b>Setup 1 (p 53)</b>	Logging	Set single, continuous, interval, start, store and other
		Alarms	High, low, STEL, alarm trigger, and relay output
		Compensations	Temperature, pressure, reference, and humidity
		Preferences	Zero save, arrow keys, log warning, fault, purge flag

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	<b>Setup 2 (p 60)</b>	Batch sample	For multi-gas applications
		Zero Warning	Set time or reference (p 58) deviation for warning
		Autozero	N/A. requires autozero hardware
		View enable	Data views, do not use Absb, Intn, or Gain views
	<b>Setup 3 (p 62)</b>	Passcode	Set passcode or leave off
		Log capacity	Set max # of sites (1-50 max) and locations (1-200)
		Location List	Enable/disable mode, order of list, how to insert new
			Locations into list. If enabled, brings up analysis mode
		Report Output	Choose log or location mode, duplicates or not.
	<b>Setup 4 (p 64)</b>	Choose Applic	See p 43 to change applications
		Applic view/edit	More extensive view & edit the application. See p 68
		User settings	Use as a quick setup for multi and single gas
			Application. Includes setting units and alarms

**To get back to the main screen from whichever screen you are in, keep pressing "Esc" on the keypad.**

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**Choosing your Site and Application:**

1. In the main menu select 3 (Site info) then select 1 (New site) and enter a new site name (up to 12 characters). Follow the on screen procedure for selecting characters and numbers. Press "ESC" to get back to the main menu.
2. In the main menu press 1 (Analyze/Start) if your application is displayed on the left hand screen and proceed to "Zero and Analysis" below or proceed to step 3.
3. In the main screen press 2 to select a new single or multi-gas application. If the application requires you to change path lengths refer to page 30. This is a mechanical adjustment.
4. Select which compensations should be activated (page 57) if you have not already set up these compensations. It is recommended that you activate all of the compensations except possibly humidity as per recommendation on page 59 of the manual.

**Zero and Analysis (page 37):**

5. In the main menu press 1 (Analysis/Start) and follow the on screen message "Install chemical filter" Use the chemical filter for zeroing. The chemical filter is labeled and is good for at least 30 zero cycles before needing replacing. Note: Zero the analyzer in an area that will be free of the chemical of measuring before the first measurement of the day. Press enter on the keypad to continue.
6. After zeroing is completed press enter on the keypad to save the zero or 1 to repeat the procedure. Remove the chemical filter. Further zeroing is not required if in the zero menu the status indicates that the last zero is still valid. The date of the last zero is also displayed.
7. Next install the particulate filter; the "particulate filter" is labeled. Do not press enter yet. Pressing enter starts the analysis immediately. Proceed to the site where you want to start sampling.
8. Press enter to start the analysis process. View the data on the screen according to the "view enable" on page 62.

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**Log data. Analysis setup (1) on page 53:**

9. Logging will start according to the setup on p 53.
10. After the sample is completed press enter on the keypad to save the log or 1 to repeat the log cycle. You can also press esc to return to the main menu. This stops the sampling and logging cycle without saving.
11. Logging saves the measurement that you make for later downloading to a PC or Printer.
12. You must have a site selected or create a new one before you can start logging. Sites can be selected from a library you have created or you can create new sites before you start logging. See p 83. You can also enter different locations for each separate measurement at the same site. This is accomplished in the “analysis menu” which you can access before logging. See p 84.

**Report/Data Transfer (page 87):**

13. Before transferring or printing data, connect the SapphIRe to a printer or pc using the proper RS232 serial cable.
14. There are 2 programs that come with the analyzer.
  - a) Thermo Match Spectrum Correlation software.
  - b) Thermo Connect software.
 If you have used the Scan application, use the Thermo Match software.  
 If you have used the Single or Multi-gas application, use the Thermo Connect software.  
 Refer to the help menu in each program in order to set up communications and to download the data.
15. In either case from the main menu press 5 (Report/Data). Press 1 to display the site list then select the site you want to transfer.
16. Open the program (Thermo Match for example) then press 3 (transfer data for example) on the analyzer keypad. The analyzer will now display “Wait for Request”. In the Thermo Match program go to “File Menu” and select “Get Scan File from Analyzer”. The file will download. The transfer is displayed in % on the analyzer screen.
17. Save the file after transfer. The scanned file should be open and ready to apply the Thermo Match.
18. Select “Perform Match” and a match of up to 5 compounds will be displayed along with the spectrum graph.
19. Refer to each program to continue analysis.



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**9. OPERATIONAL REQUIREMENTS**

The SapphIRE analyzer has no user-serviceable parts and requires no lubrication or routine cleaning. With the exception of the battery pack, all parts have an infinite storage life.

The zero gas filter should be sealed in a plastic bag when not in use. Saturation of the filter can occur given the nature and concentration of the sampling environment; replace at a minimum of 30 zero cycles and/or once annually.

The particulate filter life is also dependent on the sampling environment. Over time the filter will become clogged or contaminated with background gases. Replace when response times notably increase, or after 400 operating hours.

Optics maintenance can be prolonged by purging with dry clean air after exposure to highly concentrated gases. This will help prevent degradation of the analyzers cell windows.

**10. CALIBRATION**

Reference to calibration procedures can be found in Appendix C – Scan/Calibration Procedure of the SapphIRE manual.

AENV normally returns the SapphIRE to the vendor annually for calibration.

Before calibrating an application, the analyzing wavelength of the compound of interest must be established. If the wavelength for the compound of interest is known, a scan for the analyzing wavelength is not necessary. However, a more precise analysis is accomplished if the calibration is adjusted for the specific instrument. If the wavelength is unknown, a scan can determine the best analyzing wavelength.

The SapphIRE can do either a peak pick, fast scan, or full scan. A Peak Pick scan should be used when the approximate wavelength of the compound of interest is known. Peak Pick provides a 2.0 micron window (user selectable) of the linear variable filter (LVF) between 8.0 and 14.1 microns to be scanned. All analyzers operating at software version 4.00 or higher possess this feature.

The Fast Scan or Full Scan allows the entire LVF region between 7.7 to 14.1 microns, as well as the seven fixed band pass filters, to be scanned. This is especially valuable when the region of strongest absorbance is unknown. It also may be used to record the spectral characteristics of a gas. The fast scan takes slightly less time while still

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providing a good spectral representation of the gas. The full scan take slightly longer, but provides higher quality spectral identification through better signal to noise averaging.

All relevant sampling must be present with logged information so the user can download and interpret site location post sampling. The Log function saves measurement values for later downloading to a PC or printer. To begin the log function press 1 (Log) from the Analysis Menu.

If a site has not been created, the display reads "Must start site before logging!" If logging was not set up, the display reads "Logging is not configured!".

If the timed log feature is active but not started, the display reads "Wait for start of timed log..." Wait for the timer to time out or press ENTER to start logging now.

When logging begins, the display reads "Log in progress" and the time or samples remaining. When logging is completed and if save is manual, the display asks "Save this log?" Press 1 to repeat the logging procedure or ENTER to save the log. If saved, the display reads "-STORED-."

To stop logging, press the ESCAPE key. This has no impact on the current analysis.

For information regarding site logging and PC data transfer, refer to Chapter 8 – Site info and Chapter 9 – Report/Data of the SapphIRE manual.

## 11. APPLICABLE DOCUMENTS

- **EM-039a** Thermo-Miran 205B Series SapphIRE Instruction Manual (P.N BK3538)
- **SUI-039a** Set-up Instructions for Mirran SapphIRE Portable Gas Analyzer

## 12. LITERATURE REFERENCES

- Miran 205B Series SapphIRE Single Gas/Vapor Monitoring SOP, Number IH 75510 Rev 1, Brookhaven National Laboratory Safety and Health Services Division, Industrial Hygiene Group, prepared February 3, 2006.
- Thermo Electron Inc., *Miran 205B Series SapphIRE Instruction Manual (P.N BK3538)*, Appendix C – Scan/Calibration Procedure, C-1, June 2004.

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### 13. REVISION HISTORY

Revision 0 (new document)

Revision 1.0 added section 8.1 Quick Operation Guide and Reference

Revision 1.1 Section 1; add reference to MAML,  
Section 7; remove reference to hazardous sites and requirement for PPE  
Section 10, add annual calibration by vendor

### 14. APPROVAL



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**Approved by:** Harry Benders  
**Title:** Air Monitoring Manager

**Date:** January 21, 2011